Risk Matrix as a Guide to Develop Risk Response Strategies

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Risk management plan will be ineffective and incomplete if risk response strategies are not appropriately developed for mitigating risks. Risk response development has not been given due attention it deserves in the risk management process when compared to risk identification and assessment of the project risks (Hillson, 1999). Risk matrix is a simple yet effective tool to develop risk response strategies when risk events/factors have been identified and assessed. Based on the probability and the impact, a risk event is mapped in the risk matrix which forms the basis for formulation of the risk response strategies. An earlier survey carried out in Florida to study the risk management practices of construction companies forms the starting point of this research. The same study had revealed that over 70% of the companies depended on intuition /judgment /experience to manage risks in construction. The study had concluded that the contractors in Florida relied on risk transfer and risk elimination techniques of risk responses more than the risk reduction and risk retention techniques (Ahmed et al., 2001). However, with the use of risk matrix proposed in this paper for developing risk response techniques other appropriate risk response strategies are explored.

Keywords: Risk Response, Risk Matrix, Transfer, Retention, Avoidance

Background

Risk has always been major cause of concern in construction industry. Risks in manufacturing industries are better defined and therefore better managed. However, the risks associated with construction industry are seldom crystallized and thus their management is a daunting task. In an effort to study the different types of risks plaguing the Florida construction industry, research was carried out and a report prepared in 2001 by Ahmed et al. to develop a Risk Management Model for Florida Contractors. The study compared the risk management practices of Florida contractors with the rest of the contractors in the U.S. The study concluded that although the sources of risks were not significantly different from those that of the other states in the country, there were differences in the ways that those risks were handled. The study concluded that the contractors in Florida relied on risk transfer and risk elimination techniques of risk responses more than the risk reduction and risk retention techniques. The study found that the same was not true with the construction industry in some other states where the industry is in a better shape. The contractors in these states relied more on risk reduction and risk retention techniques of risk responses more than the risk elimination and risk transfer. Based on the conclusion and recommendation of that study, this paper researched on the use of other cost effective risk response techniques in construction projects in Florida. Since risk elimination and risk transfer are not always the optimum solution when other options of risk reduction and risk retention are available; the inclination of Florida contractors towards the risk transfer and risk elimination was an interesting topic for research. Is the behavior justified based on the sources of risks and the optimal solution to it? If not, what are the other risk response strategies that could be used by the contractors of Florida?

Problem statement

Most of the construction companies in Florida have iterated the fact that lack of time and resources is the biggest hindrance to adopting risk management practices in their companies and projects (Ahmed, Azhar, and Roldan, 2001). It was found from the same study that for the majority of the construction companies risk management practices were based on intuition/judgment/experience rather than formal risk analysis and management techniques. Although this scenario might have changed over the years for bigger companies with the introduction of advanced risk management techniques, majority of the smaller and average size companies still rely heavily on insurance companies to take their risk burden. As a result, the insurance companies thrive well by charging these companies for the risks transferred whereas the construction companies have to survive with a little margin on the profit. Other strategies to counter the risks need to be explored in order for the companies to maximize on their profit.

Objective and Scope of Research

The objective of the research is to formulate appropriate strategies to manage each of the identified risk factors based on the previous study for construction companies in Florida. Although the premise is that the developed methodology will apply to construction projects in general, the study is targeted to the construction companies in Florida.

Expected contribution

The study has developed strategies to respond to the various types of risks already identified in the previous study. Use of risk matrix to formulate strategies has been exemplified. When appropriate responses are developed, contractors can use these strategies to manage the risk proactively.

Risk matrix as a tool to formulate risk response strategies

Several criteria are used in judging whether the level of risk is high or low, such as the probability of an undesirable occurrence, the degree of seriousness, and the subsequent impact if it does occur. One of the widely followed concepts in assessing risk is to break down the risk into two main criteria (a) the probability, which is the possibility of an undesirable occurrence, such as a cost overrun, and (b) the impact, which is the degree of seriousness and the scale of the impact on the other activities if the undesirable thing occurs.

