THE PERFORMANCE APPROACH TO CONSTRUCTION WORKER SAFETY AND HEALTH

By

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This dissertation is dedicated to my children, Jamie and Matthew; my parents, James and Sheila; my closest friend, Meena; my family and everyone engaged daily in the battle against the poor safety and health performance of the construction industry.

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Accidents occur on construction sites around the world despite various occupational safety and health laws, rules, and regulations. There is an international trend away from prescribing compliance with safety laws toward a performance approach. Contractors are allowed flexibility to choose the means and methods to perform their operations safely.

This study examines whether a performance approach is an effective and acceptable approach to improving safety and health on construction sites. The study has 5 main objectives: (1) to increase understanding of the performance paradigm and its application to safety and health in construction; (2) to determine the feasibility and acceptance of the performance approach as an effective alternative to previous prescriptive approaches to construction safety; (3) to develop a model based on the review of literature on the performance approach in construction and examination of existing international construction safety and health legislation; (4) to establish whether applications for variances to OSHA's prescriptive requirements would have been obviated by the performance approach; and (5) measure the level of knowledge of the top management structures of construction firms about the performance approach and their attitude toward its implementation in their firms.

We reviewed the literature on the performance approach extensively. We studied applications for variances to OSHA's requirements. We used a self-administered questionnaire survey for the top management of 100 construction firms.

This study showed that most of the sample population (78%) believed they understood the performance approach very well. Most (58%) preferred this approach. The areas of flexibility, support for innovation, and ease of introducing new materials were regarded as being most important. Top management (54%) drove major change.

The demonstration of consistent and decisive personal leadership, introduction of appropriate training programs, and allocation of adequate resources were the most important actions for the successful implementation of the performance approach. The strongest predictor of worker participation was the importance of safety and health issues Strong predictors of the actions that would be taken to implement the performance approach were implementation factors and position within top management.

INTRODUCTION

Background to the Study

The construction industry has earned the reputation of being a dangerous or highly hazardous industry because of the disproportionately high incidence of accidents and fatalities that occur on construction sites around the world (The Business Roundtable, 1983; Churcher and Alwani-Starr, 1996; Brown, 1996; Rowlinson, 2000; Smallwood and Haupt, 2000). Dangerous refers to being risky, hazardous, or unsafe. Situations, tools, or other elements may be either imminently dangerous referring to an impending or immediate risk such as a bare electrical cord, or inherently dangerous such as poisons, explosives or chemicals.

Construction worldwide is a significant employer of labor as large proportions of its activities and operations have labor-intensive characteristics (Haupt, 1996). In Europe, for example, the construction industry employs about 7.5% of the total industrial workforce (some 11 million workers). European construction accounts for 17.5% of all work-related accidents and injuries (some 1 million accidents per year). Construction is responsible for about 22.5% of all occupational deaths, representing some 1500 fatal accidents per year (Berger, 2000; Dias and Coble, 1999). For many years construction has consistently been among those industries with the highest injury and fatality rates (Khalid, 1996; Hanna et al., 1996).

Personal hazards[1] have been cited as a general cause of accidents[2] on bridge construction sites in the United States, United Kingdom and Japan (Gee and Saito, 1997). These hazards include injuries to workers through falling, something falling on them, and tripping over obstacles.

Despite sophisticated safety and health regulations in most countries, high rates of injury and fatality persist. The procedures intended to prevent such accidents are usually mandated by the appropriate occupational safety authority in each country (Gee and Saito, 1997). Scholars and professionals within the construction industry recognize that regulations and legislation by themselves are not enough to bring about the desired goal of zero accidents and incidents on construction sites (Center to Protect Workers' Rights, 1993; Ratay, 1997). However, adherence to them alone does demonstrably improve site safety. If reasonable in philosophy, adequate in detail, and worded without ambiguity, legislation and regulations provide a basis for the employment and enforcement of good construction practices. According to Ratay (1997), good codes and standards can improve construction safety at minimal or no extra cost. On the other hand, poor codes and standards can contribute to increased costs and disputes with little or no impact on construction safety. These costs and disputes arise from delays in construction progress, penalties for these delays, financial losses, personal injuries and fatalities.

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[1] A hazard is a dangerous condition that can interrupt or interfere with the expected, orderly progress of an activity. Hazards may be negligible when they will not result in injury to people or serious damage to equipment; marginal when they can be controlled to prevent injury or damage; critical when they will cause injury or serious damage or both; and catastrophic where they will cause death to workers.

[2] In the U.S., according to worker's compensation and other insurance and liability laws, an accident is any unplanned and unexpected event that causes injury or illness.

At first glance, many safety and health legislative and regulatory frameworks are prescriptive[3]. That is, they specify, in exacting terms, how the employer must address any given conditions. Additionally, these standards and regulations tend to support the traditional command-and-control, deemed-to-comply, or prescriptive approach of addressing unsafe conditions, existing and potential hazards while placing little, if any, emphasis on addressing unsafe worker behavior. Simply providing and enforcing prescriptive rules and procedures is not sufficient to foster safe behavior in the workplace (Reason, 1998). Legislative frameworks effectively address the work environment and procedures. It is the role of management to interpret how the provisions of such legislative frameworks will be enacted on construction sites relative to working practices. If unsafe worker behavior were addressed by legislation, construction practitioners might regard themselves as being absolved from their safety and health responsibilities to their workers. For example, if the law specified that construction workers had to come to work wearing mandatory minimum protective gear, it becomes an issue regarding who should provide the gear. Further, who should enforce the implementation of the law and who should bear the costs involved become other issues to be considered. The focus of implementation and enforcement has consequently been on compliance rather than on proactive preventive measures. Punitive measures for noncompliance are usually in the form of fines.

[3] Prescription literally means connection or conformity with statutes. The prescriptive approach is concerned with enforced conformity to the law, regulations and rules. Prescriptive standards, therefore, require strict, rigid, and objective criteria to be met to be in compliance. To be in compliance means to act in accordance with all applicable rules and standards that usually represent minimum requirements and become outdated by advances in technology or changes in working procedures.

Research conducted by the National Safety Council (NSC) and the Du Pont Company (Human Performance Technologies, 1998), however, suggests that, based on the root causes of accidents that were analyzed, the focus of standards and regulations on physical conditions might be misdirected (Table 1-1). The results of both studies strongly support the notion that the behavior of workers on construction sites needs to be changed if safety performance is to be improved. The question that arises is whether unsafe behaviors can be changed by legislation or through effective management.

Table 1-1 Root causes of industrial accidents

Causes	National Safety Council (%)	Du Pont Company (%)
Unsafe conditions	10	4
Unsafe behaviors	88	96
Unknown causes	2	-
Total	100	100

Adapted from Human Performance Technologies (1998)

Advocates of the behavior-based safety approach focus their attention on the modification of unsafe behaviors through the primary processes of observation and feedback (Blair, 1999; Geller, 1988; Geller, 1988; Geller, 1999; Loafman, 1998; Krause, 1993; Matthews et al., 1999; McSween, 1993; McSween, 1995; Sulzer-Azaroff, 1999). Unsafe physical conditions, equipment and management actions and attitudes are seemingly not addressed.

Hinze (1997) however disputes the results of these studies suggesting that the numbers are unsubstantiated and meaningless. He contends that accidents are a combination of physical conditions on construction sites and worker actions suggesting that safety should therefore focus on both. However, if the results of the studies imply that between 98% and 100% of industrial accidents are caused by a combination of unsafe behaviors and unsafe conditions, then it seems that both can be addressed. Consequently, most accidents can be avoided.

The construction industry is experiencing fundamental changes brought about by several influences such as increasing trade liberalization (Alleyne, 1997), globalization and internationalism. These influences are being accompanied by direct action to make the construction industry perform more efficiently by owners of international construction projects (Atkin and Pothecary, 1994). Arguably, the movement toward global integration is unstoppable (Alleyne, 1997). Moreover, the growing markets in the Far East, Middle East, Africa and South America present numerous opportunities for industry participants. As enterprises exploit these opportunities, they are increasingly confronted with how to cope with human rights issues that include worker protection.

Human rights issues have become a focal point of debate throughout the world. Worker safety and health are a subset of these issues, and accordingly should come under the same scrutiny. However, in an international environment where no uniformly accepted international safety and health standards currently exist, it is extremely difficult for construction practitioners to ensure that they create workplaces that are safe for their workers. Consequently, workers are forced to interpret the compliance requirements of legislation, implement construction practices, and use construction materials with which they are unfamiliar.

Increasing economic globalization necessitates the international harmonization and necessitates the development of regulatory standards and requirements critical to competition and economic efficiency (Office of Management and Budget 1996). Because of reducing the regulatory burden on international construction practitioners under free trade and anti-trust agreements through uniform international standards, the economic efficiency of their operations is likely to be increased. This shift is evidenced by worldwide interest in the development of performance-based building standards.[4] This international interest is fueled primarily by the need to address the difficulties posed by current prescriptive codes and standards pose, *inter alia*, regarding the following:

– Optimization of building construction costs;
– Product or system and process innovation; and
– Establishment of fair international trading agreements (Foliente, Leicester, and Pham, 1998).

Prescriptive codes are restrictive and constitute major non-tariff trade barriers that inhibit the building and construction trade. Effectively, they do not permit construction practitioners the flexibility to reduce construction costs through the easy introduction and subsequent use of innovative and new materials and technologies. Since they are usually very country-specific making compliance requirements difficult to understand and implement, they inhibit international trade.

This drive is supported by member economies who are signatories to the World Trade Organization (WTO) who have committed themselves to the use of performance requirements in their trade dealings with each other (Foliente, Leicester, and Pham, 1998). These performance criteria can be used to evaluate the fitness of a product for a particular purpose or to evaluate the merits of accepting new and innovative products and technology in their markets.

[4] Standards are statements of conditions or levels of acceptance that are acceptable to all concerned, and are then used to evaluate conditions and performance (Marshall, 1994). Performance-based refers to the approach in terms of which performance, as defined earlier, is the principal, essential or fundamental ingredient or goal. Performance-based standards, therefore, identify important, broadly defined goals that must result from applying a standard, rather than specific technical requirements.

Pressure is mounting internationally for such performance-based standards to be developed because of the global emphasis on making workplaces safe and reasonably free from health hazards (American National Standards Institute, 1996a; ANSI, 1996b). Standards are needed that allow innovation and flexibility, especially since risk and safety vary among countries based on their socioeconomic position (Walsh and Blair, 1996; Lapping, 1997). The variance in environmental and occupational health and safety standards between different countries has been cited as a major route of the international transfer or acquisition of health risks (Alleyne, 1997). The industry has not responded well to demands for improved productivity and quality, attention to environmental issues, reduced life cycle costs, value for money and improved safety performance (Haupt and Coble, 2000a)

In the increasingly global competitiveness of the construction business, quality control and quality assurance for a consistent level of performance in health and safety in construction is no longer optional (Kashef et al., 1996). In fact, it is critical to advocate more strongly for a concerted engagement in global health issues such as safety and health in international construction to make the industry a safer one for construction workers throughout the world. Research has shown that safe workplaces and workers improve productivity accompanied by reduced costs and increased profitability (Hinze, 1997; Levitt and Samelson, 1993).

There has been a steadily growing recognition that new and different approaches are necessary to arrest the incidence of accidents and fatalities on construction sites around the world. Previous country-specific prescriptive approaches have failed to reduce the number of accidents occurring on construction sites around the world. A uniform international approach that reduces the variance of construction safety and health standards between different countries could decrease the transfer and acquisition of health risks.

In response, safety and health regulations have been subjected to major revisions during the last three decades. In some cases, new legislative and regulatory approaches have entirely replaced existing regulations and legislation. The emphasis of these new pieces of legislation in Europe, the United Kingdom and New Zealand, for example, has been on individuals and their duties. Additionally, they represent a noticeable departure from previous prescriptive approaches (Coble and Haupt, 1999; 2000). They have been based on principles designed specifically to increase awareness of the problems associated with safety and health issues. They demonstrate a new approach and commitment to the management of construction projects. The value of these new efforts lies in the requirements of all participants in the construction process to make safety and health a mandatory priority in a structured way (Caldwell, 1999; Lorent, 1999). They are performance-based. Rather than prescribing strict compliance with regulations, they focus on satisfying safety outcomes or performance requirements. Consequently, they permit flexibility in dealing with safety and health issues. Additionally, they provide a framework within which all the activities of all participants in the construction process are coordinated and managed, in an effort to ensure the safety of those involved with construction.

Research Problem Statement

Accidents, incidents, injuries and fatalities continue to occur unabated on construction sites around the world at consistently high rates (Hinze, 1997; Center to

Protect Workers Rights, 1995; Berger, 2000). This situation persists despite various regulatory systems and standards in the construction industry in most countries. These systems and standards take the form of occupational safety and health laws, rules and regulations. Over the years, different philosophical approaches to construction occupational safety and health management have evolved that have underpinned the design, implementation and enforcement of these regulatory systems and standards. They have, however, built on the basic premise that construction accidents and fatalities may be mitigated by good construction practices, utmost care, effective inspection, and strict enforcement of high standards of care (Ratay, 1997). While differing in approach, scope and application from country to country, these regulatory frameworks have maintained their universal objective of the improvement of construction safety and health performance. In the context of international construction, this objective becomes harder to achieve when all participants in the construction process,[5] including the enforcement agencies, have to follow the same rules (Ratay, 1997). Codes and standards serve this purpose. While these by themselves do not prevent all accidents, adherence to them does improve site safety. The codes and standards provide the basis for the employment and enforcement of good construction practices. However, to fulfill this role they have to be reasonable in philosophy, adequate in detail, and well worded without ambiguity (Ratay, 1997). This is precisely where the problems lie. Approaches followed include the traditional prescriptive approach and, more recently, the behavioral based approach. The focus has been largely on addressing physical factors on construction sites like job

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[5] The construction process involves the various phases of the project including initiation, definition, pre-design, preparation of design documents, preparation of construction documents, construction operations on site, hand-over, occupancy and maintenance.

conditions, mechanical hazard elimination and forms of protection; and somewhat on personal or behavioral factors such as worker training, attitudes and physical characteristics, and the job environment (Barrie and Paulson, 1984). While the implementation of these approaches has resulted in the reduction of accidents, incidents, injuries and fatalities, the construction sector is still most responsible for accidents and deaths compared with all other industrial sectors. Unfortunately, this trend is a worldwide phenomenon. Further, there is no major tangible incentive for contractors to go beyond the minimum compliance requirements of safety and health regulations (Ebohon et al., 1998).

There is an international trend, particularly in Europe and the United Kingdom, toward redirecting the focus away from the need to comply prescriptively with construction occupational safety and health laws, toward a more flexible approach. In this approach, the focus is on the process and outcome rather than on the means of compliance (Coble and Haupt, 1999; 2000). This performance-based approach allows construction contractors to determine how to perform their operations. The approach is based on the position that each project process and design is unique; and consequently, compliance with a rigid set of rules is not feasible (Lapping, 1997). Rather than enforce complex rules and regulations with punitive measures such as heavy fines for noncompliance, regulatory and enforcement agencies are required to develop efficient and effective enforcement strategies with simplified, flexible, and consistent standards (Lapping, 1997).

This study examines the performance approach to determine its appropriateness and acceptance as a safety management approach. This study is motivated by the current lack of literature on the performance approach as it relates to construction worker safety and health. Further, the performance approach, particularly in the United States, has not been readily regarded as an acceptable alternative approach to the largely prescriptive approach promoted and fostered by the Occupational Safety and Health Act and Administration (OSHA). As far as the researcher is aware, there has not been any study that has attempted to measure the level of understanding nor the acceptability of the performance approach among contractors. Against the background that there have been different legislative and regulatory attempts to introduce the performance approach, there is a need for a universal and comprehensive model that would assist participants to successfully implement the approach in their workplaces. Finally, the study is driven by the need to inform about the approach and provide a clearer understanding of the potential benefits of introducing and implementing it in the area of construction worker safety and health.

Research Objectives

The purpose of this study is to examine whether a performance-based approach to construction safety management is an effective and acceptable approach to improving safety and health on construction sites. More specifically, the study has five main objectives.

The first objective is to increase the understanding of the performance paradigm and its application to safety and health in construction. This objective is accomplished by examining what is known about the approach as it applies to the construction industry, while defining its essential elements and unique characteristics.

The second objective is to determine the feasibility and acceptance of the performance approach as an effective alternative to previous prescriptive or deemed-to-comply approaches to construction worker safety. It would be achieved by comparing alternative approaches to identify those features, which are most likely to influence safety and health performance on construction sites.

The third objective is to develop a model for implementing the performance approach to worker safety and health on construction sites anywhere in the world.

The fourth objective is to establish whether variances to OSHA's prescriptive requirements have arisen due to the nonapplicability of these measures in the particular circumstances, and whether a performance approach would obviate these variances. This objective will be achieved examining applications to OSHA for variances, the profiles of the applicants, the nature of the variance sought, the reasons and motivations for the application, and the outcomes of the applications.

The fifth objective is to measure top management's knowledge about the performance approach and their attitude toward its implementation within their organizations. We examine top management's ability and willingness in order to determine how they will implement the performance approach.

Through this study we aim to contribute to the literature on the performance approach to construction worker safety and health, especially since very little has been written about this specific application of the performance approach.

Research Methodology

The methodology of this study is shown in Figure 1-1 and consists of the following:

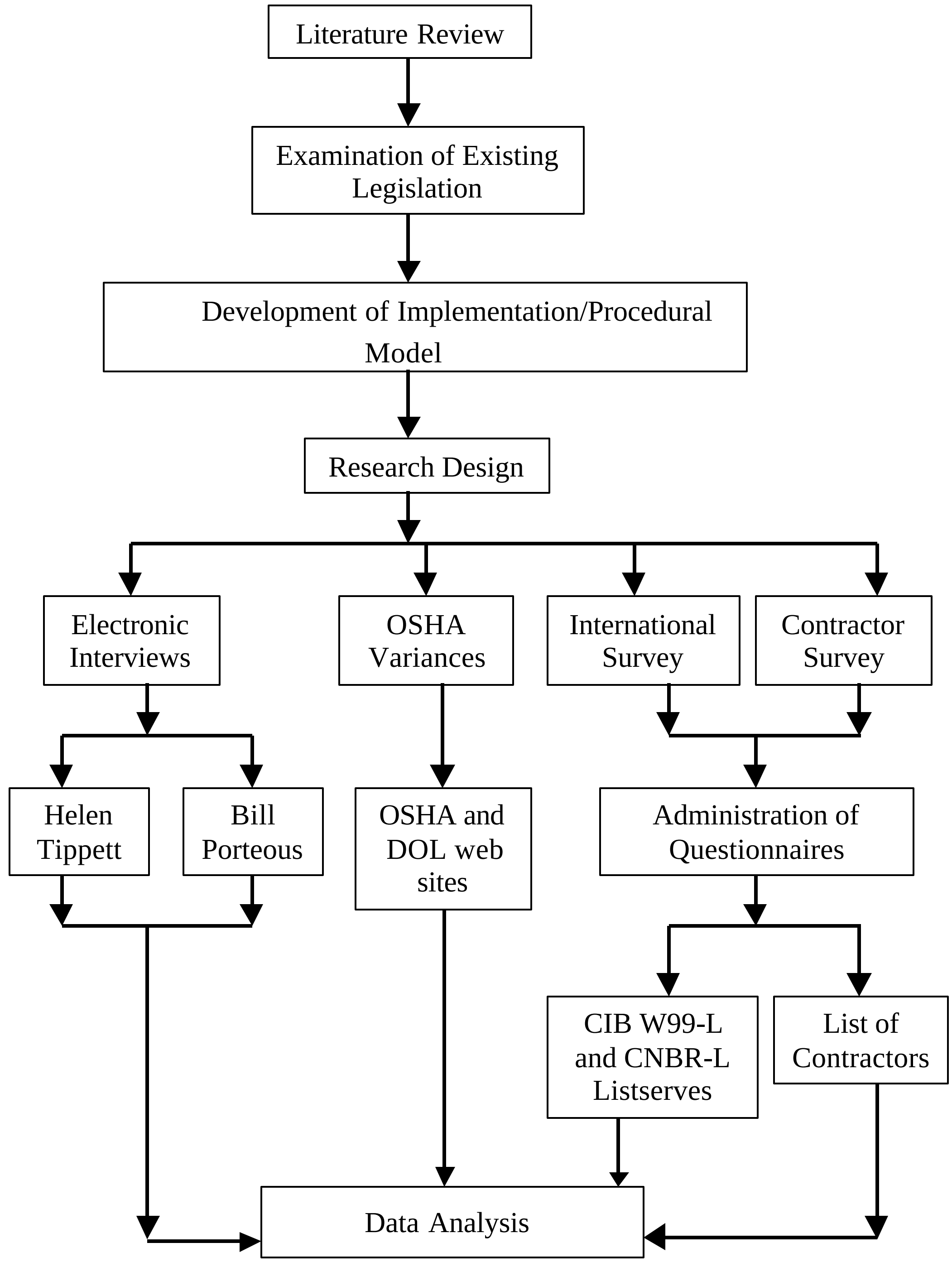

Figure 1-1 Flow-chart of research methodology

– A review of the literature to determine what is known and determine current practice of the performance approach in the construction industry regarding construction worker safety and health;

- An examination of existing international construction worker safety and health legislation, codes and standards to identify the differences between the performance and prescriptive approaches, with focus on concomitant innovations and restructuring;
- An electronic discussion with relevant experts and participants in the design and implementation of performance-based building codes and legislation (where this has occurred) to identify the motivation for the change from previous approaches, and problems encountered with implementation;
- An examination of applications for variances to OSHA requirements, the profiles of applicants, and the reasons and motivations for the applications; and
- A survey of the top management of a sample of construction firms in the United States to determine their attitudes and opinions about the performance approach and its implementation in their organizations.

Structure of Study

This introductory chapter outlines the research problem addressed by this study. It also sets out the objectives of the study and includes a brief description of the research methodological approach that is used.

In the chapter on safety performance of the construction industry, the safety performance of the construction industry is examined against the background of its importance as an economic industrial sector.

The literature on the performance approach is reviewed in the chapter entitled, The Performance Approach, to determine current practice and what is known about the approach in general, and about construction worker safety and health specifically. In this chapter, we consider several of the issues raised in the literature that affect implementation of the approach. We also consider the regulatory frameworks underpinning the performance approach in Australia, New Zealand, the United Kingdom and Canada. We discuss regulatory issues suggested by the literature pertaining to the design and implementation of a successful performance approach.

Some of the existing international legislation, codes and standards are examined in the chapter entitled, International Performance-based Safety Legislation, with emphasis on the innovations and restructuring that resulted from the change from the previous approaches. Where new legislation has been introduced, the resulting concerns are identified.

In the chapter entitled, Implementing the Performance Approach, a model for implementing the performance approach in the area of construction worker safety and health is developed and discussed. It is hoped that this model would be generalizable to all contexts anywhere in the world regardless of the prevailing paradigm and regulatory framework.

The methodology used in the study is discussed in the chapter entitled, Research Methodology. Data are analyzed in the chapters entitled, Analysis of OSHA Variances; Analysis of Findings of Top Management Survey; and Correlation, Regression Analysis and Modeling, respectively. The chapter, Summary, Conclusions and Recommendations, outlines the research findings, contributions, and recommendations for future study.

SAFETY PERFORMANCE OF THE CONSTRUCTION INDUSTRY

Introduction

The state of the construction industry in a country is symptomatic of the state of its national economy. Put another way, the fate of any national economy cannot be separated from that of the construction industry. This is a consequence of the forward and backward linkages the construction sector forges with the rest of the economy (Drewer, 1980; Ahmad and Yan, 1996). The backward linkages refer, for instance, to the construction materials and services sectors of the economy. The forward linkages refer to the economic activities that result from the use of constructed buildings and facilities. This chapter shows that as an industrial sector, the construction industry is too important to ignore. For this reason, the nature and characteristics of the construction industry are examined. Against this background, the safety performance of the construction industry is critically discussed.

Importance of the Construction Sector

The construction sector plays an important role in the economies of countries throughout the world. The role of the construction industry in economic development has been validated by several studies (Strassman, 1975; Turin, 1969; Wells, 1986; Ofori, 1988). In these studies, a strong statistical relationship has been established between the state of the construction industry and economic growth. Turin (1969) analyzed the data for 87 countries (developed and underdeveloped) between 1955 and 1965. He concluded that a positive correlation existed between the value added by construction and the Gross Domestic Product (GDP) of the country. Strassman (1975), who argued that the construction industry mirrored a pattern of structural change that reflected a country's level of economic development, echoes this conclusion.

It has further been established that where economic growth has been significant, the growth of construction output has been even more dramatic (Wells, 1986). For example, in the UK, the construction industry was projected to have an economic output of some £58 billion ($87 billion) in 1998, which constitutes approximately 10% of the GDP (Construction Task Force, 1998). In China, while the GDP was growing rapidly since 1979, the share of the construction industry as a percentage of GDP increased as well (Ahmad and Yan, 1996).

Generally speaking, the assessment of the total value of construction output in any economy is difficult to determine and usually understated. Nowhere in the national accounts of any country is there a comprehensive picture of the total output of construction (Wells, 1986). Wells, who has worked in the area of development economics as it relates to the construction industry, cites as one of the reasons for this scenario the fact that the value added by construction to GDP is the difference between the value of sales at market prices, and the market value of all current purchases. It therefore excludes the value of purchased building materials and components, fuel, transport, professional services, insurance and legal fees. Additionally, the value of capital formation in construction, which is a measure of the gross output of the construction sector, excludes the value of repairs and maintenance work. Further, a large percentage of construction activity, especially in developing countries, is carried out in the 'informal sector.'[6] This contribution is not included in national statistics.

The construction industry is a major employer of labor. This claim is confirmed by the data from selected countries in Table 2-1. Of all industrial workers, the construction sector employed between 4.9% (33.4 million) in the People's Republic of China and 16.2% (5.7 million) in Mexico from 1994 through 1997. In the United States, the average was 6.2% (7.9 million) for the same period. In the United Kingdom, the average was 7.1% (1.8 million) for the same period. In Germany the average was 14.0% (2.9 million) for the same period. The data in Table 2-1 should not be surprising since many construction activities, tasks and operations are labor-intensive.

The data in Table 2-2 confirm that construction employment in developing countries such as those in Africa follows a similar trend. As a percentage of total employment, employment in the construction sector ranged from 4.8% (313,600 workers) in South Africa in 1997 to 11.8% (41,000 workers) in Botswana in 1995.

While caution must be exercised in the use of employment statistics, particularly in developing countries, Turin (1969) found that regular construction employment contributed between 40 and 80 workers per1000 where the industry plays a lesser role, and between 300 and 400 workers per1000 where construction plays a more significant role as an economic sector in the national employment statistics.

Similarly, in most developing countries, the construction sector contributed between 2% and 6% of total employment (Low and Christopher, 1992).

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[6] The informal sector refers to those participants in the construction process who operate outside the regularly controlled sector characterized by registration, unionization and payment of various required fees

Table 2-1 Industrial and construction employment statistics (1000s)

Country[7]	1994	1995	1996	1997	Average
Egypt	15,241.4 1,019.4 (6.7%)	15,344.2 967.6 (6.3%)	N/A	N/A	15,292.8 993.5 (6.5%)
South Africa[8]	N/A	6,576.6 359.1 (5.5%)	9,113.8 555.1 (6.1%)	6,556.9 313.6 (4.8%)	7,118.8 409.3 (5.7%)
Argentina	10,529.0 900.9 (8.6%)	10,348.0 821.3 (7.9%)	10,542.0 852.3 (8.1%)	N/A	10,473.0 858.2 (8.2%)
Brazil	N/A	69,629.0 4,229.0 (6.1%)	67,920.0 4,337.0 (6.4%)	69,332.0 4,583.0 (6.6%)	68,960.3 4383.0 (6.4%)
Venezuela	7,265.9 602,9 (8.3%)	7,667.0 624,7 (8.1%)	7,819.2 600.1 (7.7%)	8,286.8 694.4 (8.4%)	7,759.7 630.5 (8.1%)
Mexico	N/A	33,881.1 5,168.4 (15.3%)	35,226.0 5,778.8 (16.4%)	37,359.8 6,264.9 (16.8%)	35,489.0 5,737.4 (16.2%)
Canada	13,291.7 743.8 (5.6%)	13,505.5 715.0 (5.3%)	13,676.2 705.4 (5.2%)	13,940.6 730.7 (5.2%)	13,603.5 723.7 (5.3%)
United States	123,060.0 7,493.0 (6.1%)	124,900.0 7,668.0 (6.1%)	126,708.0 7,943.0 (6.3%)	129,558.0 8,302.0 (6.4%)	126,056.5 7,851.5 (6.2%)
China	671,990.0 31,880.0 (4.7%)	679,470.0 33,220.0 (4.9%)	688,500.0 34,080.0 (4.9%)	696,000.0 34,479.0 (5.0%)	683,990.0 33,414.8 (4.9%)

[7] Numbers in Egypt and Mexico refer to persons aged 12-64 years and include only the civilian labor force; in Argentina persons aged 10 and over are included; in Brazil the rural population of Rondonia, Acre, Amazonas, Roraima, Para and Amapa are excluded; in Canada, Denmark, Germany, Israel, Hong Kong, Venezuela, Finland, Japan, Australia and New Zealand persons 15 years and over are included and only the civilian labor force; in Israel residents of East Jerusalem are included; in the U.S. and UK the data include only persons aged 16 years and over and the civilian labor force; in China armed forces and re-employed retired persons are excluded and the whole national economy is covered; Japan includes self-defense forces; in Turkey persons 12 years and over are included and the civilian labor force

[8] Data for South Africa were obtained fom Statistics South Africa via e-mail on February 22, 2000. However, the data for 1996 were drawn from the published census of Statistics South Africa. A possible explanation is the exclusion of the Bantustans from the e-mailed data. Further, according to The World Bank's African Development Indicators 2000 the total employment for 1997 is 15,835,000. This figure was not used because a figure for construction employment for 1997 was not available.

Table 2-1 Continued

Country	1994	1995	1996	1997	Average
Japan	64,530.0 6,550.0 (10.2%)	64,570.0 6,630.0 (10.3%)	64,860.0 6,700.0 (10.3%)	65,570.0 6,850.0 (10.4%)	64,882.5 6,682.5 (10.3%)
Hong Kong	2,872.8 220.5 (7.7%)	2,905.1 229.3 (7.9%)	3,007.7 269.6 (9.0%)	3,144.7 306.2 (9.7%)	2,982.6 256.4 (8.6%)
Israel	1,871.4 118.0 (6.3%)	1,965.0 140.6 (7.1%)	2,012.7 150.0 (7.5%)	2,040.2 146.2 (7.2%)	1,972.3 138.7 (7.0%)
Denmark	2,554.9 158.5 (6.2%)	2,609.8 163.2 (6.3%)	2,627.3 170.2 (6.5%)	2,682.0 176.1 (6.6%)	2,618.5 167.0 (6.4%)
Finland	2,080.0 109.0 (5.2%)	2,128.0 115.0 (5.4%)	2,158.0 118.0 (5.5%)	2,194.0 130.0 (5.9%)	2,140.0 118.0 (5.5%)
Germany	20,987.0 2,753.0 (13.1%)	20,939.0 2,973.0 (14.2%)	20,706.0 3,042.0 (14.7%)	20,549.0 2,873.0 (14.0%)	20,795.3 2,910.3 (14.0%)
Turkey	20,396.0 1,231.0 (6.0%)	21,378.0 1,228.0 (5.7%)	21,698.0 1,356.0 (6.2%)	20,815.0 1,323.0 (6.4%)	21,071.8 1,284.5 (6.1%)
United Kingdom	25,697.0 1,863.5 (7.3%)	25,972.7 1,835.5 (7.1%)	26,218.8 1,818.7 (6.9%)	26,681.6 1,864.8 (7.0%)	26,142.5 1,845.6 (7.1%)
Australia	7,885.5 568.8 (7.2%)	8,218.2 601.1 (7.3%)	8,324.2 596.2 (7.2%)	8,386.6 580.3 (6.9%)	8,203.6 586.6 (7.2%)
New Zealand	1,559.5 92.4 (5.9%)	1,632.6 99.7 (6.1%)	1,687.5 110.4 (6.5%)	1,735.9 115.1 (6.6%)	1,653.9 104.4 (6.3%)

Source: ILO (1999); Statistics South Africa (SSA)(22/2/2000) and SSA (1998)

The significant contribution of construction employment is confirmed by the data in Table 2-1where the range is between 4.9% and 16.2% of total employment.

In labor surplus economies where employment is scarce and seasonal, labor-intensive industries like construction remain invaluable sources of employment and income. Thus, the construction employment contribution to the countries shown in the Tables 2.1 and 2.2 is vital to the economies of these countries. Such contributions are likely to rise as the economy grows, industry develops, and per-capita income increases

(Edmonds and Miles, 1984). Per capita income refers to the average annual income per individual citizen Therefore, as economic growth accelerates, construction output will not only expand but will also be a clear linkage to the rest of the economy (Wells, 1986; Ahmad and Yan, 1996).

Table 2-2 Role of construction in national employment in African countries

Country	Year	Total Employment (000s)	Construction Employment (000s)	Share Of Construction Sector (%)
Botswana	1995	345.4	41.0	11.8%
Egypt	1995	15,344.2	967.6	6.3%
Morocco	1992	3,494.3	281.9	8.1%
Mauritius	1995	436.3	41.9	9.6%
South Africa	1997	6,556.9	313.6	4.8%

Source: ILO (1999); Statistics South Africa (1998)

Nature of the Construction Industry

The construction industry is characteristically one in which most of its products are unique for substance, form, size and purpose (Berger, 2000; Porteous, 1999). Each building or facility may, therefore, be described as being custom-made. Buildings cannot be isolated from the environment in which they are situated. From another perspective, Wells (1986) cites that the products of construction differ widely in terms of location, materials and production techniques, and the standards of the finished product regarding space, quality, durability, and aesthetic consideration. It is less well recognized that they vary from each other, even when built to identical plans and specifications (Porteous, 1999). For example, ground conditions may require different foundation depths or systems for two otherwise apparently identical buildings.

A further consideration is that the completed products are generally not mobile in that they are permanently fixed in specific locations. This consideration implies that even if components are prefabricated and/or pre-assembled elsewhere, the final assembly process remains site-specific. Where they are not unique, work operations that are similar and repetitive are executed in work environments that change from hour to hour due to changes in the environment such as weather conditions, location, physical conditions, and height (Porteous, 1999).

The physical working environment in construction varies with seasons and job site conditions. Site conditions conceivably vary between work done below natural ground level, at ground level, at elevated heights, and sometimes even over and under water. This changing working environment results in potentially hazardous situations. Construction workers are required, therefore, to familiarize themselves constantly with these new situations. Unlike manufacturing, continuity of production is not always possible, since each product of construction is usually unique.

Construction sites are subject to local conditions (Berger, 2000). The availability of materials and plant equipment may vary, requiring substitution with materials and plant with which the labor force might be unfamiliar. Moreover, each building site represents in effect the creation of a production site where new workplaces are set up. The term ‘mobile factories’ could be used to describe this phenomenon. At the end of each construction project the ‘factory’ is disassembled and relocated to the site of a new or different project. However, the conditions at the new site might be completely different to the previous project site.

