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DEVELOPMENT OF A FRAMEWORK TO EVALUATE HUMAN RISK TOWARDS SUSTAINABLE RISK MANAGEMENT

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Abstract
Risk managers are constantly faced with the challenge of making decisions at various levels of their organizations. One of the challenges, which often times is unavoidable, lies in assigning a monetary value to human risks. Such challenge necessitates engineering managers to make educated decisions on the level of risk that the organizations and businesses should accept when it comes to human. The purpose of this study is to suggest a suitable framework that captures this aspect of engineering Risk Management in order to make rational and sustainable decisions about such assessed risk. This will be accomplished by exploring the tools, techniques, and methods implemented to evaluate the human risk in the decision making process by risk managers. The study attempts to address a fundamental question that risk managers strive to seek a clear and definite answer to the question "are the benefits gained from assigning a monetary value to human life worth taking the risks, efforts, costs required to achieve such benefits?"

Key Words
Risk, risk managers, human risks, cost-benefit analysis, risk management

Introduction
"Risk Management is a decision making process whose goal is to minimize the adverse effects of the organization. Today's businesses face exposure to accidental loss from a variety of perils, both natural and man-made. These include fire, windstorm, earthquake, legal liability for defective products and the hazards of the workplace. Dealing with these exposures is the job of the organization's risk manager" (Jablonowski, 1995a, 1). Most project managers know that Risk Management is essential to good project management. Risks are tagged within the system to ensure proper review, coordination and management at the necessary management level (Perera and Holsomback, 2004).

Risk managers make decisions that should mitigate or control the consequences of risk and hazard on the system. They are using a variety of Risk Management methods. One of the most difficult decisions risk managers face is assessing the risks related to human death or injury. Cost-benefit analysis is the most famous technique that used in many industries such as Environmental Protection Agency (EPA). This technique has several pitfalls and shortcomings, especially whenever applies on human risks.

The main purpose of this paper is the management of human risks (assigning a monetary value to human risk) in systems. In this paper, we show how this technique is invalid whenever applied to human risk. Thus, the ultimate goal is to capture the aspects that lead to fair decisions and actions. To do so this paper sheds some light on the concept, history, and kinds of risk. In addition, the paper addresses how Risk Management deals with risk, especially when it comes to human death and injury. This paper illustrates the current approach that is used to assess risks.

The Concept of Risk
Humans and their lifestyles have changed dramatically in just about every single way possible. Humans continue to adapt to their changing surroundings and adjust their lifestyles based on the changes occurring around them. To most, technology continues to be an important asset to human life. High-technology lifestyles assist humans through everyday challenges and support in lifetime achievements. Such growth comes with substantial costs of accidents and risks. Tradeoffs and potential for negative consequences are always possible. The concern for safety is a common one for engineers, risk managers, and others. The idea is how to deal with issues of safety and risk, especially when they involve human death or injury. To be able to assess a risk, risk managers must correctly identify what a risk is. To do that, risk managers should know what a risk is (Harris et al., 1995).

Risks are events that, if they occur, will cause unwanted change in the cost, schedule, or technical performance of an engineering system. Risk is a probabilistic event; that is, risk is an event that may occur with probability p or may not occur with probability $(1-p)$ (Pinto, 2009). Moreover, Bell and Reinert (1992, 16) defined risk as "a combination of the frequency and the consequence of a specified hazardous event." Most of the definitions in the literature revolve around two things; the likelihood

with which a hazard happens and the magnitude of the harmful event. Vulnerability (usually inherent to system of interest), threat (usually external to the system of interest), security, and safety are some descriptions of risk.

Risk Management

It is extremely difficult to have completely a safe system or project. Projects always hold different kinds of risks. Thus Risk Management is considered a cornerstone of project management. "Risk Management is essential to protect the quality of a large-scale engineering effort. It should be a well-defined process that builds on an encompassing and detailed understanding of the purpose, elements, and contexts of the system" (Lambert et al., 2001, 1181). Risk identification is one of the most important steps of Risk Management and can be described as a process of discovering, defining, describing, documenting and communicating Risks before they become problems and adversely affect a project or system (Barati and Mohammadi 2008a).