Risk response is the process of developing options and determining actions to enhance opportunities and reduce threats to the project objectives. This process ensures that the identified risks are properly addressed. However, when the risk events cannot be solved through the other techniques of risk response such as avoidance, transference and mitigation, the only option remaining is the acceptance. This technique indicates that the project team has decided not to change the project plan to deal with a risk or is unable to identify any other suitable response strategy. Active acceptance may include developing a contingency plan to execute, should a risk occur (PMBOK, 2000). Identification and assessment of risks alone will not serve the purpose unless meaningful ways to mitigate those risks in a structured way

is planned in advance. These effective responses to the risks should meet a number of criteria according to Hillson .The risk responses should be appropriate, affordable, actionable, achievable, assessed, agreed and allocated (Hillson, 1999).

Risk Matrix is an effective tool to illustrate the importance of risk management strategies (Alexander et al., 2006). Risk Response Planning Chart used by Piney (2002) is similar to the risk matrix concept to devise strategies for risk response. Only the values and scales of the axes may change from project to project but the overall shape will remain the same. Thomas et al. (2004) used a similar graph of scatter plots to prioritize risks and propose suitable risk response strategies.

Methodology

As mentioned earlier this research is based on the recommendation of the previous research carried out in 2001 to develop a risk management model for the Florida construction industry. In the previous study numerous risk sources were identified based on the checklist from the literature and later classified under risk categories. These risk sources were also assessed in terms of probability of their occurrence and impact on the project cost if they occurred. This research however focused on the implementation of risk management and therefore a simple methodology is proposed in the following passage to devise risk responses.

Having identified and assessed the risk sources, the risk matrix can then guide the project personnel's choice of risk response strategy. Depending on where the risk source lies on the matrix shown in Figure 1, there are four broad risk response strategies (Alexander et al., 2006).

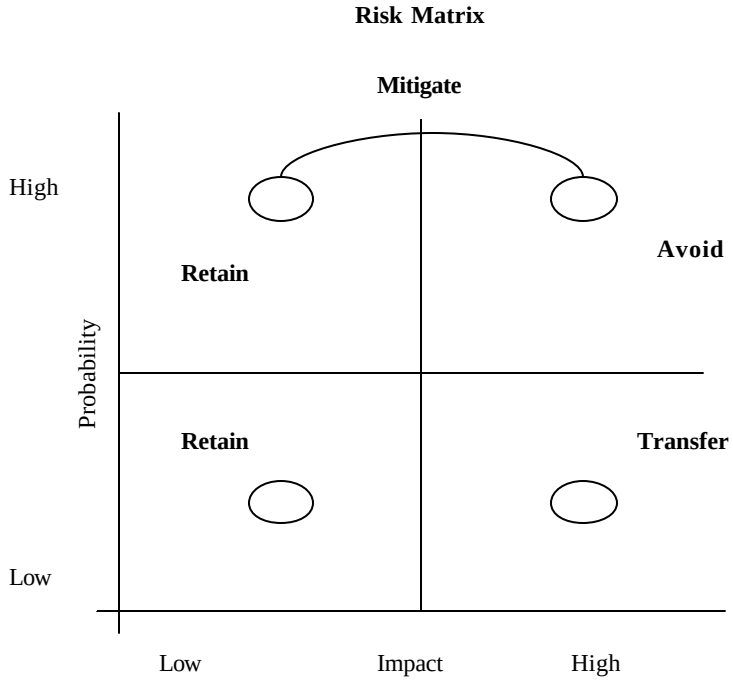

Figure 1: Risk Matrix (Alexander and Marshall, 2006).

Risk Avoidance

When the chance of occurrence of risk sources and the impact associated with it are high, then avoidance is the risk response technique that should be followed. Simply speaking, this means not choosing to do the activity. However, if this means there is a big opportunity loss by avoiding the activity, the effort should be towards clarifying the requirements by obtaining more information (Hillson, 1999). Changing the scope of work so that risky items in the scope of work are no longer undertaken is also a risk response technique. Sometimes it may not be easy to map the risk sources exactly in one of these quadrants. It may be that some of these risk sources lie on the border of these quadrants. In such cases, strategies that are most effective should be chosen. In most cases, the effectiveness is measured in terms of the cost associated with mitigating these risks.

Risk Transfer

When the impact is high even though the chance of occurrence of the risk source may be relatively low, risk transfer strategies are applied. The intention is to pass such risks to a third party which can handle them better. There are basically two ways of transferring project risks. Insuring the project against any high impact risk sources like hurricane is one way to transfer the risk to the insurance companies by paying insurance premiums. Risk sources can be transferred through the contracts to either owner or other stakeholders of the project.

