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THE RELATIONSHIP BETWEEN RISK AND COST OF QUALITY: THE CASE OF JESSE LANGFORD

SCAN ME

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Abstract

Risk permeates every moment of life, impacting both individuals and businesses through their activities. While certain risks encountered have a minimal likelihood of materializing, others possess a considerable probability. Preventing risks in life entails averting failures. The most effective approach to preventing failures, both in business and all aspects of life, is through proactive measures that eliminate the underlying causes of failure before they occur. Engaging in prevention activities is invariably more cost-effective than dealing with the potential consequences and expenses associated with failures. In situations where the risk's realization probability is high, preventive measures can be implemented to mitigate or prevent it altogether. Consequently, by actively addressing risks, failures can be averted through risk prevention.

This study aims to conduct a comparative analysis of the concepts of risk and quality within the realm of costs while introducing the concept of risk-quality cost mapping to the existing body of literature. Within this framework, the study initially establishes a connection between the elements of the risk management process and quality costs. Subsequently, a real-life case is examined to assess its implications in terms of both risk and quality costs. As can be seen in the case of Jesse Langford, it is clear that the implementation of comprehensive prevention measures plays a crucial role in minimizing failure costs, ultimately reducing them to a negligible level during travel. As a result of preventive measures, the costs associated with failures can be avoided, the impact of risks can be reduced, and in some cases, the costs of failure can be substantially eliminated.

1. Introduction

The concept of risk, originally derived from the French word “risque,” entails evaluating current conditions and acknowledging the possibility of potential harm. This concept is deeply ingrained in the Turkish language. While it is predominantly used in economic and financial contexts, it can also be applied to various fields. It is often expressed as “taking a risk” or “assuming a risk”.

The use of simile as a rhetorical device proves to be a powerful means of expression. In Turkish discourse, it is often stated, “There is no error in simile.” With reference to this statement, it is plausible to draw a comparison between “risk” and “oxygen.” Oxygen exists in the atmosphere surrounding our bodies. Although invisible to the naked eye, we inhale this vital element. Its indispensability is evident, as our existence relies on its continuous presence. Any absence of oxygen jeopardizes our lives, highlighting the imminent danger it poses.

Risk, much like oxygen, permeates our surroundings constantly, encompassing both immediate and distant realms. Whether we consciously engage in taking calculated risks or simply exist, risks permeate nearly every facet of our lives. Even our physical location exposes us to potential hazards. The possibility of a building collapsing, a fire breaking out, hail falling, lightning striking, a vehicle colliding, floods transpiring, landslides occurring, scorpions stinging, ants biting, someone assaulting us, or air pollution causing breathlessness represents a mere fraction of the myriad risks we may encounter. Certain risks have such a low probability of occurring that we can lead healthy and content

lives for extended periods. On the other hand, there are risks with such a high likelihood that they can result in the massive loss of properties, lives, and loved ones, as exemplified by the catastrophic impact of earthquakes. In such cases, the risk becomes a reality, and damage can ensue.

Preventive measures can be implemented to mitigate risks in situations where the likelihood of their occurrence is high. Within this framework, several examples of preventive actions can be taken against various risks. These include the construction of sturdy and earthquake-resistant buildings, the implementation of effective measures to insulate roads against forest fires, the establishment of protection networks to safeguard against hail damage, the installation of lightning rods, the enforcement of efficient traffic regulations, the maintenance of healthy stream beds, the promotion of afforestation efforts, the implementation of effective pest control strategies, the encouragement of an active and sportive lifestyle, and the adoption of clean energy systems.

Preventing risks in life entails averting failures. The most effective approach to preventing failures, both in business and all aspects of life, is through proactive measures that eliminate the underlying causes of failure before they occur. This approach is closely associated with ensuring quality. Engaging in prevention activities is invariably more cost-effective than dealing with the potential consequences and expenses associated with failures.

Minimizing risk is key to preventing failure. Risk management entails finding a balance between risk and reward, allocating costs to necessary preventive measures, and expecting returns in exchange for these investments.

The primary objective of this study is to establish a correlation and comparison between the distinct domains of “risk” and “quality,” which are traditionally explored as separate entities within their respective fields. Specifically, the study aims to examine these aspects of “costs.” The costs associated with preventive activities are reflective of the expenses incurred to mitigate risks, prevent failures, and uphold quality standards. We seek to establish a connection between the seemingly distinct domains of risk and quality, explore their relationship within the framework of costs, and contribute to the existing literature.

2. Risk

The term “risk,” derived from the French root “risque,” is defined as the potential for harm or danger. Additionally, it is noted that the word “riziko” in the definition has its origins in the Italian root “rizico.” (TDK, Güncel Sözlük, 2023). According to this definition, the risk is primarily associated with the potential for negative outcomes. However, it is important to acknowledge that various definitions of risk exist and that the concept is approached from different perspectives. In this particular context, risk is defined as “a concept utilized to express uncertainty regarding events and/or consequences that could have a significant impact on the goals and objectives of the organization” (Selim and Mcnamee, 1999). One perspective defines risk as the factor that encompasses the possibility of loss, the realization or non-realization of expected outcomes, the disparity between expectations and results, and the potential for gain (TÜSİAD, 2008). Furthermore, the Institute of Internal Auditors defines risk as the uncertainty surrounding an event that has the potential to impact the achievement of objectives. The Institute of Risk Management characterizes risk as the combination of the probability and consequence of an event. Based on the provided definitions, the risk is characterized as encompassing both opportunities and threats that may arise in the future. It is associated with the uncertainty surrounding the outcomes of actions and events. Furthermore, the risk is described as a phenomenon that has the potential to impact the effectiveness and efficiency of an organization's key processes, either by hindering or facilitating them (Hopkin, 2018).