The construction industry has often been described as an industry characterized by fragmentation (Center to Protect Workers' Rights, 1993; Helledi, 1999). This description has arisen due to the number of stakeholders and participants in the construction process from project inception through project completion and beyond – each with divergent roles, goals, expertise and skills. This fragmentation has resulted in the following:

- Increased construction costs;
- Low productivity;
- Poor communication between all participants;
- Increased, and often, unnecessary, confusing and contradictory documentation;
- Ineffective and inefficient project management;
- Unnecessary delays;
- Unsatisfactory quality performance;
- Rework;
- Poor safety performance; and
- Costly and lengthy disputes (Haupt, 1996).

Additionally, the composition of construction project teams responsible for the design, project management and project execution, changes from project to project, resulting in a lack of continuity and consistency. Traditionally, design is separated from the actual construction process with resultant problems in communication, coordination and interpretation. Significant professional, legal and institutional barriers have accompanied this separation, which has created continuity problems between the various members of the project team, constructors and subcontractors.

The divorce of design from production in the construction process is reinforced by the rigid compartmentalization of training in the various design and construction professions (Wells, 1986). A consequence of this compartmentalized approach has been the isolation of professionals from technical developments in the industry due to a corporate approach to construction activities that disallows innovation and technological development in the industry. The effect of this isolation results in little consideration being given to alternative construction materials and techniques. Even more fundamental, is the consequent and apparent lack of concern for worker safety. It is rarely central to the thinking of owners, designers, contractors and unions (Center to Protect Workers' Rights, 1993).

Under the traditional building procurement system,[9] there is little incentive to investigate alternative materials, methods and safety options as a result of professional fees being linked to the final cost of the project (Wells, 1986). The cost of the time spent in investigating alternatives not be recovered from the client under such procurement and contractual arrangements.

Further, this separation of design from production provides the ideal breeding ground for disputes between the various participants in the construction process. Apart from the separation of design from production, contracting by its very nature is adversarial. The objectives of the different contracting parties are different (Binnington, 1999). The objectives of the major contracting parties, namely, the client and constructor are divergent regarding the traditional project parameters of time, cost, and quality. For example, constructors are constantly under pressure from clients to submit highly competitive bids and reduce the cost of construction. Competitive tendering usually results in the selection of the contractor who is prepared to take the biggest risk or who has made the biggest mistake (Binnington, 1999). This tension contributes to the climate

[9] The traditional building procurement system is one in terms of which the architect heads up the project team receives the project brief and is solely responsible for all communication with the client. The architect appoints the other participants in the construction process.

of disputes. Consequently, safety is one of the first areas to be sacrificed in the effort to reconcile the divergent objectives.

Research conducted in New Zealand in 1997 (Site Safe, 2000) suggested that cost driven projects and the competitive nature of the tender process resulted in lack of margins and cost cutting of safety.

The construction industry is subject to economic cycles and is dependent on changing governmental priorities[10] and policies producing ‘stop-go’ approaches in the sector (Ahmad and Yan, 1996). In most economies in the world, the intensity of construction activity fluctuates according to variations in investor confidence, availability and cost of finance and consumer demand, or even a combination of these (Porteous, 1999). These variations are typical investor and consumer reactions to changing governmental priorities and policies.

Consequently, the construction industry does not enjoy continuous demand for its products and services. This scenario implies that the demand for people with the appropriate construction skills also fluctuates. Qualified and trained workers, needing employment of some kind, leave the industry when demand for their services disappears. The impact of this occurrence is evident in the lack of investment in, and lack of commitment to worker training that is an important component of any plan to improve safety performance.

[10] For example, in China the sensitivity of the construction sector to the national economy was evidenced during the period of the recent austerity program when the government slammed brakes on the State Fixed Investment through a slowdown in approval of new projects and a credit squeeze.

Once construction activity increases, the shortage of skilled and trained people is even more acute. To make up for this shortage, the labor force may be augmented with, or even consist of, workers who lack the appropriate training and experience needed to properly and safely execute the essential processes of construction assembly.

Frequently, these workers are expected to acquire totally new skills 'on the job'[11] but without any structured instruction or training program (Porteous, 1999). Usually a proper induction program that has been shown to be effective in safety and health programs is not conducted for these new employees. These workers constitute the group most likely to experience accidents (Hinze, 1997).

According to Porteous (1999), a further consequence of this fluctuation is the variation in the numbers of workers who have been trained as distinct from educated. A trained worker would know how to execute a construction activity in a certain manner, while an educated worker would know why the activity should be executed in that particular manner. Additionally, it takes much longer to educate a worker than to train one. The acquisition of knowledge of the various sciences relating to construction is a more gradual process than merely learning how to perform a sequence of activities. The industry, therefore, responds to meeting the acute shortage of skilled workers by investing in skills training of workers rather than in providing them with a good education in covering all aspects of the construction process.

The procurement systems used within the industry are frequently based on competitive tendering. This tendering practice results in contractors undertaking

[11] 'On the job' refers to training that occurs on the actual job site where the worker is employed and it implies that this skill acquirement is a consequence of performing the work.

construction projects on a ‘one-off’ basis. By implication each project is, therefore, treated as being unique, without the prospect of either the physical structure being reproduced, or the project team working together again on the next project. Since this practice is the predominant means of obtaining work in many countries, it is difficult for contractors to determine their future workload, plan or invest for the future. The risks associated with this uncertainty lead to limited investment in fixed capital, minimum employment of permanent staff, and the increased use of subcontractors and casual labor (Center to Protect Workers’ Rights, 1993). There are few opportunities to learn from mistakes on one building when the next one to be constructed is an entirely different one. Legal considerations tend to make the makers of mistakes reluctant to publish their newfound knowledge (Porteous, 1999). In addition, the highly competitive nature of the industry does not encourage the sharing of knowledge with other potential competitors (Porteous, 1999). Industry practitioners will avoid their responsibility regarding safety and health, using the reasons just given as excuses for not observing safety and health policies.

Because of the financial rewards and incentives to build more cheaply in the short-term, one of the first areas, unfortunately, to experience cost cutting to improve the competitiveness of tenders is that of safety and health (Porteous, 1999; Site Safe, 2000). As long as the products of construction are commodities, built for immediate sale or financial returns on completion, there will be strong incentives for investors to push the minimum mandatory requirements for safe and healthy buildings. Short-term market forces are antipathetic to the expenses incurred in complying with a building code. Building control regimes neither encourage nor discourage the construction of buildings that exceed the minimum safe and sanitary requirements. It is likely that the minimum mandatory requirements of the code will become the norm as long as short-term financial outlooks prevail.

A further characteristic of the industry is the unfavorably high supervisor-worker ratio, which according to Hinze (1997) should be of the order of 2.7 workers to 1 supervisor. Supervisors who have a more personal and positive relationship with their workers have more favorable safety performance records (Hinze 1997, Levitt and Samelson 1993). This relationship is difficult to develop if the ratio is high.

For a long time, the construction industry has been labeled as one with a poor health and safety culture. Efforts to improve health and safety performance will not be effective until the health and safety culture is improved (Dester and Blockley, 1995). That is, there is a need for a major paradigm shift regarding attitudes toward safety and health on construction sites.

Safety Performance of the Construction Industry

In the industrialized nations of the world, accidents[12], now cause more deaths than all infectious diseases and more than any single illness[13] except those related to heart disease and cancer (Brittannica Online, 1998). The construction industrial sector is a dangerous or highly hazardous one (The Business Roundtable, 1983; Churcher and Alwani-Starr, 1996; Birchall and Finalyson, 1996; Khalid, 1996; Smallwood and Haupt,

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[12] Accidents are unplanned and undesirable events that interrupt planned activities that may or may not result in injury or property damage.

[13] An illness is a bodily impairment resulting from exposure over a period of time to a harmful substance or environment, which does not occur immediately and is not evident until some time after the exposure.

2000). It has earned itself this unfortunate and unenviable reputation due to the disproportionately high incidence of accidents and fatalities which continue to occur on construction sites around the globe. For instance, in New Zealand, construction workers are three times more likely to be killed and twice as likely to be seriously injured than the general workforce (Site Safe, 2000). Internationally, construction workers are two to three times more likely to die on the job than workers in other industries while the risk of serious injury is almost 3 times higher (Site Safe, 2000).

The construction industry in the United Kingdom, for example, has for many years consistently had the highest incident rate for fatal accidents and serious injuries[14] when compared with all other industrial sectors (Joyce, 1995). In New Zealand during 1998 more than 3,000 workers had injuries serious enough to prevent them from working for more than five days (Site Safe, 2000). The number of fatalities in construction represents only a fractional part of the problem, with thousands of major injuries, and even more minor ones, resulting in lost time.

In the United States of America, for example, the construction industry employs in the region of 6% of the entire industrial workforce (Table 2-1). However, the construction sector has generally accounted for nearly 20% of all industrial worker deaths (Hinze, 1997; Center to Protect Workers' Rights, 1993).

In Europe, the situation is more serious with the construction industry employing on average between 5% of the industrial workforce in Finland and 14% in Germany (Table 2-1). Construction accounts for on average between 7.5% of all accidents and

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[14] Injuries are bodily impairments that are immediate, occur at a fixed time and place, resulting from accidents.

injuries in the United Kingdom and 12.6% in Finland as evidenced in Table 2-3. The sector is responsible for 30% of all fatalities (Berger, 2000; Lorent, 1999).

The Accident Rehabilitation and Compensation Insurance Corporation (ACC) in New Zealand, reported that the construction industry employed 5.8% of the total workforce (11% of the part time workforce) in 1998. Construction was responsible for about 11.5% of the expenditure from the employer account of the ACC (Site Safe, 2000). In 1998, construction fatalities accounted for 32.9% of total workplace fatalities (Site Safe, 2000).

Although the incidence of injuries and fatalities has decreased by more than 50% during the last 30 years, the number of accidents, injuries and deaths continues to remain unacceptably high. In the United States alone, accidents in the construction industry cost over $17 billion annually (Levitt and Samelson 1993). Data from the ACC in New Zealand indicate that between 1994 and 1996, claims for construction injuries increased by 28%, which is about twice the rate of increase for all other industries (Site Safe, 2000). In 1997, the ACC spent NZ$69 million on treatment and compensation for construction injuries, while the indirect cost to firms and workers was conservatively estimated at NZ$21 million.

The Center to Protect Workers' Rights (1993) reported that in the United States, workers in many construction trades died 8 to 12 years earlier, on average, than did many white-collar workers. In the United States, three to four construction workers die from injuries on the job each workday (representing 18.6 to 34 fatalities per 100,000 full-time workers). Further, construction has more deaths from injuries on the job than any other industrial sector. It is estimated that there are on average more than 229,000 lost-time construction worker injuries in the United States requiring restricted work or time off to recover (Table 2-3).

Table 2-3 Industrial and construction accident statistics (1000s)

Country[15]	1994	1995	1996	1997	Average
Egypt	60.7 5.7 (9.4%)	57.3 4.4 (7.7%)	55.4 4.3 (7.8%)	50.9 4.2 (8.2%)	56.1 4.7 (8.3%)
South Africa	9.0 0.8 (8.9%)	10.5 0.9 (8.6%)	9.6 0.8 (8.3%)	6.3 0.5 (7.9%)	8.9 0.8 (9.0%)
Namibia	5.0 0.9 (18.0%)	3.9 0.7 (17.9%)	4.2 0.6 (14.3%)	4.9 0.8 (16.3%)	4.5 0.8 (17.8%)
Panama	16.8 2.2 (13.1%)	16.8 2.1 (12.5%)	16.5 2.2 (13.3%)	15.8 1.4 (8.9%)	16.5 2.0 (12.0%)
Canada	429.7 33.4 (7.8%)	411.2 31.0 (7.5%)	378.6 29.9 (7.9%)	380.7 30.5 (8.0%)	400.1 31.2 (7.8%)
Mexico	N/A	442.7 45.7 (10.3%)	401.8 39.3 (9.8%)	428.9 35.9 (8.4%)	424.5 40.4 (9.5%)
United States	3,061.0 246.1 (8.0%)	2,967.4 221.9 (7.5%)	2,832.5 220.5 (7.8%)	2,866.2 230.7 (8.0%)	2,931.8 229.8 (7.8%)
Venezuela	8.0 2.1 (26.3%)	7.6 2.2 (28.9%)	6.5 1.1 (16.9%)	5.2 1.5 (28.8%)	6.8 1.7 (25.4%)
Puerto Rico	28.0 2.1 (7.5%)	25.6 1.9 (7.4%)	27.2 2.2 (8.0%)	26.0 1.2 (4.6%)	26.7 1.1 (4.2%)
China	16.3 2.7 (16.6%)	28.5 2.1 (7.4%)	29.0 2.0 (6.9%)	26.4 1.6 (6.1%)	25.1 2.1 (8.4%)
Hong Kong	64.4 16.7 (25.9%)	59.4 15.5 (26.1%)	59.5 16.7 (28.1%)	62.8 19.1 (30.4%)	61.5 17.0 (27.6%)

[15] Numbers in Egypt include establishments employing 50 or more workers; in South Africa before 1996 they exclude occupational diseases, but include non-fatal cases without lost workdays; in the U.S. they include establishments with 11 or more employees; in China state owned enterprises only are included; in the UK road traffic accidents are excluded; in Australia Victoria and Australian Capital Territory are excluded.

Table 2-3 Continued

Country	1994	1995	1996	1997	Average
Israel	84.2 10.1 (12.0%)	88.3 10.5 (11.9%)	92.3 12.0 (13.0%)	83.8 10.4 (12.4%)	87.2 10.8 (12.3%)
Jordan	13.7 2.4 (17.5%)	15.3 2.4 (15.7%)	14.8 2.7 (18.2%)	13.4 3.3 (26.4%)	14.3 2.7 (18.9%)
Denmark	47.7 4.1 (8.6%)	49.7 4.5 (9.1%)	50.6 4.3 (8.5%)	N/A	49.3 4.3 (8.7%)
Finland	56.1 7.3 (13.0%)	57.6 6.9 (12.0%)	53.1 6.9 (13.0%)	N/A	55.6 7.0 (12.6%)
Norway	24.0 2.3 (9.6%)	30.1 3.2 (10.6%)	27.8 2.8 (10.1%)	34.1 3.4 (10.0%)	29.0 2.9 (10.0%)
United Kingdom	159.6 11.7 (7.3%)	150.3 10.3 (6.9%)	158.3 12.0 (7.6%)	167.3 13.8 (8.3%)	158.9 12.0 (7.5%)
Australia	135.7 13.1 (9.7%)	139.1 12.8 (9.2%)	133.4 12.2 (9.1%)	123.9 10.8 (8.7%)	133.1 12.2 (9.2%)
New Zealand	31.6 2.5 (7.9%)	40.0 3.6 (9.0%)	42.6 4.0 (9.4%)	36.5 4.1 (11.2%)	37.7 3.6 (9.4%)

Source: ILO (1999)

The data in Table 2-3 from selected countries indicate the number of accidents in the construction industry during the period 1994 through 1997. The data suggest that the construction industry is responsible for, on average, between 7.5% of all types of accidents in the United Kingdom and 27.6% in Hong Kong. Noticeably, the sector accounts for, on average, 7.8% of all types of accidents in the United States and Canada, and 9.5% in Mexico for the same period.

The range for the African countries selected is from 8.3% in Egypt to 17.8% in Namibia. For Asian countries selected, the range is 8.4% in Mainland China to a staggering 27.6% in Hong Kong. For the selected South American countries, the range is 4.2% in Puerto Rico to 25.4% in Venezuela. For Europe, the range is 7.5% in the United

Kingdom to 12.6% in Finland. For Oceania, the range is much closer with Australia being 9.2% and New Zealand 9.4%. In the Middle East, the range is from 12.3% in Israel to 18.9% in Jordan.

Table 2-4 Statistics for industrial and construction fatalities

Country[16]	1994	1995	1996	1997	Average[17]
Egypt	203 39 (19.2%)	201 40 (19.9%)	154 33 (21.4%)	180 21 (11.7%)	185 33 (18.0%)
South Africa	913 103 (11.3%)	879 114 (13.0%)	612 54 (8.8%)	482 74 (15.4%)	722 86 (11.9%)
Namibia	41 6 (14.6%)	41 3 (7.3%)	48 6 (12.5%)	18 2 (11.1%)	37 4 (9.25%)
Panama	65 8 (12.3%)	85 16 (18.8%)	60 7 (11.7%)	76 7 (9.2%)	72 10 (13.2%)
Canada	724 145 (20.0%)	749 137 (18.3%)	703 150 (21.3%)	833 149 (17.9%)	752 145 (19.3%)
Mexico	N/A	1,618 261 (16.1%)	1,315 209 (15.9%)	1,568 220 (14.0%)	1,500 230 (15.3%)
United States	6,632 1,028 (15.5%)	6,275 1,055 (16.8%)	6,202 1,047 (16.9%)	6,238 1,107 (17.7%)	6,337 1,059 (16.7%)
Puerto Rico	67 7 (10.4%)	82 20 (24.4%)	58 14 (24.1%)	41 6 (14.6%)	62 12 (19.0%)
China	7,235 1,513 (20.9%)	20,005 1,474 (7.4%)	19,457 1,358 (7.0%)	17,558 1,056 (6.0%)	16,064 1,350 (8.4%)
Hong Kong	263 76 (28.9%)	247 89 (36.0%)	278 70 (25.1%)	247 63 (25.5%)	259 75 (29.0%)

[16] In Egypt establishments with 50 or more employees are included; in Namibia and Finland deaths occurring within 1 year of accident are included; the U.S. includes establishments with 11 or more employees; China includes deaths occurring within 1 month of accident; Hong Kong includes manual workers; in the UK road traffic accidents are excluded; in Australia Victoria and Australian Capital Territory are excluded

[17] All data in this column have been rounded up to the nearest whole number

Table 2-4 Continued

Country	1994	1995	1996	1997	Average
Japan	2,301 942 (40.9%)	2,414 1,021 (42.3%)	2,363 1,001 (42.4%)	2,078 848 (40.8%)	2,289 953 (41.6%)
Jordan	23 3 (13.0%)	27 3 (11.1%)	10 4 (40.0%)	18 9 (50.0%)	20 5 (23.8%)
Denmark	75 15 (20.0%)	84 14 (16.7%)	76 13 (17.0%)	N/A	78 14 (17.9%)
Finland	55 8 (14.5%)	46 12 (26.1%)	48 6 (12.5%)	N/A	50 9 (17.3%)
Norway	42 10 (23.8%)	60 12 (20.0%)	53 0 (0%)	64 11 (17.2%)	55 8 (15.0%)
United Kingdom	211 59 (28.0%)	233 66 (28.3%)	220 66 (30.0%)	230 59 (25.7%)	224 63 (27.9%)
Australia	324 43 (13.3%)	289 43 (14.9%)	246 38 (15.4%)	289 30 (10.4%)	287 39 (13.4%)
New Zealand	45 7 (15.6%)	55 7 (12.7%)	59 4 (6.8%)	43 7 (16.3%)	51 6 (12.3%)

Source: ILO (1999)

The data in Table 2-4 reflect the extent to which the construction industry is responsible for fatalities when compared with the total number of fatalities in the work place.

The construction industry contributes, on average, from 8.4% in Mainland China to 41.6% in Japan of all industrial fatalities from 1994 through 1997. The sector accounts for, on average, 16.7% of all types of industrial deaths in the United States, 19.3% in Canada, and 15.3% in Mexico for the same period. The range for the African countries selected is from 9.25% in Namibia to 18.0% in Egypt. For Asian countries selected, the range is 8.4% in Mainland China to a staggering 41.6% in Japan.

For the selected South American countries, the range is 13.2% in Panama and 19.0% in Puerto Rico. For Europe, the range is 15.0% in Norway and 27.9% in the United Kingdom. For Oceania, the range is much closer with Australia being 13.4% and New Zealand 12.3%. In Jordan, the contribution is 23.8%.

While the data in Table 2-4 confirm that the construction industry is responsible for a major proportion of all workplace-related deaths, a more illustrative statistic would be the rate of fatalities per1000 workers employed. These data are reflected in Table 2-5 for selected countries.

An examination of the data in Table 2-5 confirms, on average, that for every 10,000 workers employed in construction the number of workers that will be fatally injured in:

- Egypt, Canada, Bolivia, Spain and Korea will be 3 workers;
- Panama will be between 4 and 5 workers;
- Turkey will be between 5 and 6 workers; and
- Hong Kong will be between 10 and 11 workers.

Apart from the actual costs incurred regarding injuries and fatalities, the national economy of any country suffers enormous cost and loss of productivity due to the number of workdays lost as a consequence of occupational injuries and deaths.

The data in Table 2-6[18] provide an indication of the magnitude of this problem in selected countries and suggest that the construction sector is responsible for a major proportion of the workdays lost as a result of occupational injuries.

[18] The countries were selected based on the completeness of the data listed in the ILO Yearbook of Labour Statistics with the intention of obtaining an idea of the magnitude of the potential losses because lost workdays in construction; Egypt includes establishments with 50 or more employees; Australia excludes Victoria and Australian Capital Territory

Table 2-5 Industrial and construction fatalities per1000 employees

Country[19]	1994	1995	1996	1997	Average
Egypt	0.12 0.32	0.11 0.34	0.09 0.30	0.11 0.25	0.11 0.30
Zimbabwe	0.19 0.21	0.21 0.29	N/A	N/A	0.20 0.25
Panama	0.17 0.44	0.16 0.66	0.11 0.27	N/A	0.15 0.46
Canada	0.0647 0.3225	0.0655 0.3015	0.0609 0.3287	0.0705 0.3151	0.0654 0.3170
Bolivia	0.156 0.000	0.125 0.198	0.117 0.385	0.111 0.711	0.127 0.324
United States	0.005 0.015	0.005 0.015	0.005 0.014	0.005 0.014	0.005 0.015
Puerto Rico	0.075 0.151	0.089 0.412	0.061 0.255	0.042 0.138	0.067 0.239
Hong Kong	0.104 1.273	0.098 1.357	0.110 0.934	0.098 0.772	0.103 1.084
Korea	0.37 0.38	0.34 0.32	0.33 0.32	0.33 0.31	0.34 0.33
Spain	0.1063 0.3080	0.1007 0.3141	0.0979 0.2986	0.1006 0.3126	0.1014 0.3083
Sweden	0.062 0.077	0.023 0.067	0.023 0.055	0.023 0.058	0.033 0.064
Turkey	0.283 0.547	0.208 0.408	0.322 0.669	0.299 0.503	0.278 0.532
United Kingdom	0.010 0.068	0.011 0.080	0.010 0.080	0.010 0.057	0.010 0.071
Australia	0.07 0.17	0.06 0.15	0.05 0.13	N/A	0.06 0.15

Source: ILO (1999)

For the countries selected, the range, on average from 1994 through 1997, is between 3.4% in Togo in Africa and 63.3% in Bahrain in the Middle East. For the African countries selected, the range is from 3.4% in Togo (400 lost workdays) and 18.9% in Tunisia (143,600 lost workdays). Regarding the American countries selected, the range is from 3.5% in Nicaragua (3,300 lost workdays) to 14.4% in El Salvador (58,600 lost workdays).

[19] UK excludes road traffic accidents and Australia excludes Victoria and Australian Capital Territory

Table 2-6 Workdays lost due to industrial and construction injuries (1000s)

Country	1994	1995	1996	1997	Average
Egypt	1,234.8 119.8 (9.7%)	1,177.3 114.9 (9.8%)	1,085.4 94.9 (8.7%)	1,045.1 115.9 (11.1%)	1,135.7 111.4 (9.8%)
Togo	9.0 1.3 (14.4%)	12.4 0.2 (1.6%)	18.9 0.2 (1.1%)	9.3 0.0 (0.0%)	12.4 0.4 (3.4%)
Tunisia	N/A	742.4 135.3 (18.2%)	813.9 159.6 (19.6%)	718.5 136.0 (18.9%)	758.3 143.6 (18.9%)
Guatemala	3,019.0 332.1 (11.0%)	2,861.0 314.7 (11.0%)	2,306.2 253.7 (11.0%)	2,140.6 235.5 (11.0%)	2,581.7 284.0 (11.0%)
Nicaragua	53.6 1.4 (2.6%)	78.8 1.6 (2.0%)	107.0 2.8 (2.6%)	136.9 7.2 (5.3%)	94.1 3.3 (3.5%)
El Salvador	385.3 55.5 (14.4%)	429.4 61.9 (14.4%)	411.4 59.3 (14.4%)	400.1 57.7 (14.4%)	406.6 58.6 (14.4%)
Bahrain	26.4 11.6 (43.9%)	97.2 80.1 (82.4%)	21.0 6.9 (32.9%)	22.0 7.0 (31.8%)	41.7 26.4 (63.3%)
Hong Kong	583.5 196.3 (33.6%)	614.9 210.0 (34.2%)	614.0 217.3 (35.4%)	663.5 250.6 (37.8%)	619.0 218.6 (35.3%)
Israel	2,646.3 368.9 (13.9%)	2,789.2 390.5 (14.0%)	2,990.2 466.1 (15.6%)	2,690.0 408.4 (15.2%)	2,778.9 408.5 (14.7%)
Singapore	95.7 26.3 (27.5%)	87.7 27.3 (31.1%)	108.2 35.1 (32.4%)	144.9 65.4 (45.1%)	109.1 38.5 (35.3%)
Spain	13,111.2 2,571.6 (19.6%)	14,440.1 3,004.7 (20.1%)	15,592.3 3,288.8 (21.1%)	15,489.9 3,266.9 (21.1%)	14,658.4 3,033 (20.7%)
Finland	1,152.6 177.5 (15.4%)	1,138.6 163.7 (14.4%)	1,051.2 157.6 (15.0%)	N/A	1,114.1 166.3 (14.9%)
Sweden	976.5 112.9 (11.6%)	874.0 100.8 (11.5%)	851.4 95.4 (11.2%)	890.0 94.4 (10.6%)	898.0 100.9 (11.2%)
Turkey	1,926.1 388.2 (20.2%)	1,763.4 338.6 (19.2%)	1,788.7 324.1 (18.1%)	1,992.5 386.0 (19.4%)	1,867.8 359.2 (19.2%)
Australia	1,020.8 122.8 (12.0%)	1,021.2 92.7 (9.1%)	1,041.9 96.1 (9.2%)	987.6 93.3 (9.4%)	1,017.9 101.2 (9.9%)

Source: ILO (1999)

For Hong Kong (218,600 lost workdays) and Singapore (38,500 lost workdays), construction is responsible for 35.3% of all workdays lost. Construction in Israel is responsible for 14.7% of the total workdays lost (408,500 lost workdays). The range for the European countries selected is from 11.2% in Sweden (100,900 lost workdays) to 20.7% in Spain (3,033,000 lost workdays). In Australia, the contribution of the construction sector is on average 9.9% or 101,200 lost workdays.

Table 2-7 Primary safety and health hazards on U.S. construction sites

Deaths and injuries	
Type of injury	
Falls (more than 33% of deaths)	
Being struck by/against (falling object) - 22% of deaths	
Caught in/between (trench cave-ins) – 18% of deaths	
Electrocution – 17% of deaths	
Other – 10% of deaths	
Musculoskeletal disorders	
Cause of injury	*Areas most affected*
Lifting	Lower back, shoulders
Awkward postures	Knee, hip, shoulders, lower back
Repetitive motion	Shoulders, neck, wrists
Hand-tool vibration	Fingers, wrists
Chronic health hazards	
Hazard	*Organ or system most affected*
Noise	Hearing
Asbestos and manmade fibers	Lungs
Lead and other metals	Kidneys, nervous and reproductive systems
Solvents	Kidneys, liver, nervous system
Hazardous wastes	Kidneys, liver, nervous and reproductive systems
Heat and extreme cold	Circulatory system

Source: Center to Protect Workers' Rights, 1993

Construction workers experience a high rate of injury partly due to where they actually work. For example, they work on scaffolding several hundred feet above the ground, in noisy areas shared with moving heavy machinery, in trenches, and in confined spaces.

Construction sites have been described as 'crawling with hazards,' which affect the health of construction workers (Marsicano 1995). Some of these include:

- Noise and particulates associated with the operation of heavy equipment;
- Dust produced during dry wall operations; and
- Metal fumes associated with welding and cutting.

Further, construction workers incur injuries due to the positions that they have to assume while working. For example, much of the finishing work in construction involves areas that are above shoulder height or below knee level (Schneider and Susi, 1993). The main types of safety and health hazards for workers in the United States on construction sites are shown in Table 2-7.

The leading causes of construction fatalities in New Zealand are falls, electrocutions and being 'caught between' (Site Safe, 2000). The main causes of injuries in New Zealand that lead to ACC claims are listed in Table 2-8.

Table 2-8 Main causes of injuries leading to ACC claims in New Zealand

Cause of injury	
Falls, loss of balance, trips and slips	- 36% of injuries
Long-term back or joint problems	- 20% of injuries
Hitting or being hit by objects	- 15% of injuries
Stretching or lifting	- 14% of injuries
Noise induced hearing loss	- 5% of injuries

Source: Site Safe, 2000

The advancement of technology, development of sophisticated plants, new construction techniques, increased size and complexity of construction works, and improvements in the recognition of risks[20] and hazards, suggest that there is still an opportunity for improvement in the safety record of the construction industry (Joyce 1995). The success of any construction project is usually measured in terms of the universally acceptable project parameters of time, cost and quality. Safety performance on projects should be just as much a measure of the success of that project as are project completion within the desired time frame, within the budget and to satisfactory quality performance standards (Hinze 1997). It is inconceivable to regard a project as 'successful' when limbs and lives have been lost through accidents that could have been prevented, had achieving adequate safety performance on the project been regarded as important as productivity and quality.

However, to work toward the goals of zero accidents and zero incidents, a concerted and coordinated effort is required on the part of all the participants in the construction process. At present construction industry safety activities are untargeted, inconsistent and uncoordinated with the focus of the industry on compliance with minimum standards rather than best practice (Site Safe, 2000). Risks of exposure to hazards need to be eliminated at source. Where it is not possible, the risks must be controlled and the means for protecting workers against these risks must be considered (Lan and Arteau, 1997).

Chapter Summary

It is more important to reduce the occurrence of accidents than to reduce injuries. If accidents and hazardous exposures can be eliminated, injuries and illnesses can consequently be eliminated (Marshall, 1994).

[20] Risk, in this context, is defined as the probability of an adverse effect to human health,

In this chapter, the construction industry has been shown to be an important sector of any national economy, especially regarding its employment potential. The nature and characteristics of construction have been examined. The unsatisfactory safety and health record of the industry has been highlighted. The construction industry tends to have a low awareness of the long-term benefits of safe practice, while the tendering process often gives little attention to safety, resulting in cost and corner cutting.

In the next chapter, the literature on the performance-based approach is reviewed with reference to what is known about the approach and what is being done in practice. The regulatory frameworks underpinning the performance approach in Australia, New Zealand, United Kingdom and Canada are examined. This examination will demonstrate the different ways in implementing the approach to construction worker safety and health that countries have chosen to follow within the contexts of their national industries.

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property and the environment and the severity of that effect.

PERFORMANCE CONCEPT

Background to the concept

The performance approach is not a new approach. For example, since the late 1960's the Norwegian Building Research Institute (NBRI) was already working with the performance concept in building (Bjørneboe, 1982). Most of the work of the NBRI has however concentrated on developing performance requirements for building components and parts of buildings.

The confusion and misunderstanding of the performance concept as it applies to the construction industry, arises from the approach meaning different things to different people (Gross, 1996). Generally the performance approach involves the practice of thinking and working in terms of ends rather than means (CIB[21], 1982; Gibson, 1982). In this sense, it is concerned with what buildings or building products are required to do, and not with prescribing how they are to be constructed.

The approach describes the target performance to be achieved rather than what solution should be selected to achieve the performance (Foliente et al., 1998). It refers to the attempt to define how a result or solution aimed at should be able to perform. It does not actually describe what that result should be (CIB, 1975). The concept defines requirements without imposing restrictions on the form or materials of the solutions.

[21] International Council for Research and Innovation in Building and Construction.

The Working Commission W60[22] (1982), and Gibson (1982), further describe the concept as no more than the application of rigorous analysis and scientific method to the study of buildings and their constituent parts. This assertion refers to the way performance criteria are determined, and to the testing methods employed in evaluation and assessment procedures.

Literature on the performance approach as it pertains to building and construction, suggests that it is possible to apply the performance concept to a variety of circumstances and people. For example, its application to the area of sustainable construction has recently been investigated. This investigation revolved around the need to encourage the use of innovative environmental technology in construction (Bröchner et al., 1999). It also promoted the need to establish uniform demanding target performance levels in an international building assessment system. The assessment system had to provide consistency, be feasible and practical within a specific country or region (Todd and Geissler, 1999; Cole, 1999; Cooper, 1999). It was argued that criteria based on levels of performance rather than prescriptive actions would be readily customized to reflect regional differences.

The strategies for achieving performance levels could be chosen on what was most appropriate and effective for each location. Criteria that prescriptively mandated the use of particular technology, equipment, material or design would be less amenable to customization, resulting in actions that might possibly be inappropriate in some regions.

The complex maze of building regulations which exist in most countries is regarded by many as being overly prescriptive and, consequently, an impediment to the

[22] CIB Working Commission W60 has as its focus the performance concept in building

introduction of new technologies and design concepts (CIB, 1997; Simenko, 1996). According to Foliente, Leicester and Pham (1998), the development of building standards that are performance-based has drawn international interest as a result of some of the difficulties presented by deemed-to-comply or prescriptive codes and standards. These difficulties arise from the need to:

- Make building construction more cost effective;
- Allow for easier introduction of product or system and process innovation; and
- Establish fair international trading agreements.

In the global construction market the relatively inflexible, prescriptive codes and standards are increasingly being criticized as being non-tariff barriers to trade (CIB, 1997; Simenko, 1996). For example, to move away from the prescriptive or deemed-to-comply building codes and standards that hinder building and construction trade, the World Trade Organization (WTO) has included Clause 2.8 of the Agreement on Trade Barriers to Trade.

This clause states that:

> Wherever appropriate, Members shall specify technical regulations based on product requirements in terms of performance rather than design or descriptive characteristics (WTO, 1997).

The introduction of this clause, therefore, implies a commitment of signatories to the General Agreement on Tariffs and Trade (GATT) to the use of performance requirements:

- In the evaluation of the appropriateness of products for their desired purpose; and
- In the acceptance of new and/or innovative products in their markets.

It might also be counter-argued that the country-specific compliance requirements of the prescriptive approach, especially in developing countries, constitute an effective protectionist measure. Prescription based legislation would potentially act as a barrier to trade in favor of the indigenous construction industry. While unlikely against the background that developing countries have historically been ‘standard-takers[23]‘ and not ‘standard-setters,’ this situation would pose problems to world free trade, trade liberalization and trade expansion when globalization and internationalization are priorities.