Risk Mitigation

Not all the risk sources can be solved by risk avoidance and transfer. In fact most of the risks cannot be addressed by the above two risk responses. Therefore, for majority of the risks, reduction or mitigation techniques need to be applied. Depending on where the risk source lies in the risk matrix, mitigation may be done either by reducing the probability of risks or by reducing their impact or both. If the impact of the risk is high, risk reduction may be done by lessening the extent of the damage. If the risk occurs very often, it is wiser to tackle the risk sources at their root by inhibiting their trigger (Hillson, 1999). Whenever the risk probability and the impacts are high, the response strategy should be to reduce both.

Risk Acceptance

When the risk sources fall in the low impact-low probability quadrant of the risk matrix, such risks are deemed acceptable. Acceptance can be passive when the impact is minor for which no prior plans may be required. Acceptance can be active if the impact if it occurs needs to be further reduced and for such risks contingency plan should be put in place by allocating sufficient time and resources (Piney, 2002).

Procedure

The following steps are involved in the strategy formulation:

1. Identify risk sources
2. Assess the probability of risk and its impact for the identified risk for the project.
3. Plot risks in the risk matrix similar to the one shown in Figure 1.
4. Recommend risk response strategies based on where the risk lies on the risk matrix.

Steps 1 and 2 are not the focus of this paper. This paper addresses step 3 and 4. However, to show the complete process of risk management for construction companies in Florida, steps 1 and 2 are taken from the past research carried out by Ahmed et al. in 2001. Their study was based on questionnaire survey from 38 contractors from Florida. The study identified risks in different categories with the probability and impact elicited from the experienced project personnel through questionnaire survey. The result of the risk survey and the assessment is summarized in Appendix A and is taken from the technical report entitled 'Development of a Risk Management Model for Florida Contractors' prepared for Building Construction Industry Advisory Committee (Ahmed et al., 2001). Risk sources were then plotted in a risk-matrix chart as mentioned in step 3 of the strategy formulation procedure. Based on where the risk source lied on the risk-matrix, suitable strategies are proposed. These strategies stem from the recommendation of the earlier studies applied in similar circumstances (Alexander et al. 2006; Piney 2002, and Hillson 1999).

Results and Discussions

Risk sources under six different categories plotted in separate risk matrix charts are shown in Figure 2 to Figure 7.The X-axis of the chart shows the cost impact of the risk in percentage of the total construction cost and the Y-axis of the chart shows the likelihood of occurrence of each risk in percentage. The risk matrix chart not only shows the risk levels but it is divided into quadrants to show the criticality of the risk sources. Different quadrants have different strategies for managing risk. This kind of chart helps to identify high risk sources and understand the relationship between the likelihood and consequence of risks. When the risk is beyond an unacceptable level these high risks should be mitigated either by reducing the likelihood of the occurrence of the risk or by reducing the impact of the risk or both.

Design Risks

There are no critical design related risks that were identified by the contractors in Florida. Incomplete design has a higher probability of occurrence and therefore, the strategy should be to reduce the likelihood of incomplete design by thoroughly checking the drawings before bidding. Part of the project whose design is incomplete should be avoided as far as possible and should be included as a separate cost item. The cost associated with defective design should not be borne by the contractor and should be transferred to the owner. Different site condition risk and inadequate specification risk should be transferred to the owner. Errors and omissions and defective specification possess no critical risk and strategy should be to retain these risks by the contractor with constant monitoring.