Risk can be categorized into two main classes: systematic risk and unsystematic risk. Systematic risk, commonly referred to as market risk, arises from broader societal, economic, and political changes that impact the overall market conditions (Parlakkaya, 2003). This type of risk is market-specific and affects all firms operating in that market. It is important to note that systematic risk cannot be eliminated or diversified, although some measures can be taken to protect against it (Mandacı, 2003). Systematic risk encompasses various types of risks, including market risk, political risk, inflation risk, interest rate risk, and exchange rate risk. On the other hand, unsystematic risk refers to risks that are specific to a particular sector or firm. This type of risk can be mitigated or eliminated through diversification, as it is unique to a specific entity or industry. Unsystematic risk can be further classified into different categories, such as financial risk, industry risk, and management risk (Usta, 2012).

2.1. Risk Management

Risk management is a dynamic and comprehensive strategy that involves systematically recognizing, quantifying, examining, and addressing risks with the aim of minimizing or eliminating potential threats faced by an organization during its operations, thus ensuring the attainment of its objectives at an acceptable level (Schroeck, 2002; Merna and Al-Thani, 2008). Within this framework, the primary objective of risk management is to optimize the enterprise’s value by actively managing its risk

profile, which involves the elimination of certain risks and the control of others (Meulbroek, 2002)

While risk management has a well-established lineage, its conceptualization dates to the 1950s. In 1963, Mehr and Hedges conducted a seminal study titled "Risk Management and the Business Enterprise," which introduced the foundational principles of the risk management process. The primary objective of their study was to enhance the production efficiency of enterprises through effective risk management strategies. During the 1960s, the risk management process primarily centered around pure risks, which were characterized as risks that either resulted in losses or no losses. Insurance played a significant role in mitigating these risks, highlighting its importance. However, in the early 1970s, risk management underwent further advancements, distinguishing itself from insurance management. This period witnessed a growing recognition of financial risks as a pressing concern for businesses, particularly due to the repercussions stemming from the collapse of the Bretton Woods system in 1972. During the 1980s, the concept of risk management expanded to encompass credit risk, loss risk, and market risk. As the risks faced by enterprises continued to grow in the 1990s, there was a gradual increase in recognition of the importance of risk management. Consequently, in addition to financial risk, operational risk began to be acknowledged and considered. In the early 2000s, the broadening scope of risk prompted enterprises to transition from traditional risk management approaches to adopting an enterprise risk management (ERM) framework. In this context, the enterprise risk management approach offers a more comprehensive handling of risks. It goes beyond addressing solely financial and operational risks and extends throughout the entire organization. This approach encompasses the consideration of operational and strategic risks, ensuring a holistic and integrated approach to risk management across all levels of the organization (Arslan, 2008).

2.2. Enterprise Risk Management

Enterprise risk management is a dynamic and ongoing process that permeates the entire organization, is influenced by key stakeholders such as the board of directors, management, and employees, and aims to provide reasonable assurance in attaining the enterprise's objectives while effectively managing risks within the boundaries of the organization's risk tolerance (COSO, 2004). Within the context of this definition, enterprise risk management centers on organizational goals and does not view risks as obstacles to attaining those goals. Furthermore, enterprise risk management embraces the concept of assuming acceptable risks at suitable junctures and under suitable circumstances, while effectively overseeing and controlling such risks (Tekgül, 2007).

The above definition of enterprise risk management by COSO was revised in 2017 and was defined as the culture, capabilities, and practices integrated into an organization's process for producing and protecting value as well as determining and implementing risk management strategies (Burca, 2017). By highlighting the significance of organizational value and strategy in corporate risk management, it is intended to harmonize the concept of risk with strategy and performance (Kurt & Uysal, 2018). The components of enterprise risk management have also been divided into five categories: performance; investigation and review; information, communication, and reporting (COSO, 2017).

Enterprise risk management provides the following benefits to organizations (COSO, 2017:3-4):

- It facilitates the emergence of fresh opportunities within the organization.
- It aids in the identification and effective management of risks across the organization.
- It enhances the organization's efficiency in recognizing risks and implementing suitable responses, consequently mitigating costs and minimizing losses.
- It assists in identifying risks that could potentially impact the organization's performance and proactively addressing them to avoid associated failures.
- It streamlines resource allocation within the organization.
- It increases organizational resilience.