Saga (1995), explained that Risk Management could be inactive or proactive. Inactive when risk managers neglect to consider risk issues at all in the system. The probability of hazard to occur is very low or close to zero. This is a kind of bad Risk Management. Proactive Risk Management occurs when risk managers plan and forecast risk potentials and then adopt systems management activities for technical direction that control or mitigate risk potentials. Defiantly proactive Risk Management is required to control and fairly assess human risks. Risk Management is not just the job of risk managers or engineers. It is a part of every manager's job, and the organizational culture should encourage thinking in terms of risk. Importantly, risk managers must observe and inspect the database before make decisions (assess risk). They must examine if the database is still valid and reflect reliability before rely upon them. The power of knowledge plays a vital role to classifying if the risk is acceptable or not. Later on in this paper we will explain how risk managers make decisions on imperfect knowledge.

Types of Risk Management

Engineers and risk managers face different kinds of risk in any system. Each type has different characteristics. In order to maintain viability in the system, the design of any system should be able to mitigate or control the risks in the system at minimal. Failing to eliminate the risks, the survivability of the system will be questionable. So risk managers should handle the risks and differentiate between acceptable and unacceptable risks. The following exhibit 1 shows some kinds of Risk Management.

Exhibit 1. Kinds of Risk Management.

Risk	Definition
Operation risks	Deal with physical entities (machine) defeats.
Social-Technical risks	Occurs when human involve in the system. The social functions are the people's portion that provides the planning, monitoring and controlling (Henrie and Delaney, 2005).
Project risks	The risks of undertaken the project
Human risks	Human death and injury.

In spite of operation, social and project risks are important, the present paper will address and concentrate in detail about human risks according to the challenges that risk managers face when dealing with risks related to human death or injury.

Human Risk

Human risk is embedded with the organization's structure and strategy and impact on its competition. Thus, risk managers must develop and improve an approach to address it. All risk estimates are uncertain because of factors like limitations in data, understanding, and competing approaches to modeling the risk. The degree of uncertainty is not the same for all kinds of risks (that we mentioned earlier), however, because these factors differ across assessments (Gray, 2009a). "Tools for quantification of the uncertainty inherent in risk assessments have been developed and continue to be refined. This more complete characterization of risk is necessary to understand the implications of different choices made in a decision analytic approach to human risks" (Gray, 2009b, 1). The goal of this paper is not to describe or evaluate the tools used to assess the risks but to find a framework that captures all the aspects that help risk managers to find rational and moral decisions related to human risks (values).

In an ideal world, all risks of a system that lead to the death or injury of an individual should be reduced to a level of insignificance. In reality,

however, there are always economical restrictions that apply. Therefore, we will not always be able to eliminate all risks. As we do in our personal life, we have to assess risks and the costs of eliminating these risks to decide if it is worth taking the risk or accepting the costs of eliminating the risk. **"**In general, there is no best tool for all attributes of concern (e.g., risks of multiple health and environmental consequences, resources devoted to reducing risks). In determining whether one tool is better than another, it is necessary to evaluate whether the harms imposed on some people (e.g., costs of compliance) are offset by the benefits conferred on others (e.g., reduced health risk). Similarly, one must determine whether the losses on some attributes (e.g., the resources devoted to compliance that cannot be used for other social purposes) are offset by the gains on others (e.g., reduced health risk)" (Hammitt, 2009, 2).

Risk managers choose from a variety of methods to minimize the effects of accidental loss upon their organizations especially when it comes to human death or injury. Risk managers choose from several techniques. "Among these, loss transfer via the purchase of commercial insurance, self assumption with internal financing of loss and cost-benefit analysis. The choice of technique (s) for handling a particular exposure to accidental loss depends upon that exposure's probability/ loss characteristics (i.e., its probability distribution function)" (Jablonowski, 1995b, 1). The next section reviews the current approach (cost-benefit analysis) which is used by many vital organizations and firms such as EPA and OSHA.