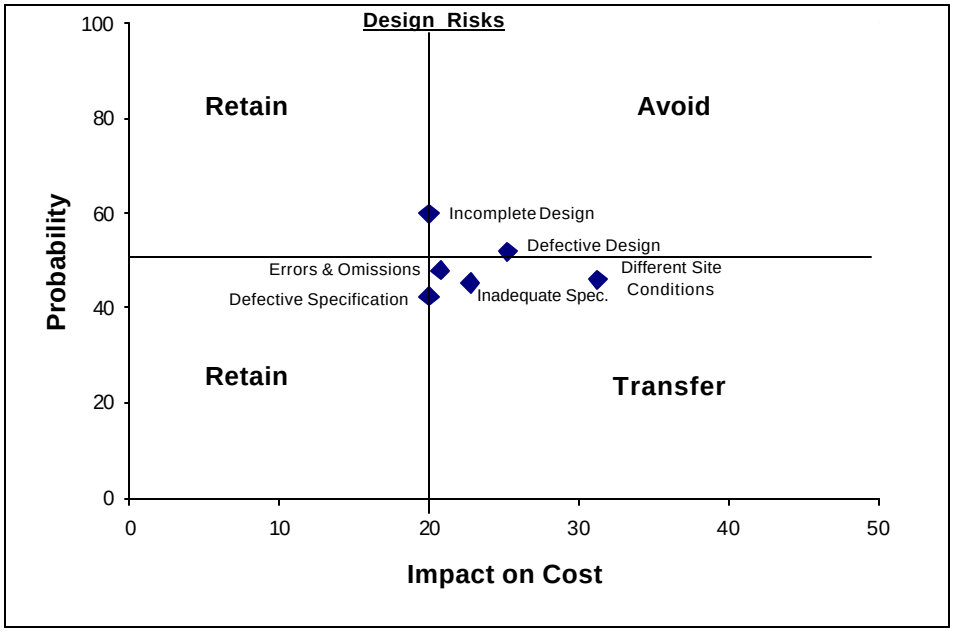

Figure 2: Risk Matrix- Design Risk

Construction Related Risks

Design changes were assessed to be critical in construction related risks. The strategy should be to reduce both the likelihood and the impact of this risk. Likelihood can be reduced by starting the construction only after design has been fully completed. However, whenever this is not practical it is worthwhile for the contractor to lessen the impact associated by proposing value engineering solutions to the problems and also discussing constructability issues with the designer before the design is finalized. When the scope is undefined and the design changes are inevitable, the contractor should not take the cost risks associated with it. Rather contractor should opt for cost plus basis of contract for such kind of projects. Labor productivity is also seen as a risk variable whose impact on the project is quite substantial. This kind of risk associated with low labor productivity should be transferred to the subcontractor. Risk pertaining to different site conditions should be transferred to the owner. Similarly unrealistic schedule risk should be transferred to the third parties, owner as well as the subcontractors. Weather delays are uncontrollable and therefore cannot be avoided. The best strategy would be to lessen the impact due to the inclement weather. This risk should be retained by the contractor by allocating sufficient contingency in the schedule for such delays. Defective work is the responsibility of the contractor and should be retained by the contractor. To bring the risk to an acceptable level, the contractor should emphasize on its quality control and quality assurance. Equipment failure and labor dispute were thought to be of lesser risk rating and should be retained by the contractor.