2.3. Risk Management Process

This process encompasses the stages of risk identification, risk assessment, risk response, control activities, information and communication, and monitoring. The explanations for each stage are provided below:

2.3.1. Risk Identification

The initial stage in developing an enterprise's risk profile is the identification of risks. During this stage, it is crucial to ensure that the identified risks are directly associated with the organization's business objectives. The first step in risk identification involves determining the risks that the enterprise is likely to encounter for the first time during the establishment of the risk management process. The second step in risk identification occurs when existing risks pertaining to the business expire or undergo changes, leading to the emergence of new risks (Treasury, 2004). Risk identification refers to the systematic process of identifying potential threats and opportunities that may impact the attainment

of an enterprise's goals and objectives. To effectively conduct this process, it is essential to consider the enterprise's vision, mission, and values and possess a comprehensive understanding of both internal and external factors that can influence the enterprise's operations (Derici et al., 2007).

Various methods are used to identify risks. Among these, PESTLE analysis, SWOT analysis, brainstorming (Public Internal Control Guide, 2014: 32), interviews and workshops, and focus group studies (Derici et al., 2007) are widely used.

2.3.2. Risk Assessment

Once the risks have been identified, the subsequent stage involves assessing them. This stage serves as a foundation for determining the appropriate risk management strategies. Risk assessment is defined as the process of evaluating the likelihood of occurrence and the potential impact of the identified risks. In this context, the impact of risk refers to the effect it would have on the organization if it were to materialize. The probability of realization, on the other hand, pertains to the likelihood of a risk event occurring (Hevesi, 2005).

Risk assessment encompasses several steps, including measuring risks, prioritizing them based on their impact levels, and documenting them. In this process, it is essential to determine the impact and probability of occurrence of risks and evaluate them in terms of inherent risk and residual risk. The risk matrix approach is commonly employed as a method for conducting this evaluation (Public Internal Control Guide, 2014). The risk matrix is widely regarded as an effective and straightforward approach for systematically reviewing and prioritizing risks based on their significance (Cox, 2008). The vertical column of the risk matrix represents the probability of risk realization and is typically rated as high, medium, or low, while the horizontal column represents the impact level that would arise if a risk event materialized, and the impact level is also rated as high, medium, or low, signifying the magnitude of consequences associated with the risk event (Derici et al., 2007). By utilizing the risk matrix, risks can be ranked and categorized using different colors or shading, typically from the highest impact level and highest probability of occurrence to the lowest impact level and lowest probability of occurrence (Dinapoli, 2009 as cited in Akçakanat, 2012).

2.3.3. Risk Response

Responding to risks is a critical process aimed at mitigating the threats posed by assessed risks and leveraging potential opportunities. This process involves various strategies to transform uncertainty into favorable outcomes for the business, like accepting, reducing, sharing, and avoiding risks (Arslan, 2008).

- ***Accepting Risks:*** Some risks may be deemed acceptable or within the organization's risk tolerance level. In such cases, the decision is made to acknowledge the risks and their potential consequences without implementing specific risk mitigation measures. This approach may be appropriate when the potential impact of the risk is low, the cost of mitigation outweighs the benefits, or the risk is considered an inherent part of the business operations (Derici et al., 2007).
- ***Reducing Risks:*** Risk reduction involves implementing measures to lessen the likelihood of a risk event occurring or minimize its potential impact (GAO, 2014).
- ***Sharing Risks:*** Risk sharing involves transferring or distributing the potential impact of risks to external parties or partners through insurance. Risk transfer does not reduce the source or significance of the risk. Sometimes external parties do not realize that they are assuming shared risk, and even transferring the risk can significantly increase the risk to which the entity is exposed (Moeller, 2005).
- ***Avoiding Risks:*** Avoiding risks involves taking-action to put an end to risk-causing activities (GAO, 2014).

2.3.4. Control Activities

Control activities refer to the implementation of policies and procedures aimed at assisting an organization in achieving its objectives and managing risks effectively (GAO, 2014). These activities can be categorized into four groups based on their nature: directive, determinative, preventive, and corrective controls.

Directive controls encompass the guidelines and instructions governing the "who, when, where, and how" aspects of the activities undertaken by the organization to accomplish its objectives. Examples of directive controls include laws, regulations, policies, organizational charts, and task allocation charts (Ekici, 2015).

Determinative controls are implemented to assess and determine the extent of damages and losses that may occur in the event of undesirable outcomes. These controls involve measures such as asset controls, reconciliation processes, counts, and comparisons (Public Internal Control Guide, 2014).

Preventive controls are designed to proactively mitigate the likelihood of undesirable outcomes. They include measures like

authorization protocols, segregation of duties, approval procedures, identity cards, password controls, and traffic lights (Ekici, 2015.

Corrective controls are established to rectify undesirable results in the event of identified risks (Treasury, 2004: 28). These controls include actions such as insurance coverage, reviews, monitoring activities, rectifying detected discrepancies, and holding communication meetings (Ekici, 2015)

2.3.5. Information and Communication

In risk management, the availability of quality information and effective communication play crucial roles. The organization relies on high-quality information to achieve its objectives and address risks effectively. Management acquires relevant data from internal and external sources based on identified information requirements and utilizes this information in the decision-making process. It is also essential to communicate the quality information obtained effectively and in a timely manner. To facilitate this, management determines appropriate communication methods, such as written documents or face-to-face meetings, to engage effectively with both internal and external stakeholders (GAO, 2014).