Cost-Benefit Analysis "Current Approach"

Government agencies like the Environmental Protection Agency (EPA) and Occupational Safety and Health Administration (OSHA) assess the risks related to human death or injury in different ways. They do not base the value of a life on someone's income or age but on how much value people would pay to take risks with their lives (Ciarcia, 2009).The EPA economists look at how much more people are paid to do riskier jobs, and how much people would be willing to pay to cut their own personal risks. With these factors, the calculations lead to an average value of a statistical life. In 2008, the EPA assessed this value to $6.9 million per person. The EPA uses this number for cost-benefit analysis. It is the cost associated with enacting a new law that would lead to the benefit from reducing deaths or illnesses (Block, 2008).

For an individual, the value per statistical life (VSL) is generally estimated by dividing his or her willing to pay for a small risk change in a defined time period by the size of the change. For example, if an individual is willing to pay $60 for a 1 in 100,000 reduction in his own current-year mortality risk, then his VSL is $6 million ($60 ÷ 1/100,000 = $6 million). The VSL does not measure the value of a "life" or an individual's intrinsic worth; rather, it measures how individuals trade-off income (or spending on other goods and services) and small risk changes (Robinson, et al., 2010, 3)**.**

EPA, OSHA, and many other organizations use cost-benefit analysis approach. The course of action that produces that greatest benefit relative to cost is the one that should be chosen (Harris et al., 1995). Despite this method is widely used, this paper informs that it has many difficulties especially when it comes to assign a monetary value on human risks. First, cost-benefit analysis only considers the economic factors. It never looks to the spiritual factors or justice. Current income and future earnings are focal focus factors to determine individual's life. This implies that the lives of others such as elders, children, and who do not work have no value. In other words, the dollar value for those groups is close to nothing. Second, there is an ambiguity in the way of defining the greatest benefit, and the process of applying cost-benefit analysis. Third, the applications for cost-benefit analysis have no accurate distribution of costs and benefits. The greatest good (benefit) for the majority of people is a disaster or harm for many others. Yet, since the majority is happy, so the risk is acceptable according to the utilitarian thinking that most risk managers have. Fourth, the most issue using this approach is how to assess in cost-benefit terms the loss of human life or even serious injury **(**Harris et al., 1995). It is extremely tricky to determine what factors will be relevant in the future. Fifth, cost-benefit analysis focuses on direct consequences and neglect long term consequences. The course of action that is chosen to apply the greatest good could produce harm in the long term. This paper observes that this approach should be changed or become progressively less useful. In another way, it means this change should focus on risks connected with human death or injury.

Framework

This paper admits that transform all the benefits and risks into monetary terms is an extremely difficult task, but we still believe that cost-benefit analysis is not justified. Thus, we try to find a suitable framework that captures all the aspects to help risk managers achieve ethical decisions whenever come to human risks. The framework comprised of three dimensions: knowledge, context, and Kant's principles (Harris et al., 1995). These dimensions, in addition to the current income, future earning, should be applied whenever risk managers make decisions related to human risks.

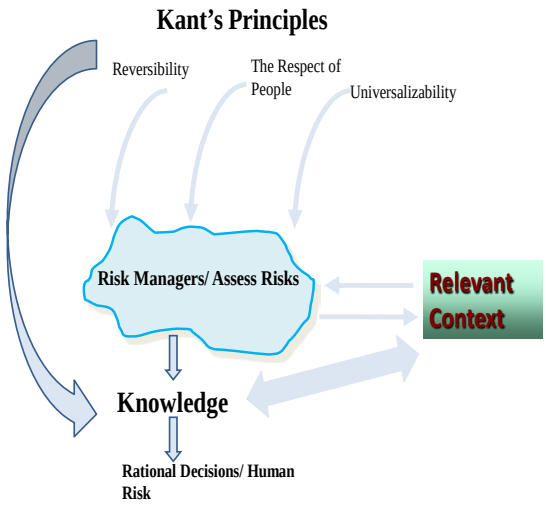
Knowledge. Risk managers adopt cost-benefit analysis to select the course of action that creates the greatest good. Unfortunately most of the time knowledge is not available at the time decisions must be made. In nature, systems are complex and dynamices according to the their high interrelationship between entitiites.So knowledge of understanding the risks and hazards of a complex system of systems (SoS) can never be complete, and is always subject to mistakes. For SoS, this knowledge is still in its infancy as the laws, principles, concepts, and theories still developing (Keating, 2008). Accordingly, detailed information and observations should be gathered to evaluate risks. Risks in nature are uncertain and ambiguous to deal with, especially when it comes to human risks. Risks are an unwanted events /factors / threats that have negative consequences (Barati and Mohammadi 2008C). Stakeholders (public sector) in any particular system should have in advance the knowledge related to risks and hazards (probability of happing, consequences) that they will face, and most importantly the size of harm that could be happened once the risks occur. Even this process is costly and time consuming but it helps to achieve rational and sustainable decisions about assessed risks.