Since the construction industry plays an important role in the economy of any country, the performance approach could arguably pose a potential threat to developing countries such as in Africa. It has been suggested that the development of the indigenous construction industries will contribute to economic growth and development in those countries (Haupt, 1996). As the construction industry develops rapidly, it gives the opportunity for the development of other relevant industries such as construction materials, light industry, machinery, and electronics (Ganzhi, 1996). The introduction of an approach would be counter-productive that would favor the penetration of large international construction enterprises into the domestic market, inhibiting the growth and development of local construction capacity.

Performances based building standards, arguably, provide the means of overcoming the difficulties presented by prescriptive codes and standards (Foliente et al., 1998). They are replacing traditional codes (CIB, 1997), particularly in highly industrialized countries. These standards essentially standardize the description of the performance of an attribute of a product in some measurable manner. Once the required level of performance has been established, the designer of the product is free to use any

[23] Developing countries have tended to accept international standards developed and adopted in industrialized countries (standard-takers) rather than develop and set their own standards (standard-setters).

form or materials consistent with the final product meeting this performance level (Walker, 1997; 1998).

Performance Concept and Construction Worker Safety

While there has recently been considerable discussion directed to performance standards, the literature is largely silent regarding the application of the performance concept to construction worker safety and health. For example, the CIB Report 32 (1975) suggests that the application of the performance concepts requires the satisfaction of certain needs or requirements. These end or 'end result'[24] requirements are described as:

- User needs that refer to the activities of the end users or occupants of the building facility within the facility;
- Human needs that refer to more generally accepted human factors and requirements; and
- Other needs that include technical, physiological, psychological and sociological considerations relative to the safety, health and comfort of those for whom the building is intended, which might include equipment, goods, or animals that may be housed in the building; and
- The satisfaction of economic and social considerations.

Bayazit (1993) endorsed this perception by describing user requirements as the requirements of the end users, owners, financiers, building managers, and all the related groups affected by the completed building facility. The needs of those responsible for the actual construction of the facility, namely, the safety and health of the construction workers (the first, albeit temporary users of the facility), are not referred to, overlooked or ignored. Reasons that have been cited for this oversight include the perceived difficulty in the link between performance specifications and the ability to design

[24] Performance specifications are also known as 'end result' specifications in the building materials sector

adequate tests to set performance criteria. The assessment and evaluation of whether these criteria have been satisfied or not present another difficulty.

This study argues that the requirements of workers as temporary users can also be expressed in terms of performance requirements that need to be met during the construction process. Further, it is possible to assess and evaluate whether performance criteria for executing construction activities and tasks have been satisfied. In the absence of substantive literature on the application of the performance approach to construction worker safety and health, the literature is reviewed that deals with the performance approach as it applies to building design, materials, elements and components.

Defining the Performance Approach

There is still some confusion on what is meant by the performance approach. For example, OSHA in the United States responded to a request for a permanent variance from 29 CFR 1910.212(a)(1), the standard that defines the general machine guarding requirements of OSHA (OSHA, 1994). OSHA suggested that by not specifying the types of machine guards that must be used, this standard should be referred to as a performance standard. Accordingly, the employer is free to adopt a machine guard that performs in such a manner as to meet the objective of the standard. This objective is to protect employees from the identified hazards. The standard does, however, recommend several specific types of machine guards but leaves the employer the decision regarding which machine guard best suits the working conditions. Ironically, should the employer select any type of machine guard that is not listed among the recommended types, the employer would have to apply for a variance to the standard, which is an onerous, tedious and time-consuming process. This is typical for a prescriptive standard. This example shows the extent of the confusion very well. By merely allowing the employer some latitude regarding a choice of equipment or means, OSHA claims the standard to be performance-based. OSHA standards are generally considered to be prescriptive in nature. As stated earlier, the performance approach focuses on ends rather than means.

Further, OSHA (1998), in clarifying the requirements of 29 CFR 1926.800 that deals with underground construction, makes use of what it terms ‘performance language’ in paragraph (b)(2). Here it stipulates the provision of access and egress ‘in such a manner that employees are protected…’ However, very specific requirements are prescriptively contained in the next paragraph, namely, (b)(3). Again, it seems that whenever specific requirements are not stipulated within an otherwise prescriptive standard, OSHA regards it as performance-based. This does not fully conform to the generally accepted definition of the performance concept and approach.

There is also confusion on how performance-based standards should be developed and implemented (Foliente et al., 1998). Since the performance concept implies a new way of looking at things (buildings in this case), its application raises questions about the usual meaning of words used in construction (CIB, 1975).

Because of the continual pressure that is being experienced by the construction industrial sector through the introduction of new materials, designs, and technologies, it has become necessary to devise ways of evaluating all of these in terms of the functions that they are required to fulfill (CIB, 1975). The word *performance* has been selected to characterize the requirement of products to have certain properties to enable them to function as desired or specified. The *nature* of performance has been described by CIB (1975), as dealing with how the building fabric and the spaces within the fabric react to the stresses that are brought to bear on them. The building fabric is defined as any of the building materials, building components, products, units, elements of construction, and assemblies of which they are composed. The stresses, on the other hand, refer to agents, agentia, forces, states of simultaneous stress, and external stresses, which stem from natural, and artificial or man-made phenomena in their surroundings or environments or contexts. To apply the concept of performance it is necessary to match the requirements of the users with this reaction to stresses within the fabric and the spaces within the fabric.

CIB Working Commission 60 has defined the word *performance* as, 'behavior related to use' (CIB, 1975; Gereben, 1982). This definition is related to the utilization[25] period of a building, and to its users. The idea is that users should be able to conduct their activities in safety, satisfy their comfort requirements, without impairment of their health, expediently, and permanently. There is another definition for the term, namely, 'behavior in construction' which relates primarily to materials. However, with regard to design and construction decisions, both these definitions relate to decisions impacting the end product and end users (Bayazit and Kurumu, 1982). The construction worker is not considered to be an end user and, therefore, not included as a user.

A more comprehensive definition is offered by Kreijger (1982:99), in terms of which performance is the 'organized procedure or framework within which it is possible to state the desired attributes of a material, a component or a system to fulfill the requirements of the intended use or user without regard to the specific means to be

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[25] The utilization period may be defined by either the physical and/or economic life of a building facility.

employed in achieving the results.' It is possible that the requirements of the construction worker as a user could be recognized under this definition.

The concept may also be graphically represented to demonstrate how performance requirements impact the relationships between the planning and design, construction and use or utility phases as shown in Figure 3-1.

Since the performance approach is primarily concerned with ends rather than means, it does not necessarily imply that means are not considered, especially construction methods and types, products or materials (CIB, 1982). When means are considered, it is strictly in terms of whether they will achieve the ends, and will do so reliably for a defined period of time. While the approach is not fundamentally new, it does break fresh ground by calling for a disaggregate and flexible approach to building construction, and by subjecting all parts of buildings to systematic scrutiny (CIB, 1982).

The performance approach implies:

- Assembling data and criteria from different contributors[26] to the total building design and attempting to state them in common terms that, while it does not, but should, according to this researcher, include worker safety;
- Extending the scope of quantitative *performance assessment*,[27] which were previously taken for granted, especially when dealing with innovative designs or products;
- Defining all design objectives clearly;
- Demanding evidence of compliance with requirements by means of accepted methods of *performance test*[28] and evaluation; and

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[26] These contributors would include the client, designers, engineers, financiers and local building regulation enforcement agencies

[27] Defined as 'a prediction of performance in use, involving judgment, based on a comparison of test data with the performance requirement' (CIB, 1975)

[28] Defined as 'an examination giving data from which the performance of an item can be assessed' (CIB, 1975)

– Defining methods of ranking or weighting individual aspects of performance to give a measure of overall quality where products or designs, and/or, according to the researcher, construction methods are being compared with performance criteria (CIB, 1982) or *functional performance requirements*[29].

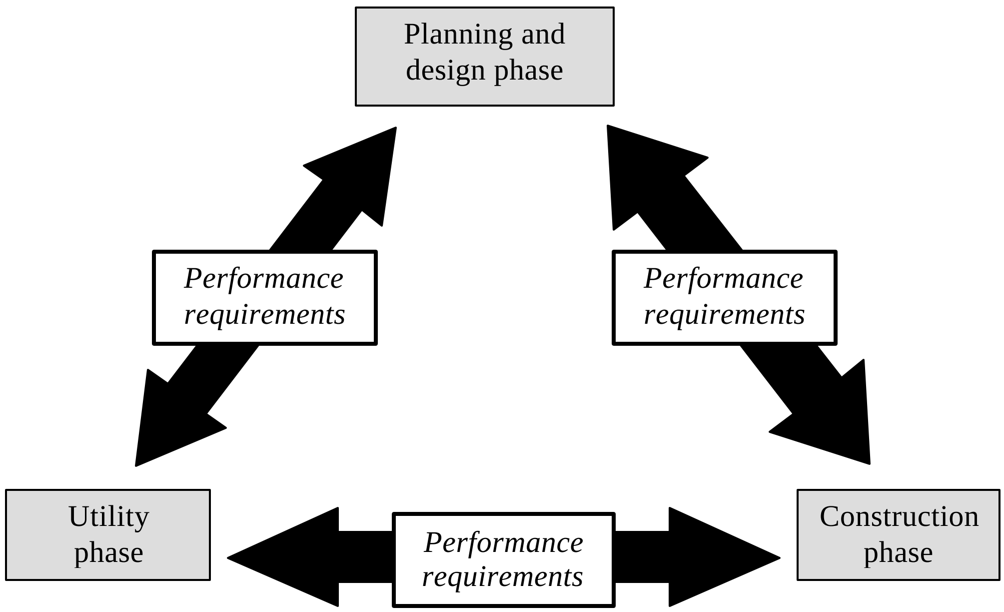

Figure 3-1 Relationship between planning, construction and use

The trend toward the performance approach and performance specification[30] is driven by several forces, which include:

– The accelerating rate of change of building technologies;
– The availability of improved space-planning and design concepts and techniques;
– Higher expectations of the conditions which buildings must provide (cib, 1982); and, according to this researcher,
– The demand to improve safety performance on construction sites based on the volume of research confirming the global concern about this aspect of construction.

[29] These are 'statements of need expressed in qualitative or quantitative terms' (CIB, 1975). A functional requirement addresses one specific aspect or required performance of the building to achieve a stated goal (Foliente et al., 1998).

[30] Defined as 'a specification which states the performance or performance levels required of an item and may refer to tests' (CIB, 1975).

A practical definition, therefore, for the performance approach as it applies to construction worker safety and health would be the identification of important broadly-defined goals, ends or targets (user requirements) that must result from applying a safety standard, regulation or rule without setting out the specific technical requirements or methods for doing so. As such, the performance approach describes what has to be achieved to comply with the regulations and leaves the means and methods of complying up to the contractor.

Features of the Performance Approach

It is argued by CIB W60 (CIB, 1982) that the performance approach as it applies to building design, materials, elements and components, permits new developments to be exploited, while safeguarding and assuring a level of quality adequate for the purpose in question. It does not block technical change (Bröchner, Ang and Fredriksson, 1999). It allows for choices of solutions to meet the performance requirements of the intended user, which in turn permits optimization (Wright, 1982). The approach provides incentives for designers to innovate and to adopt new systems and materials (Briggs, 1992; Walsh and Blair, 1996; Bröchner, Ang and Fredriksson, 1999). It is possible, by introducing the performance concept in the conceptual stage, to emphasize the importance and significance of user needs, including the needs of construction workers. This emphasis should establish a good framework for the analysis of the project, and a good basis for the selection of the systems and materials to be used on the project (Jones, 1982). For this process to be effective, there has to be communication between designers and other members of the project team (Simenko, 1996). However, research conducted in

Canada confirmed a serious lack of communication between designers and constructors, resulting in designs which could not be built as expected (Crawford, 1982).

Further, the approach is dependent on the availability of a large and wide-ranging body of scientific knowledge on each aspect of building function, and on building techniques or methods, and materials. This scientific knowledge is not always available and consequently impedes the widespread application of the approach, making it extremely difficult to write and implement performance codes (CIB, 1997). The appropriate knowledge that is required includes:

- The requirements which could be those of owners, end users, and/or construction workers as temporary users;
- The context within which the building would need to satisfy these requirements such as weather, frequency and severity of usage, hazards and potential hazards; and
- The available methods of evaluation of behavior in use or performance (Gibson, 1982; CIB, 1982).

Additionally, this knowledge has to be quantitative, or capable of quantitative interpretation, to facilitate a workable and unambiguous basis for performance appraisal and regulation (Gibson, 1982; CIB, 1982).

Thinking in terms of performance, according to Bröchner, Ang and Fredriksson (1999), produces a sharper focus on quality instead of price only. By speaking in the functional language of the client and building users, communication between them should be improved, resulting in raising the level of client satisfaction. In this respect, the approach facilitates the supply of systematic, user-orientated information. It is potentially possible that the approach could produce a similar focus on worker safety resulting in improved communication on safety issues, while improving worker safety performance on the construction site.

Resorting to the performance concept should reduce costs by encouraging more efficient ways of providing a given function, using known or new solutions (Bröchner, Ang and Fredriksson, 1999; Simenko, 1996). Research studies have shown that investing in construction worker safety reduces costs (The Business Roundtable, 1991; Hinze, 1997; Levitt and Samelson, 1993).

There are also reasons to believe that the approach simplifies and reduces the volume of construction regulations. In the European Community, for example, the safety regulations which are performance-based, are contained in less than 20 pages when compared with the 100's of pages with limitless and confusing cross-references of OSHA in the United States, which are largely prescriptive in nature (Coble and Haupt, 1999; 2000). According to OSHA (1993), 96% of the variance applications received by OSHA are not actual requests for variances, but rather are requests for clarification or interpretation of standards. These clarifications and interpretations often stem from cross-references that are conflicting and difficult to understand.

Performance-based regulations support international trade through the harmonization of construction regulations across borders, as is evidenced in Europe (Coble and Haupt, 1999; 2000; Simenko, 1996). By removing trade barriers it will be more attractive to develop and introduce new technologies which are 'worker-safety-friendly.' The performance approach will enhance the prospects of the introduction of technologies that have been carefully evaluated in terms of their level of safety and hazard exposure of those who will implement them.

However, the prediction of performance is a key difficulty. On the one hand, it is possible to establish acceptable performance criteria. These criteria are usually set based on a combination of any set of judgment, practical tests, theoretical considerations or behavior. On the other hand, it is more difficult to assess before the building is constructed whether the criteria are going to be met by the proposed design, construction method, and building materials. There is considerable interest around the world in developing a system of reliable and valid test methods and assessment procedures that combines robustness, sophistication, and an ability to reflect regional or national concerns. There could be a common set of underlying characteristics relevant to the structure of all assessment methods (Cole, 1999), which might provide:

- A common and veritable set of criteria and targets;
- The basis for making informed design decisions; and
- An objective assessment of the impact that a building would have on, say, the safety and health of workers.

When these core criteria are made explicit, they can provide a clear starting point for developing customized methods for specific building types, geographic regions, and specific intentions (Todd and Geissler, 1999).

Many of those responsible for the administration of building regulations are less enthusiastic about the performance concept, due to code officials and inspectors not having the background nor the training required to deal effectively with the performance approach (Jones, 1982). Without the required knowledge it is difficult to make judgments regarding whether the user and performance requirements have been adequately met or not by a proposed solution or alternative approach.

When monitoring actual performance in a contractual relationship, there is a range of risks to be managed. These risks may be defined as the probability of adverse effects to human safety and health, property and the environment, and the severity of those effects. It is also frequently difficult to identify the party responsible for managing the risks. Building clients, contractors and government regulatory authorities lack the basic competence needed for expressing, interpreting, and monitoring requirements expressed in terms of performance. There has not been adequate investment in the development of this competence (Bröchner, Ang and Frериksson, 1999). Additionally, there are costs associated with the management of data specific to a particular material, component, method or project. The varied legal and jurisdictional structures under which these codes have to function make the process even more arduous.

There are two categories of barriers to the implementation of the performance concept, namely,, measurement limitations to determine if proposed solutions meet the performance criteria, and institutional non-technical barriers (Wright, 1982). There are problems associated with access to data, choice and use of measurement methods, and in deriving a consistent practice for using performance data as input to assessment methods (Bröchner, Ang and Frериksson, 1999).

The institutional barriers include:

– Lack of resources for designers to develop a variety of solutions to meet the performance criteria;
– Lack of research capability of designers to evaluate these solutions and select the best suited;
– Lack of appropriate tools to determine user needs at the design stage;
– Lack of a knowledge base built up from past and present performance experiences in practice;
– Lack of ability to learn in a cumulative way from successes and failures due to the dispersed nature of the building community; and
– Uncertainty about who should be responsible for evaluating whether the completed building has met the performance criteria - the architect, engineer, constructor, or manufacturer (Wright, 1982; Christensen, 1982).

The situation is exacerbated when construction worker safety is added to the equation. Until very recently, building contractors were held solely and exclusively responsible for the safety of their workers. Designers felt no compulsion until recently to become involved with giving consideration to the impact that their designs had on construction worker safety.

It is obvious that different participants in the construction process will have distinctly different sets of interests in the performance approach. These participants include the community, building end users, clients, designers, constructors, manufacturers, suppliers, insurers, and construction workers.

Responsibilities are assumed by those setting performance requirements as well as those expected to meet them. Any decision about a level of performance bears with it a connotation of risk, in terms of known sources of uncertainty and possible errors of judgment. The responsibilities associated with meeting performance requirements vary in degree, according to circumstances. All or part of these responsibilities may be assumed by any of the participants.

Comparison with the Prescriptive Approach

The prescriptive approach describes means, as opposed to ends, and is primarily concerned with type and quality of materials, method of construction, and workmanship (CIB, 1982). It attempts to standardize the work process using prescriptive rules and procedures usually backed by the monitoring of compliance and by sanctions for noncompliance (Reason, 1998). The approach has been described as being conservative in that it is difficult to take account of variations in workmanship and materials (Walsh and Blair, 1996). It is problematic to refine the approach to keep pace with innovation, better construction techniques, and new materials. For example, when OSHA proposed to modify its existing standards on respiratory protection in 1994 (29 CFR 1910.134, 29 CFR 1915.152 and 29 CFR 1926.103), reasons cited for the modifications included changes in methodology, technology and approach to respiratory protection. The existing standard did not provide for these. OSHA claimed that research on the proper use of respiratory protective equipment resulted in new technology that improved protection for wearers. Further, the existing standards did not reflect what had become accepted practice for implementation of comprehensive respiratory protection programs to protect employees. The process to introduce these amendments was extremely tedious and time-consuming, and included public hearings over a lengthy period of time.

Issues of aesthetic content are extremely difficult to handle in terms of performance and tend rather to be very prescriptive. The focus should rather be on the contexts in which performance requirements carry a potential for overall gains (Bröchner, Ang and Freriksson, 1999). The performance approach is unsuitable on the larger scale typical of entire buildings and the broader physical environment, where social, political and aesthetic issues weigh more heavily than when developing and selecting components and construction technology. This claim is only valid against the current understanding of the application of the performance concept as described in the literature on the performance approach that excludes the safety of 'temporary users' or construction workers.

Safe working procedures are continually being amended reactively to prevent actions implicated in a recent accident or incident (Reason, 1998). These amendments become increasingly restrictive over time. Consequently, the range of permissible actions is reduced to far less than that necessary to get the job done under anything but optimal conditions. Reason (1998) rightly suggests that very rarely do the latent conditions, local triggers and other active failures that lead to an accident occur in precisely the same form.

The inability to cover every conceivable situation comprehensively in a prescriptive way, arguably, leads to deviations from these prescriptive rules and regulations by construction workers. Some of the many factors that influence the successful execution and completion of any construction activity are illustrated in Figure 3-2.

It is evidently extremely difficult to account for each and every one of these in a prescriptive way. One of the effects of continually tightening up safe working practices in a prescriptive manner is the increase in the likelihood of deliberate deviations from these practices. The scope for allowable action shrinks so much that procedures are routinely violated or when operational necessity demands it. These violations increase the probability of a subsequent error and the likelihood of a bad outcome such as an accident or injury (Free, 1994; Parker et al, 1995).

A further concern revolves around potential conflicts between the requirements of several agencies due to each having their own prescriptive standards. For example, in granting a variance to 29 CFR 1910.106(b)(2)(viii)(f), OSHA recognized that there was a conflict between that standard and the requirements of Environmental Protection Agency (EPA) under 40 CFR 761. 65(b)(1) concerning the draining and flushing of combustible/flammable liquids.

Prescriptive or ‘recipe’ requirements might be simpler to work with than performance or ‘end result’ requirements. There is an element of duration in the application of any performance test method, in contrast to adherence to prescriptive specifications, which is often instantaneous and based upon visual conformity with the specification (Bröchner, Ang and Freriksson, 1999). However, the latter can potentially stand in the way of the most efficient and economical solution to a building problem (CIB, 1982).

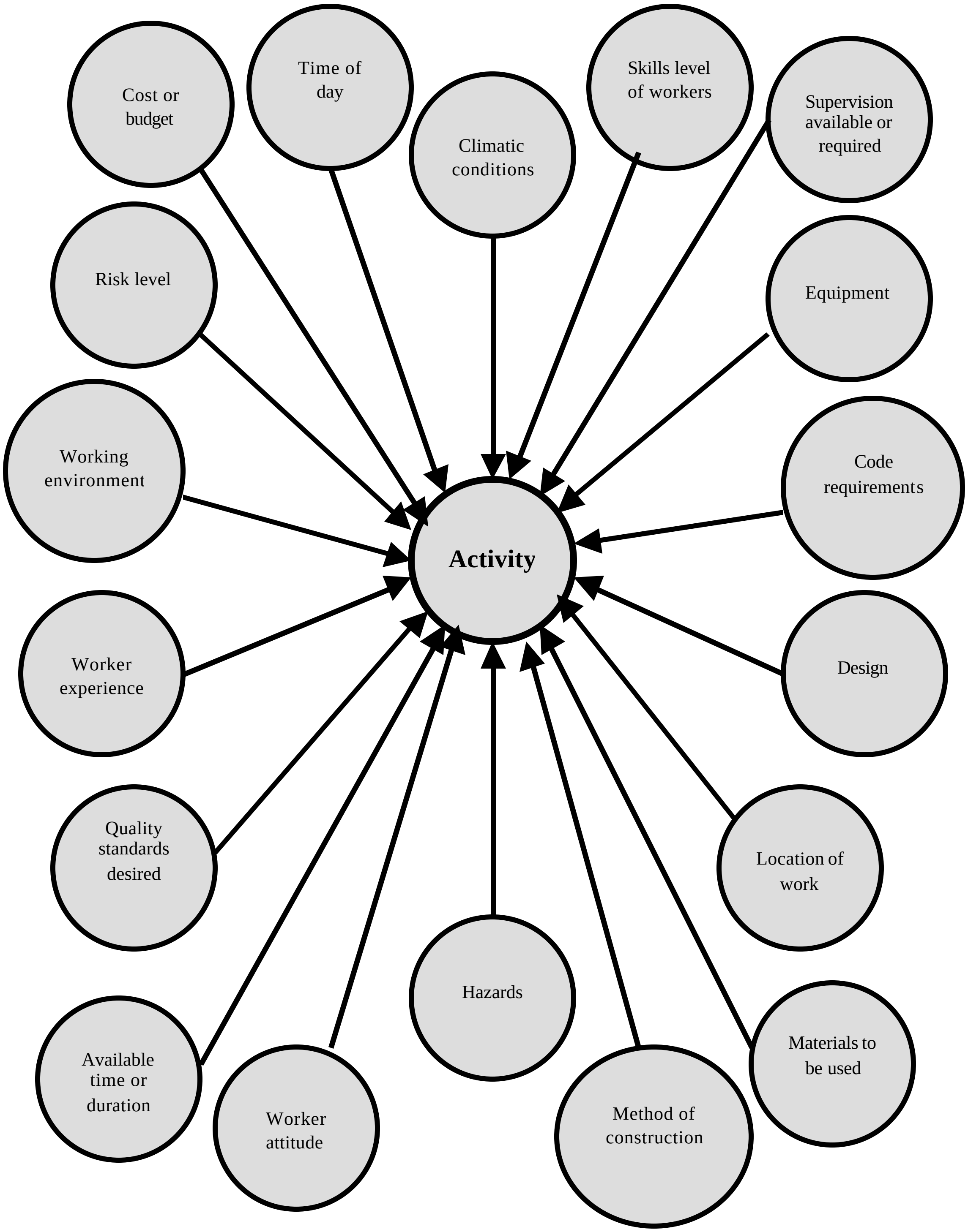

Figure 3-2 Factors that affect the successful completion of a construction activity

By being prescriptive regarding a restricted range of solutions, they exclude innovation, impede the introduction of new technologies and design concepts, reduce cost-effectiveness, and international harmonization (Simenko, 1996). Additionally, they do not provide the best means of making use of the knowledge and ideas of others.

To describe the defining relationship between prescriptive and performance approaches, buildings may be viewed as a matrix of parts and attributes (Hattis, 1996). The main difference between the traditional prescriptive and the performance approaches may then be described as follows:

- In the prescriptive approach, the building parts are described, specified and procured, resulting in a building with a unique but implicit set of attributes; and
- In the performance approach, the building attributes are described and specified, and many combinations of different building parts can be procured for which it can be demonstrated that the specified attributes will be provided.

There are several characteristics in terms of which performance-based codes are expected to be superior to traditional prescriptive codes (CIB, 1997). The following are the characteristics that are directly related to the structure of the performance code documents:

- Ease of understanding the intent of regulation; and
- Transparency for ease of:
- Evaluation of alternative and/or innovative solutions;
- International scrutiny within trade agreements;
- Consistency of interface for users;
- Ease of authoring and maintaining the code documents; and
- Ease of representation and delivery in Information Technology (IT) systems and in supporting associated navigation and retrieval functions (CIB, 1997).

Prescriptive specifications will continue for some time to play a significant but supplementary role. It is possible for there to be specific instances where aspects of a specification might deliberately be retained in prescriptive terms. These include:

- Finite limitations, for example, where a building client may desire to prescribe or restrict aspects of the building design or materials to be used in a building for aesthetic purposes;
- Economic reasons where the cost of a performance evaluation may be too high in relation to the value of the product; and
- The state of the construction industry where professional resources are scarce or the local industry might not be able to respond to a performance specification (CIB, 1982).

According to Jones (1982), it is acceptable to use performance-based regulations wherever possible and then fill in with prescriptive measures as required. However, extreme caution must be exercised to ensure that the safety and health of construction workers is not compromised in the process.

Performance-based Regulatory Frameworks

The idea of controlling building construction within a performance-based regulatory framework is appealing to virtually every segment of the construction industry. Architects, engineers, building manufacturers, and the other participants in the construction process view the performance approach as a logical route for obtaining acceptance of new ideas, products and technologies in the construction sector (Jones, 1982). In fact, building regulations in many countries are perceived to be overly prescriptive and an impediment to this view. They are criticized increasingly as being inflexible non-tariff barriers to international trade. In many countries where performance-based standards, building codes and regulations have replaced the traditional prescriptive ones, these newer regulatory structures are based on variations of the Nordic Five Level System illustrated in Table 3-1 (CIB 1997).

Broad requirement characteristics of these regulatory structures are that they:

- Respond to social needs;
- Are based on user needs;
- Are based on sound technical knowledge;

– Are useable and verifiable; and
– Are enforceable.

Table 3-1 Nordic 5 Level System

Level	Basic Heading	Description/Comments
1	Goal	Addresses the essential interests of the community at large regarding the built environment, and/or the needs of the user-consumer
2	Functional Requirement	Building or building element specific qualitative requirements.
3	Operative Requirement[31]	Actual requirements, in terms of performance criteria or expanded functional description
4	Verification	Instructions or guidelines for verification of compliance
5	Examples of acceptable solutions	Supplements to the regulations with examples of solutions deemed to satisfy the requirements

(CIB, 1997; Foliente et al., 1998)

In the Nordic 5 Level System, levels 4 and 5 are concerned with the specifics of meeting the objectives of the minimum structure as set out in levels 1, 2 and 3. Levels 2 and 3 represent an elaboration of the objectives component of the minimum structure which is level 1, while levels 4 and 5 refer to the ways of meeting the objectives.

Levels 4 and 5 may be combined to form a general four level regulatory system such as reflected in Figure 3-3 (Adapted from Foliente et al., 1998). This is generally regarded as the basic performance model. If the method of verification selected shows that the performance requirements have not been met, the solution needs to be re-examined and another attempted until the requirements have been fully met.

These differences and commonalties have been reflected in Figure 3-4 (taken from CIB, 1997) by drawing comparisons between the Nordic 5 Level System and those

[31] Sometimes referred to as the 'Performance Requirement,' and wherever possible should be stated in quantified terms (Foliente et al., 1998).

applied in Australia, New Zealand, United Kingdom, and Canada. Very similar characteristics are found in the regulatory frameworks developed in European countries.

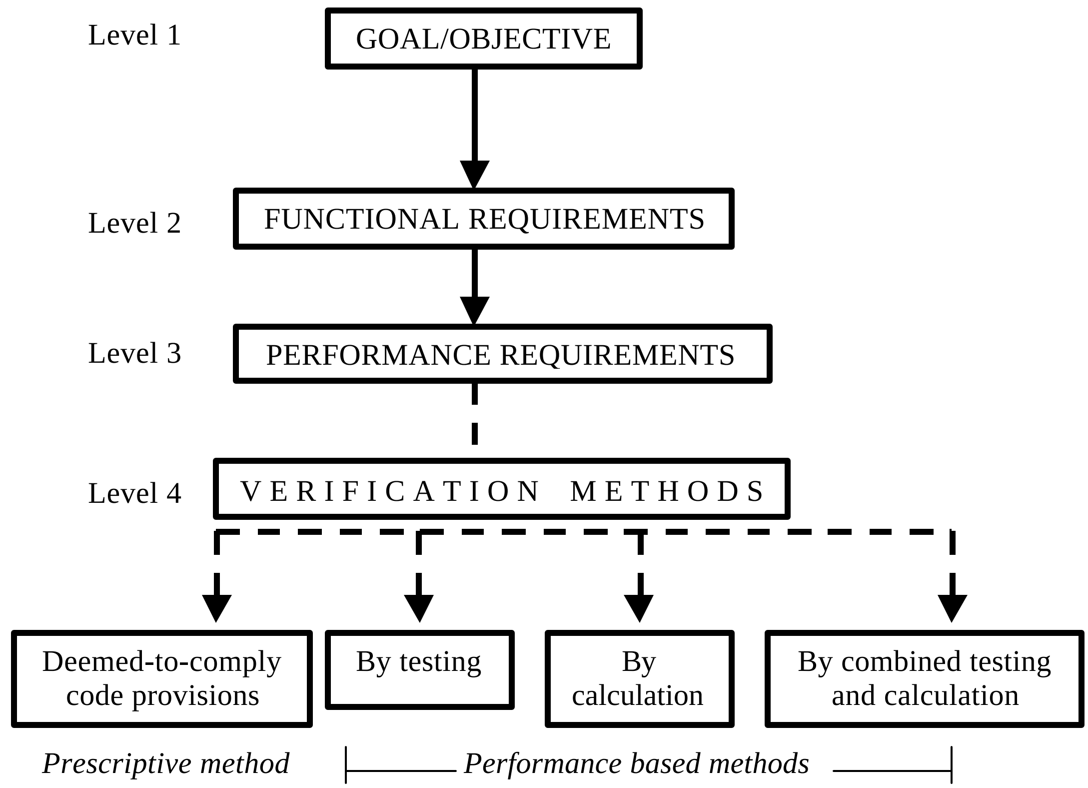

Figure 3-3 General four level regulatory system

<table>
<tr><th>Level</th><th colspan="2">Australia</th><th>New Zealand</th><th>United Kingdom</th><th>Canada</th></tr>
<tr><td>Goals</td><td colspan="2">Objectives</td><td>Objectives</td><td>Goals</td><td rowspan="2">Objectives</td></tr>
<tr><td>Functional Requirements</td><td colspan="2">Functional Statements</td><td>Functional Requirements</td><td rowspan="2">Functional Requirements</td></tr>
<tr><td>Operational Requirements</td><td>Performance Requirements</td><td>Deem-to-satisfy</td><td>Performance Requirements</td><td>Functional Requirements</td></tr>
<tr><td rowspan="2">Verification Methods</td><td colspan="2" rowspan="3"></td><td rowspan="2">Verification Methods</td><td>Performance</td><td rowspan="3">Acceptable solutions</td></tr>
<tr><td>Technical Solutions</td></tr>
<tr><td>Acceptable Solutions</td><td>Acceptable Solutions</td><td>Alternative Approaches</td></tr>
</table>

Figure 3-4 Nordic 5 Level System compared with structures in selected countries

On the one hand, the United Kingdom has applied the least formal approach with very brief goals and functional requirements. On the other hand New Zealand has opted for a structure which is very formal and complete (CIB, 1997).

Potential for Improving Construction Worker Safety

From the review of the literature on the performance concept, it is evident that the performance approach has focused almost exclusively on the needs of end users and the consequent performance requirements of the building fabric to meet these needs. The literature, where it refers to safety and health, does so in the context of end users such as occupants of building facilities and the general public (Gambatese, 2000). The underpinning motivation for addressing safety and health in this way is to address liability issues should the building structure fail to meet the performance requirements.

The literature is largely silent regarding the safety and health of construction workers on site while the structure is being erected, remodeled or demolished. The requirements of workers have either been ignored or overlooked. As the first users of the building facility, the performance approach should be able to be applied to them as well (Hinze, 2000).

The literature on the performance approach to building also suggests that the earlier phases of the construction process are critical to the successful implementation of the performance approach. The pre-design and design phases are important, as it is during these early stages that the end user and performance requirements are established. Research has shown that the early involvement of all participants, particularly designers, in the construction worker safety effort has great potential for reducing exposure to hazards and potential hazards. The consequence of this early involvement potentially results in the reduction of accidents, injuries and fatalities (Gambatese, 2000a; Hinze, 1994; Hinze and Wiegand, 1992; Gambatese, Hinze and Haas, 1997; Gambatese, 2000b; Smallwood and Haupt, 2000; Lorent, 1999; Hinze et al., 1999). By including construction workers as users, designers have the potential to consider their particular requirements and the performance required to meet them during the pre-design and design phases of construction (Hinze, 2000).

During the construction phase, workers engage in construction tasks during which they are exposed to hazards due to the nature of the activities being carried out, the properties of the materials being worked with, and the complexity of the construction methods being used. Other impacting factors include the location in which the activity is being performed, the environment, climatic conditions, and personal attitudes. These have to be considered during risk assessments, qualitative and quantitative identification of their requirements as users, and implementation of solutions that will satisfy these user and performance requirements. Unfortunately the requirements of construction workers as users of the building during construction is given scant attention in the available literature. The only reference to safety appears to be regarding safety in use (Blachère, 1993; Sneck, 1993). In this context reference is made to:

- Safety of maintenance work;
- Safety against injuries to occupants;
- Safety during circulation; and
- Security against intrusions.