2.3.6. Monitoring

Monitoring entails the review and evaluation of the effectiveness of the risk management process (Derici et al., 2007: 169). This stage involves examining the status of existing risks, assessing the likelihood of their occurrence, analyzing changes in their impact, identifying new risks, and evaluating the efficiency of control activities. Through monitoring, the organization and management gain agility in adapting to changing conditions (Public Internal Control Guide, 2014).

3. Quality

Quality refers to the ability of a product or service to meet the needs and expectations of customers (Dalcı and Tanış, 2002). In simpler terms, quality can be understood as an approach or system that reflects how well a product or service conforms to the expectations of the consumer (Yükçü, 1999).

Throughout history, the concept of quality has been defined by various individuals and organizations, incorporating different perspectives such as philosophical, product-based, user-based, production-based, and value-based approaches. Philosophically, quality is defined as "innate excellence," the product-based approach defines it as a "precise and measurable variable," the user-based approach emphasizes "suitability for use," the production-based approach focuses on "suitability for requirements," and the value-based approach considers quality as "affordable excellence" (Gravin, 1984).

3.1. Quality Costs

Quality costs are defined as the costs arising as a result of the activities executed to prevent possible errors that may arise, planned quality inspections, the production process of the product, and the errors encountered after the delivery of the product to the customer (Yükçü, 1999). These costs include all the investments made to achieve a specific quality standard or produce a product or service at the desired level of quality (Kaygusuz, 2012). Consequently, quality costs can be characterized as the costs incurred in the process of ensuring and maintaining quality, as well as the losses incurred when the desired level of quality is not attained (American Society for Quality Control-ASQC, 1971; British Standard-BS 6143, 1990, as cited in Hwang and Aspinwall, 2010).

3.2. Classification of Quality Costs

The initial efforts to categorize quality costs were pioneered by Feigenbaum and Masser (1956, 1961). In this context, quality costs are divided into three main categories: prevention, evaluation, and failure costs. Failure costs can further be classified as internal failure costs and external failure costs (Giakatis et al., 2001). In addition, prevention and evaluation costs are referred to as compliance costs, and internal and external failure costs are referred to as non-compliance costs (Shah and Mandal, 1999). This classification system is widely utilized in research studies and is also incorporated into BS 6143 standards.

3.2.1. Prevention Costs

Prevention costs encompass the expenses associated with designing and implementing a quality system and integrating it into the organization (Yükçü, 1999). These costs can be incurred in two ways: during the design and creation of the system and routine operation after the system is installed (İçerli, 2020). Prevention costs can be listed as follows: quality planning, design, and development of quality measurement and test equipment; quality review and design verification; assessment and maintenance of quality measurement and test equipment; assessment and maintenance of production equipment used in quality assessment; supplier guarantee; quality training and audits; final state analysis and reporting of quality information; quality improvement programs (Yükçü, 1999; Juran and Godfrey, 1999):

3.2.2. Assessment-Evaluation Costs

Assessment-evaluation costs refer to the expenses incurred to assess the level of conformity with quality requirements (Juran

and Godfrey, 1999). These costs are absorbed to achieve the desired quality level of the products (Yükçü, 1999). Examples of assessment and evaluation costs include pre-production verification, receiving inspection, laboratory acceptance testing, inspection and testing processes, equipment used for inspection and testing, materials consumed during inspection and testing, analysis and reporting of inspection and testing results, field success testing, permits and approvals, and stock valuation (İçerli, 2020).

3.2.3. Internal Failure Costs

Internal failure costs are the costs that are identified before the delivery of the product or service to the customer and are incurred as a result of nonconformities or defects at any stage of the quality cycle (Giakatis et al., 2001). These costs include those incurred for reasons such as residuals, rework, repair, troubleshooting, inspection and test repetition, defect analysis, time losses, change permits, and concessions (İçerli, 2020).

3.2.4. External Failure Costs

External failure costs are the costs associated with non-conformities or defects after the delivery of the product or service to the customer (Giakatis et al., 2001). External failure costs arise when the delivered product or service does not meet the organization's quality standards or fails to meet customer expectations (İçerli, 2020). Examples of external failure costs include expenses related to warranty claims, customer complaints, product returns, losses in revenue associated with support activities, customer attrition, and decreased sales (Juran and Godfrey, 1999).

4. Relationship Between Risk and Quality

To examine the correlation between risk and quality, we have compiled the following tables to align the risk management process with quality costs: These tables illustrate the quality costs associated with each step of the risk management process. The tables employ the following abbreviations: **P:** Prevention Costs, **AE:** Assessment and Evaluation Costs, **IF**: Internal Failure Costs, and **EF:** External Failure Costs

Table 1. Relationship between Risk Identification and Quality Costs

IDENTIFICATION OF RISK	**QUALITY COSTS**	
• *Creating Risk Management Process* • *Risk Profiling*	• *Quality Planning*	***P***
	• *Design and Development of Quality Measurement and Test Equipment*	***P***
	• *Quality Review and Design Verification*	***P***
	• *Measurement and Maintenance of Quality Measurement and Testing Equipment*	***P***
	• *Measurement and Maintenance of Production Equipment Utilized in Quality Assessment*	***P***
	• *Supplier Warranty*	***P***
	• *Quality Training*	***P***
	• *Quality Audits*	***P***
	• *Final Status Analysis and Reporting of Quality Information*	***P***
	• *Quality Improvement Programs*	***P***

Source: Table 1 was created by our team using relevant literature on risk management and quality costs.