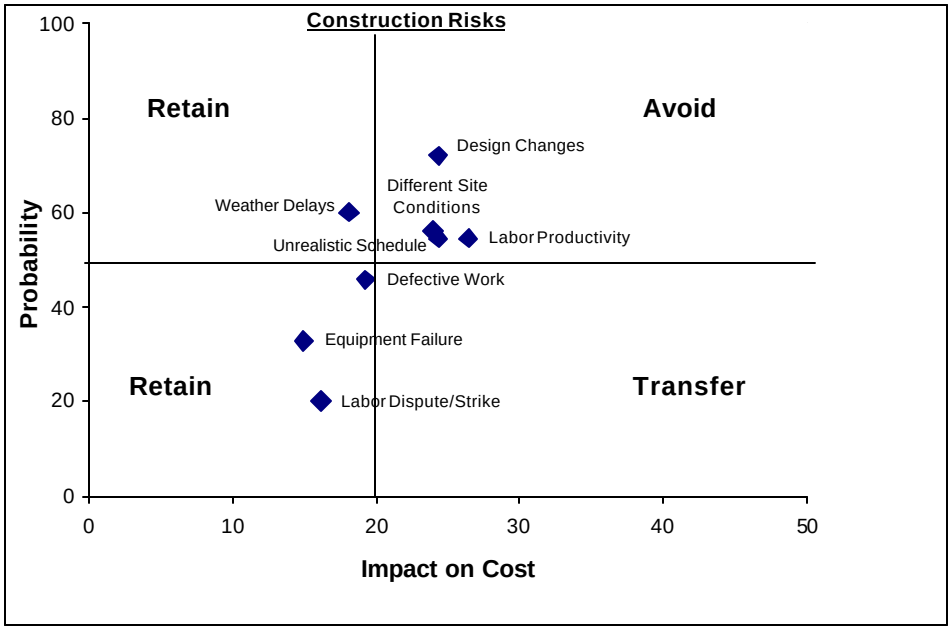

Figure 3: Risk Matrix- Construction Related Risks

Financial and Economical Risks

Financial default of the subcontractor is found to be a critical risk in this category. The impact associated with such risks is quite high and therefore the strategy should be to reduce the impact by demanding performance bonds from the subcontractors. This is one of the risk transfer techniques. Availability of funds from clients is a major risk that has a significant impact on the contractor's profitability even though the likelihood of such risks may not be that frequent. The strategy is to work with clients who have clean past records regarding the financial stability and timely payments. It is best to avoid those clients who do not pay on timely manner and have poor financial status. Cost underestimation is a controllable risk with a high impact. Since the impact cannot be reduced the strategy should be to reduce the probability of cost underestimation by building a strong cost estimating team capable of accurately determining the bidding cost. Exchange rate fluctuations and inflation were not perceived as very high risks and should be retained by the contractor. Inflation should be accounted during the cost estimation and included in the bid. However, if the project duration is long and the inflation rate is very unpredictable, the strategy should be to transfer the risk to the owner.

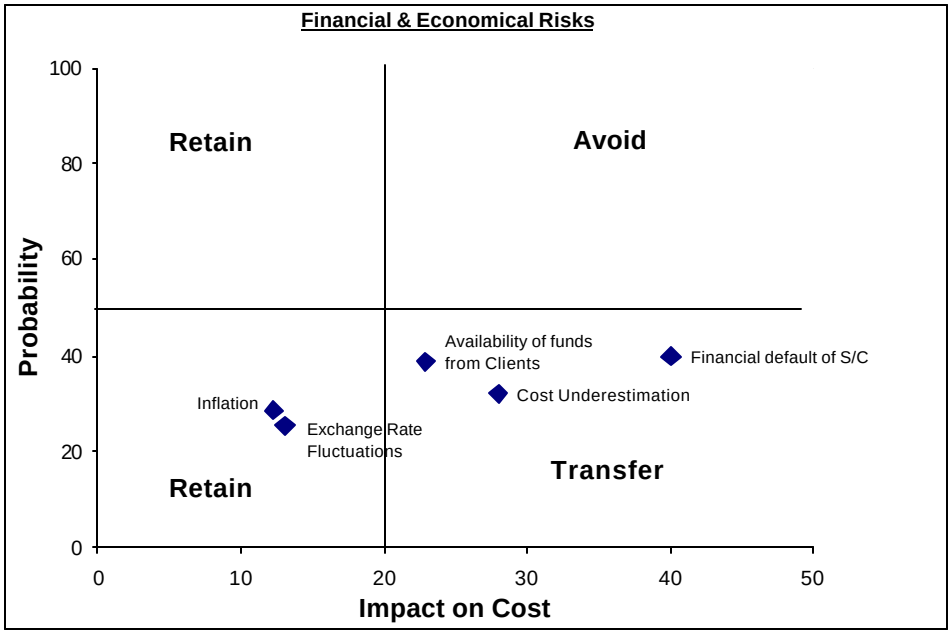

Figure 4: Risk Matrix- Financial and Economical Risks

Political and Environmental Risks

Projects entangled with bureaucratic problems should be avoided. These projects are frequently delayed and the contractor is the ultimate sufferer. Permits and approvals with major impact on project duration should be transferred to the owner whereas those having lesser impact should be accepted by the contractor. Acquisition approvals should be transferred to the client where as compliance to the pollution and safety rules should be taken by the contractor. Compliance to pollution and safety rules could be transferred to the subcontractor as well. Changes in laws and regulations are uncontrollable risks that should be transferred to the client. Risk of political pressure and disturbance is not deemed a major risk by Florida contractors and is accepted passively.