Regarding hygiene or health, the only reference appears to be in terms of:

- Pollution of the building environment; and
- Emission or development of noxious or unhealthy substances in the building as they affect end users (Blachère, 1993; Sneck, 1993).

The differences between construction workers and the end users lie in the nature of the activities in which they engage as well as the environment within which these activities take place. Construction workers are engaged in activities designed to erect the building. The environment is constantly changing as the construction process continues toward final completion.

Construction workers are users, and as such have performance or user requirements that have to be met regarding their safety and health while carrying out construction tasks. This notion needs to be accepted by all the participants in the construction process. Construction workers and their safety and health needs have to be given the same serious consideration as all other users of the building facility. Once this occurs, the performance approach can influence the safety performance of the construction industry.

Application of the Performance Approach

The need to adopt the performance concept in building activities is well established at an international level (Borges, 1982). However, this need seems to be restricted to the developed and industrialized countries. According to Antoni (1982), the prime task of the performance concept is to rationalize procedures and facilitate the economic use of resources. He questions whether the lack of application of the approach in developing countries is due to it being too sophisticated to be useful for, or used by, those who have the most urgent needs, most scarce resources, and the largest problems. He suggests that the approach would be of great value and a means of more effective transfer of technologies to these countries. A problem with this argument is that it fails to recognize that there might, in fact, be technologies that could be transferred, in the reverse direction as commonly accepted, from the developing countries to the developed and industrialized countries.

Other arguments affecting the application of the performance approach in developing countries revolve around whether the focus would be on other benefits such as trade liberalization and expansion rather than on safety and health; and whether the drive toward the performance approach constitutes a watered down approach to safety and health. There have been many efforts to introduce performance-based[32] concepts into building codes[33] and standards. When codes cover technical aspects of performance they incorporate or refer to relevant standards, becoming users of standards. Clients for their own assurance of performance also use standards.

Gibson (1982) suggests that standards[34] retain the benefits of interchangeability while being tools for reducing trade barriers and stimulating innovation. Some countries have legislated the functional or qualitative level of the performance concept that

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[32] Other performance concepts that might be applicable to safety and health have been explored. 'Performance oriented' refers to being concerned with making adjustments or adaptations in relation to facts, principles or particular situations. Safety and health training could be described as being performance-oriented since it should empower workers to be able to make adjustments to particular hazardous situations or adapt to changing environments to ensure their safety. On the other hand, management should become more 'performance directed' in their management styles. By this is meant that management should manage all construction by the shortest uninterrupted course of action to achieve the goal or objective of safety for their workers.

[33] A building code or regulation refers to a document, typically legal, used by a local, state, provincial or national governing body to control building practice, through a set of statements of acceptable minimum requirements of building performance. These vary from country to country, or locality to locality, because acceptable requirements are usually established based on socio-political and/or community considerations (Foliente et al., 1998).

provides the intent of the law, offering some examples of situations that are deemed to satisfy the concepts. Others have retained a mixture of detailed performance and prescriptive requirements (CIB, 1997). The effectiveness of either approach has yet to be tested.

The performance concept can be applied in a wide variety of circumstances, by a wide range of people making various types of contribution to the design and construction of buildings, and in a wide variety of ways (Gibson, 1982). These include:

– The design and construction of a continuing building program as well as a single project;
– The development and marketing of building products, while appreciating the added value of superior performance;
– The improved preparation and structuring of design guidance as a result of the development of design methods and the increase in the volume of information available to designers; and
– The control of construction quality and construction worker safety through inspection, approval or certification, providing feedback from practice that is essential for the continued refinement of performance criteria, and of design and evaluation methods.

The purposes served by each of these areas are listed in Table 3-2.

Examples of the Application of the Performance Approach

Attempts have been made to apply the performance approach in the energy-efficient design of new commercial buildings (Briggs, 1992). In this case, standards and guidelines based on the performance of an entire building provide maximum flexibility for the designer to creatively address project requirements, while ensuring overall energy efficiency.

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[34] A standard is essentially a technical document seeking to standardize some activity in relation to building and construction, usually in terms of quality or performance, size or procedure (Walker, 1997).

Table 3-2 Examples of purposes served

Specific building projects	Design data and guidance
Functional briefing Design delegation Design competitioDesign commissioning (sketch and detailed design) Design and build Building system/method selection Building component selection Assembly and construction	Collection of basic data Validation and consistency of criteria and methods Structuring and organization of documents such as checklists, general lists of performance requirements, design data and aids, performance specifications, building regulations, standards, product literature and agrément certificates
Product development and marketing	**Quality (and safety) control**
Research and development Promotion and marketing Product literature	Performance-based building regulations Performance-based safety standards Certification of products and systems

Source: Adapted from CIB (1982)

The performance standards provided incentives for the designers to innovate and adopt new systems and materials. For example, a designer might be allowed to include larger window areas in the design than would otherwise be permitted. In contrast, prescriptive requirements provided no incentive for performance that exceeded the required minimums and could even serve to freeze design practice at currently accepted levels.

The objective of the Energy Sciences Department in the United States is to surmount the technical challenges that have to be addressed if performance-based energy standards are to be made practical and widely accepted by the construction industry. These technical challenges include the capability to generate targets that are responsive to the unique combinations of functions, site, energy and construction costs encountered in most new commercial building projects. The challenge is also for the energy-performance levels to be economically sound for them to be accepted, and be implemented so that they are easy for designers to use.

The fire protection and loss control industries describe the approach as the future of loss control. The existing current fire safety design and approval processes, and codes and standards inhibit the introduction and application of new technologies (Simenko, 1996). It is claimed that savings in the $170 billion spent on fire protection in the United States could be brought about through a performance-based approach (Jones, 1997). The approach is intended to provide flexibility in maintaining accepted fire safety levels while ensuring life safety and reducing property loss. Performance-based requirements should reduce design and construction costs, and maintenance and liability coverage costs.

The Australian Model Code for Residential Development (AMCORD) has emphasized the use of an integrated performance-based approach to urban residential development in new and existing urban areas in Australia. AMCORD suggests that this approach provided a practical alternative to outdated prescriptive methods, flexibility in development approaches, and encouraged more responsive development outcomes (AMCORD, 1997). Further, the approach encouraged flexible and environmentally responsive planning, containing clear site planning and design objectives supported by simple statements of intent. AMCORD recognized that the performance approach represented a shift in perspective. For instance, regulatory processes would be streamlined resulting in fast track approvals of plans and minimization of bureaucracy. The performance approach covered the entire range of residential development, from subdivision planning to the design of single homes and large multi-unit developments.

The trucking industry in the United States has rejected the prescriptive one-size fits all regulatory schemes for safety enforcement. Instead they have opted for performance-based regulations that provided drivers and companies with the flexibility they needed to operate safely (American Trucking Association, 1998; Strah, 1996).

The U.S. Environmental Protection Agency (EPA) concluded in a study conducted in Virginia that the previous prescriptive command-and-control approach to the management of water quality was inefficient and ineffective (Kerns, 1991). This approach was based on a fragmented pollutant-by-pollutant basis oriented toward specific technologies to control each pollutant. The EPA emphasized the need to move beyond the prescriptive approach of uniform, source-specific emission and effluent limits that were backed by enforcement actions. This change in approach occurred due to the complexity of the current water quality concerns requiring an equivalent complexity in responses. The responses proved to be uneconomical and not cost-effective. They have subsequently made use of a performance approach that included performance-based standards for hazardous pollutants, and performance targets for reformulated fuels. The water quality management industry was allowed to meet these emission reduction targets in the most cost-effective way possible.

The California Department of Toxic Substances Control (CDTSC) has recommended the development of performance-based standards for laboratory waste management. These standards have proven to be very efficient in allocating compliance resources to maximize the benefit to the environment (CDTSC, 1998). This reform would result in a more efficient and effective system of managing laboratory waste, while protecting health and the environment. Further, it was argued that these standards appeared to suit laboratories well because of the variety and variability of laboratory activities.

While it has been held that the performance approach is unsuitable for large scale projects, the Dutch Government Building Agency has applied the concept in the current program for procuring new courthouses and tax offices, corresponding to an investment volume of about $1 billion (Bröchner, Ang and Freriksson, 1999). These projects made use of design-build contracts where the effect of using performance specifications was more obvious as the design tasks were allocated to the contractor. The intention was to take advantage of efforts and creativity in the private sector by allowing firms to come in very early in the design phase. Interaction between architectural design, building physics, and other design specialties was supported along with the link to environmental assessment experts and decision support systems.

Chapter Summary

Some of the key literature on the performance concept and approach has been reviewed regarding its conceptual nature, its advantages and disadvantages, and its international appeal. Some of the terminology used to describe the approach has been examined. The confusion, which exists as a consequence, has been considered. Difficulties regarding implementation, application and enforcement have been identified and discussed. In particular, the difficulties refer to the assessment of performance criteria, and the knowledge base required. The available literature on the performance approach is largely silent regarding the application of the performance concept to the safety and health of construction workers. The reason for this omission is that construction workers are not considered users of the building structure with user requirements that have to, or should be satisfied by a performance approach. Examples have been provided of the application of the performance approach, albeit not necessarily to construction worker safety and health. The regulatory issues suggested by the literature pertaining to the design and implementation of a successful performance approach have been discussed and examined. The commonalties and differences between various regulatory approaches have been highlighted.

In the next chapter, examples of performance-based safety and health legislation in Australia, United Kingdom, New Zealand and Europe are examined. Legislation in the United States that is largely prescriptive in nature is also considered.

INTERNATIONAL PERFORMANCE-BASED SAFETY LEGISLATION

Introduction

Both legislators and safety professionals in the construction industry have held that responsibility for safety and health should be placed on those indirectly involved in construction as well as the contractors who actually carry out the works. Designers, architects and, particularly, clients influence the construction process. Many accidents would be avoided if that influence were used with accident prevention in mind - from project inception through project execution and then throughout the life of the facility until its final demise through demolition (Joyce, 1995; Berger, 1999).

Given the unique nature of the construction industry and the interdependence of the large number of stakeholders, the teambuilding approach to construction safety and health is pivotal to achieving safety and health on construction projects (Smallwood and Haupt, 2000). The monumental task facing the construction industry is to encourage every person involved in the design, management, and execution of construction projects to give priority to safety and health issues which have until now failed to attract the necessary attention, especially from clients and designers (Joyce, 1995). The exclusion of health and safety from specifications, and health and safety being the sole responsibility of the contractor have been identified as primary causes of accidents in construction (Ngowi and Rwelamila, 1997).

The results of investigations in the U.S. into major catastrophes in construction have shown that a lack of planning and engineering oversight has been a primary contributor to the cause of these failures (Lapping, 1997). Further, in a study conducted in South Africa, planning was identified as the primary preventive action that could have been taken in 40% of the cited cases (Szana and Smallwood, 1998). Additionally, in a study into scaffolding accidents in the United States, South Africa, and Turkey, designing for safety and enforcement of regulations and standards were suggested as reasonably practicable preventive precautions (Müngen, et al., 1998).

The poor safety and health performance record of the construction industry has resulted in safety and health regulations around the world being subjected to major revisions during the last three decades.

In this chapter, the approach is examined that is advocated by the Council Directive 92/57/EEC that forms the basis for construction worker safety and health legislation in Europe, The Construction (Design and Management) Regulations (CDMR) 1994 in the United Kingdom, The National Model Regulations, and the National Code of Practice for the Control of Workplace Hazardous Substances 1994 in Australia, and the Health and Safety in Employment Act 1992 and Regulations 1995 in New Zealand. These examples of safety and health legislation are performance-based and have as their main thrust the redistribution of responsibility for health and safety on construction sites away from the contractor to include clients and planning professionals (ILO, 1992; Lorent, 1999; Caldwell, 1999). Additionally, the Occupational Safety and Health Act of 1970 (OSHA) in the United States is also examined, as legislation that is largely prescriptive in nature, but is slowly moving toward a performance approach.

Construction (Design and Management) Regulations (CDMR) of 1994

The CDMR were introduced in the United Kingdom (UK) in March 1995 in compliance with the European Union Council Directive 92/57/EEC in 1992, in terms of which all European Union member states were to implement the terms of the directive into national legislation by 1994. The directive was, however, not implemented in its entirety by the CDMR. Rather the CDMR implemented the organizational and management aspects (Caldwell, 1999). The regulations were, additionally, a response to the study conducted by the Health and Safety Executive (HSE) which recorded that during the period 1981 through 1985, 739 people were killed in the construction sector (Munro, 1996). An analysis of the main causes of accidents in UK construction revealed the following:

- A lack of supervision by line managers in the industry;
- Inadequate equipping of workers to identify dangers and to take steps to protect themselves from these; and
- A lack of coordination between the members of the professional team at the pre-construction phase (Joyce, 1995).

They were consequently designed to provide a legislative framework aimed at achieving cooperation and coordination in the drive to improve construction safety and health on construction sites.

The regulations promote the teamwork approach during the design and construction life of construction projects, which was advocated by Sir Michael Latham in his 1994 report, *Constructing the Team.* They place new responsibilities and duties on clients, designers, and contractors (Caldwell, 1999). The CDMR carry a criminal sanction of up to 2 years imprisonment and unlimited fines for noncompliance with their provisions. The primary objective of the CDMR is to ensure proper consideration of safety and health issues throughout each phase of the construction process from project inception through to the eventual demise of the building by demolition (Tyler and Pope, 1999). The CDMR have been described as a management solution. They involve coordination in a notoriously fragmented industry as well as the integration of the major participants in the construction process.

Major distinguishing characteristics of this legislation include:

- A departure from the traditionally prescriptive or 'deemed-to-comply' or 'command-and-control' approaches to a performance-based approach in terms of which no standards for compliance are set;
- The compelling of safety and health management as an obligation into the planning and design of virtually all but the smallest of construction projects;
- Emphasis on the identification of construction hazards and the assessment of risks to eliminate, avoid or at the very least reduce perceived risks;
- Consideration of safety and health issues not just during the construction life of the project, but from project inception through to the final demise of the facility by demolition, including the operation, utilization and maintenance periods;
- The redistribution of responsibility for construction worker safety away from the contractor, who was previously solely responsible, to include all participants in the construction process from the client through to the end-user;
- The introduction of a new participant to the construction process, the planning supervisor, with responsibility to coordinate the other participants and documents to facilitate better management of safety and health on construction projects;
- Mandatory safety and health plans as instruments facilitating exchange and communication of safety and health issues between all participants in the construction process, on all 'notifiable' projects where the construction phase is longer than 30 days or will involve more than 500 person days, and where there are more than 5 persons carrying out construction work at any one time; and
- Mandatory compilation of a safety and health file by the planning supervisor to be handed over to the client upon completion of the facility.

The CDMR acknowledge the roles of each participant in construction. For example, whereas designers were not previously extensively involved in giving advice about systematic consideration of health and safety issues, they are now required to avoid foreseeable risks as a duty for all construction projects.

The establishment cost to the industry in the UK was calculated to be in the region of $825 million with the cost of compliance by designers an additional annual amount of about $435 million. The practical implications of CDMR are set out below in some detail to facilitate easy comparison between the UK and European Economic Community positions:

Client

Once the client decides to proceed with a construction project, the initiative to apply the CDMR lies with the client. The client, or client's agent, has an obligation under the CDMR to appoint a planning supervisor and principal contractor.

Planning Supervisor

The role of the planning supervisor includes ensuring the preparation of a project-specific safety and health plan, the monitoring of safety and health aspects of the project design, the provision of adequate advice to the client and any contractor, and ensuring the preparation of a project-specific safety and health file. Further, the planning supervisor has the responsibility to ensure that all members of the professional team liase and communicate within a management framework on all safety and health issues.

Principal Contractor

In terms of the CDMR, the principal contractor is responsible to take over and further develop the safety and health plan of the project, coordinate the activities of other contractors as well as provide information, training and consultation with all employees to minimize risks to safety and health.

Designer

The designer is required under the CDMR to ensure that the design avoids unnecessary risks to health and safety or reduces the risks so that the project can be constructed and maintained safely. The risk to safety and health produced by a design feature must be weighed against the cost of excluding the feature entirely by designing to avoid risks to safety and health, tackling the causes of risks at source, or if not possible, reducing and controlling the effects of risks by appropriate means aimed at protecting anyone at work who might be affected by the risks and, in so doing, yielding the greatest benefit. Additionally, the designer has the responsibility to keep the client informed of duties that will arise as a result of the project design.

Other Contractors

All contractors are to co-operate with the principal contractor with regard to safety and health risks arising or likely to arise from their own work on site.

Prior Notice

A prior notice must generally be submitted to the Health and Safety Executive responsible for safety and health at work on all construction sites where the construction phase will be longer than 30 working days, and on which more than 5 workers are employed at the same time, or on which the amount of construction work to be carried out will involve more than 500 person-days. This notice must be periodically updated if necessary and be displayed on the construction site.

Health and Safety Plan

The health and safety plan is the instrument that facilitates the exchange and communication of safety and health issues between all participants in the construction process. During the pre-construction phase the plan is prepared using information from the client, designers, and planning supervisor. Prior to commencement of the project works the plan is further developed by the principal contractor to include details of safety and health risk management and prevention which arise due to the construction activities of contractors and sub-contractors. The safety plan is subject to continuous review and amendment as construction progresses.

The information contained in the health and safety plan, while it is project-specific, should include provisions covering the following:

- General;
- Program;
- Existing off-site conditions;
- Existing on-site conditions;
- Existing records;
- The design;
- Construction materials;
- Site layout and management;
- Relationship with the client's undertaking;
- Site rules; and
- Procedures for the continuing review of the health and safety plan (Joyce 1995).

Health and Safety File

The planning supervisor is required under the CDMR to compile a health and safety file to be handed to the client upon completion of the project.

The following information should be included in the health and safety file:

- Historic site data;
- Site survey information;
- Site investigation reports and records;
- Photographic record of essential site elements;

- Statement of design philosophy, calculations, and applicable design standards;
- Drawings and plans used throughout the construction process, including drawings prepared for tender purposes;
- Record drawings and plans of the completed structure;
- Maintenance instructions;
- Instructions on the handling and/or operation of equipment together with the relevant maintenance manuals;
- Results of proofing or load tests;
- Commissioning test results;
- Materials used in the structure identifying, in particular, hazardous materials including data sheets prepared and supplied by suppliers;
- Identification and specification of in-built safety features, for example, emergency and fire fighting systems and fail-safe devices; and
- Method statements produced by the principal contractor and/or contractors (ACOP 1995).

Council Directive 92/57/EEC of 24 June 1992

The Council of European Communities committed itself to ensuring greater protection of the safety and health of construction workers through the adoption of minimum requirements for encouraging improvements in working environments on construction sites to ensure a better level of protection. In particular, increased responsibility was placed on employers accompanied by new obligations for workers and greater involvement by all participants in the construction process – owners to workers – in the management of risks (Lorent, 1999). The imposition of additional administrative, financial, and legal constraints that would impact negatively on small and medium-sized undertakings was not intended. Rather the Council Directive 92/57/EEC of 24 June 1992 was designed to guarantee the safety and health of workers on construction sites in the European Community wherever building or civil engineering works were carried out. The Directive was transposed into national law in most member countries of the European Union with minor changes in the management or personnel structure and/or the safety measures advanced by the original Directive. In some countries the adoption of the

Directive was necessitated by the need for organizational change due to developments to improve the cohesion of the construction process and communication, as well as the structural changes caused by the cluster of sub-contracting arrangements characterizing their construction industries (Lorent, 1999).

The Commission recognized that more than 50% of occupational accidents on construction sites were attributable to unsatisfactory architectural and/or organizational options, or poor planning of the works at the project preparation stage (Lorent, 1999). Moreover, the Commission recognized that large numbers of accidents resulted from inadequate coordination especially where various undertakings worked simultaneously or in succession at the same construction site. This recognition represented a major paradigm shift. Previously all responsibility for safety and health on construction sites was attributed solely to contractors. The provisions of the Directive were directed to bring about a cultural change to improve the poor safety culture prevalent within the industry (Schaefer and De Munck, 1999).

The main distinguishing features of the Directive include:

- The performance-based nature of the provisions of the Directive;
- Ensuring that safety and health issues are taken into account through all phases of the construction process, extending to the operation, utilization, and maintenance periods, and the final demise of the facility through demolition;
- The redistribution of responsibility for construction worker safety away from the contractor, who was previously solely responsible, to include all participants in the construction process from the client through to the end-user;
- The introduction of the project supervisor who is responsible, while acting for the client, for all applicable general safety and health requirements during the stages of design and project preparation, including ensuring that the safety and health plans and files are accordingly adjusted;
- The appointment of one or more safety and health coordinators by the client or the project supervisor, for either or both the project preparations and project execution stages, their duties in terms of each stage being different;
- The compilation of mandatory safety and health plans by the client or project supervisor before actual work commences on site;

- The giving of a prior notice, which must be updated periodically and displayed on the construction site, submitted to the authorities responsible for safety and health at work on all construction sites where the work is scheduled to last longer than 30 working days, and on which more than 20 workers are employed at the same time, or on which the amount of work to be carried out is scheduled to be more than 500 person-days;
- The mandatory preparation of a file appropriate to the characteristics of the project containing relevant safety and health information to be taken into account during any subsequent works; and
- The fact that the entire Directive, together with all annexures, is contained in a total of 17 pages.

The following are typical examples of performance-based standards taken from the Council Directive:

Scaffolding and ladders

- All scaffolding must be properly designed, constructed and maintained to ensure that it does not collapse or move accidentally.
- Work platforms, gangways and scaffolding stairways must be constructed, dimensioned, protected and used in such a way as to prevent people from falling or exposed to falling objects.

Demolition work

- Where the demolition of a building or construction may present a danger:
- appropriate precautions, methods and procedures must be adopted; and
- the work must be planned and undertaken only under the supervision of a competent person.

These sections are the equivalent of OSHA 29 CFR 1926 Subparts L (1926.450-453) and T (1926.850-860). The actual text of sections of the applicable OSHA standards is given in the section dealing with OSHA.

Resistance to change in any form is normal and is to be expected. Reaction to this directive was no different. Architects, in particular, across Europe felt very uncomfortable with this change in responsibility from the contractor to the client who was required to take appropriate steps regarding safety and health in the planning and execution of a construction project. Further, the client was responsible for organizing the work on the construction site in such a way that risks to life and health were avoided as far as is possible, and where not possible, to maintain residual risk at the lowest level possible (Berger, 2000). The practical implications of Council Directive 92/57/EEC follow:

Project Supervisor

The project supervisor while acting on behalf of the client is responsible for the design, and/or execution, and/or supervision of the execution of a project. The directive requires that the project supervisor take cognizance of all applicable general safety and health requirements during the stages of design and project preparation. Additionally the project supervisor is responsible for ensuring that the safety and health plans and files are accordingly adjusted.

Safety and Health Coordinators

The directive requires one or more safety and health coordinators to be appointed by the client or the project supervisor. Coordinators may be appointed for either or both the project preparations and project execution stages and their duties in terms of each stage are different.

Regarding the project preparations stage safety and health coordinators are responsible for the coordination of the implementation of the provisions that consequently arise out of the involvement of the project supervisor in the design and project preparation stages. Further they are responsible for the formulation of a safety and health plan as well as a file containing all the relevant safety and health information applicable to the project.

During the project execution stage coordinators are required to coordinate all aspects of safety and health relative to the project and ensure strict compliance with all such provisions. Additionally they are required to facilitate cooperation between all contractors on the site, ensure that safe working procedures are followed and that only authorized persons are allowed onto the construction site. These coordinators do not relieve the client or project supervisor of any of their responsibilities in terms of the construction project.

Safety and Health Plan

Additionally, the client or the project supervisor is responsible for the compilation of a safety and health plan before actual work begins on site. These safety plans must take into account the work involving particular risks listed in Annex II of the directive.

Prior Notice

A prior notice must be submitted to the authorities responsible for safety and health at work on all construction sites where the work is scheduled to last longer than 30 working days and on which more than 20 workers are employed at the same time, or on which the amount of work to be carried out is scheduled to be more than 500 person-days. This notice must be periodically updated if necessary and be displayed on the construction site.

Obligations of Employers

The directive in no way absolves employers from their responsibilities toward their workers, and require them to take measures in compliance with the minimum safety and health requirements for construction sites as set out in Annex IV of the directive.

Workers

All workers must be informed and kept informed of all measures to be taken regarding their safety and health on the construction site. They are to be involved on a consultative and participatory basis in all matters of safety pertaining to their activities at the workplace.

Concerns

However, concerns remain among many of the member countries of the EU about the cost to implement the revised structure embodied in the provisions of the Directive. This cost has been estimated to range between 0.2 and 2% of the total project cost distributed on the basis of 35% for coordination during the project preparation phase and 65% during the project execution phase (Lorent, 1999; Berger, 1999).

Further, there is concern about the lack of a standard and simplified system of reporting construction-related accidents, injuries, fatalities and diseases which might have been embodied in the Directive (Papaioannou, 1999; McCabe, 1999; Casals and Salgado, 1999; Onsten and Patay, 1999). This lack makes it difficult to conduct comparative analyses of the effectiveness and impact of the introduction and implementation of the Directive in member countries on the safety performance of the industry on a country-by-country basis. This difficulty was encountered first hand when trying to conduct the international survey described earlier.

Additionally, there is confusion in some countries about the need for and content of the project-specific safety and health plan (Onsten and Patay, 1999; Casals and Salgado, 1999; Caldwell, 1999). A final concern revolves around the poorly defined competence and qualification requirements of project supervisors and safety coordinators with mutual recognition of training and development programs and qualifications (McCabe, 1999; Dias, 1999; Gottfried, 1999; Casals and Salgado, 1999; Caldwell, 1999).

Australian Regulations and Legislation

It was realized in Australia that it would be impossible to draft appropriate standards to cover each of the between 21000 and 37,000 chemicals individually that are used in Australian workplaces. It was recognized further that specific substance controls were insufficient to deal with the wide range of workplace situations where large numbers of hazardous substances were used.

The National Model Regulations, and the National Code of Practice for the Control of Workplace Hazardous Substances, of 1994 are consequently generic rather than substance-specific. They provide cover for all hazardous substances used in workplaces throughout Australia. The model regulations apply to all workplaces where hazardous substances are used or produced, and to all persons with potential exposure to hazardous substances in those workplaces (Lawson, 1996).

The regulatory package is an example of performance-based regulations. The health and safety outcomes are specified in the regulation, but not the means to achieve them, as has been the case for previous prescriptive Australian safety and health regulations and legislation of the past. The regulations provide a comprehensive approach to the control of health risks from exposure to hazardous substances by setting the outcomes to be achieved and by setting the processes to be followed. They do not prescribe how risks must be controlled. The regulations give industry the flexibility to select the most appropriate control measures for different workplace conditions, based on the identification and assessment of risk (Lawson, 1996).

A risk management process is incorporated in the National Model Regulations for the Control of Workplace Hazardous Substances. Features of this process include:

- Establishment of the context regarding scope and objective. The regulations apply to all workplaces where hazardous substances are encountered in the course of work. The objective of the regulations is to minimize the risk of adverse health effects due to exposure to hazardous substances.
- Identification of hazards or risks. Hazardous substances used at work need to be provided with labels and Material Safety Data Sheets (MSDS). Workers, who will potentially be exposed to hazardous substances used in a work activity, need to be provided with information and training on the nature of the hazards. Workers need to participate in the hazard identification process, which begins with the manufacture or importation of the hazardous substance. Manufacturers and importers produce, review, and revise MSDS for all hazardous substances that they supply. Suppliers provide appropriate labeling on all containers of hazardous substances supplied for use at work. Employers identify hazardous substances in the workplace by reference to the MSDS or labels.
- Risk assessment. This assessment includes the identification of any hazardous substance used or produced in that work, review of information about hazardous substances, and identification of any risk of exposure to any hazardous substance used or produced in that work.
- Risk control. Employers need to select appropriate measures to achieve and sustain control, arrange induction and training, and determine if monitoring or health surveillance is required. These aspects are covered in the National Code of Practice.

When evaluating the effectiveness of the new performance risk management style regulations when compared with the former prescriptive, rules-based approach, Gun (1994) referred to the report of the Health and Safety Executive in the UK, where it was established that there had been significant improvements in the assessment and control of risks arising from hazardous substances in the workplace since the introduction of the new regulations. There had been a greater awareness of risks from hazardous substances resulting in improved management strategies to prevent and control risks. The increased awareness resulted in the detection of an increased amount of chemical-related morbidity. About 49% of the survey respondents reported more efficient use of chemicals, and a similar percentage reported a range of other benefits including better management of plant. The regulations had enabled companies to focus on the individual realities of their own workplaces and develop appropriate and effective action.

Health and Safety in Employment Act 1992 and Regulations 1995

The New Zealand Building Code (NZBC) is an integrated performance-based code, divided into clauses, that sets out descriptions of objectives, general functional requirements, and specific mandatory performances that must be achieved to comply with the law (Table 4-1).

Methods for compliance are not prescribed. The NZBC originated from building industry requests for reform dating back to 1979 with a Ministry of Works and Development sponsored research project. It was the culmination of 10 years research at Victoria University of Wellington in the School of Architecture Industry Research Group and Centre for Building Performance Research under the direction of Dr. Helen Tippett[35], and the service of five people for four years to reform the existing national building regulatory system.

Table 4-1 Example of a performance code from the New Zealand Building Code

Objective	F4.1 The objective of this provision is to safeguard people from injury caused by falling
Functional Requirement	F4.2 Buildings shall be constructed to reduce the likelihood of accidental fall
Performance	F4.3.1 Where people could fall 1 meter or more from an opening in the external envelope or floor of a building, or from a sudden change of level within or associated with a building, a barrier shall be provided

[35] An electronic interview was conducted on 9 December 1999 with Dr. Helen Tippett on performance-based codes - refer to Appendix B

The national building code had to be performance oriented (Building Industry Authority, 2000), consistent with public interest, and within a suitable economic framework regarding efficiency and accountability underlying the restructuring of the New Zealand economy. The NZBC aimed to encourage innovative design and advance technology applications in the most cost effective way by allowing 'alternative solutions' in that the NZ government established the why and what was to be controlled whereas the industry, researchers and academics provided the know-how and how much.

The code, and its performance base, is regarded as the best building control tool to encourage innovation, remove barriers to international trade, and to minimize the guessing game of why regulators insist upon particular prescriptive requirements (Hunt and Killip, 1998). These benefits are being gained through a custom-made administrative legislative framework uniquely designed for New Zealand.

The Health and Safety in Employment Act 1992 (HSE Act) shows the confidence which the New Zealand government has in the performance approach. It extends the application of the performance approach to worker safety and health. The HSE Act has reformed the law and many separate regulations and altered their nature from a prescriptive base to a performance-based platform of legislation. In this way, it provides, for the first time, comprehensive coverage and a consistency of approach to the management of safety and health in all workplaces. Responsibilities and obligations of all participants in the construction process have changed to include everyone. It is intended to reduce the amount of legislation and change the emphasis from the control of specific hazards to managing risks in relation to work activities. The emphasis moved from a prescriptive base to that of a performance base and has a five-level format; similar to the

Nordic Five Level System described earlier. The HSE Act provides comprehensive coverage for all work situations, clearly defines responsibilities, promotes systems for identifying hazards and dealing with them, enforces involvement of employees in health and safety issues along with requirements for health and safety training and education.

It has been claimed that attitudes toward safety and health have improved throughout all industries. The guidelines to the HSE Act regarding the construction industry include checklists to aid in identification of risks, and the assessment and control of those risks. Some key features of the HSE Act follow:

Objective

The principle objective of the HSE Act is to prevent harm to workers while at work. All principals (or clients) are expected to ensure that actions at work do not result in harm to employees of contractors or sub-contractors, including members of the public.

Locus of Performance

Under the HSE Act, the principle responsibility is to take 'all practicable steps' to ensure the health and safety of everyone carrying out work of any kind throughout all stages of a construction project, including those who might be affected by the project, such as the general public (Site Safe, 1999). This obligation is not simply a reactive one but rather a proactive one.

Rogers (2000) cites the case of Mair v Regina Ltd. where the judge observed the nature of this obligation as: 'The Act contains a new philosophy... it requires employers to be proactive... employers are now required to be analytical in providing or maintaining a safe working environment. It is not just a matter of meeting minimum standards and codes lay down by statute. It requires employers to go further and set down their own standards commensurate with the principal object of the Act, after due analysis and criticism.'

Management of Hazards

The HSE Act sets out a hierarchy for action to limit the effects of work hazards. This involves the following:

- Identification of the hazards by breaking work into elements, identifying activities within elements and extracting known hazards from checklists and allocating to activities; and
- Evaluation of the significance and consequent management of the hazards by the following hierarchy:
- Elimination;
- Isolation; and if elimination or isolation is not possible
- Minimization.

Responsibilities of Principals

A principal is someone who forms a contract with a third party to carry out a building project or any part of such a project. Although the client has responsibility as a principal, other members of the project team can be principals at any one time, and all key participants in the construction process have a duty to provide for the health and safety needs of their own areas of operation (Site Safe, 1999). The following are some of the issues which principals need to consider:

- Designers and consultants possess adequate safety and health knowledge, expertise and experience;
- Contract periods and budgets make provision for safety and health aspects to be included in the project;
- Assessment of the ability of contractors to manage and control safety and health on the project;
- Provision for on-site safety and health monitoring;
- Provision of all relevant safety and health information such as known hazards, to consultants and contractors; and
- On-going coordination of information and activities between all participants in the construction of the project (Rogers, 1999; Site Safe, 1999)

Responsibilities of Employers

Employers are responsible under the HSE Act 1992 to identify hazards and ensure that the proper controls are in place to manage them regarding the threat that they pose to employees and the general public. Regular reviews of the workplace have to conducted to ensure the effectiveness of the controls and to identify new hazards. Employers are required to provide adequate supervision and training to employees in the safe use of all plant, equipment and protective clothing that they may use or handle. Further they are required to record all accidents and investigate all accidents and near misses. Additionally, all employees have to be involved in the development of emergency procedures.

Responsibilities of Employees

Employees are responsible for their own safety and that of their fellow workers as far as practicable.

Additional Comments on NZBC

Consequent to a request for information of the performance approach to construction worker safety and health via cnbr-l, an international list serve, Dr. Helen Tippett from the Victoria University of Wellington, responded. She had been one of the leading experts involved in the development of the New Zealand Building Act and Building Code during the period 1980 through 1990. Eleven open questions were submitted to her (Appendix B).

These questions were intended to determine the motivation for the change from the former prescriptive approach in favor of the performance approach, the initial impact and reception of this change on and by industry participants, and the effect on the safety and health performance of the industry. Some of the answers to the questions are contained in Table 4-2. On the suggestion by Dr. Helen Tippett, six open questions were submitted to Dr. Bill Porteous[36], the Chief Executive of Building Industry Authority (BIA) in New Zealand (Appendix E). The answers to some of the questions are set out in Table 4-3.