Upon analyzing Table 1 to understand the connection between risk and quality costs, it becomes apparent that the risk identification phase aims to establish the risk management process and determine the risk profile. Its purpose is to mitigate or prevent potential risks. Within the context of quality costs, prevention costs include expenses incurred to avert failure costs if the identified risk occurs. As a result, the risk identification process is aligned with prevention costs.

Table 2. Relationship between Risk Assessment and Quality Costs

RISK ASSESSMENT	QUALITY COSTS	
• *Quantification of Risks* • *Prioritization of Risks* • *Recording of Risks*	• *Pre-Production Validation*	***AE***
	• *Receiving Inspection*	***AE***
	• *Laboratory Acceptance Test*	***AE***
	• *Inspection and Test*	***AE***
	• *Inspection and Test Equipment*	***AE***
	• *Materials Consumed in the Inspection and Testing Process*	***AE***
	• *Analysis and Reporting of Inspection and Test Results*	***AE***
	• *Field Achievement Test*	***AE***
	• *Permits and Approvals*	***AE***
	• *Stock Valuation*	***AE***

Source: Table 2 was created by our team using relevant literature on risk management and quality costs.

During the risk assessment stage, various activities such as measuring, prioritizing, and documenting risks are undertaken to establish the desired level of risk tolerance (Tamplin, 2023). Assessment and evaluation costs, within the realm of quality costs, include the expenses incurred to attain the desired quality level. Therefore, through the determination of the desired risk level and the achievement of the desired quality level, it becomes feasible to mitigate or eliminate potential failure costs that may arise if the identified risk is realized. As a result, Table 2 serves as compelling evidence for a strong correlation between the risk assessment phase and the assessment and evaluation costs.

Table 3. Relationship between Responding to Risks and Quality Costs

RESPONDING TO RISKS	QUALITY COSTS	
• *Accepting Risk* • *Minimizing Risk* • *Avoiding Risk*	• *Pre-Production Verification*	***AE***
	• *Receiving Inspection*	***AE***
	• *Laboratory Acceptance Test*	***AE***
	• *Inspection and Test*	***AE***
	• *Inspection and Test Equipment*	***AE***
	• *Materials Used in Inspection and Test Process*	***AE***
	• *Analysis and Reporting of Inspection and Test Results*	***AE***
	• *Field Achievement Test*	***AE***
	• *Permits and Approvals*	***AE***
	• *Stock Valuation*	***AE***
• *Sharing the Risk*	• *Product Responsibility*	***EF***

Source: Table 3 was created by our team using relevant literature on risk management and quality costs.

Table 3 shows that the components of accepting, reducing, and avoiding risks within the risk response process align with the assessment and evaluation costs associated with preventing failure costs if the risk occurs. These elements are specifically targeted at reducing the impact of the risk. The component of sharing the risk aligns with the quality cost of product responsibility, which falls under the category of external failure costs.

Table 4. Relationship between Control Activities and Quality Costs

CONTROL ACTIVITIES	QUALITY COSTS	
• *Preventive Controls*	• *Quality Planning*	***P***
	• *Design and Development of Quality Measurement and Test Equipment*	***P***
	• *Quality Review and Design Verification*	***P***
	• *Measurement and Maintenance of Quality Measurement and Test Equipment*	***P***
	• *Measurement and Maintenance of Production Equipment Used in Quality Assessment*	***P***
	• *Supplier Guarantee*	***P***
	• *Quality Training*	***P***
	• *Quality Audits*	***P***
	• *Final Status Analysis and Reporting of Quality Information*	***P***
	• *Quality Improvement Programs*	***P***
	• *Pre-Production Validation*	***AE***
	• *Receiving Inspection*	***AE***
	• *Laboratory Acceptance Test*	***AE***
	• *Inspection and Test*	***AE***
	• *Inspection and Test Equipment*	***AE***
	• *Materials Consumed in the Inspection and Testing Process*	***AE***
	• *Analysis and Reporting of Inspection and Test Results*	***AE***
	• *Field Achievement Test*	***AE***
	• *Permits and Approvals*	***AE***
	• *Stock Valuation*	***AE***
• *Determinative Controls*	• *Inspection and Test*	***AE***
	• *Inspection and Test Equipment*	***AE***
	• *Materials Used in the Inspection and Testing Process*	***AE***
	• *Analysis and Reporting of Inspection and Test Results*	***AE***
• *Guiding Controls*	• *Pre-Production Verification*	***AE***
	• *Receiving Inspection*	***AE***
	• *Laboratory Acceptance Test*	***AE***
	• *Inspection and Test*	***AE***
	• *Inspection and Test Equipment*	***AE***
	• *Materials Used in Inspection and Test Process*	***AE***
	• *Analysis and Reporting of Inspection and Test Results*	***AE***
	• *Field Achievement Test*	***AE***
	• *Permits and Approvals*	***AE***
	• *Stock Valuation*	***AE***
• *Corrective Controls*	• *Replacement, Remanufacture, and Repair*	***IF***
	• *Inspection and Test Repetition*	***IF***
	• *Obligations Realized during the Guarantee Period*	***EF***
	• *Unaccepted and Returned Products*	***EF***
	• *Reconciliation*	***EF***

Source: Table 4 was created by our team using relevant literature on risk management and quality costs.