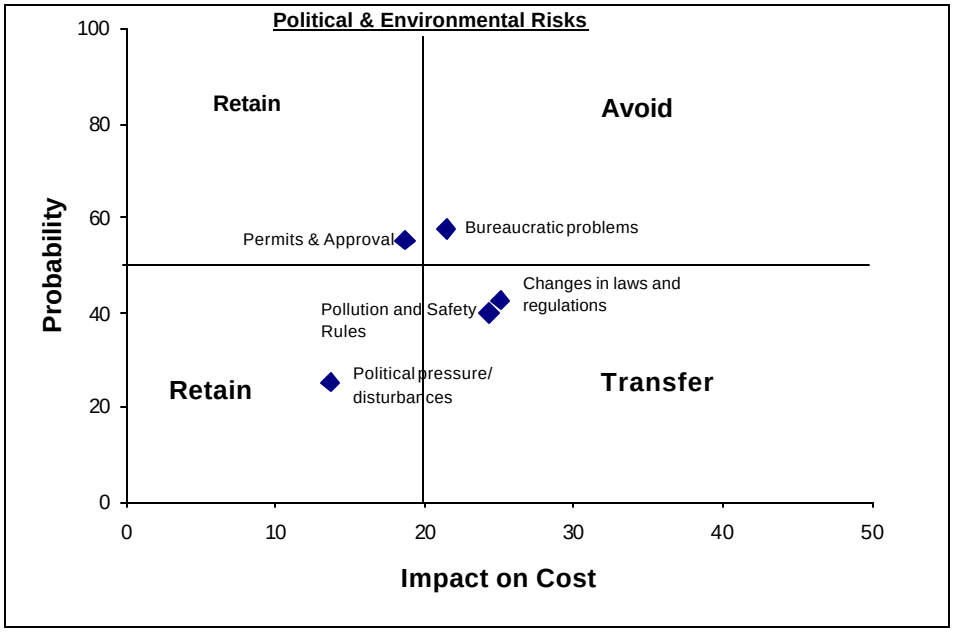

Figure 5: Risk Matrix- Political and Environmental Risks

Physical Risks

Almost all the risks falling in physical risk category are high impact risks and the best strategy is to transfer the risk through insurance. Material/equipment fire and theft, labor injuries and damage to equipment are insured. Impact and likelihood of labor injuries should be reduced by proper safety management by the contractor. Since there is zero tolerance to labor injuries the strategy should be to reduce the likelihood of the occurrence of the labor injuries and fatalities as much as possible and then impact should be transferred to the insurance companies in cases of any mishaps. Damage to structure was not perceived to be a major risk and should be retained by the contractor.

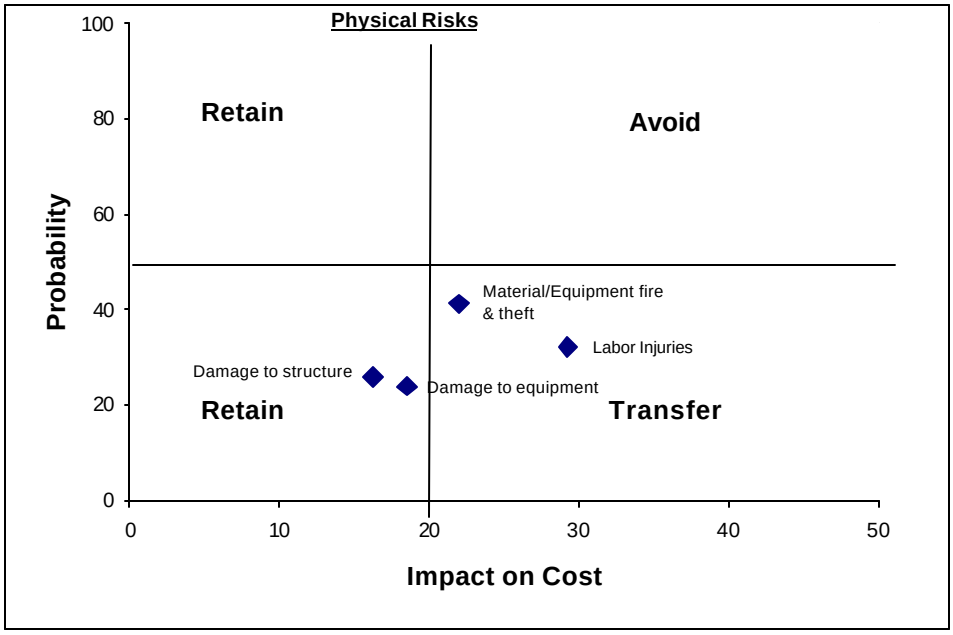

Figure 6: Risk Matrix- Physical Risks

Acts of God Risks

Wind damage, hurricane/flood damage and fire are all high impact risks falling in this category. Since they are uncontrollable and unpredictable, the strategy should be to transfer these risks through insurance. Landslide is not a major risk and should be retained passively by the contractors.