Table 4-2 Selected answers to questions on NZBC

Question	Answer
What prompted New Zealand to develop and then adopt a performance-based building regulatory system?	Industry submission to government in 1981 pointing out that the cost of multiple prescriptive regulatory systems was not commensurate with public benefit. Change of government in 1985 with a strong deregulation agenda.
How was the transition from the old code to the new code received by all participants in the construction process?	Mixed feelings and skepticism that it would encourage innovation or more cost effective compliance.
Has the new code in any way impacted the structure of the industry and organizations?	Yes, accredited private certifiers, accredited products, more consistent territorial authority granting of building consents, responsibility of owner for ongoing compliance.
How was the change managed?	New Building Act of Parliament and new national authority (Building Industry Authority)
What was the cost involved in the transformation?	Significant
Has the code improved the performance of the industry?	To some extent - the opportunity for improvement is greater than actual
Would such an approach work in the area of construction worker safety and health?	Yes, refer BIA and subsequent legislation (HSE Act)

Concerns

The results of research conducted in 1997 indicated several areas of concern (Site Safe, 2000) that needed to be addressed if the safety and health record of construction

[36] An electronic interview was conducted on 23 October 1999 with Dr. Bill Porteous, the Chief Executive of Building Industry Authority in New Zealand on performance-based codes - refer to Appendix E

were to improve further. Before the production of a Guidelines document, the roles and responsibilities of the various participants in the construction process for safety and health were unclear. There was little reliable information on actual injury rates and safety practices. There had until recently been no systematic analysis of injury patterns or planning of injury prevention activities. The tendering or procurement process encouraged participants to cut corners to reduce project costs. Some clients had only a paper compliance to avoid prosecution. Some participants considered rewards for safe practices from the ACC experience rating system insignificant. Most participants viewed ISO 9000 registration as expensive and ineffective in enhancing injury prevention. Further, workers' compensation insurers focused on claims and injury management rather than on injury prevention. There was inadequate information about injury prevention methods regarding both equipment and procedures. Tight project timelines, poor housekeeping or untidy construction sites, and carelessness were identified as the largest contributing factors to accidents.

Table 4-3 Selected answers to questions on NZBC by the BIA

Question	Answer
How has the introduction of the new code (NZBC) impacted the structure of the construction industry itself and also construction firms?	No measurable effect so far as we are aware
Was there any large scale resistance to the change in legislative approach?	No 'large scale resistance' was observed
What was the cost involved in bringing about the transformation?	Not known. As with any change to the law of the land the cost fell mainly on the taxpayer. The cost of learning to work within the new regime has not been quantified but would have been borne by both local government and the building industry.
Has the code improved the performance of the industry?	We would say 'yes' because innovation has been encouraged and alternative solutions accepted.

Occupational Safety and Health Act (OSHA) of 1970

OSHA in the United States applies specifically to employers, which in construction are contractors. Consequently, contractors have been held solely responsible for safety and health on construction sites in the United States. There is considerable resistance to any attempt to shift the liability for safety to include other participants in the construction process such as manufacturers, suppliers, and designers. These interest groups have considerable lobbying power to prevent changes to current legislation. Manufacturers and suppliers for example shift the liability for the products they manufacture or supply to contractors in the form of various data sheets (MSDSs).

The OSHA standards have historically been formulated on the basis of traditional prescriptive and 'deemed-to-comply' approaches. Contractors are required to comply rigidly with the provisions of the standards. Noncompliance is censured in the form of punitive fines.

The OSHA regulations cannot, and do not, cover every conceivable work condition or situation. Construction contractors hold the position that each project process and design is unique and compliance with a rigid set of rules is not feasible (Lapping, 1997). In cases where the regulations do not cover a particular situation, contractors have to apply to OSHA to obtain permission to deviate from the applicable standard. Historically, the requests for these variances have been relatively few, and the number of variances actually granted tends to be even smaller (Hinze, 1997).

The OSHA standards for construction consist of over 200 sections, and more than 1000 subsections, ranging from short paragraphs to several pages. The sections are grouped into 26 subparts (A through Z). Examples of prescriptive codes for demolition work and scaffold platforms are supplied in Figure 4-2.

The effort to change the culture of the current regulatory system enjoys support at the highest level of government. Contractors have requested the government to allow them the flexibility to choose the means and methods to perform their operations (Lapping, 1997). Federal regulatory agencies have begun to write rules that satisfy this request for flexibility by the construction industry (Lapping, 1997). It has been recognised that developing tailored and cost-effective standards, as well as altering or eliminating existing rules that are obsolete or no longer make sense, have to be supported by sound science and good information.

The following example of a prescriptive code covering demolitions is drawn from OSHA 29 CFR 1926 Subpart T 850(k):

> Employee entrances to multi-story structures being demolished shall be completely protected by sidewalk sheds or canopies, or both, providing protection from the face of the building for a minimum of 8 feet. All such canopies shall be at least 2 feet wider than the building entrances or openings (1 foot wider on each side thereof), and shall be capable of sustaining a load of 150 pounds per square foot. Employee entrances to multi-story structures being demolished shall be completely protected by sidewalk sheds or canopies, or both, providing protection from the face of the building for a minimum of 8 feet. All such canopies shall be at least 2 feet wider than the building entrances or openings (1 foot wider on each side thereof), and shall be capable of sustaining a load of 150 pounds per square foot.

The following example of a prescriptive code covering scaffolding platforms is drawn from OSHA 29 CFR 1926 Subpart L 451 Scaffolding:

> (b) 'Scaffold platform construction.'
>
> (b)(1)(ii) …. the platform shall be planked or decked as fully as possible and the remaining open space between the platform and the uprights shall not exceed 9 1/2 inches (24.1 cm).
>
> (b)(2) Except as provided in paragraphs of this section, each scaffold platform and walkway shall be at least 18 inches (46 cm) wide.

> (b)(5)(I) Each end of a platform 10 feet or less in length shall not extend over its support more than 12 inches (30 cm) …
>
> (b)(5)(ii) Each platform greater than 10 feet in length shall not extend over its support more than 18 inches (46 cm), unless it is designed and installed so that the cantilevered portion of the platform is able to support employees without tipping, or has guardrails which block employee access to the cantilevered end.
>
> (b)(7) On scaffolds where platforms are overlapped to create a long platform, the overlap shall occur only over supports, and shall not be less than 12 inches (30 cm) unless the platforms are nailed together or otherwise restrained to prevent movement.

There is increasing support for a move away from the traditional focus on strict compliance with procedural requirements and heavy fines for noncompliance in favour of a system based on results or outcomes. At the same time, compliance assistance will be offered when the requirements are not met. To this end, OSHA for example, has been pilot testing a system which will give both construction managers and workers the primary responsibility for ensuring safety and health at their individual work sites.

For its part, OSHA, in a May, 1995 report, entitled 'The New OSHA,' has committed itself to promoting common sense regulations, encouraging partnerships, and eliminating red tape, while at the same time ensuring greater safety and healthier working conditions for American workers (Office of Management and Budget 1996). To achieve these improvements, OSHA is:

– Offering incentives to employers with good safety and health programmes;
– Either eliminating or amending outdated and confusing standards;
– Improving consultation with stakeholders in the construction industry; and
– Establishing performance measures that evaluate programmes based on safety and health results and outcomes.

The August 1996 revision of the OSHA standard protecting approximately 2.3 million workers on scaffolds in the construction industry is an example of a performance-based approach. The standard establishes performance-based criteria, where possible, to protect employees from scaffold-related hazards such as falls, falling objects, structural stability, electrocution, and overloading (Office of Management and Budget 1996). Employers are allowed greater flexibility in the use of fall protection systems to protect workers on scaffolds. This flexibility extends to workers erecting and dismantling scaffolds. The training of workers using scaffolds is also strengthened. Further, the standard specifies when retraining is required. According to estimates, the new standard will prevent 4,500 injuries and 50 deaths annually, saving construction employers at least $90 million in annual costs resulting from lost workdays due to scaffold-related injuries.

Chapter Summary

The benefits of the adoption of the Council Directive 92/57/EEC in Europe, the CDMR in the UK, National Model Regulations and the National Code of Practice for the Control of Workplace Hazardous Substances in Australia, and HSE Act 1992 and Regulations 1995 in New Zealand have not been extensively measured and evaluated yet. It is anticipated that the paradigm shift promoted by this type of regulatory framework will have positive results for the construction industry and contribute to the common vision of accident free construction on construction sites. Further, for the fully successful introduction of a performance-based code an effective and efficient administrative and legal underpinning must support it.

The value of the CDMR, Council Directive 92/57/EEC, and HSE, in particular, lies in the requirements of all participants in the construction process to make safety and health a mandatory priority in a structured way. They are performance-based, permitting flexibility in dealing with safety and health issues and the relationships, which are common for construction projects. Additionally, they provide a framework within which all the activities of all participants in the construction process, are coordinated and managed in an effort to ensure the safety of those involved with, or affected by, construction. It must be noted though that there are still several serious concerns about these legislative frameworks.

While OSHA is still largely prescriptive in nature, there are signs of increasing acceptance of a paradigm shift toward a performance-based approach. There is a steadily growing recognition that new approaches are necessary to arrest the incidence of accidents and fatalities on construction sites around the United States. A willingness to shift liability for safety away from contractors to include other participants in the construction process is necessary, but seems unlikely against present resistance.

In the next chapter, implementation issues surrounding the performance approach in the area of construction worker safety and health are discussed.

IMPLEMENTING THE PERFORMANCE APPROACH

Introduction

The tendency to protect self, family, and friends is a natural one that has been evident throughout the history of the human race. However, people have invariably been willing to take chances in exchange for possible gains - sometimes with tragic consequences. Accident prevention is not the priority that it should be, for the most part, due to ignorance of hazards and the magnitude and consequences of potential accidents.

The question might be asked whether it is necessary to construct and enforce safety and health standards, codes and regulations. It seems that while people in positions of responsibility should consider the welfare of others as a matter of conscience, they frequently fail to uphold standards of safety and health, either from ignorance or from selfishness.

This chapter presents the basis for the implementation of the performance approach to construction worker safety and health. Since the implementation process might require several changes within construction firms, we discuss the requirements and management of change. Further, we discuss briefly the evolution of safety and health legislation.

Change and Change Management

The many forces of change rooted in the prevailing social, economic, and political conditions have created enormous pressure on all organizations to respond or risk stagnation and decline (Bonvillian, 1997). In particular, organizations have to cope with globalization of the economy, new market opportunities, technological advancements, emergence of new management approaches and paradigms, and appropriate response to the needs of workers.

All people and organizations are affected by change. According to Bennis (1993: 19),

> ‘if change has now become a permanent and accelerating factor in American life, then adaptability to change becomes increasingly the most important single determinant of survival. The profit, the saving, the efficiency, and the morale of the moment become secondary to keeping the door open for rapid readjustment to changing conditions.’

Weatherall (1995) goes even further by claiming that continuing change will be the constant in this present next century. Change has been described as being ‘pervasive, important and most frustratingly, elusive’ (Weston, 1998:78). It is painful, illuminating, and time-consuming (Diamond, 1998). It is a process of transition and transformation of people and systems.

Change that might be temporary or permanent may, according to Whetton (2000) be broadly characterized into

- Functional change;
- Operational change;
- Novel change; and
- Repetitive change.

One of the most salient features of human behavior is resistance to change (Marshall, 1994), especially transformational change (Almaraz, 1994; Almaraz and Margulies, 1998). Generally, people are hesitant to accept change if it was not their idea and they had no part in developing it. Some reasons, according to Nadler (1988) why people resist or reject change include:

- Fear of the unknown;
- Possibility of economic insecurity;
- Threats to social relationships; and
- Failure to recognize the need for change.

Other reasons include:

- Lack of confidence in the party promoting the change;
- Lack of evidence of any benefit to be gained for themselves from the change;
- Preference for things to remain comfortably the way they are; and
- Fear that the change will affect them adversely.

The performance approach to construction worker safety and health requires a paradigm shift from the traditionally prescriptive approach. It does not depend on compliance with the minimum requirements of prescriptive standards. Rather, it requires a culture change that relies on a continuous and long-term commitment to understanding, evaluating and improving construction activities and processes. The acceptance of a new paradigm regarding construction worker safety and health, such as the performance approach, often necessitates a redefinition of the corresponding science (Kuhn, 1970). For the performance approach to be implemented successfully and effectively, organizations will need to depart radically from their old way of doing things (Nadler and Tushman, 1989; 1990) until it becomes a corporate culture and part of the way business is done. Statzer (1999:32) describes this process as becoming ‘transparent.’ Change may result in adjustments in the interconnection of any of the four components of people, task, technology, and structure. Such change will affect the culture of the organization, transforming it in the process. Depending on the existing culture and the degree to which a change differs from that culture, an organization might be more or less ready for such a change.

A model for determining the readiness of an organization for change is offered by Sink and Morris (1995) as follows:

$$C = (a)\ (b)\ (d) > R$$

where

C = readiness for change;

a = level of dissatisfaction with the status quo;

b = clearly understood and desired future state;

d = practical first steps in the context of an overall strategy for actualizing the desired future state; and

R = perceived cost or risk of changing.

The difference between what the organization wants to achieve (variable b) and what presently exists (the status quo) creates a level of dissatisfaction (variable a). Once both of these variables are established, the first practical steps (variable d) and overall strategy for achieving the desired future state are decided. It should therefore become obvious that the degree by which these factors outweigh the perceived cost or risk of changing (variable R) will determine the readiness of the organization for change (variable C). If the probability of achieving the future desired state is greater than the perceived cost or risk of changing, the more ready the organization would be to change.

The importance of the role and commitment of management in supporting the safety and health effort in their organizations is well-documented (Hinze, 1997; Samelson and Levitt, 1993).

> ‘Management’s reaction to change determines [the] success [of change]. When upper management ‘buys in’ to the changes, it ensures success.’ (Petersen, 1996:278)

Change, such as a paradigm shift from a prescriptive toward a performance approach, is difficult and almost impossible unless top management is totally committed to supporting and driving it. Management leadership, commitment and accountability are crucial (Statzer, 1999). Organizational change demands executive commitment and investment that is cognitive, emotional and financial (Diamond, 1998). According to Boles and Sunoo (1998), the largest barriers to managing change are lack of management visibility and support, employee resistance, and inadequate management skills.

Resistance to change is particularly relevant when the vision of management differs from the values and beliefs of the existing organizational culture. If the organizational culture fails to assimilate this vision and its implications, the desired change will never become accepted and will ultimately fail (Almaraz, 1998). Management is the key that allows safety performance improvements to occur in organizations (Freda, Arn and Gatlin-Watts, 1999; Hinze, 1997; Samelson and Levitt, 1993; Statzer, 1999). However, few managers acknowledge the need for a change in management beliefs and values to support and nourish the new cultural reality (Almaraz, 1998; Boles and Sunoo, 1998) that the performance approach to construction worker safety represents. The importance of top management commitment and the issues of organizational culture cannot be underestimated. Improved safety and health performance within an organization has to become a strategic choice. The extent of culture change needed will not be an overnight process. Such change must be planned and carefully implemented. The extent to which top management chooses to support the program of change will determine its ultimate success. It becomes apparent that the implementation of the performance approach to construction worker safety will be dependent on the capacity and willingness of management to introduce and support the changes necessary.

> ‘Another way in which behavior is strongly influenced is through modeling (learning by imitation). The research on modeling tells us that if we want to maximize approach (rather than avoidance) tendencies in workers, we [managers] must exhibit that behavior ourselves.’ (Petersen, 1996:266)

Managers and supervisors must strive to demonstrate safe work practices and make decisions that reflect their commitment to safety (Cook and McSween, 2000).

Common Law Approach to Worker Safety and Health

The improvement of construction worker safety and health has gone through several stages of development. The concept of common law prevailed before the enactment of occupational safety and health legislation to reduce the number of work-related accidents, injuries and fatalities. Common law develops from custom and precedent. Accordingly, when workers accepted employment they also accepted the consequences of exposure to any risks and hazards associated with that employment. Employers were not required to point out work-related hazards. Workers were generally expected to be smart enough to avoid danger in the workplace (Marshall, 1994). Workers were on the job by their own choice and therefore deemed to have accepted the risk of working there. They were also consequently expected to assume some responsibility for their own safety as well as the safety of their fellow workers. However, workers rarely intervened on behalf of their fellow workers.

In the absence of safety legislation, workers were solely responsible for their own actions and workplace safety. They were expected to work safely without being specifically informed nor trained about how they were to achieve this performance objective. It is therefore conceptually appropriate to suggest that, prior to the enactment of safety legislation, the prevailing approach to worker safety and health was performance oriented. Safety objectives were implied to have been determined for each construction activity. Employers expected workers to take responsibility for their actions during the execution of their tasks, for their own safety as well as that of their fellow workers. Further, workers themselves accepted the associated risks of each activity. They decided on the most appropriate method to satisfy the specific performance requirements to meet these safety objectives. The appropriateness or success of the method selected was established by whether the activity was executed safely without any accident, injury or fatality.

Emergence of the Prescriptive Approach

As industrial growth was experienced in Europe in the 19th century, the concern for the safety of workers increased. However, it was not until about 1900 that a body of work-related law made its appearance. These first laws dealt with compensation rather than accident prevention. Safety and health standards were typically developed after the recognition of the need for guidelines for the design and operation of equipment, and only after many workers had been injured or killed in serious work-related accidents (Marshall, 1994). These standards and regulations usually originated from professional societies, industry-sponsored organizations, trade associations, government agencies that have jurisdiction, international associations and specific companies. Sometimes they were developed for very specific situations and were not appropriate beyond that area.

Consequent to studies of occupational accident statistics in the United States, several bills controlling safety and health were passed. The most notable of these was the

Occupational Safety and Health Act (OSHA) of 1970. OSHA had as its stated purpose the provision for the general welfare and the assurance, so far as possible, of every working man and woman in the U.S. safe and healthful working conditions and the preservation of human resources. OSHA effectively transferred the responsibility for the safety and health of workers to employers, who, in construction, are contractors. Most of the standards promulgated and enforced by OSHA are referred to as specification or prescriptive standards.

In terms of the approach depicted in Figure 5-2, the means to meet the objective to execute a construction activity in a safe and healthy manner are prescribed and require compliance. Noncompliance with the prescriptive standards is dealt with punitively, usually by means of fines levied against the employer.

This approach (also known as the command-and-control approach) has relied on efforts to improve engineering and work environments accompanied by authoritarian management models dependent on hierarchical structures, formal rules and procedures and the policing of workers to ensure compliance (Human Performance Technologies, 1998).

While some of the standards are vague, most are very specific and rigid. It is also not possible to cover every possible situation with prescriptive regulations.

In 1978, over 900 standards were revoked because they were found picayune, obsolete or insignificant. Revisions of standards became an on-going and time-consuming task since new knowledge and technology needed to be incorporated in them. Additionally the standards were written in legal terminology rendering them difficult to interpret. In many cases employers are aware of a violation but do not possess the knowledge to correct the hazard to comply with the prescribed provisions. Because of the thousands of standards that had to be enforced, it was problematic to find a sufficiently large core of knowledgeable compliance officers to enforce the provisions of the legislation (Hammer, 1981; Marshall, 1994).

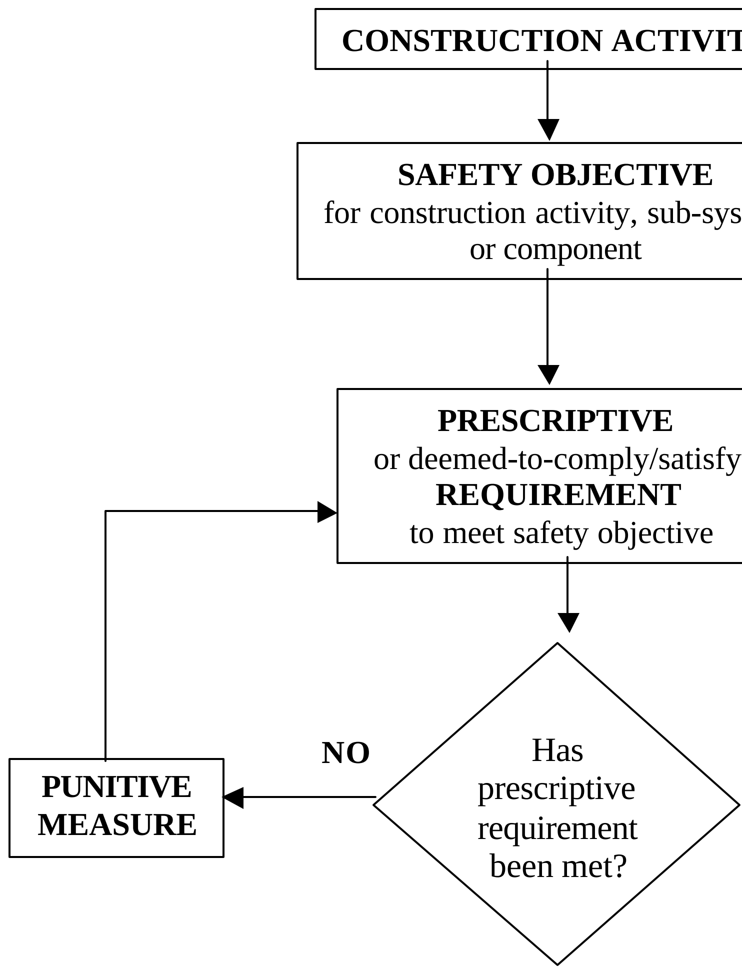

Figure 5-2 Traditional prescriptive model

This prescriptive form of legislation has become the norm in most countries where occupational safety and health legislation has been introduced. Unsafe acts are generally accepted to be the major contributing cause of accidents. Despite this situation, prescriptive legislation is primarily aimed at unsafe conditions when enforcement will not completely eliminate or adequately reduce unsafe acts. This intensively regulatory approach has tended to evolve into a reactive rather than proactive one.

Model for Implementation of the Performance Approach

A procedural model for implementing a performance approach to worker safety and health by contractors on construction sites is depicted in Figure 5-3. The model has been adapted from the approaches advocated in safety and health legislation in Australia, New Zealand, Europe and the United Kingdom. It promotes the resolution of planning issues ahead of organizational issues as suggested by Hawkins and Booth (1998). Planning, in this case, is the determination in advance of the safety objectives of the organization and deciding upon the course of action that will most effectively achieve those objectives. Planning is essential for the initial implementation of an overall management system and for specific elements that make up that system (AS/NZS 4804:1997). The model fosters a proactive approach since management and workers are involved in setting the safety objectives to be achieved regarding each activity before it is undertaken. Further, the model does not conflict with the clients' responsibility under legislation such as the Construction (Design Management) Regulations in the UK and the various hybrids of Directive 92/57/EEC[37] in Europe, regarding the role of the planning or project supervisor, and the various safety and health coordinators. The requirement to produce project-specific safety and health plans and files remain unaffected.

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[37] The countries in the European Union were allowed to incorporate the provisions of Directive 92/57/EEC into their national legislative frameworks. While some incorporated them in their totality, several did so with many changes from Directive 92/57/EEC. However, the essence of the Direction remained entrenched in the new national legislation

The model is somewhat similar to the industrial engineering solution delivery process depicted in Figure 5-2 that can be conceptualized as a series of steps that are repeated.

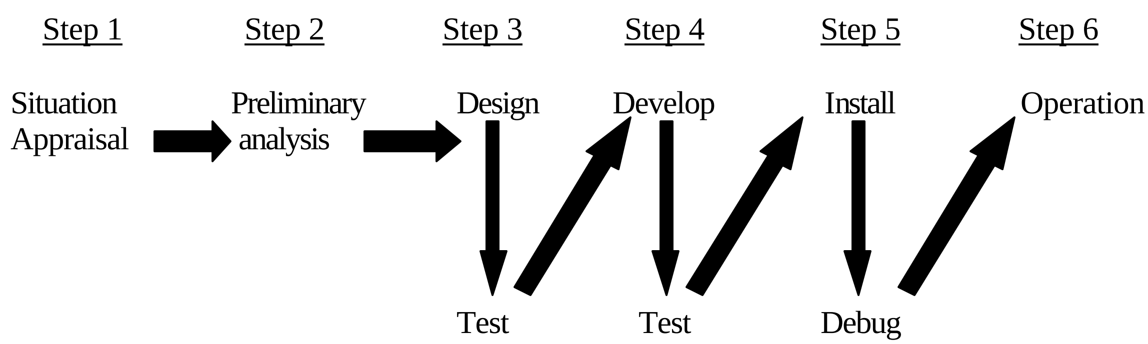

Figure 5-2 Solution delivery (adapted from Sink and Morris, 1995)

The main steps involved in the model in Figure 5-3 are outlined below:

Classify Construction Activity

In particular, the following information about each construction activity should be gathered as part of the classification process:

- The duration and frequency of the tasks involved;
- The location of the work;
- The number and trade category of workers that will execute the work and be exposed;
- The other parties that might be affected by the work;
- The training which workers had received about the tasks to be carried out;
- The written systems of work and/or permit-to-work procedures prepared for the tasks, where these exist;
- The plant, equipment, powered hand tools and machinery that may be used together with manufacturers' or suppliers' instructions for their operation and maintenance;
- The size, shape, surface nature and weight of building materials that might be handled to complete the tasks;
- The distances and heights that building materials have to be moved manually;
- The nature, quantity, physical form and hazard data sheets (msds's) of substances used or encountered during the tasks;
- The requirements of legal acts, regulations and standards relevant to the work being done, plant and machinery used, and substances used or encountered;
- The examination of the firm's control measures already in place; and

– The firm's incident, accident and ill-health experience associated with the work being done, and plant, equipment and substances used (adapted from BS 8800:1996).

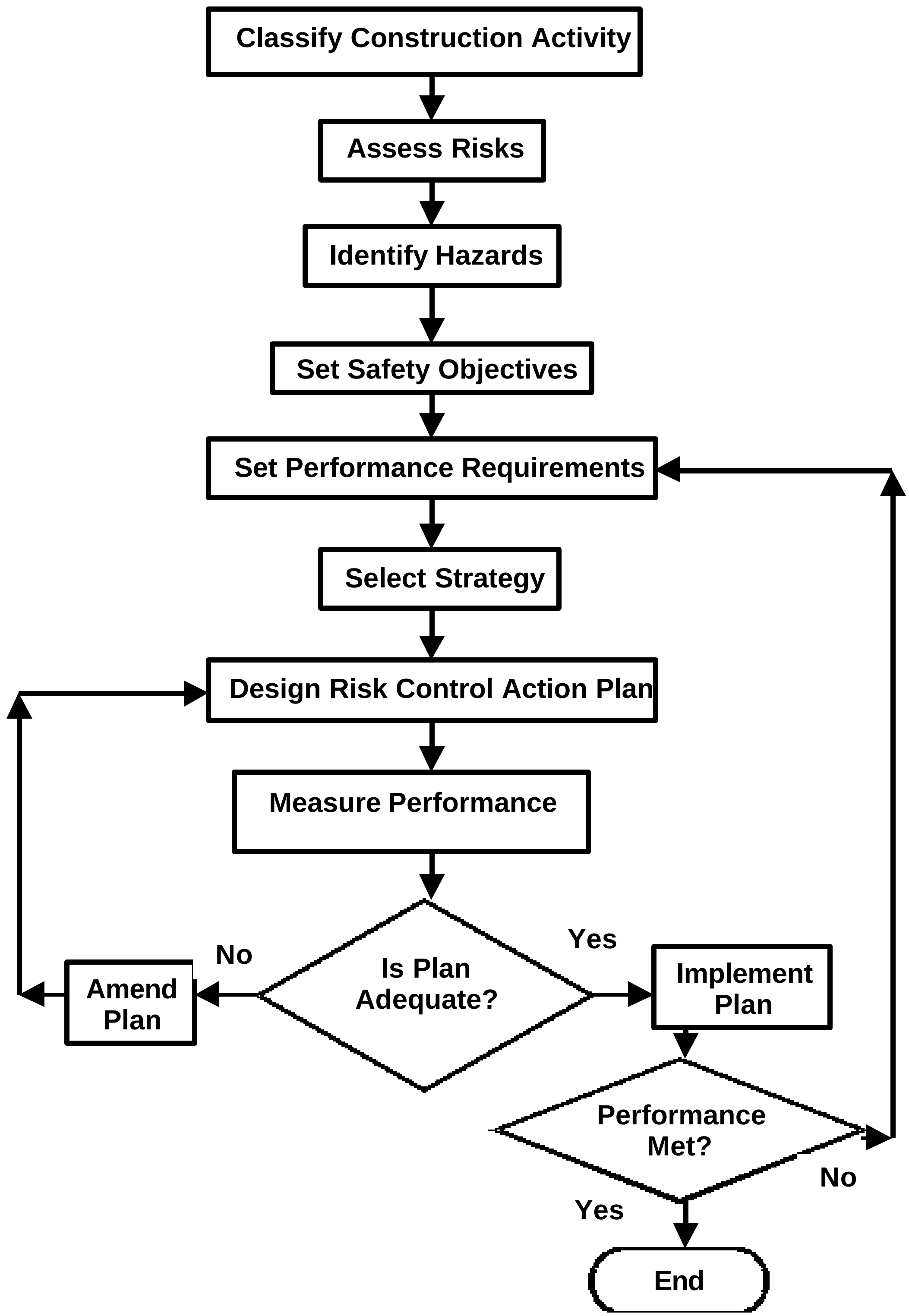

Figure 5-3 Implementation procedures of the performance approach

Risk Assessment

The contractor initially assesses the risks subjectively associated with each construction activity, assuming that planned or existing controls are in place. This assessment could form part of an integrated approach to risk management within the overall business strategy. Risk in this context refers to the likelihood that an accident might occur and the consequences of having an accident (BS 8800:1996). This assessment might be carried out by a specialized safety professional in the employ of the contractor

The determination of the severity or tolerability of the risks associated with the particular activity will be based on either the contractor's own experience or the experience of the industry. Severity of the risks will determine the level of resources that the contractor needs to allocate to reduce the risks themselves, and the exposure of workers to them. In particular, risk assessment needs to be carried out for situations where hazards appear to pose a significant threat and it is uncertain whether existing measures are adequate. By using a participative approach, management and workers agree safety procedures based on shared perceptions of the hazards and risks (BS 8800:1996).

A risk assessment pro forma may be used to record the findings of an assessment effort. This form, for example, should cover:

– Details of the work activity;
– Hazard(s) and/or potential hazards;
– Controls in place;
– Levels of risk; and
– Action to be taken once assessment is completed (BS 8800:1996).

Procedures for making an informed determination of risk have to be developed. Examples of these include safety reviews, checklists, what-if-analysis, failure mode and effects analysis, and cause-consequence analysis (Stavrianidis, 1998).

Further, criteria have to be established for deciding whether risks are tolerable where the risk has been reduced to the lowest level that is reasonably practicable.

A simple risk assessment model is illustrated in Table 5-4.

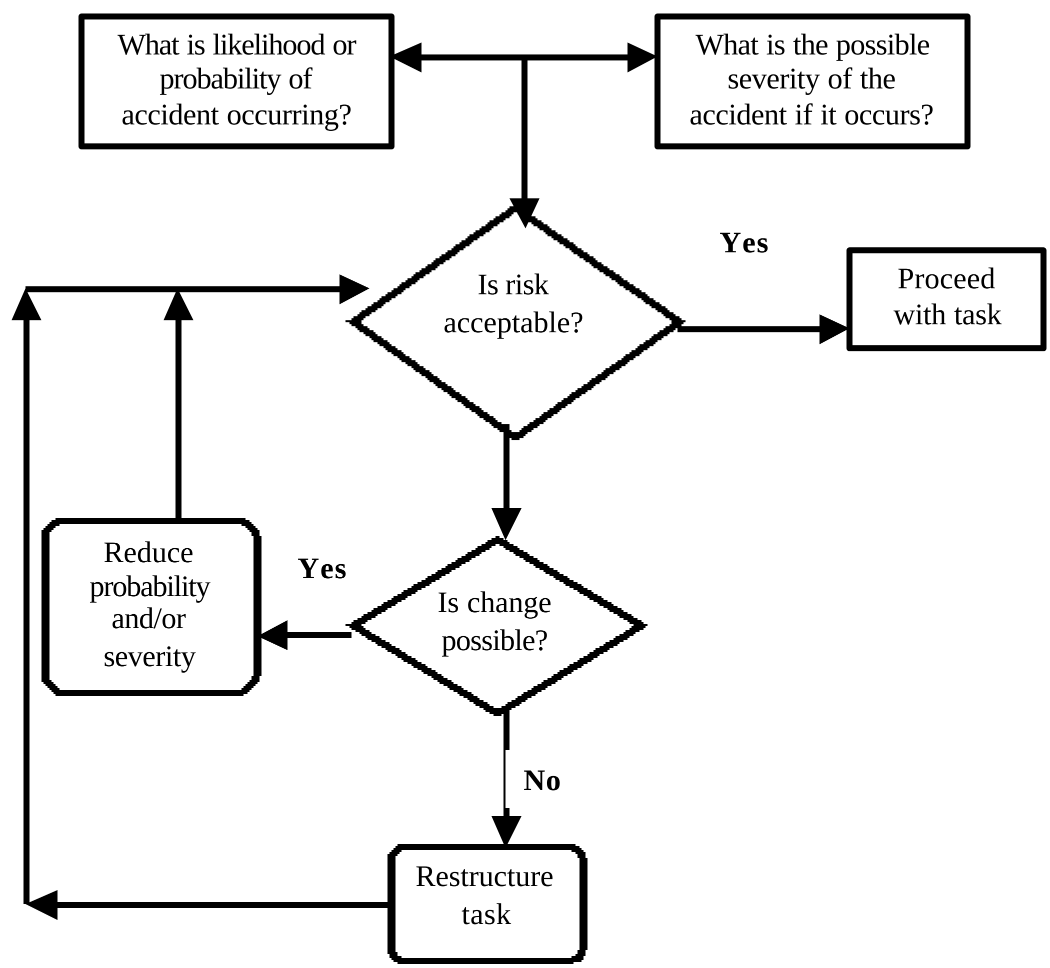

Figure 5-4 Simple risk assessment model

In this model the likelihood or probability of an accident occurring while a task is carried out and the severity of the accident should it occur is determined before the task is executed. If the risk is acceptable, the task proceeds. If the risk is considered unacceptable, the task is restructured if change is not possible. Where change is possible, the probability and/or the severity is reduced. In either case, the acceptability of the risk involved in the task is measured before it proceeds.

An alternative way of assessing risk is represented in Figure 5-5, adapted from Statzer (1999), where one axis represents the likelihood of a risk occurring and the other its expected cost. It is likely that by using such a matrix, construction firms may discover that they are allocating resources on potential risks that are extremely unlikely, while ignoring less-costly risks that may occur at any time.

The severity of harm needs to be considered regarding the part of the body most likely to be affected. The nature of the harm could range from slightly harmful to extremely harmful. Table 5-1 provides an example of an estimator of the level of risk.