Preventive controls in the control activities phase of the risk management process presented in Table 4 overlap with both prevention and assessment and evaluation costs. While determinant controls are associated with some of the assessment and evaluation costs, directive controls are associated with most of the assessment and evaluation costs. In other words, since these controls are activities targeted at preventing or mitigating the risk by considering the probability of its occurrence, they largely overlap with prevention, assessment, and evaluation costs. In addition, since corrective controls are activities aimed at eliminating the risk, they overlap with internal and external failure costs, which are the costs of correcting the failure.

Table 5. Relationship between Information, Communication, and Quality Costs

INFORMATION AND CONTACT	**QUALITY COSTS**	
• *Getting Quality Information* • *Establishing Effective Communication*	• *Quality Planning*	***P***
	• *Design and Development of Quality Measurement and Test Equipment*	***P***
	• *Quality Review and Design Verification*	***P***
	• *Measurement and Maintenance of Quality Measurement and Test Equipment*	***P***
	• *Measurement and Maintenance of Production Equipment Used in Quality Assessment*	***P***
	• *Supplier Guarantee*	***P***
	• *Quality Training*	***P***
	• *Quality Audits*	***P***
	• *Final Status Analysis and Reporting of Quality Information*	***P***
	• *Quality Improvement Programs*	***P***
	• *Reconciliation*	***EF***
	• *Complaints*	***EF***
	• *Customer Contact Costs*	***EF***

Source: Table 5 was created by our team using relevant literature on risk management and quality costs.

According to Table 5, the information and communication stage includes quality information and effective communication elements that align with prevention costs and aim to minimize the likelihood of risk occurrence or prevent risks altogether. If a risk does occur, information and communication are associated with external failure costs, encompassing expenses related to reconciliation, handling complaints, and maintaining customer contact.

Table 6. Relationship between Monitoring and Quality Costs

MONITORING	**QUALITY COSTS**	
• *Reviewing the Functioning of the Risk Management Process* • *Assessment of the Effectiveness of the Risk Management Process*	• *Pre-Production Verification*	***AE***
	• *Receiving Inspection*	***AE***
	• *Laboratory Acceptance Test*	***AE***
	• *Inspection and Test*	***AE***
	• *Inspection and Test Equipment*	***AE***
	• *Materials Consumed in the Inspection and Testing Process*	***AE***
	• *Analysis and Reporting of Inspection and Test Results*	***AE***
	• *Field Achievement Test*	***AE***
	• *Permits and Approvals*	***AE***
	• *Stock Valuation*	***AE***

Source: Table 6 was created by our team using relevant literature on risk management and quality costs.

The final stage of the risk management process is the monitoring activity, which involves assessing the effectiveness and functionality of the risk management process. Through careful observation of the probability of risk realization and the changes in its impacts, significant reductions or even prevention of risk exposure can be achieved. Assessment and evaluation costs, categorized as part of quality costs, are the expenses incurred to attain the required level of quality. By incurring these costs, failure can be avoided. Therefore, by investing in assessment and evaluation costs in relation to the probability of risk realization, failure costs can be greatly minimized. From this perspective, it can be said that the monitoring element intersects with the concepts of assessment and evaluation costs.

5. Jesse Langford Case

The issues analyzed in our study related to the Jesse Langford case can be collected under the following headings:

5.1. Purpose of the Case

The Jesse Langford case is a real-life case that has captured significant interest. Due to its intriguing nature, the individuals involved in the case have shared it with the public. The experience gained from the case has been expanded upon and transformed into a magazine article, while serious documentary channels have produced documentaries featuring the heroes of the case. Given its strong connection to risk and quality costs, efforts have been made to develop and incorporate the Jesse Langford case into the literature. It is anticipated that a close relationship exists between risk processes and quality costs in this context. Through this case study, we aim to present a concrete exploration of the relationship between risk and quality costs within the scientific community. As human beings, we engage in activities that inherently carry risks, even if they are small. In our daily lives, we encounter numerous risks without even realizing them, such as spraining a foot while stepping off a curb. In this study, we have chosen a case of moderate complexity, namely the Jesse Langford case, to shed light on the scientific relationship between risk and quality costs (Perry, 2020; Netflix, 2022). The objective is to establish a connection between risk and quality costs by examining the outcomes of this case.

5.2. Jesse Langford Case[1]

Whakatane is a small town located in the northern part of the North Island of New Zealand. Within the Whakatane region, approximately 48 kilometers off the east coast of the North Island, lies White Island. This island is home to Whakaari Volcano, the most active volcano in the country. The region holds significant importance in terms of tourism, thanks to the volcano's easy accessibility. Adventure-seeking tourists are particularly drawn to visiting White Island through tour companies to witness the volcanic activity up close. The beginning of December marks the busiest period on the island, attracting many visitors. The journey to the island can be made by sea, taking around 90 minutes aboard boats with a capacity of 40 or 50 people, or by air with small helicopters, requiring only 20 minutes of travel time. The White Island tour company operates four boats and two small helicopters to provide transportation services to the island.