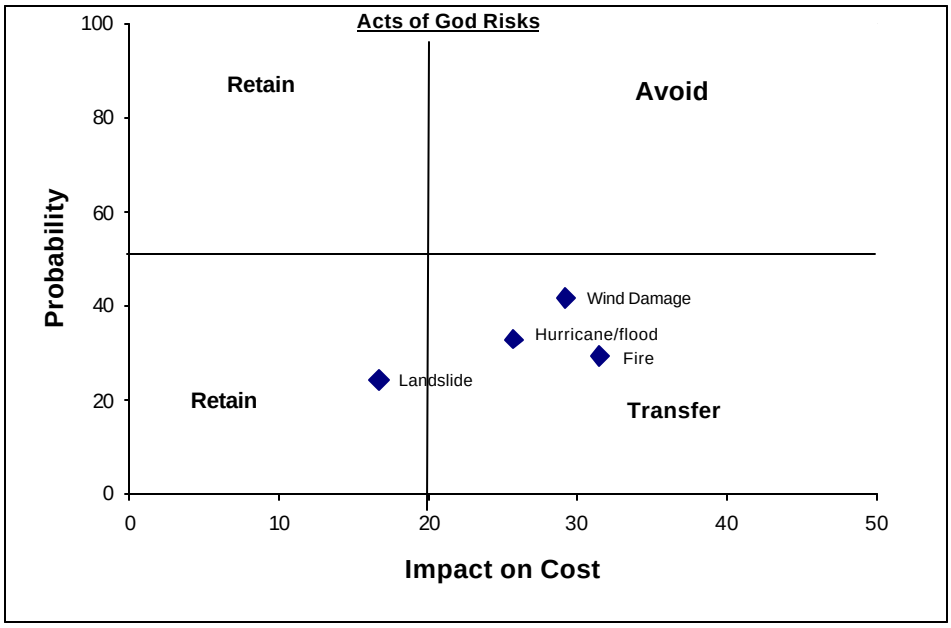

Figure 7: Risk Matrix- Acts of God Risks

Conclusion

Risk response is an important and crucial risk management step without which the whole risk management process is futile. Risk matrix serves as a good guide to develop strategies to cope with the various risks identified. It is a simple tool to initiate the strategy formulation so that risks for small and medium sized construction companies are managed well. The risk matrix can be used effectively when the criticality of the risks are represented well. Following the steps outlined in the methodology it was possible to develop appropriate strategies (avoid, transfer, mitigate or retain) for Florida contractors. With the risks allocated to the parties which can handle them best, the owner of each risk can further refine the responses for risks which they own. The guidelines outlined in this paper offer a framework for developing appropriate risk responses from the risk identified during the preconstruction stage so that risk can be managed proactively.

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Appendix A

The assessed critical risks classified according to their category

Risk	Chance of Occurrence	Potential Loss (% of project total cost)
Design	**%**	**%**
Incomplete Design	60	20
Defective Design	52	25.3
Defective Specification	42.6	20
Errors and Omissions	48	20.7
Inadequate Specifications	45.4	22.7
Different Site Conditions	46.2	31.2
Construction Related		
Weather Delays	60	18.1
Labor dispute and Strike	20	16.2
Labor Productivity	54.6	26.4
Unrealistic Schedule	54.6	24.4
Design Changes	72	24.4
Equipment Failure	32.8	15
Defective Work	45.8	19.3
Different Site Conditions	56	24
Financial and Economics		
Inflation	28.6	12.3
Availability of Funds from Clients	38.6	22.9
Financial Default of Prime / S/C	40	40
Exchange Rate Fluctuations	25.4	13.1
Cost Underestimation	32	28
Political and Environmental		
Changes in Laws and Regulations	42.6	25
Permits & Approval	55.2	18.7
Pollution and Safety Rules	40	24.3
Political Pressure/Disturbances	25.4	13.6
Bureaucratic Problems	57.6	21.4
Physical		
Damage to Structure	25.8	16.2
Damage to Equipment	24	18.5
Labor Injuries	32	29.3
Material & Equip. Fire and Theft	41.2	22
Acts of God		
Hurricane/Flood	33	25.7
Landslide	24.2	16.7
Fire	29.2	31.5
Wind Damage	41.6	29.2