Context. The failure to accurtly address rational decisions to human risk can easliy come from the contextual issues. Context is another aspect that must be taken whenever makes decisions dealing with human death and injury. Context represents the circumestance, conditions, or patterns that influence decision or the deployment of this decioin. We cannot look for everything so we have to focus on the relavant context such as the emotional feeling for individuals who suffer from tragic events. The decisoins should be consistant with the context of the system. it is unacceptable to apply the same decision of assessing risk to another situation. We should understand the cause-and-effect relationship. Provide the knowledge base for the societal decision on whether or not a risk should be taken and, if so, how the risk can possibly be reduced or contained (Selke and Ortwin, 2009).

Kant's principles. The last aspect that risk managers must apply whenever deal with human risks is Kant's maxims. These maxims work as a foundation and framework to achieve ethical and moral decisions (Harris et al., 1995). Kant describes maxims as subjective rules that guide our behaviors or decisions. This paper believes that risk managers should apply these maxims to make ethical decision and fulfill justification related to human risk. The following points describe these maxis:

1. Univeralizability for every situation. The idea here if you are going to be categorical imperative then you have to apply univeralizability principle for any situation you face or decision you make related to human risks. Risk Management should take this maxim into consideration whenever makes decisions involved human death or injury (Exhibit 2).
2. The respect of people. Risk managers need to make sure that the decisions should not manipulate or use people as means. Every person deserves respect.
3. The last maxim is reversibility. Reversibility is a special application of univeralizability (Harris et al., 1995). It means that any decision that involves human death or injury, risk managers must first think what the consequences of applying this decision on themselves are. These maxims work as s guide and direct our decisions to be embedded with ethic. So, the rules that come out of these maxims should meet the requirement of maxims.

Exhibit 2. Framework for Human Risk Evaluation.



Conclusions

Assessed risk is a challenge task for risk managers, especially when it comes to human death and injury. The economic value of human risks is determined by the willingness of a company or employer to pay for a change in the risks employees face. There are many different computational methods used depending on the discipline. Since financial and operational abilities are always limited, there must be trade-offs regarding what needs to be safer for humans and at what cost. With increasingly complex technologies, risk managers are required to determine the appropriate level our society is willing to bear. As technology allows us to build

more complex and powerful systems, it is important to have an accurate and wholly accepted value of human life to ensure that risk is captured appropriately. The current approach (cost-benefit analysis) used to assess risks is not justified, especially when it comes to assess human risks. In closing, in this paper we have developed a suitable framework that captures the aspects of engineering risk management in order to make rational and sustainable decisions about such assessed risks.

Future research

In fact assigning a monetary value to human risk is still in the embryonic stage. Indeed, more research is needed to validate a well accepted decision related to human life (value). The way used to asses risk is under doubt. Therefore researches should find other tools and methods that capture not only the technical aspect but also the social aspect. As shown in this paper cost-benefit analysis is not a suitable tool to value human life but unfortunately it is used from many industries. More investigation is needed to explain how we can deal with issues of safety and risk, especially when human death or injury is involved. As mentioned in this paper, context is considered a critical aspect to achieve rational decisions related to human injury. So more examinations is needed to study how we can capture all the contextual aspects within any system. The power of knowledge has a big effect of classifying a risk as accepted or not. So the more studies to understand the nature of the risk in any system we have, the more ethical decisions to value the human risk we get.

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