White Island features scorching air, gas flames reaching temperatures of 1200 degrees, a highly acidic lake that surpasses the standard pH scale, and an abandoned sulfur mine. It is worth noting that White Island was recognized as one of the most closely observed islands globally, benefiting from a comprehensive surveillance system. This system comprised webcams, seismographs (highly sensitive devices that detect the location, duration, and intensity of earthquakes), UV spectrometers (devices used for analyzing the spectra of rays), and boundary pegs (devices employed to physically demarcate land boundaries). Furthermore, the chemical composition of the island's air and water was subject to continuous monitoring. The data collected through these monitoring efforts were carefully analyzed by GeoNet, a geological monitoring service, using an alert level ranging from 0 to 5 to indicate the volcano's activity and associated risks. The regulations imposed on tour companies, limiting their trips to White Island to alert levels 1 and 2, coupled with the authority to cancel landings if conditions are deemed unsuitable, have played a crucial role in preventing fatalities for over a century. This remarkable safety record is even more impressive considering the continuous volcanic activity experienced on the island from 1975 to 2000. Notably, there have been no life-threatening explosions, lava spewing, or sudden excessive gas releases during this period. The alarm level was raised from 1 to 2 in the latest analysis conducted by GeoNet on November 19, 2019. However, a subsequent statement indicated that there was no danger. Moreover, helmets and gas masks are utilized during the journey.

On December 9, 2019, a group of approximately 100 tourists embarked on a visit to White Island from Whakatane using three boats and two helicopters. The first boat, Peejay IV, departed Whakatane at 09:30. The second boat, Phoenix, skippered by Kingi, set off at 10:30. Finally, the Puia Whakaari, skippered by Plews, left at 11:30. By around 13:00, the Puia Whakaari had arrived at the island, while the first boat had already returned to Whakatane. Passengers from the second boat had completed their

[1] The Case has been created by referencing Perry, A. (2020). The True Story of the White Island Eruption. Outside and Watch the Volcano: Rescue from Whakaari, https://www.netflix.com/tr/title/81410405 .

walk on the island and were preparing to return to the boat. At 14:05, the first helicopter departed for Whakatane, followed by the second helicopter, which was waiting for the remaining passengers ten minutes later. The last group to leave the island consisted of 38 passengers and 4 guides. On that day, a group of 21 individuals, led by Hayden, who had organized his 1111th trip to the island, were near the crater lake on White Island. The remaining tourists were close to the shore. However, at 14:10, a massive explosion occurred as the Whakaari volcano became active. Within a minute, a towering cloud and dense smoke engulfed the area. Upon witnessing the eruption, the captains in the sea immediately alerted the coast guard in Whakatane, reporting that approximately three White Island tour company ships with 100 tourists were on the island. The coast guard dispatchers swiftly initiated contact with search and rescue teams. In response to the immediate aftermath of the explosion, a flight ban to White Island was imposed by the international air center for safety reasons. This decision was made following the strict health and safety regulations upheld in the country.

Phoenix, which had just departed the island, swiftly turned back to White Island to aid the injured and set course toward Whakatane. Meanwhile, Kingi, the captain of the boat, remained on the island to conduct a thorough check and ensure the safety of everyone present. As Kingi made his way deeper into the crater, he noticed a staggering figure covered in ash. It was Jesse Langford, a 19-year-old member of Guide Hayden's group. Against all odds, Jesse has miraculously traversed from the edge of the crater lake to the shore. Tragically, Jesse has sustained severe burns on almost ninety percent of his body.

Despite the flight ban, three rescue helicopters disregarded the order and took off toward the island. Upon arrival, they were met with a scene of injured and deceased individuals still wearing their helmets and gas masks scattered on the ground. The pilots, recognizing the urgency of the situation, decided to take the risk and evacuate 12 wounded individuals to Whakatane within a remarkable timeframe of 40 minutes. However, eight people remained stranded on the island. Out of the 47 individuals present on White Island, 21 lost their lives in the explosion, while 24 others sustained injuries. The process of recovering and treating the survivors was a lengthy ordeal. Among the survivors, Jesse Langford's story stands out as truly extraordinary. During the eruption, Jesse witnessed the tragic demise of his parents and was unable to locate his sister. Despite sustaining burns on almost ninety percent of his body, he managed to descend from the edge of the crater to the coastline. His road to recovery was arduous, undergoing a total of 21 surgeries and requiring nearly two years to recuperate fully.

It is worth noting that just two months before the eruption, an occupational safety inspector conducted a tour of White Island and reported no significant concerns. However, the catastrophic eruption tragically resulted in physical harm and the loss of life among the tour participants.