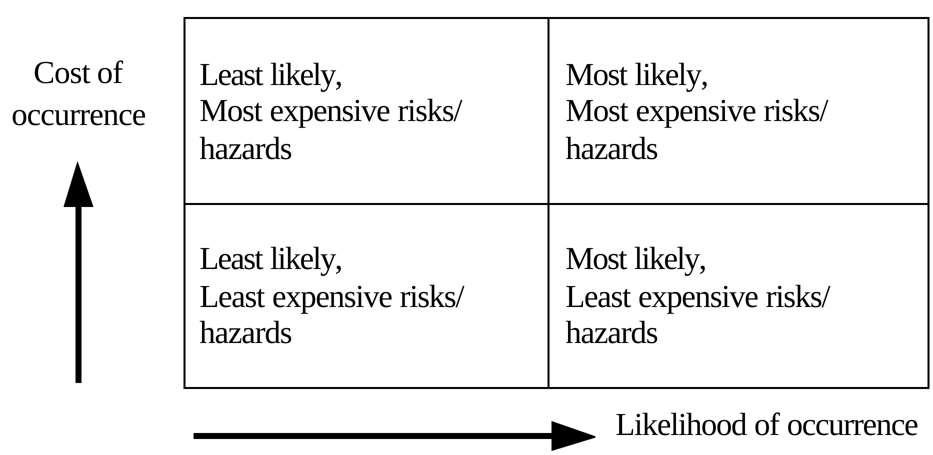

Figure 5-5 Evaluating relative risks/hazards

The action that should be taken regarding each of the risk levels indicated in Table 5-1 is suggested in Table 5-2. The identification of the level of risk will result in the development and implementation of suitable prevention and protection strategies (Lan and Arteau, 1997). In both tables, a risk that is 'tolerable' is taken to imply that the level of risk associated with the construction activity has been reduced to the lowest that is practicable.

Table 5-1 Estimator of risk level

	Slightly harmful	Harmful	Extremely harmful
Highly unlikely	Trivial risk	Tolerable risk	Moderate risk
Unlikely	Tolerable risk	Moderate risk	Substantial risk
Likely	Moderate risk	Substantial risk	Intolerable risk

(BS 8800:1996)

Identify Hazards

All the significant hazards related to each construction activity should be identified. In particular, consideration should be given to which workers will be exposed and what the consequences of such exposure might be. Methods to identify and categorize hazards have to be established. For example, a hazard prompt list might be developed taking into account the nature of the work activities of the organization and locations where work is carried out. Examples of such lists are contained in both the guideline documents to the UK and New Zealand safety legislation (Appendix F).

Set Safety Objectives and Performance Requirements

Objectives or user (worker) requirements should be specific, measurable, achievable, relevant and timely. Once key objectives have been selected, they need to be quantified. For example, objectives to increase or reduce something should specify a numerical figure and a date for their achievement; objectives to introduce a safety feature or eliminate a specific hazard should be achieved by a specified date; and objectives to maintain or continue existing conditions should specify the existing level of activity (BS 8800:1996).

Table 5-2 Action for risk levels

Risk level	Action and timescale
Trivial	No action is required and no documentary records need to be kept
Tolerable	No additional controls are required. Consideration may be given to a more cost-effective solution or improvement that imposes no additional cost burden. Monitoring is required to ensure that the controls are maintained.
Moderate	Efforts should be made to reduce the risk, but the costs of prevention should be carefully measured and limited. Risk reduction measures should be implemented within a defined time. Where the moderate risk is associated with extremely harmful consequences, further assessment may be necessary to establish more precisely the likelihood of harm as a basis for determining the need for improved control measures.
Substantial	Work should not be started until the risk has been reduced. Considerable resources may have to be allocated to reduce the risk. Where the risk involves work in progress, urgent action should be taken.
Intolerable	Work should not be started or continued until the risk has been reduced. If it is not possible to reduce risk even with unlimited resources, work activity has to remain prohibited.

(BS 8800:1996)

Additionally, appropriate performance requirements and outcome indicators that should preferably be quantitative need to be selected to indicate the extent to which the safety objectives have been achieved. It is also necessary to measure the situation before the implementation of a safety plan, also known as the baseline. An example of a safety objective associated with the performance requirement to prevent falls from scaffolds is shown in Table 5-3.

Regarding duty of employers in relation to heights at some workplaces, the New Zealand regulations require that every employer shall take all practicable steps to ensure means are provided to prevent the employee from falling. This provision is covered under clause 21 that deals with heights of more than 3 meters (9'). It applies to every place of work under the control of that employer where any employee may fall more than 3 meters. Employers must ensure that any means provided to prevent employees from falling are suitable for the purpose for which they are to be used.

Table 5-3 An example of a safety objective to prevent falls from scaffolds

Quantified key objective	Increase the usage rate of guardrails, toe boards and tying off on all scaffolds from the present (measured) value of 50% to 100% on this job
Performance requirement	A guardrail 35'-43' above the walking platform must be erected along the exposed edge of all scaffolds A mid-rail must be incorporated A toe board must be included All workers on scaffolds over 9' high must wear individual fall arrest systems such as lanyards and static lines
Outcome indicator	Records of observed usage of guardrails, toe boards and individual fall arrest systems on scaffolds

Select Strategy to Meet Performance Requirements

There are several possible strategies that could be used to meet the performance requirements and the safety objectives that have been set. These strategies are outlined in Figure 5-6.

In the example in Table 5-3, the contractor had several options with which to ensure that the safety objective was met of preventing falls from scaffolds - all of which would have satisfied the requirements of the performance-based regulations. The contractor could have used any of the following:

– A new method;
– A newly developed individual fall arrest system;
– An innovative patented scaffolding system;
– An improvement to existing work practices within the organization; or
– An established industry or company safe working practice.

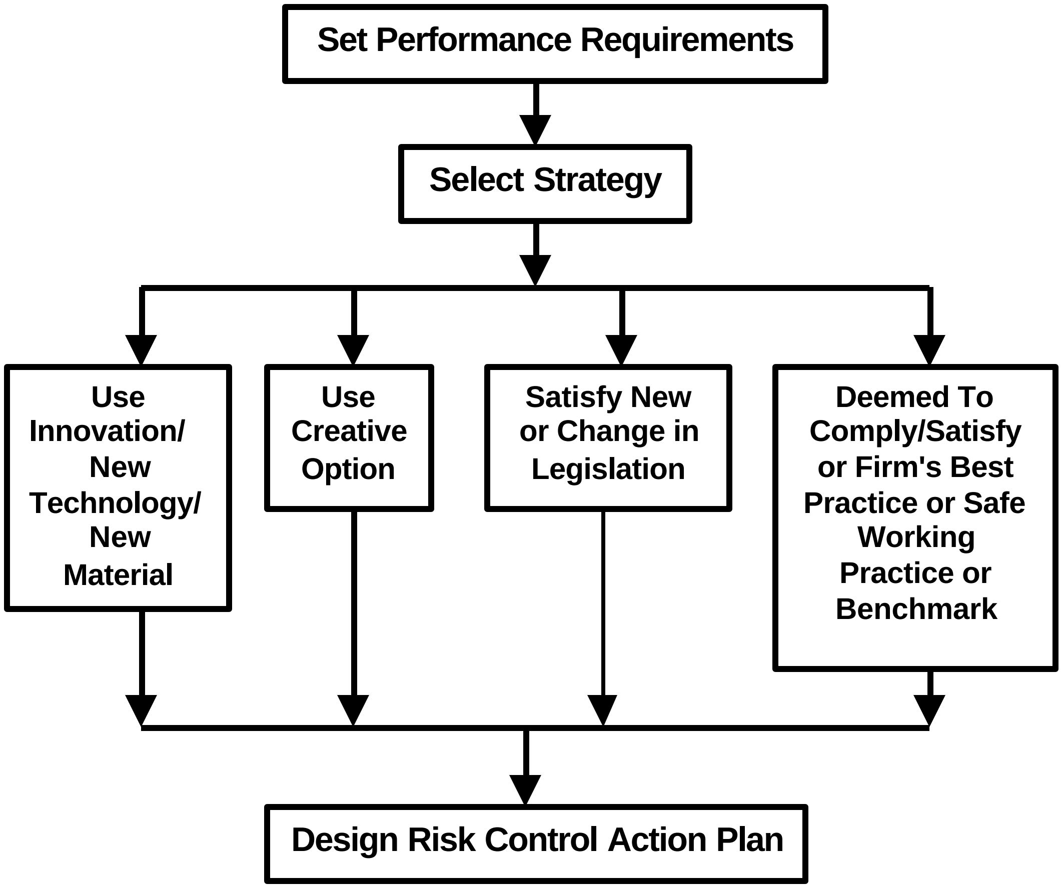

Figure 5-6 Possible strategies to meet performance requirements

In this example, the contractor selected the last option since the use of guardrails, toeboards and tying off was already an established practice both within the firm and the industry at large. However, the usage needed to be increased from the present value of 50% to 100% on the particular job.

Design Risk Control Plan and Select Method of Measuring Performance

Contractors can do both the steps of designing the risk control plan and selecting the method of measuring performance at the same time. The latter step is the equivalent of verification in the basic performance models described earlier.

A plan to control the risks associated with the construction activity needs to be designed. The risk control plan specifies who will do what, by when, and with what result (BS 8800:1996). For its success, the plan must of necessity enjoy the support of top management (Cook and McSween, 2000; Petersen, 1996). Further, it should be fully costed and have adequate financial resources allocated for its implementation.

The plan should be implemented in accordance with the performance requirements and outcome indicators decided upon to achieve the key safety objectives. An example of the broad elements of a risk control plan for preventing falls from scaffolds is reflected in Table 5-4.

Trends in the outcome indicators should be monitored continually throughout the implementation period of the plan. The adequacy of the plan needs to continually evaluated and the plan amended as required. The cost effectiveness of the safety objectives and the risk control plan should be reviewed to determine which elements of the plan contributed to its success. Those, which were unnecessary, may then be eliminated.

Table 5-4 Risk control plan to prevent falls from scaffolds

Gain commitment from top management
Agree on a budget for implementing the performance requirements
Train workers, foremen and supervisors in the required method of erecting scaffolds
Train workers in the proper use and maintenance of individual fall arrest systems
Frequent observations and inspections to check that scaffolds have guardrails, mid rails, and toe boards and that workers are tied off and using individual fall arrest systems correctly

In Table 5-5 attention is drawn to the likelihood that an objective may be achieved even though the control plan failed to be implemented.

Table 5-5 Review of risk control plan

		Was control plan implemented?	
		Yes	No
Was objective Achieved?	Yes	No corrective action required, but continue to monitor	Plan was not relevant. Find out what has led to the achievement of objective
	No	Plan is not relevant, therefore prepare a new plan	Make renewed effort to implement plan; continue to measure outcome indicators

(BS 8800:1996)

Contractors have several methods that they could use to measure whether the action plan was effective and whether the performance requirements have been met to satisfy the safety objectives for the particular task. These include the following:

- Checklists;
- Inspections;
- Safety samplings;
- Benchmarking;
- Environmental sampling;
- Attitude surveys;
- Behavior sampling;
- Walk-throughs;
- Document and record analysis; and
- Expert and consultant involvement.

For the example in Table 5-3, recording the results of regular observations was selected as the outcome indicator and would be appropriate to determine whether the performance achieved the safety objective.

Review Adequacy of Risk Control Action Plan and Measuring Performance

The final stage in the implementation process is the review of the performance requirements by measuring the outcome indicators to determine whether the control plan was effective and the safety objectives achieved. Where the performance requirements were not met, new performance requirements might have to be established. In this event, different outcome indicators might have to be decided upon. It is also likely that a new or revised risk control plan might have to be drawn up, the plan implemented, the outcome indicators measured until the performance requirements have been met, and the safety objectives achieved.

Should the review indicate that the safety objectives for the particular construction activity have been satisfactorily and cost effectively achieved, the performance solution selected might become an organizational safe working practice to be prescriptively followed on all future projects for that activity.

Chapter Summary

This chapter has established that implementation of the performance approach to construction worker safety and health will require a paradigm shift from the prescriptive approach accompanied by organizational cultural and structural change. The implementation will be dependent on the readiness and capacity of top management of construction firms to bring about these changes. The chapter has examined the evolution of safety and health legislation to the present pre-occupation with a performance approach. A model was developed for the implementation of such an approach on construction sites anywhere in the world, irrespective of the legislative and regulatory framework. It was demonstrated that the safety and health requirements of workers as users could be met using a performance approach.

In the next chapter, the research methodology is described to achieve the stated research objectives.

RESEARCH METHODOLOGY

Introduction

Polls and surveys are popular means of obtaining information from people by asking questions. Surveys are one of the most frequently used methods in social research (May, 1997). The benefits of using surveys rely on following protocol in random sampling procedures that allow a relatively small number of people to represent a much larger population (Schuman and Presser, 1981; Sonquist and Dunkelberg, 1977; May, 1997; Ferber et al., 1980). Survey research carries with it the responsibility to follow certain ethical norms such as respect for the privacy and the voluntary nature of the participation of the respondents (Salant and Dillman, 1994).

Surveys have been characterized by the collection of data from large numbers of people to describe or explain the characteristics or opinions of a population through the use of a representative sample (May, 1997). According to Ferber et al. (1980:3), a survey then is

> 'a method of gathering information from a number of individuals, a 'sample', to learn something about the larger population from which the sample is drawn.'

Additionally, surveys have been characterized into 4 categories, namely,, factual, attitudinal, social psychological and explanatory (Akroyd and Hughes, 1983). Researchers have argued that there is a relationship between attitudes and behavior by suggesting that the possession of a certain attitude necessarily means that a person will then behave in a particular way (May, 1997; Spector, 1981). Further, surveys are an effective means to gain data on attitudes on issues and causal relationships. However, surveys for the most part can only show the strength of statistical association between variables. They do not account for changes in attitudes and views over time, nor do they guarantee that the questions are correctly interpreted by the respondents (May, 1997).

Essentially, since surveys measure facts, attitudes or behavior through questions, hypotheses must operationalize into procedures and measures through questions that respondents can understand and are able to answer (Spector, 1981). These answers must then be capable of categorization and quantification to examine patterns of relationships between them by employing the techniques of statistical analysis, the findings of which have to be statistically significant.

Importantly, the survey has to ensure that the research is both valid and reliable. According to Kidder (1981:7),

> 'research is valid when the conclusions are true. It is reliable when the findings are repeatable. Reliability and validity are requirements for both the design and the measurement of research. At the level of research design, we examine the conclusions and ask whether they are true and repeatable. At the level of measurement, we examine the scores of observations and ask whether they are accurate and repeatable.'

Validity means that the research instrument measures what it is designed to measure, while reliability refers to the replicability of the results of the research (Spector, 1981).

The methods are described in this chapter that were used to gather the data about whether variances to OSHA's prescriptive requirements had arisen due to the nonapplicability of these measures; and the attitudes of the upper management of construction firms to the performance approach and its implementation within their organizations.

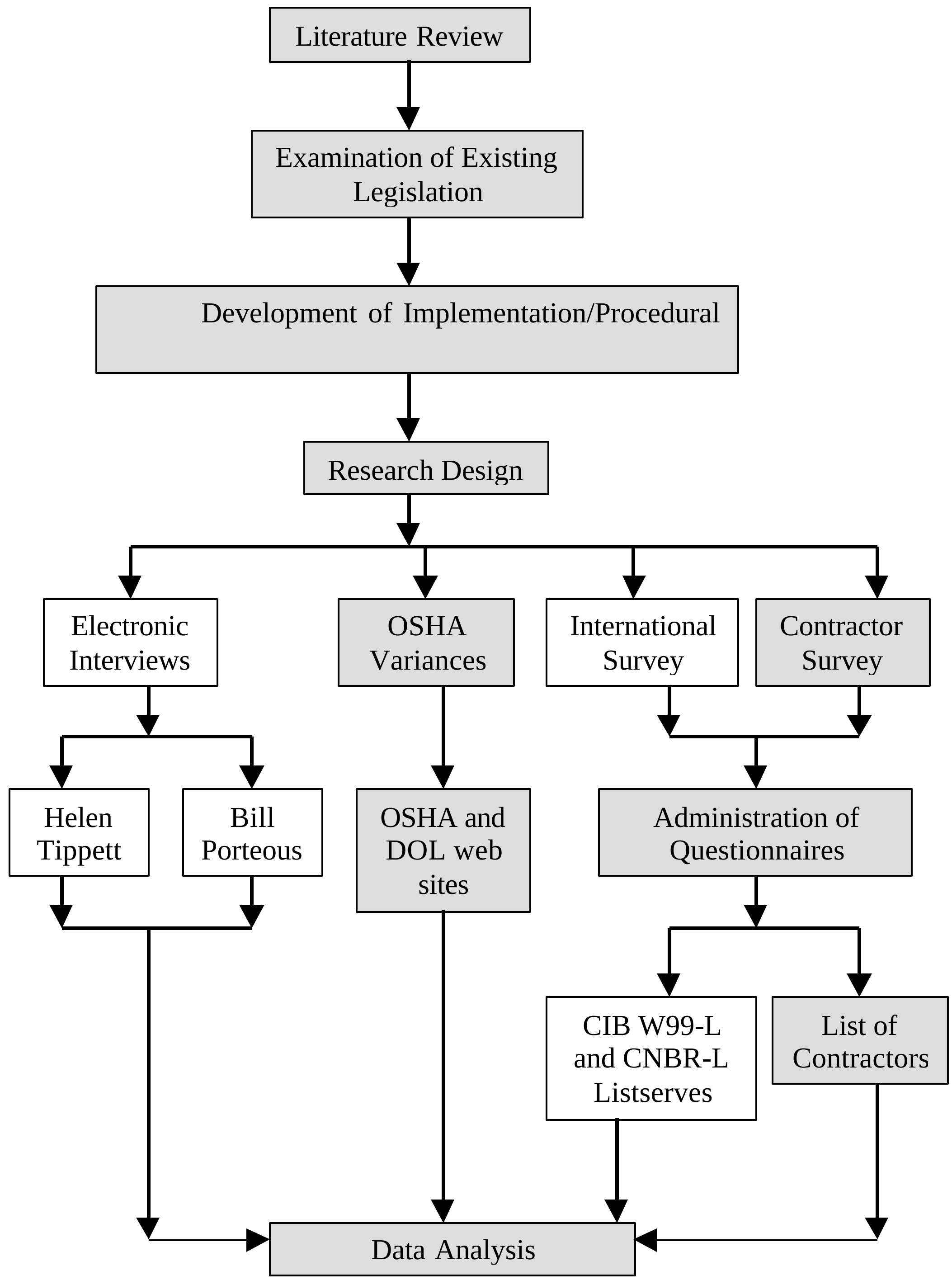

Figure 6-1 Flow-chart of Research Methodology described in this chapter

In particular, the various forms of survey instruments discussed in this chapter will provide the data for the results discussed in the next three chapters, and several of the research conclusions in the final chapter. The flow-chart in Figure 6-1 summarizes the major steps undertaken in this study with the shaded steps being covered in this chapter.

Initially, a pilot study was conducted using a structured questionnaire (Appendix A) to determine the construction activity most responsible internationally for accidents, injuries and fatalities on construction sites. Responses were obtained from several respondents using the cnbr-l and cibw99-l international listserves domiciled in Australia and Hawaii respectively. However, it was extremely difficult to compare the data provided because of differences in the reporting methods used in each country. The study was useful even if only to provide anecdotal evidence of this problem. A consolidated record of the responses is included as Appendix D. Instead the International Labor Organization's (ILO's) Yearbook of Labor Statistics provided more comparable statistics about the safety performance of the construction industry in several countries. These statistics were used in the chapter on the safety performance of the construction industry to describe the industry's safety record around the world.

Structured electronic interviews were conducted with two experts in New Zealand to determine what prompted the introduction of the performance approach in that country and the impact of its introduction on the industry (Refer to Appendices B and E). The results of these discussions were included in the chapter on international performance-based safety legislation.

Applications to OSHA in the United States for variances to existing standards and related information leaflets were studied to determine the circumstances under which

OSHA granted variances. The results of this study are discussed in the chapter on the analysis of OSHA variances.

A structured questionnaire (Appendix C) was used to measure the attitudes of contractors in the United States toward the performance approach to construction worker safety, and their opinions on issues related to bringing about the changes that the approach requires. The results of this survey are presented and discussed in the chapters on the analysis of the top management survey and correlation, regression analysis, modelling.

Examination of OSHA Variances

An electronic Internet search was conducted of the websites of OSHA and United States Department of Labor (DOL) to examine variances to the OSHA regulations, particularly those that pertained to the construction industry. All the variance applications that were listed in the Federal Register were looked up to identify the circumstances surrounding the applications, the profiles of the applicants, the reasons and motivations for the applications, and the determinations of OSHA for each. Where variances were granted, it was noted whether they were permanent or temporary. Further, a few of the OSHA rulings and comments were also examined regarding litigations involving deviations from the OSHA standards.

Theory Foundation for the Survey of Upper Management Attitudes

Systems and structures embody deep-seated values that may work against change. The structure of organizations reflects the values of leaders working within them. The values most critical to change are the ones espoused by those holding key positions (Hinings, 1996). All organizations contain functional and occupational groups that operate from different perspectives (Filby and Willmott, 1988; Watson, 1982). The upper management of organizations makes up one of these groups. The influence of leaders on the performance of their organizations may be summed up as follows:

> '…organizational decision-makers, managers and professionals alike hope to ensure that their central values and beliefs influence the performance of their organizations by designing functional arrangements and hierarchies to facilitate and support those views.' (Ranson et al., 1980:199)

The values of individuals holding the top organizational positions are the ones that are promoted and perpetuated throughout organizations (Hage and Dewar, 1973). Enz (1986:42) echoes this view when she claims

> '…clearly, top management is a critical group in examining values because of its control over organizational design and functioning. To understand the role of values in an organizational context requires close examination of the organizational leaders and how their beliefs operate to influence the activities within the firm.'

Organizational arrangements develop from the ideas, values, and beliefs that underpin them (Hinings, 1996).

Leaders of change are only as good as their ability to form trustful bonds and to communicate and collaborate effectively with their participants. Since top-down change is problematic, workers need to be partners in organizational change. Upper management can no longer operate on behalf of organizations making decisions for others without their participation and investment (Porter-O'Grady, 1997). The respect and trust of the majority of the workforce is essential (Quinn, 1996). Deep change will not occur if workers feel they are powerless and lack a voice in the strategies and structures of organizational change. For change to have any chance of success, the genuineness of management commitment has to be evidenced in consistent acts of real empowerment of the workforce.

Major change is impossible unless the upper management of organizations actively and demonstrably supports and understands the need for the changes they introduce (Freda, Arn and Gatlin-Watts, 1999). Not only is pressure to change required but also support in the form of time, financial resources, and decision-making authority. Additionally, barriers to change need to be broken down.

The literature on change reiterates the need for management to:

- Define the objectives of change;
- Communicate the change required, orally, in writing, and in action; and
- Review the progress toward the change (Hensler, 1993; Quinn, 1996; Saunders and Kwon, 1990; Freda, Arn and Gatlin-Watts, 1999).

According to Saunders and Kwon (1990) and Freda, Arn and Gatlin-Watts (1999), communication is the most critical activity in ensuring successful change. Workers want to know the specifics of any change, how it will affect them, and how they can prepare for it. Other factors for successful change include phased introduction and implementation of the changes, training of those affected by it, and documentation of the change process.

Weston (1998) suggests that the guiding principles of successful change initiatives have been well documented, namely,, leadership, implementation and reinforcement.

Leadership involves creating and communicating a consistent, coherent and compelling vision. Implementation requires deliberately identifying and removing the structural and behavioral impediments to change. Further, implementation also requires ability, willingness, knowledge and skill (Sink and Morris, 1995) on the part of the leadership. Reinforcement implies institutionalizing and reinforcing the gains and ensuring that the organization is open for further change. The vision of firms have to be reviewed and, if necessary, revised (Freda, Arn and Gatlin-Watts, 1999). Change has to become institutionalized as a core organizational value and systematically reinforced (Trahant and Burke, 1996).

Having concluded that the leadership or upper management of organizations is pivotal to the successful introduction and implementation of programs that might involve change, the survey was designed to measure the opinions of upper management of construction firms toward the performance approach to construction worker safety,.

Design of Upper Management Questionnaire

The type of population, the nature of the research questions and available resources determine the type of questionnaire to use to conduct the survey. Three types of questionnaires are generally used:

– Mail or self-completion questionnaire;
– Telephone survey; and
– Face-to-face interview schedule (May, 1997).

The main strengths of mail questionnaires include:

– A lower cost than face-to-face interviews;
– Advantageous anonymity on ethically or politically sensitive issues;
– Consideration of responses by respondents in their own time;
– Less bias from the way in which different interviewers ask questions; and
– Possibility of covering a wider geographic area at a lower cost (May, 1997).

The weaknesses of mail questionnaires include:

– Need to keep questions relatively simple and straightforward;
– Absence of probing beyond the answer given by respondents;
– Lack of control over who answers the questionnaire;
– Low response rate; and
– Inability to check on bias of final sample (May, 1997).

Having taken cognizance of both the merits and demerits of using various questionnaires, it was decided that mail or self-administered questionnaires would be the most appropriate survey instrument to use in this exploratory study.

The option was considered of measuring the readiness of organizations themselves to implement the performance approach to construction worker safety. It was recognized that the likelihood that organizational respondents will respond to survey requests is a function of their

- Authority to respond where they might not have the formal or informal authority to respond on behalf of the organization;
- Capacity to respond where they might not have the capacity to facilitate the assembly of the relevant knowledge to reply adequately to the survey request; and
- Motive to respond where they might not be sufficiently personally or organizationally motivated to disclose information about the organization (Tomaskovic-Devey, 1994).

By measuring the opinions of upper management of construction firms, these issues would not be problematic to the respondents. Rather than requesting information about their organizations, their own personal opinions would be measured regarding the performance approach to construction worker safety.

Questions pertinent to the research were developed, critically reviewed by faculty from the M.E. Rinker, Sr., School of Building Construction at the University of Florida, and then refined to address the issues as specifically as possible. Those questions with a limited set of possible choices were identified, and the corresponding sets of answers were developed. A pilot study was performed among 10 contractors in Hawaii, Georgia and Florida to test the proposed questions and to obtain feedback regarding other relevant issues that should be addressed. Only minor revision of the questionnaire was required largely to make it user-friendlier. The questionnaire took about 15 minutes to complete.

The questionnaire length of 5 pages excluding the cover page was in line with the recommendation that the optimal length for a questionnaire is 10 to 12 pages (Dillman, 1978). According to Dillman, there is no difference in response rates for various questionnaire lengths below 12 pages.

Questions that were open-ended were kept to a minimum, either to cater for the wide range of expected or possible responses or to allow the respondents the freedom to fully explain their choice of responses. For most of the questions a 7-point Likert scale was deemed appropriate and scaled answers were developed. The Likert scale is the mostcommon scale for obtaining the opinions of respondents (Fellows and Liu, 1997) This type of scale can be used to produce hierarchies of preferences which can then be compared. The semantic differential rating scale (Osgood et al., 1957) was chosen because of its simplicity and flexibility. To facilitate the rating of intensity, the extreme scale positions were labeled. These labels appear to define rating positions that are about equidistantly spaced, which is a prerequisite for an accurate measurement.

Several variations of Likert scales were used. The 4 variations used were understanding scale, preference scale, influence scale, and importance scale. They are illustrated in Table 6-1. The questionnaire was divided into three sections, namely, demographic information, management attitude to the prescriptive and performance approaches, and change management (The questionnaire has been attached as Appendix C).

Management Attitude to the Approaches

This section dealt with the level of understanding, beliefs and opinions on the prescriptive and performance approaches to construction worker safety and health.

Before responding to any of the questions in this section, respondents were requested to study the definitions of the prescriptive and performance approaches as well as the accompanying illustrative examples of each approach. The objective of this request was to ensure that the respondents had an idea of what the approaches were and also the differences between them.

Table 6-1 Examples of Likert scales used

Understanding scale	1 Very poorly	2	3	4	5	6	7 Very well
Preference scale	1 Performance	2	3	4	5	6	7 Prescriptive
Influence scale	1 Not influential	2	3	4	5	6	7 Extremely influential
Importance scale	1 Not important	2	3	4	5	6	7 Very important

The first question presented respondents with a hypothetical situation. It was a closed question and allowed the respondents to make a choice between the prescriptive and performance approaches as a solution to the situation. The question was designed to establish the approach that respondents preferred.

This question was followed by one that was open-ended and required respondents to provide an explanation for their choice in the previous question.

To provide an indication of how well the respondents understood the prescriptive and performance approaches, question was included that allowed them to indicate their level of understanding using a 7-point understanding scale. This question was followed up by one which cross-checked the response to the first question in this section by asking respondents to indicate which approach they preferred conceptually using a 7-point preference scale.

To verify that respondents understood the two approaches, a series of 10 pertinent issues drawn from the literature on the performance approach were listed. Respondents had to indicate using a 7-point influence scale the influence that each approach had on the issues listed. For example,

- Ease of introduction of new technologies (7-point influence scale);
- Cost effectiveness of approach (7-point influence scale); and
- Ease of implementation (7-point influence scale).

The final question in this section investigated on a 7-point importance scale how important a list of 5 issues were to respondents regarding construction safety and health management. For example,

- Cost effectiveness of approach; and
- Potential to improve safety performance on sites.

Change Management

The questions in this section of the questionnaire were designed to measure the capacity for change within the organizations of respondents. The questions also probed which issues motivated or prompted change within their organizations.

The first question investigated the involvement of various parties in the sponsorship of major change within their organization. Respondents had to indicate the extent of the involvement in these changes of top management, middle management, site management, workers, and first-line supervisors by way of percentages.

The next question examined the influence using a 7-point influence scale of a list of 13 issues in driving change within the organizations of respondents. For example,

- To improve financial performance;
- To keep up with competitors;
- To improve the safety record; and
- To meet worker demands.

This question was followed up by a question investigating whether respondents had observed the introduction of major changes in the organizations.

The next series of 5 questions investigated on a 7-point importance scale the extent of participation of workers and first-line supervisors in the process of change and change management. These questions were:

- If the company were to consider introducing a change to improve safety performance how important would be the willingness of workers to accept the change before the change is implemented?
- How important would it be to break down the resistance of workers to change by convincing them to accept the change?
- How important would it be to build credibility and trust with the workers before implementing a change?
- How important would it be to enlist the opinions of workers on a proposed change before it is implemented?
- How important do you regard the receptiveness of first-line supervisors (foremen) to change?

The following question informed on the level of importance, using a 7-point importance scale, of a list of 10 factors on the implementation of a new approach to safety. For example,

- Top management support;
- Open communication;
- Adequate resources;
- Creativity; and
- Workshops and training.

This question is followed by one that investigates the importance on a 7-point importance scale of a list of 11 actions for the successful implementation of a new approach to construction worker safety and health. For example,

- Demonstrate consistent and decisive personal leadership;
- Allocate adequate financial, equipment and staff resources;
- Amend corporate vision and mission;
- Introduce and support appropriate training programs; and
- Reward workers for being innovative, and looking for new solutions.

The final question requests the number of recordable injuries that the organization had during the preceding year. Provision is made at the end of the questionnaire for additional comments by respondents on performance and prescriptive regulations and standards.

Sample Selection

The sample was drawn from a database compiled by the M.E. Rinker, Sr., School of Building Construction at the University of Florida. The database consisted of the contact details of 843 construction organizations throughout the United States. These organizations were representative of the entire construction industry and included general contractors, homebuilders, subcontractors, specialty contractors, developers, and professional consultants. Since it was not financially feasible to include all 843 organizations in the sample, a sample size of 200 firms was decided to be adequate.

While it was originally intended to make a random selection from the database, it was decided to only include those organizations that had telephone numbers listed in the database. The reasoning behind this decision was to facilitate making telephonic contact with the firms during the administration process to improve the response rate. The 432 organizations without telephone numbers were eliminated from the list, leaving 411 organizations that could be randomly selected from. This number was further reduced by the 5 organizations in Florida and Georgia that had participated in the pilot study. This revised list comprising of 406 organizations made up the sampling frame. Every organization in the sampling frame had an equal chance of being selected. The organizations on the list were numbered consecutively from 1 through 406.

To select 200 organizations from the sampling frame, the probabilistic procedure of systematic random sampling was used. This was the most practical procedure available. In this procedure the researcher begins by making a random selection from the sampling frame, and then systematically samples every *n*th element (Salant and Dillman, 1994; May, 1997). Accordingly, the first construction organization was randomly selected from the revised list. Since this sample would be a one-in-two sample, every second (*n*th) organization was systematically selected until the sample comprised 200 organizations.

Questionnaire Administration

The process of distributing the survey and receiving the completed questionnaires took approximately 10 weeks. To maximize both the quality and quantity of responses, attention was given to every detail that might affect response behavior. Proven methods to increase response rate were implemented to maximize the number of respondents.

The survey packet comprising of a cover letter, questionnaire, and pre-addressed postage paid return envelope was mailed out to the sample of construction organizations in mid-December 2000. The cover letter was printed on the University of Florida letterhead stationery and addressed to each individual organization. The letter explained that participation was voluntary; that all responses would be confidential; and that respondents needed to only answer those questions they felt comfortable with. The importance of the participation of the respondents in the study was stressed. Each letter included individual salutations and was personally signed by the researcher. Respondents were assured of anonymity. A sample of the cover letter is provided in Appendix F.

About one month after the initial mailing, every organization that had not yet responded was contacted by telephone. Each questionnaire had been marked with individual identification numbers so that follow up could be done regarding only those who had not responded. The telephone calls served to verify the accuracy of the contact details of the database regarding address and telephone numbers, whether the survey package had in fact been received, and whether a response could be expected.

Through this process of follow up telephone calls, it was learnt that the contact details of 100 organizations in the sample were incorrect and that no new information was available. Replacement survey packages could not be sent out to them. Uncompleted survey packages were returned by 2 organizations who did not want to participate in the study. The sample size was consequently reduced to an effective 98 respondents.

As a result of the follow up telephone calls, survey packages were faxed to 18 organizations, and e-mailed as attachments to 37 organizations. The importance of their participation was again stressed. Each of these organizations was requested to fax back their responses.

The number of completed questionnaires received including those of the pilot study were 67, representing an overall response rate of 68.4%. Given the nature of the study, the length of the questionnaire, and the time and budgetary constraints the response was considered to be acceptable. No further attempts were made to increase the number of responses.

Chapter Summary

In this chapter, the methods were outlined that were used to gather data about OSHA variances and top management attitudes toward the performance approach and its implementation. The theoretical foundation for the survey of the top management of construction firms was discussed. The influence of the leaders in organizations was outlined with special reference to their value systems and pivotal role in bringing about major changes. The design was described of the questionnaire used to gather data about top management attitudes. Additionally, the sample selection and questionnaire administration processes were outlined.

In the next chapter the findings of the OSHA variance examination are presented and analyzed.

ANALYSIS OF OSHA VARIANCES

Introduction

Variances from OSHA standards are recorded in the Federal Register. For the purposes of this study, an electronic Internet search was conducted of the Occupational Safety and Health Administration (OSHA) and Department of Labor (DOL) websites to examine the records of the Federal Register relative to variances. The results of this search are described in this chapter.

OSHA Variance Applications

In the United States, in instances where regulations do not cover a particular circumstance, or contractors wish to use alternatives to comply with the specific requirements of an OSHA standard, contractors have to apply to OSHA to obtain permission to deviate from the applicable standard. A contractor or group of contractors for specific workplaces may request a variance. For example, contractors may be unable to comply fully with a new safety and health standard in the time provided as a result of a shortage of staff, materials or equipment. Further, contractors may sometimes be using methods, equipment or facilities that differ from those prescribed by OSHA, but they believe are equal to or better than the requirements of OSHA.

Variances from OSHA standards are authorized under sections 6 and 16 of OSHA of 1970 (29 United States Code 65), and the implementing rules attached in the Code of Federal Regulations (29 CFR 1905). Requests for variances under OSHA regarding construction safety and health standards are considered variances under the Construction Safety Act. There are several types of variances. These are:

Temporary Variance

A temporary variance is designed to provide a contractor time to come into compliance with the requirements of an OSHA standard subsequent to the effective date of that standard. For example, a contractor may not be able to comply by the prescribed date because the necessary construction, or alteration of the facility cannot be completed in time or when technical personnel, materials or equipment are temporarily unavailable. To be eligible for a temporary variance, the contractor must put in place an effective program that will ensure that compliance with the standard or regulation as quickly as possible. Application for the variance must be made within a reasonable time after the promulgation and prior to the effective date of the standard. The contractor must inform all workers of the application and of their rights. The contractor must demonstrate to OSHA that all available measures are being taken to safeguard workers against the hazards covered by the standard.

The following must be provided:

- The standard or portion of the standard from which variance is requested;
- The reasons why the contractor cannot comply by the effective date of the standard;
- The measures already taken and those to be taken (with dates) to comply with the standard must be documented;
- The certification that workers have been informed of the variance application and a copy given to their authorized representative;
- The summary of the application is posted wherever notices are normally posted in the workplace; and
- The communication informing workers that they have a right to request a hearing on the application.

The procedures that must be followed for temporary variances are documented in 29 CFR 1905.10 in reference to OSHA section 6 (b) (6) (A).

Temporary variances are not granted to contractors who indicate that they cannot afford to meet the costs of coming into compliance. Usually, a time-limited interim order is issued pending the decision on the temporary variance.

Permanent Variance

A permanent variance authorizes an alternative to a requirement of an OSHA standard subject to the workers of the contractor being provided with employment. Additionally, the contractor has to demonstrate that the methods, conditions, practices, operations or processes provide a safe and healthful work place as effectively as compliance with the standard. Due to the conservative approach of OSHA, it is reasonable to expect that OSHA will require that the protection that has to be provided to workers must be much better than the standard. Further, the probability of liability suits and the litigative environment contribute to this conservative approach.

Workers have to be informed of the application and their right to request a hearing. Essentially, applications for permanent variances must contain the same information as applications for temporary variances. The procedures to be followed for permanent variances are set out in 29 CFR 1905.11 in reference to OSHA section 6 (d).

In making a determination on a permanent variance, OSHA reviews the application and evidence of the contractor, makes an on-site visit to the work place as deemed necessary, and notes the comments of workers and other interested parties. If the request has merit, OSHA may grant a permanent variance. Final variance orders detail the specific responsibilities and requirements of the contractor and explain precisely the differences between the requirements of the standard and the alternative.

Interim Order

A contractor may apply to OSHA for an interim order when seeking a temporary variance so that work may proceed under existing conditions until a final order is made on the application for variance. This application may be submitted separately or with the application for variance.

If the interim order is granted, the terms of the order are published in the Federal Register. The contractor must inform workers of the order, provide a copy to their authorized representative, and post a copy wherever notices are normally posted.

Experimental Variance

OSHA grants the experimental variance when such a variance is necessary to allow the contractor to participate in an experiment designed to demonstrate or validate new or improved safety and health techniques to protect the health and safety of workers. The procedures to be followed for experimental variances are described in OSHA section 6 (b) (6) (C).

Defense Variance

OSHA may grant reasonable variations, tolerances and exceptions to and from the requirements of OSHA to avoid serious impairment of the national defense. These variances may not be in effect for more than 6 months without notifying workers and offering a public hearing on the issues. The procedures to be followed for defense variances are described in 29 CFR 1905.12 in reference to OSHA section 16.

Findings of Investigation

The electronic Internet search of the OSHA and DOL websites indicated a total of 53 records covering variances in the Federal Register from 1973-1999. These are summarized in Table 7-1, and graphically represented in Figure 7-1. A list containing the details of each record is attached as Appendix G.

Table 7-1 Summary of Federal Register records of OSHA variances

Year	Total Records	General Industry	Construction
1973	2	1	1
1974	3	3	0
1975	0	0	0
1976	2	2	0
1977	2	2	0
1978	2	2	0
1983	1	1	0
1984	1	1	0
1985	18	15	3
1986	6	6	0
1987	8	5	3
1988	3	2	1
1989	2	2	0
1997	1	1	0
1998	1	1	0
1999	1	1	0
Totals	53	45	8

The low number of records was a concern since a much higher number of applications had been anticipated. The sheer size of the construction industry in the United States suggests that there should have been a higher number of applications. However, considering the time and cost constraints and that these records were available, it was decided to proceed and work with them.

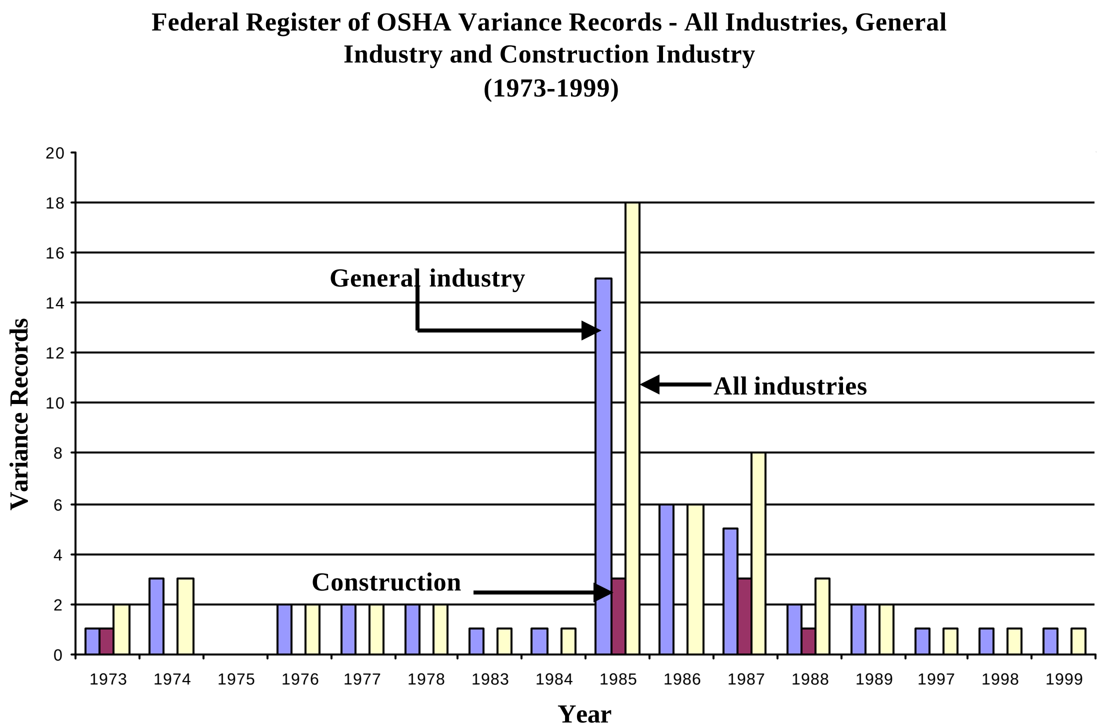

Figure 7-1 Distribution of Federal Register records of OSHA variances by year

There were no entries or records from 1979-1982 and 1990-1996. Further, most records (18) were entered in 1985, amounting to almost 34%. Of the total number of records, only 15% (8) were construction related variance entries.

However, further examination of the records revealed that many were not related to variance applications *per se*. Several of them dealt with meeting and hearing notices, and application withdrawals. The adjusted number of records covering only variance applications are indicated in Table 7-2.

The outcomes of variance applications and the types of variances for each of general and construction industries are listed in Table 7-3. Of the 27 variances granted, only 22.2% (6) were for the construction industry. Of these, 50% (3) were temporary variances, 16.7% (1) were permanent variances, and 33.3% (2) were interim orders.

Table 7-2 Federal Register records of variance applications

Year	Total Records	General Industry	Construction
1973	2	1	1
1974	3	3	0
1975	0	0	0
1976	2	2	0
1977	2	2	0
1978	2	2	0
1983	1	1	0
1984	1	1	0
1985	13	10	3
1986	1	1	0
1987	6	3	3
1988	3	2	1
1989	2	2	0
1997	1	1	0
1998	0	0	0
1999	1	1	0
Totals	40	32	8

According to OSHA (1993), about 96% of the variance applications received by OSHA were not actual requests for variance, but rather were requests for standard clarification or interpretation, or are from employers wishing to avoid complying with a standard.

The number of variance applications made is extremely small as evidenced from this investigation. The number of variances actually granted is even smaller. Considering that from of 26 years from 1973 to 1999, only 6 variances (about 1 every 4 years) from construction standards were granted provides a more graphic indication of the probability that a variance application will be successful.

Possible reasons for the small number of applications for variances include:

- The procedures to be followed to obtain a variance that are tedious and time-consuming with no certainty of the application succeeding;
- The low probability that the variance application will be successful;

- The onus placed on the applicant to prove by a preponderance of evidence that compliance with the alternative procedure provided protection that was equivalent to that provided by compliance with the standard;
- The need to possibly employ the services of professionals to certify that the alternative satisfied this requirement; and
- The need for the provision of substantial technical data for the evaluation of alternatives to the standard.

Table 7-3 Outcomes of variance applications

Year	General Industry	Temp. variance	Perm. variance	Interim order	Construction	Temp. variance	Perm. variance	Interim order
1973	1	1			1	1		
1974	3	3			0			
1976	2	2			0			
1977	2	2			0			
1978	2	1	1		0			
1983	1	1			0			
1984	1			1	0			
1985	6	3		3	3	2		1
1986	1		1		0			
1987	0				1		1	
1988	1			1	1			1
1989	0				0			
1997	0				0			
1998	0				0			
1999	1		1		0			
Total	21	13	3	5	6	3	1	2

While it was possible to establish the identity of the applicant from the Federal Register records, it was not possible to determine the profile of the applicant nor the exact details pertaining to the variance applications. However, it was possible to establish that variances had been granted where there was a clear conflict between the OSHA standard and that of another body such as the Environmental Protection Agency (EPA), and where there were 2 standards that covered 1 construction activity. It was not possible to determine based on the information provided in the Federal Register whether a performance approach would have obviated the need to request these variances.

Of the 20 variances still in effect, only 17 of these were listed in the Federal Register records linked to the OSHA website. A further concern is that while it seems that each variance granted has a unique number assigned to it, the last record for 1999 is number 2318. The questions that arise from this situation are:

- Were there more than 27 variances granted?
- If there were, how many more were there?
- Why are there only 53 listed in the Federal Register linked to the OSHA website? and
- Where are the details of the other variance applications if there were more?

However, if the percentages derived from this study are applied to the possible larger number of granted variances, namely, 2,318, the number of variances from construction standards granted would be 515 (22.2%). This number would represent an annual average of about 20, which is still very small.

Chapter Summary

The records of the Federal Register were examined relative to variances from OSHA requirements. The types of variances that contractors could apply for included temporary, permanent, experimental and defense variances. They could also obtain interim orders. Of the variances granted, 22.2% were for the construction industry. Of these variances, 50% were temporary variances, 16.7% were permanent variances, and 33.3% were interim orders. The examination confirmed that the number of applications for variances was extremely small. The number of variances actually granted was even smaller. While the identity of the applicant could be established from the Federal Register records, it was not possible to determine the profile of the applicant, nor exact details pertaining to the application. It was also not possible to determine whether a performance approach would have obviated the need to request variances in the case examined.

ANALYSIS OF FINDINGS OF TOP MANAGEMENT SURVEY

Introduction

Statistical evidence is necessary to draw conclusions from empirical data and establish the strength of relationships between the variables that the data represent. The data from the questionnaires were analyzed with the aid of the SPSS computer software package. This chapter summarizes the data obtained, and deals with the descriptive statistical analysis itself. The chapter concludes with a summary of the analysis findings.

Demographic Information

1. **What is your position within your organization?** More than half (54.5%) of the respondents held positions within their firms that are traditionally regarded as being upper or top management positions. These positions were not directly related to safety and health. The response frequency distribution is shown in Figure 8-1. Of these management positions, 38.8% (26) were CEO's, Presidents, Vice-presidents or General Managers of their firms and 14.9% (10) were either Project or Contracts Managers. The remaining 46.3% were management positions related to safety and health. For example, 41.8% (28) were either Safety Managers or Directors.
2. **Approximately how long have you held your current position?** The duration which respondents held their current positions within their firms ranged from 6 months to 36 years. The sample mean before categorization was 7.57 and the median was 5.00 years of service in these positions (Figure 8-2).
3. **What is the average number of employees in your firm?** The average number of employees ranged from 2 to 25,000 workers. The sample mean is 542.5 workers as a result of the extreme outliers, namely, a few very high and very low values. The median of 175 workers provides a better representation of the central value of the sample. Firms that employed between 0 and 100 employees made up 42.4%; between 101 and 250 employees made up 19.7%; and more than 250 employees made up 37.9% of the respondents. The most frequently occurring value was 200 employees. The response frequency distribution is shown in Figure 8-3.
4. **What is the approximate annual value of construction contracts?** As a result of outliers such as $1.4 million and $12 billion, the median of $61 million provides a better representation of the central value of the annual value of construction contracts of the sample. Most of the firms, namely, 59.4% (38), had approximate annual

construction contract values less than or equal to $100 million. The response frequency distribution is shown in Figure 8-4.

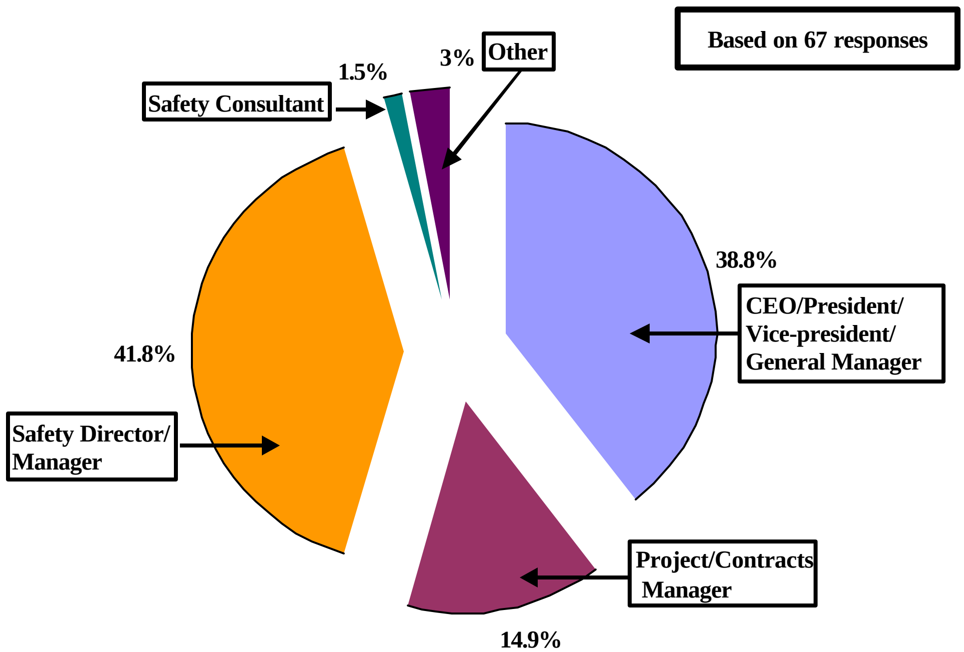

Figure 8-1 Distribution of management positions

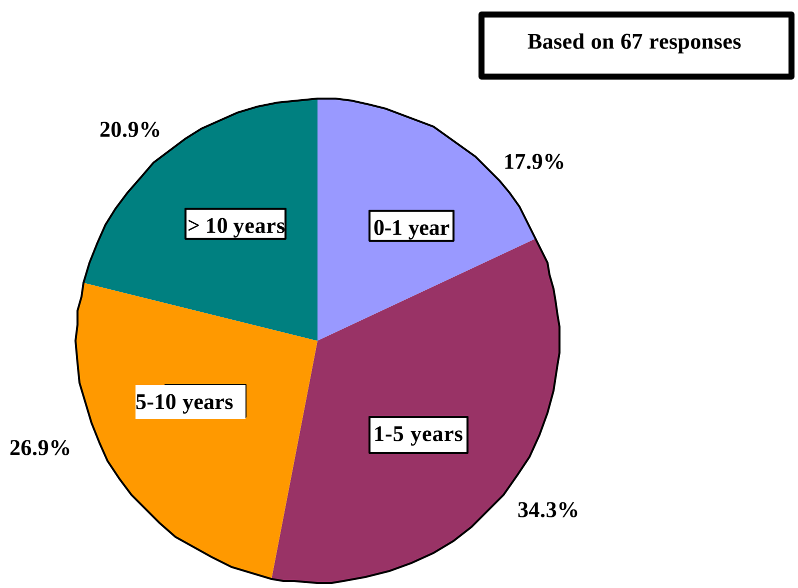

Figure 8-2 Distribution of employment in current position

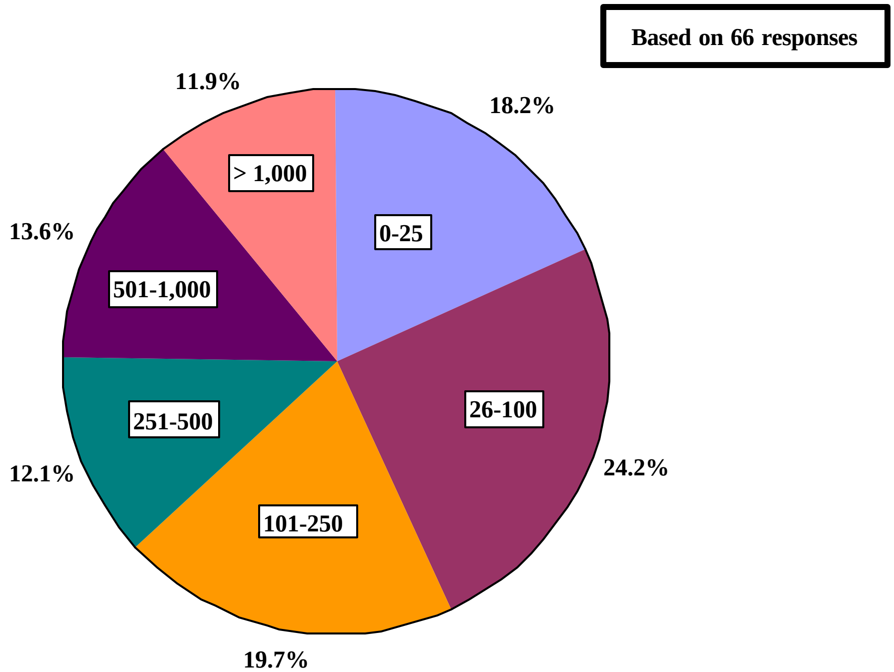

Figure 8-3 Distribution of average number of employees

5. **Under what contracting arrangements are the firm's revenue acquired?** The approximate total annual value of construction contracts is derived from the contracting arrangements as shown in Figure 8-5. No firms derived 100% of their revenue from construction management (agency) (CMA). However, 11 firms (16.7%) derived some of their income from CMA. Only 12 firms (18.2%) derived their revenue exclusively from general contracting (GC). However, 39 firms (59.0%) derived at least some of their income from GC. In fact, 51.5% derived more than 50% of the contracting revenue through this arrangement. This was the most widely used contracting arrangement. Similarly, 16 firms (24.2%) obtained some of their income from subcontracting (SC) while 5 firms (7.6%) did so exclusively from SC. Only 3 firms derived each (1.5%) of their incomes entirely from construction management at risk (CMR), specialty contracting (S), and design-build (DB) respectively. Further, 15 firms (22.7%) obtained some of their revenue from CMR, 8 firms (12.1%) did so from S, 25 (37.9%) from DB, and 5 firms (7.5%) derived some of their income from other contracting arrangements. Further, 9 firms (13.7%) derived at least 75% of their revenue from SC. At least 6 firms (9.1%) derived at least 50% of their contracting revenue from CMR. Additionally, 2 firms (3.0%) obtained at least 70% of their contracting revenue from SC. Similarly, 7 firms (10.6%) derived their revenue from DB.

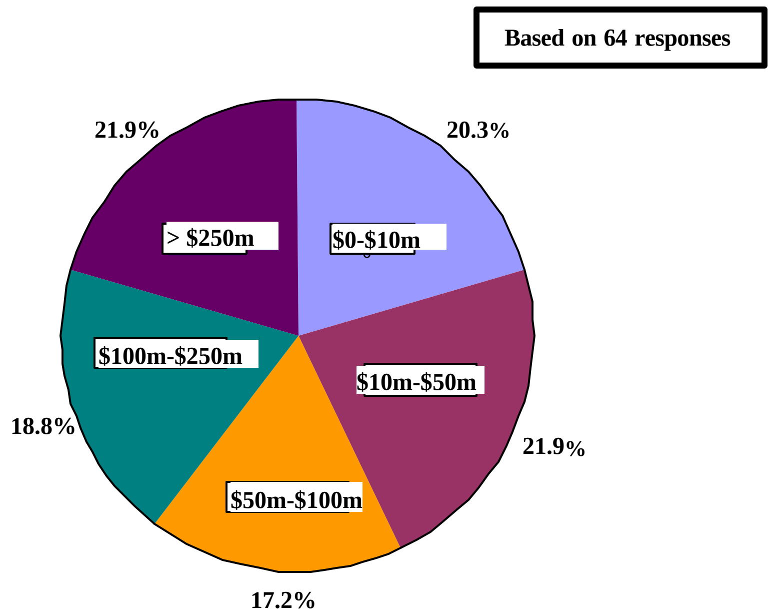

Figure 8-4 Distribution of annual value of construction contracts

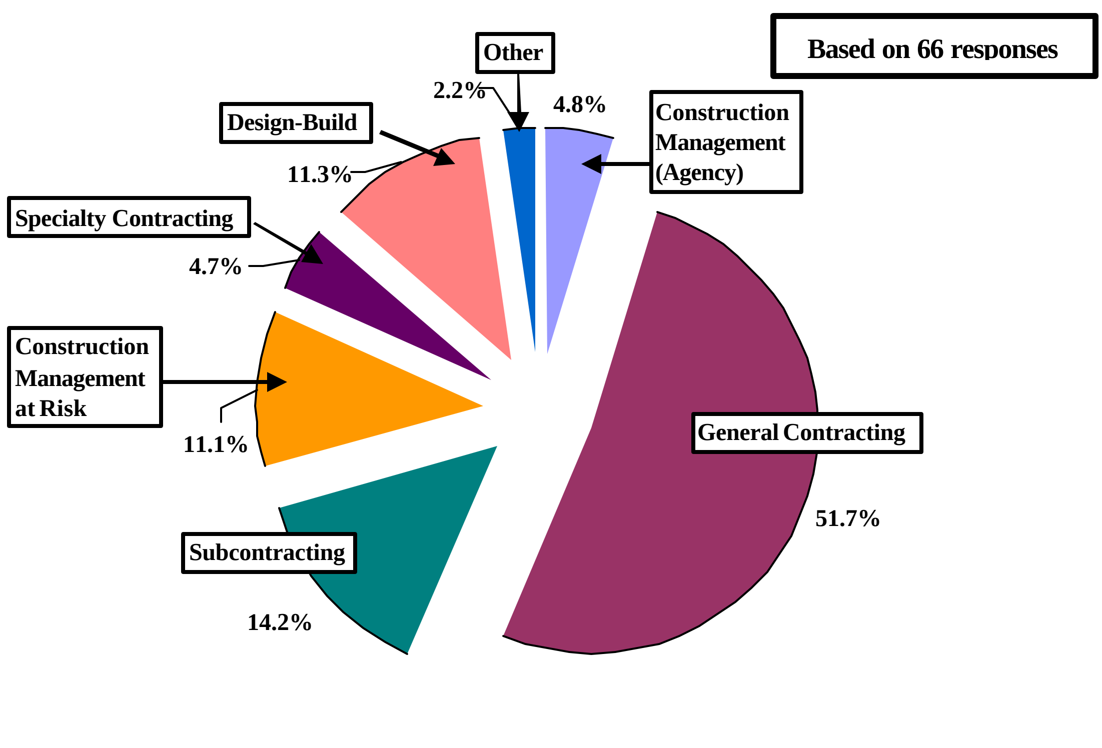

Figure 8-5 Distribution of firms' annual sources of revenue

6. **Describe the firm's area(s) of operation.** Regarding the areas of operation of the responding firms, the breakdown of the derivation of their contracting revenue was 1.86% from international (57 of 65 stated none); 21.91% from national (46 of 65 stated none); 33.62% from regional (33 of 65 reported none); and 42.62% from local operations (30 of 65 reported none). While 8 firms (12.3%) undertook some of their work internationally, no firm operated exclusively internationally. On the other hand, 9 firms (13.8%) operated exclusively nationally, 15 firms (23.1%) operated entirely regionally, and 19 firms (29.2%) did so entirely in their local areas.

Management Attitude to the Prescriptive and Performance Approaches

7. **Assuming that you were erecting scaffolding on a project in a country where both approaches were acceptable and legitimate, which approach would you prefer?** In response to this hypothetical situation, 28 respondents (42.4%) indicated that they would prefer the prescriptive approach while 38 (57.6%) preferred the performance approach. The respondents tend to favor the performance approach.
8. **Please explain why you made this choice.** The reasons given by respondents for choosing one approach over the other are listed in Table 8-1. The most frequent explanations given for selecting the prescriptive approach were the following:

– More definitive and compliance can be measured objectively (16 respondents - 23.4% of all respondents and 59.3% of those choosing the prescriptive approach); and
– Workers need specific instructions to avoid shortcuts (6 respondents - 9.2% of all respondents and 22.2% of those choosing the prescriptive approach).

The following reasons were given for preferring the performance approach:

– Differing conditions may require different approaches (9 respondents - 13.8% of all respondents and 23.7% of those choosing the performance approach);
– Minor changes allowed due to site conditions (3 respondents - 4.6% of all respondents and 7.9% of those choosing the performance approach);
– Provides contractor with flexibility (16 respondents - 24.6% of all respondents and 42.1% of those choosing the performance approach); and
– Responsibility of solution choice vests in contractor (3 respondents - 4.6% of all respondents and 7.9% of those choosing the performance approach).

The explanations that were given by the respondents regarding their preferences related very well to those for which each approach is reportedly known to be characteristic.

9. **How well do you feel that you understand the concepts of prescriptive and performance standards?** Most of the respondents, namely, 51 (78.5%) felt that they understood the concepts well. Only 1 of the respondents (1.5%) felt that their understanding of the concepts was very poor. This finding is supported by the

measures of central tendency, with a mean of 6.14, a median of 6.00, and a mode of 7.00. It is important since the responses to the remaining questions are dependent on the level of understanding of both concepts. The histogram of the response frequency distribution is shown in Figure 8-6.

Table 8-1 Explanations for selecting approach

Prescriptive	Performance	Reasons for preference
	9	Differing conditions may require different approaches
	3	Minor changes allowed due to site conditions
16		More definitive and compliance can be measured objectively
6		Workers need specific instructions to avoid shortcuts
	16	Provides contractor with flexibility
	1	Easy for workers to understand requirements
	3	Responsibility of solution choice vests in contractor
	1	Allows for innovation and ingenuity
	1	Consistent structural strength better maintained
	1	Unit president concept resembles performance approach
1		Contractors caused safety issue in first place
1		Minimum prescriptive standards help subcontractor management
	1	Minimizes liability exposure to general contractor
1		Eliminates subjective inspections
	1	Better working rapport with supervision
1		Lack of knowledge to use performance approach
	1	No strong preference
1		Contractor should be responsible for safety
27	38	

10. **Conceptually, which approach to construction worker safety do you prefer?** The respondents had no conceptual preference for either the prescriptive or the performance approach. The measures of central tendency were all concentrated around the central value, namely, 4, of the 7-point Likert scale[38]. The sample mean was 4.02 and the median 4.00. The mode was 6.00. The range of response values was 1.00 to 7.00. While 9 respondents (13.6%) stated they did not prefer one approach above another, 28 respondents (42.4%) preferred the performance approach and 29

[38] In this case, the lower end of the scale, namely, 1-3, represented preference for the performance approach with 1 representing a very strong preference. The upper end of the scale, 5-7 represented preference for the prescriptive approach with 7 representing a very strong preference. The value 4 represented no preference for either approach.

respondents (43.9%) the prescriptive approach. This finding is somewhat surprising since the response to the hypothetical situation indicated a stronger preference by 17% for the performance approach. This result suggests that might be a difference in conceptual preference and practical implementational preference. The histogram of the response frequency is shown in Figure 8-7.

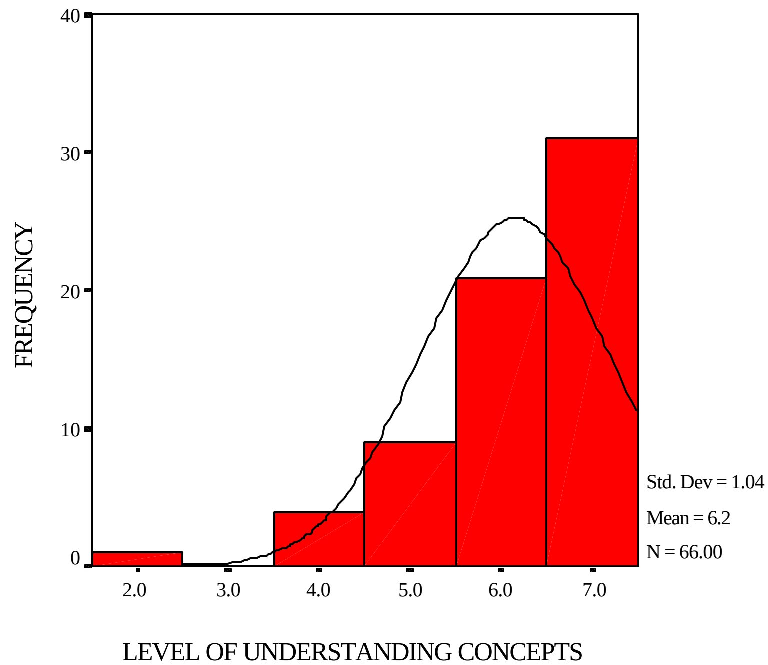

Figure 8-6 Frequency distribution of level of understanding concepts[39]

11. How influential are the types of approaches to the following issues? The respondents were asked to rate the influence that either the prescriptive or the performance approach had on several issues based on how they understood the approaches. For each issue, a 7-point Likert scale of influence was used with the performance approach at the lower end of the scale and the prescriptive approach at the upper end of the scale[40]. It was noted that the range of response was from 1 to 7, covering the full range of responses.

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[39] The scale used to indicate the level of understanding of the concepts in Figure 8-6 is a 7-point Likert scale with 1 representing very poor understanding, 4 representing neither poor nor good understanding (neutral), and 7 representing excellent or very good understanding. This form of scale of measurement is used in all histograms

[40] In this case, the lower end of the scale, namely, 1-3, represented the level of influence that the performance approach would have on the issues with 1 representing a very strong influence. The upper end of the scale, 5-7 represented the level of influence that the prescriptive approach would have on the issues with 7 representing a very strong influence. The value 4 represented that neither approach would be influential

- **Ease of introduction of new technologies.** The measures of central tendency for the sample indicate a bimodal frequency distribution. The value of the mode is 6.00. The mean is 4.08 while the median is 4.00. The findings suggest that the respondents are almost equally divided regarding their opinions on the influence of either approach to the ease with which new technologies may be introduced into construction. The histogram of the response frequency distribution is shown in Figure 8-8. While 26 respondents (49.6%) opined that the performance approach was more influential, 30 (46.9%) felt that the prescriptive approach was more influential. Examination of the extremes of the scale reveal that those with strong feelings were represented almost equally, namely, 23 respondents (35.9%) toward the performance approach and 25 respondents (39.0%) toward the prescriptive approach. The range of response values was 1.00 to 7.00.

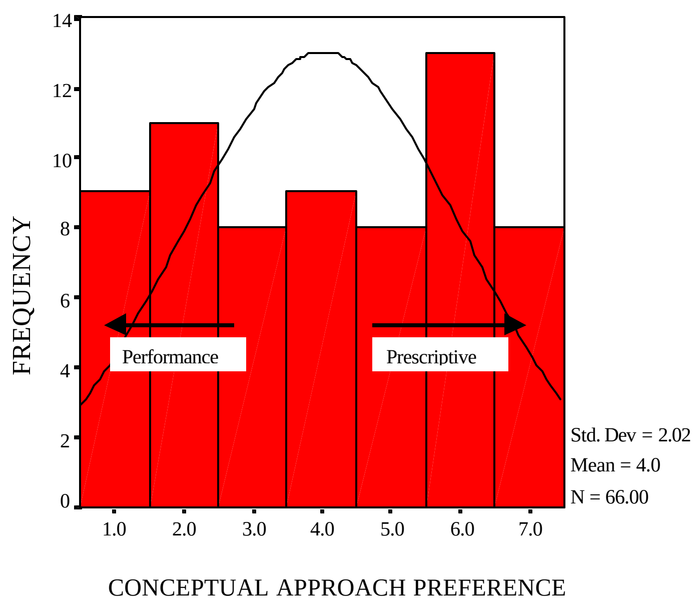

Figure 8-7 Conceptual preference for prescriptive and performance approaches

- **Cost effectiveness.** The sample mean (3.73) indicated a slight leaning in favor of the influence of the performance approach regarding cost effectiveness. However, a closer look at the extreme values of the scale indicated 6 additional respondents (9.1%) favored the performance approach. A significant number of 11 respondents (16.7%) were undecided about which approach had the greater influence. Overall, 32 respondents (48.5%) felt the performance approach had the greater influence, while 23 respondents (34.8%) were inclined toward the prescriptive approach. The histogram of frequency of responses is shown in Figure 8-9.
- **Flexibility.** The sample mean (2.70), median (2.00) and mode (1.00) suggest that respondents felt that the performance approach had a greater influence on the issue of flexibility. The 45 respondents indicating a preference for the performance approach, represented 68.2% of the sample, while those who felt that the prescriptive approach had the greater influence represented 22.7 % of the sample (15 respondents. The histogram of the response frequency distribution is shown in Figure 8-10.