5.3. Analysis of the Case in Terms of Risk and Quality Costs

Upon analyzing the case, it becomes evident that significant prevention costs were invested to mitigate harm to guests participating in the touristic trip. Various preventive measures, such as the use of webcams, seismographs, UV spectrometers, boundary pegs, and hard hats and gas masks for tourists, were implemented. These measures aim to minimize the risks and ensure the safety of the participants, but they are costly. However, despite these preventive activities and associated costs, they were unable to predict or prevent the eruption in this particular case, resulting in harm to the health of the tourists and even the loss of life. It highlights that the prevention costs incurred up to that date were insufficient to anticipate and address such failures. The costs of failure might not have been as high if more sophisticated explosion warning systems had been created or purchased if the tourists and tour guides had worn heat and impact-resistant helmets and protective clothing, if those on the island had worn cutting-edge masks that filter toxic gases, and if there had been heat and impact-resistant shelters. By comparing the Langford case with the current situation and an ideal scenario where comprehensive prevention costs are invested, we can highlight the potential savings that can be achieved through effective risk management.

The figures in Table 7 are estimated by taking the market value of the materials needed in disasters such as pandemics, earthquakes, forest fires, floods, etc., in line with today's purchasing power and prices.

Table 7. Comparison of the Current Situation and Full Prevention Cost Situation in the Jesse Langford Case (From the Travel Company's Perspective)

	CURRENT STATUS	FULL PREVENTION COST
PREVENTION		
• Web Cameras	5.000 $	5.000 $
• Hard hat	2.000 $	200.000 $
• Mask	30.000 $	300.000 $
• Fireproof Dress	-	500.000 $
• Fireproof Shoes	-	150.000 $
• Cost of Analysis	20.000 $	20.000 $
• Health Team	-	400.000 $
• Shelters (Steel Huts)	-	1.500.000 $
ASSESSMENT AND EVALUATION		
• Seismograph	15.000 $	15.000 $
• UV spectrometers	10.000 $	10.000 $
• Boundary latches	8.000 $	8.000 $
TOTAL COST OF PREVENTION + ASSESSMENT AND EVALUATION	**90.000 $**	**3.108.000 $**
• **INTERNAL FAILURE**		
• Patient Transport	2.000.000 $	1.000 $
• Loss of Life	22 people	None
• **EXTERNAL FAILURE**		
• **Compensations**	100.000.000 $	-
• Image Loss	Yes	None
• Health Costs	50.000.000 $	None
• Organization Cancellation	300.000 $	No (300.000 $)
TOTAL COST	**152.390.000 $**	**2.809.000 $**

Source: Table 7 was created by our team.

Based on the data presented in Table 7 for the travel company in the Jesse Langford case, it is evident that the sum of prevention, assessment, and evaluation costs is considerably lower than the ideal situation where full prevention costs are incurred. However, not incurring sufficient prevention, assessment and evaluation costs against the possibility of risk realization significantly increases internal and external failure costs. When the ideal scenario is considered, even though the costs of prevention, assessment, and evaluation expended to minimize or avoid the risk are considerable, they significantly decrease the failure costs if the risk is realized. It is feasible to say that there is a considerable difference between the current condition and the ideal situation due to failure costs when both scenarios are analyzed in terms of the total cost.

Table 8. Comparison of the Current Situation and the Full Prevention Cost Situation in the Jesse Langford Case (From Jesse Langford's Perspective)

	CURRENT SITUATION	FULL PREVENTION COST
PREVENTION		
• Increasing Travel Safety	0	300 $
ASSESSMENT AND EVALUATION	0	0
PREVENTION + ASSESSMENT AND EVALUATION TOTAL COST	**0**	**300 $**
INTERNAL FAILURE		

• Suffering • Loss of Relatives	Yes Yes	None None
EXTERNAL FAILURE • 21 Operation	 10.000.000 $	 0
TOTAL COST	**10.000.000 $**	**300 $**

Source: Table 8 was created by our team.

Table 8, which is organized for the comparison of the current situation and the ideal situation (full prevention cost) for the individual in the Jesse Langford case, shows that no prevention, assessment, and evaluation costs are incurred according to the current situation. However, if the risk is realized, significant failure costs occur. According to the ideal scenario, it was found that the costs associated with prevention, assessment, and evaluation for the reduction or avoidance of the risk eliminated the costs associated with failure. It becomes clear that there is a significant difference between the current state and the ideal one when the total expenses of the two scenarios are compared, which is caused by failure costs.

5. Conclusions

This study discusses a real-life case to investigate the connection between the risk management process and quality costs and how each stage in the risk management process aligns with the costs associated with prevention, assessment, and evaluation, as well as internal and external failures. From this perspective, it is clear that the implementation of comprehensive prevention measures plays a crucial role in minimizing failure costs, ultimately reducing them to a negligible level.

In the case of Jesse Langford, implementing better-quality and heat-resistant gas masks and helmets during travel could have had a substantial impact on reducing or even eliminating the costs associated with failures, despite the accompanying increase in prevention costs. Similarly, the utilization of fireproof clothing and footwear as a preventive measure could have significantly mitigated or eliminated failure costs related to health expenses, compensations, and other potential consequences despite the increased upfront costs of implementation of these preventive measures.

As a result of preventive measures, the costs associated with failures can be avoided, the impact of risks can be reduced, and in some cases, the costs of failure can be substantially eliminated. Numerous incidents like the one described above occur every day, highlighting the pervasive nature of risks and failures in various contexts. Therefore, the expected situation is to minimize the losses incurred through prevention activities.

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