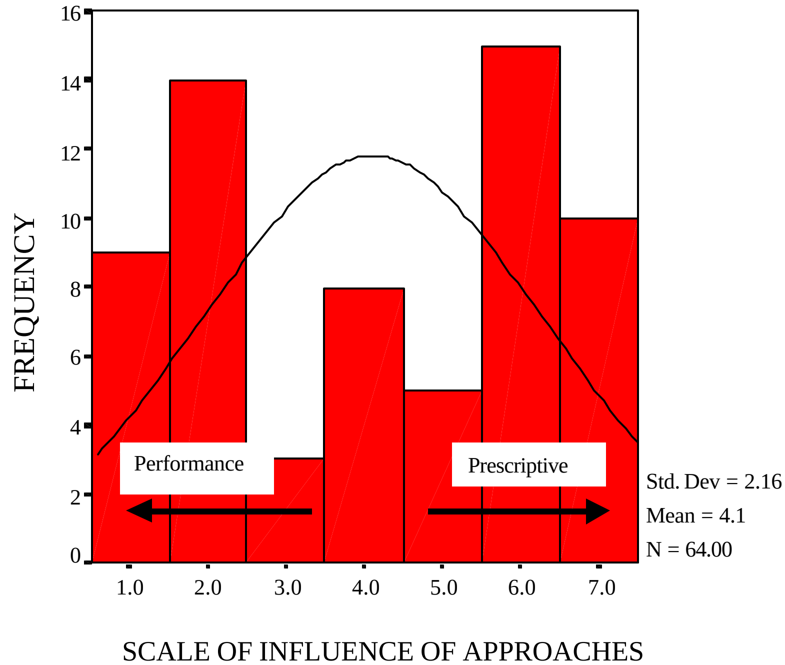

Figure 8-8 Frequency response for ease of introduction of new technologies

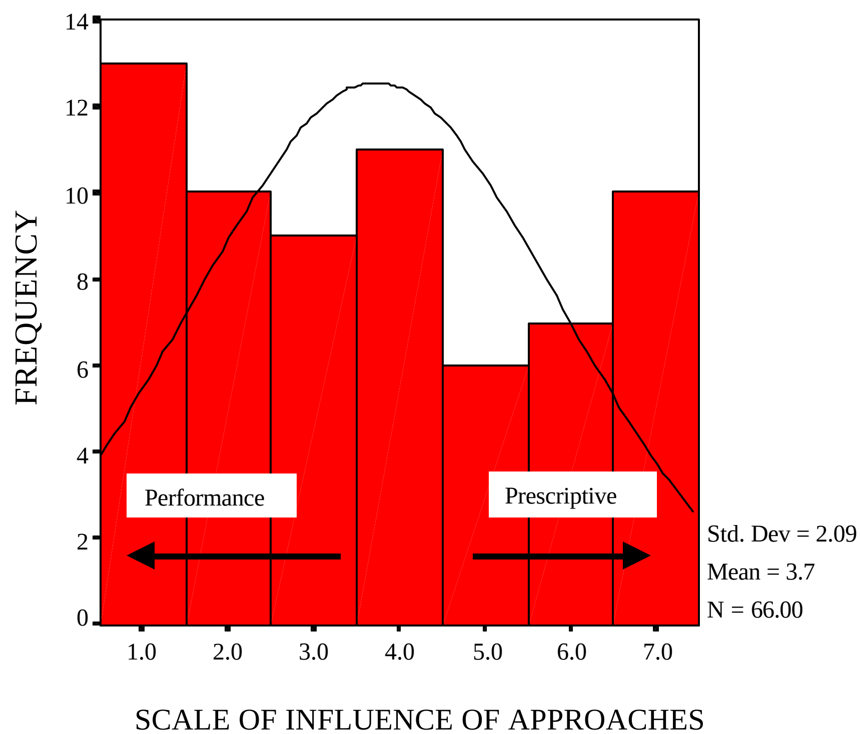

Figure 8-9 Frequency distribution for cost effectiveness of approach

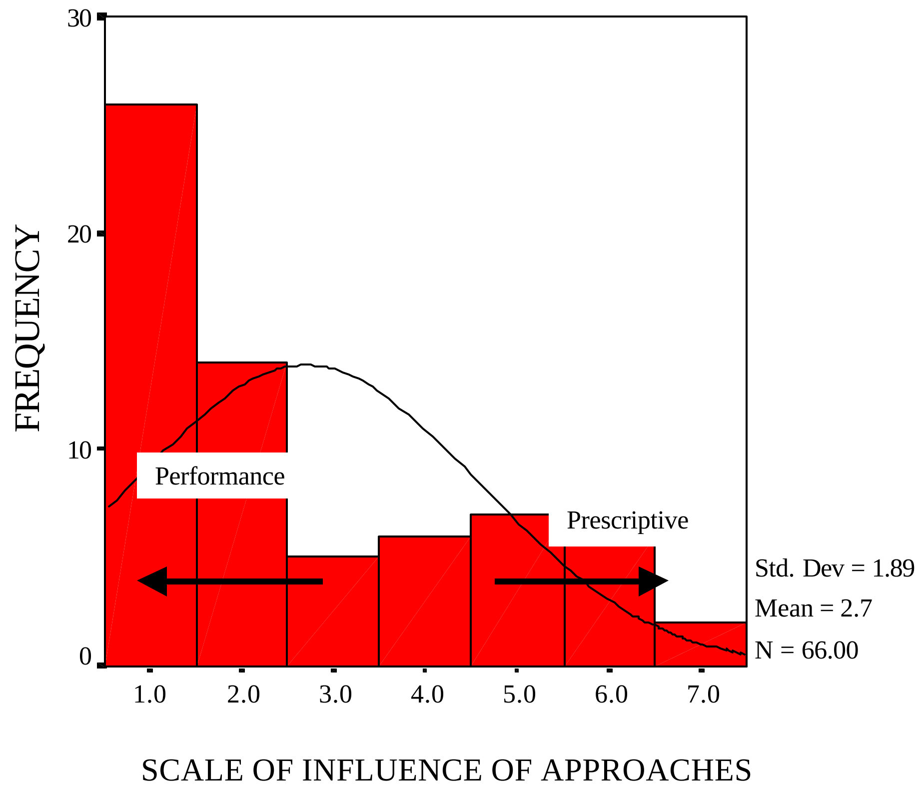

Figure 8-10 Frequency distribution for flexibility

- **Ease of implementation.** A larger proportion of the sample (31 respondents or 47.0%) felt that the performance approach was more influential regarding the ease of implementing an approach to construction worker safety. A significant number (10 respondents or 15.2%) were undecided about which approach had the greater influence. The histogram of the response frequency distribution of the sample is depicted in Figure 8-11.
- **Ease of understanding compliance requirements.** The measures of central tendency of the sample indicate a stronger preference for the prescriptive approach influencing the ease of understanding compliance requirements for worker safety. Of the sample, 34 respondents (51.5%) preferred the prescriptive approach, while 26 respondents (39.4%) expressed a preference for the performance approach. The histogram of the response frequency distribution is shown in Figure 8-12.
- **Support for innovation.** The sample median (2.00) and mode (1.00) show that respondents felt that the performance approach was more supportive of innovation than the prescriptive approach. These 40 respondents made up 60.6% of the sample, while those leaning toward the prescriptive approach made up 22.7% (15 respondents). The histogram of the response frequency distribution is shown in Figure 8-13.

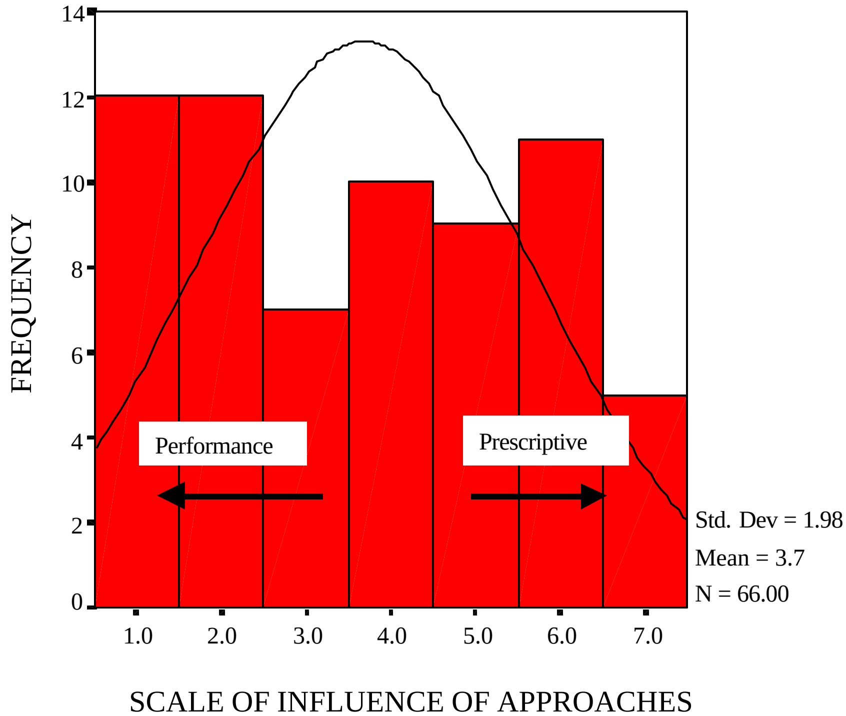

Figure 8-11 Frequency distribution for ease of implementation

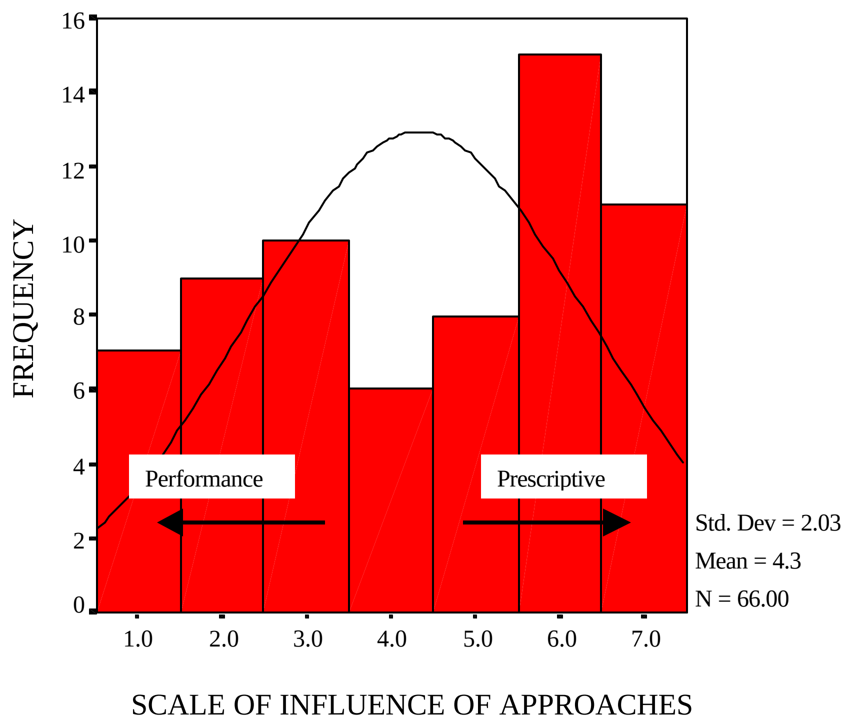

Figure 8-12 Frequency distribution for ease of understanding compliance requirements

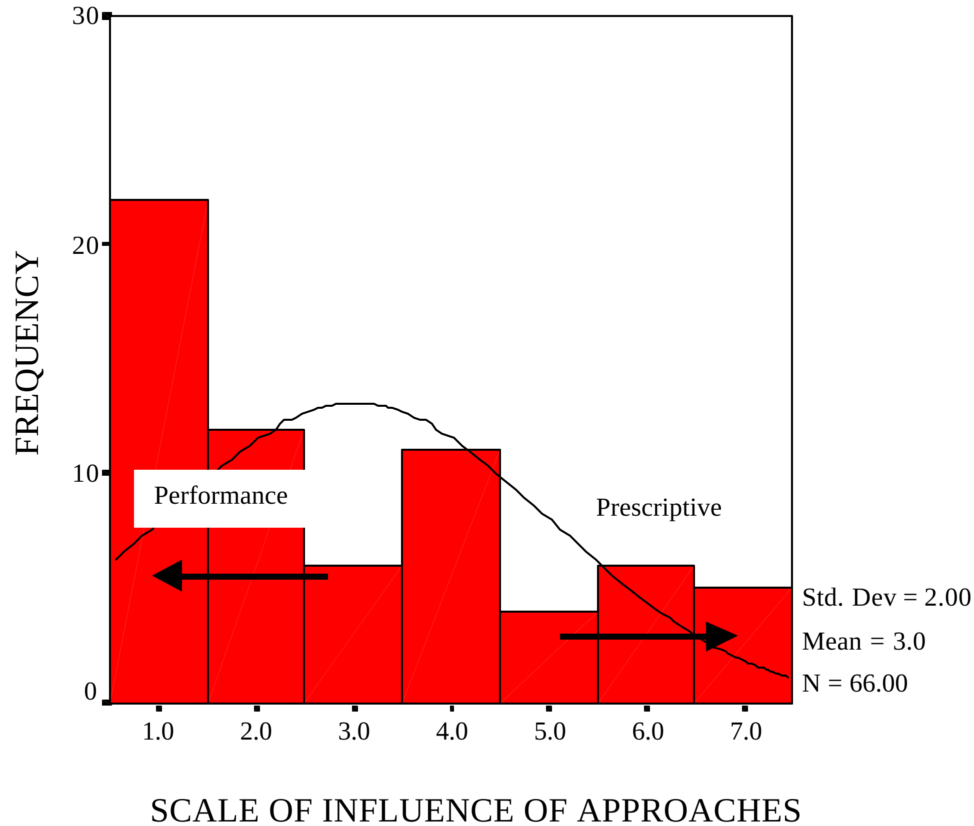

Figure 8-13 Frequency distribution for support for innovation

- **Ease of introduction of new materials.** A larger proportion of the sample (56.7%) opined that the performance approach was more influential regarding the issue of the ease of introducing new materials, while 29.9% (20 respondents) felt that the prescriptive approach had the greater influence. The sample mean was 3.40. The histogram of the response frequency distribution is shown in Figure 8-14.
- **Corporate culture, vision and mission of your organization.** Similarly, 47.8% of the sample (32 respondents) felt that the performance approach was more influential with regard to the corporate culture, vision and mission of firms. However, a significant number of respondents (22.4%) were undecided about which approach was the more influential. The sample mean was 3.48. The histogram of the response frequency distribution is shown in Figure 8-15.
- **Potential to improve safety performance on sites.** The sample median (3.00) and mode (1.00) suggested that there was a preference for the performance approach having more influence on the potential to improve safety performance on construction sites. Some 34 respondents (50.7%) favored the performance approach, while 25 respondents (37.3%) favored the prescriptive approach. The histogram of the response frequency distribution is shown in Figure 8-16.

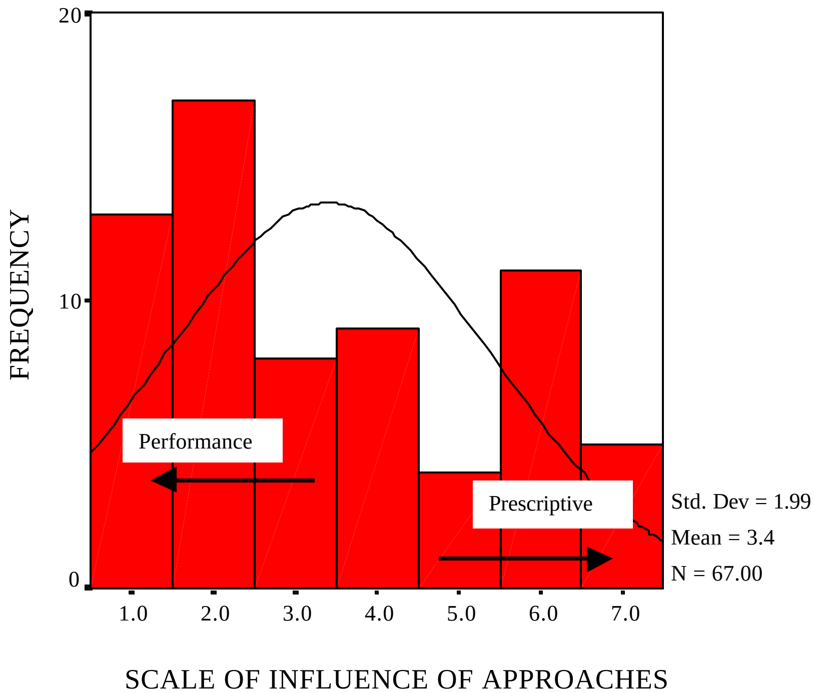

Figure 8-14 Frequency distribution for ease of introduction of new materials

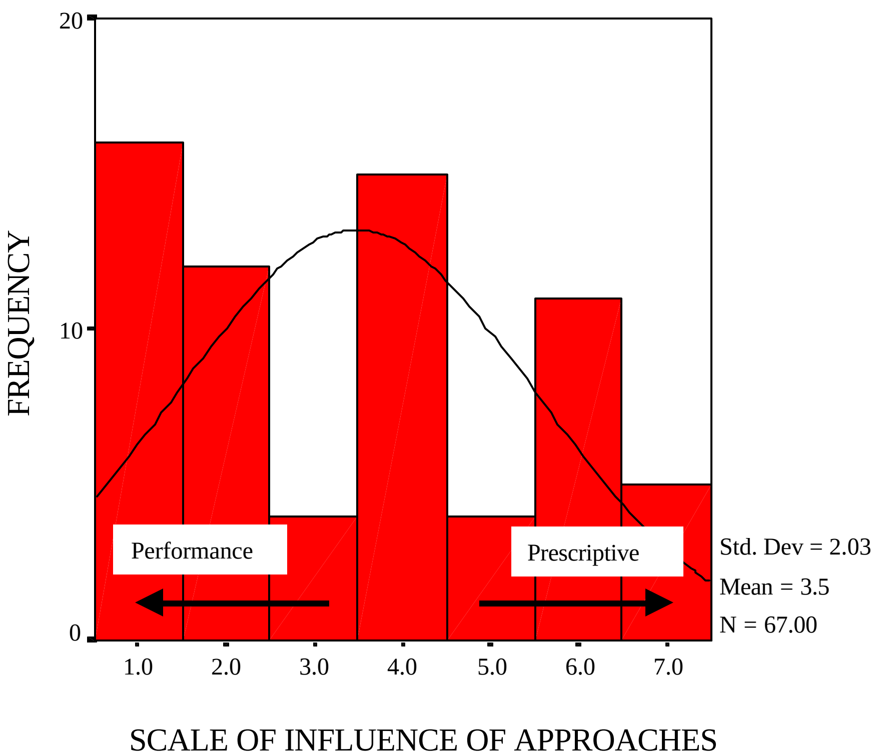

Figure 8-15 Frequency distribution for corporate culture, vision and mission

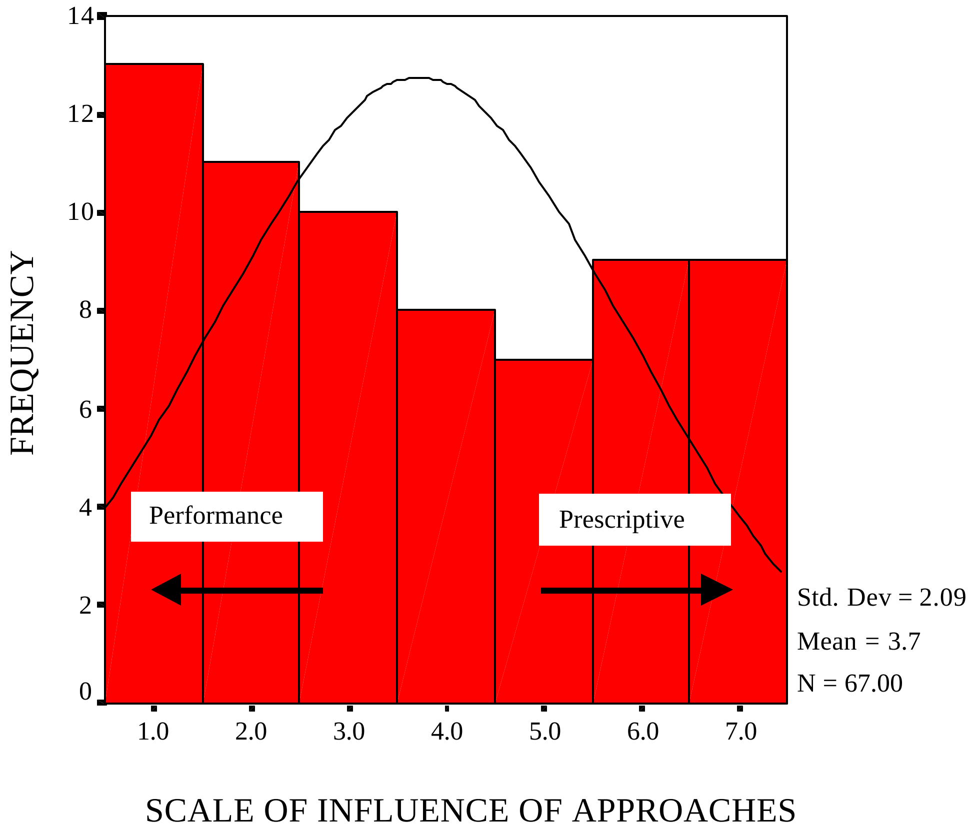

Figure 8-16 Frequency distribution for potential to improve safety performance on sites

– **Simplicity of interpretation.** The sample mean (4.21) provided a good measure of central tendency of the sample. This is evident, as a slightly larger proportion of the respondents (47.8%) preferred the prescriptive approach while 40.3% leaned toward the performance approach being more influential to the issue of respect to simplicity of interpretation. The histogram of the response frequency distribution is shown in Figure 8-17.

– **Ease of compliance.** The sample was almost equally divided between respondents favoring either approach influencing the issue of ease of compliance. However, the sample mean (4.11) indicated a slight preference for the prescriptive approach. There were 13 respondents who had no preference. The histogram of the response frequency distribution is shown in Figure 8-18.

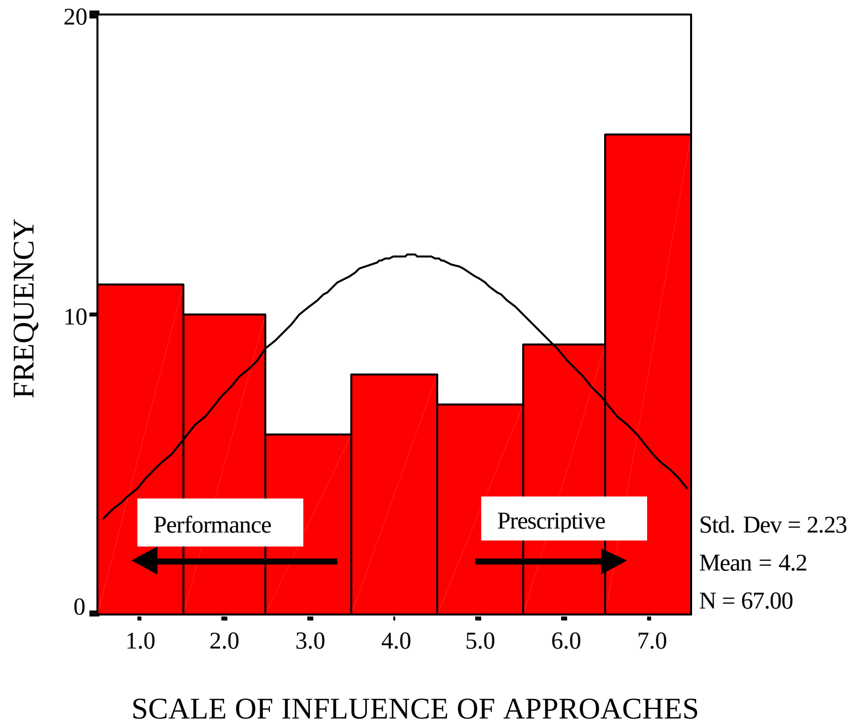

Figure 8-17 Frequency distribution for simplicity of interpretation

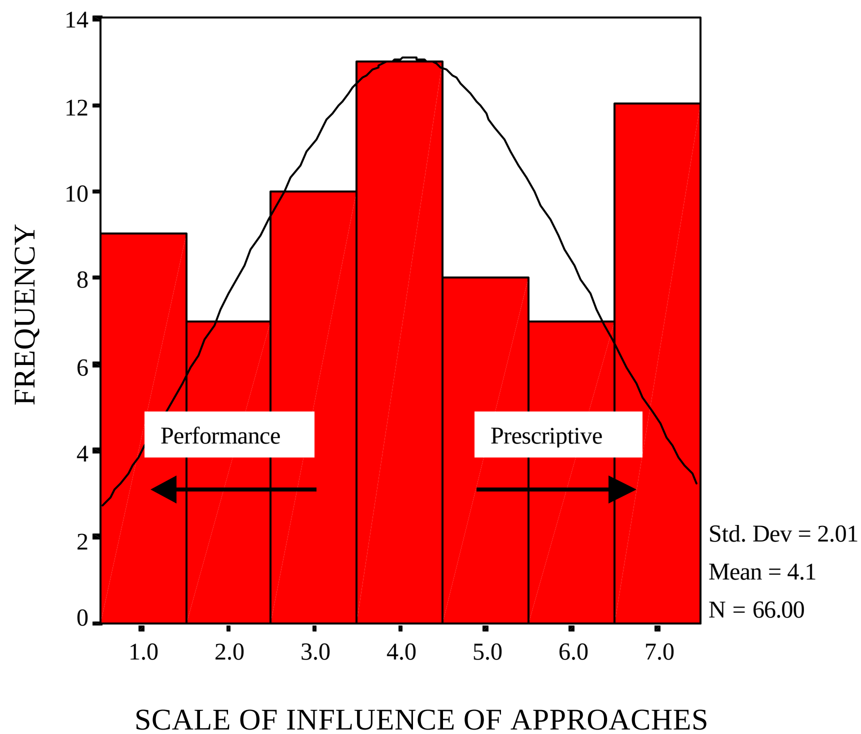

Figure 8-18 Frequency distribution for ease of compliance

Comparison of Means

By comparing the means of the various frequency distributions, it was possible to rank the influence of the various approaches on the 11 issues. By ranking the means in ascending order it was possible to rank the issues in order of the influence that the performance approach had on them. The 7-point scale of influence suggested that mean values closer to 1 suggested a stronger influence of the performance approach, while mean values closer to 7 suggested a stronger influence of the prescriptive approach. This ranking in order of influence is reflected in Table 8-2.

Table 8-2 Ranking the influence of the approaches on issues

Rank	Issue	N	Mean	Std. Deviation
1	Flexibility	65	2.6615	1.8815
2	Support for innovation	65	2.9692	1.9841
3	Ease of introduction of new materials	66	3.3636	1.9817
4	Corporate culture, vision and mission of your organization	66	3.4242	1.9928
5	Ease of implementation	65	3.6462	1.9719
6	Cost effectiveness of approach	65	3.6769	2.0699
7	Potential to improve safety performance on sites	66	3.6818	2.0914
8	Ease of compliance	65	4.0769	2.0102
9	Ease of introduction of new technologies	63	4.0794	2.1650
10	Simplicity of interpretation	66	4.1667	2.2228
11	Ease of understanding compliance requirements	65	4.2923	2.0212

The performance approach had the greatest influence on the issue of flexibility with a mean value of 2.66. It had the least influence on ease of understanding compliance requirements with a mean value of 4.29. Support for innovation ranked 2nd and ease of introduction of new materials ranked 3rd. This finding conforms with the issues that the literature on the performance approach suggests motivate the decision to adopt the approach. The potential to improve safety performance on sites ranked 6th.

To determine whether the influence of the approaches differed by preference for approach, the means were compared based on preference. The results of this comparison yielded slightly different results (Table 8-3).

Table 8-3 Ranking influence of the approaches on issues by approach

Sample Rank	Issue	Perform	Mean	Std. Dev.	Prescript	Mean	Std. Dev.
1	Flexibility	1	2.47	1.89	11	3.00	1.89
3	Ease of introduction of new materials	2	2.76	1.75	8	4.35	1.95
2	Support for innovation	3	2.89	2.09	10	3.18	1.91
6	Cost effectiveness of approach	4	2.92	1.88	5	4.82	1.89
4	Corporate culture, vision and mission of your organization	5	2.92	1.79	9	4.32	2.06
7	Potential to improve safety performance on sites	6	3.03	1.85	6	4.71	2.05
5	Ease of implementation	7	3.08	1.75	7	4.50	2.01
8	Ease of compliance	8	3.24	1.74	2	5.25	1.82
9	Ease of introduction of new technologies	9	3.33	1.90	4	5.11	2.10
10	Simplicity of interpretation	10	3.45	2.18	3	5.21	1.95
11	Ease of understanding compliance requirements	11	3.61	1.85	1	5.32	1.87
	Valid N (listwise)	36			28		

The issue of flexibility ranked highest for those preferring the performance approach and lowest for those preferring the prescriptive approach. The ease of understanding compliance requirements ranked the lowest for those preferring the performance approach but highest for those preferring the prescriptive approach. The ease of introducing new materials and support for innovation ranked 2nd and 3rd respectively for those preferring the performance approach. The ease of compliance and simplicity of interpretation ranked 2nd and 3rd for those preferring the prescriptive approach. The potential to improve safety performance on sites ranked 6th for both groups. The ease of the introduction of technology ranked 9th for those preferring the performance approach and 4th for those preferring the prescriptive approach. This result seems to be an anomaly since it would have been predicted to be higher for the performance group and lower for the prescriptive group. The range of responses was from 1 to 7 for all issues except ease of implementation for which it was 1 to 6.

12. **How important are the following issues to construction safety and health management?** The respondents were asked to rate on a 7-point Likert scale of importance[41] how important they regarded several issues regarding an approach to construction safety and health management.

– **Cost effectiveness of the approach.** The sample mean (4.80), median (5.00) and mode (5.00) indicate that most of the respondents regarded cost effectiveness to be important to an approach to construction safety and health management. Some 39.4% (26 respondents) regarded this aspect as particularly important, whereas 13.6% (9 respondents) regarded it as relatively unimportant. The histogram of the response frequency distribution is shown in Figure 8-19.

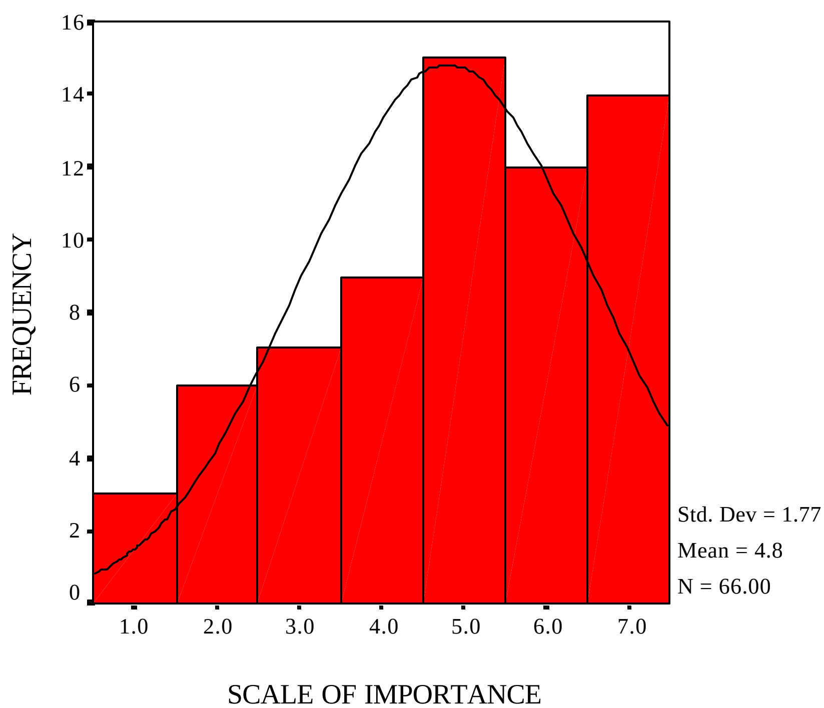

Figure 8-19 Frequency distribution of importance of cost effectiveness

[41] The scale used to indicate the level of importance is a 7-point Likert scale with 1 representing not important at all, 4 representing a neutral attitude, and 7 representing very or extremely important. This form of scale of measurement is used in all histograms

– **Ease of implementation of the approach**. Similarly, the sample mean (5.84), median (6.00) and mode (7.00) indicate that respondents regarded the ease of implementation of the approach as more important to safety and health than its cost effectiveness. Only 3% (2 respondents) regarded this issue as not important, 7.5% (5 respondents) were undecided about its importance, while 60 respondents (89.6%) regarded it with varying degrees of importance. In fact 34.3% (23 respondents) regarded it as very important. The histogram of the response frequency distribution is shown in Figure 8-20.

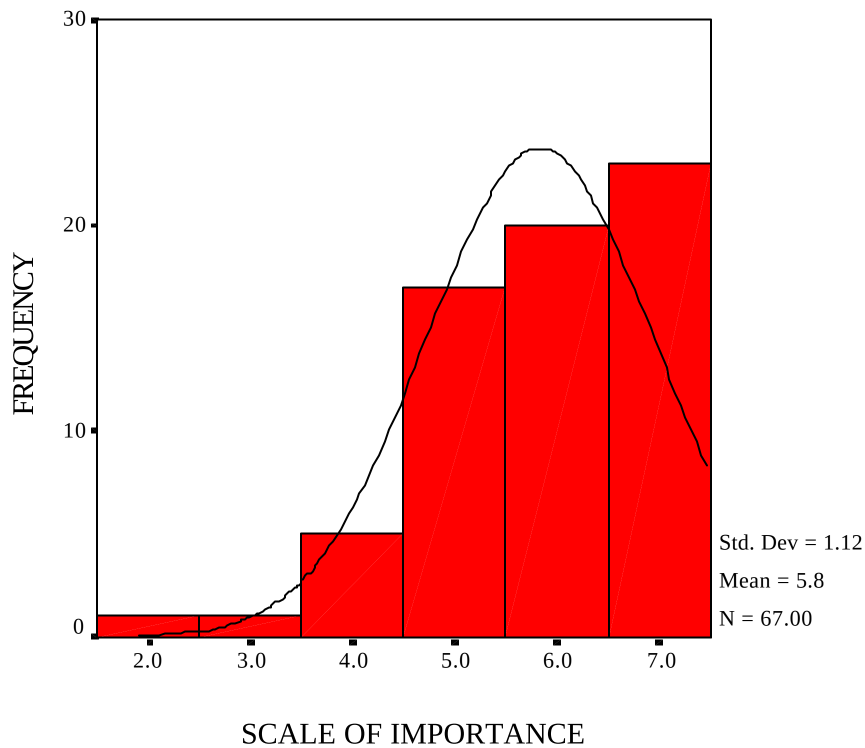

Figure 8-20 Frequency distribution of importance of ease of implementation

– **Ease of understanding compliance requirements.** The respondents regarded the ease of understanding compliance requirements as important. This finding is suggested by the sample mean (6.04), median (6.00) and mode (7.00). There were no respondents who regarded this issue as unimportant. Only 4 respondents (6.0%) were undecided about how important the issue was to construction safety and health management. The histogram of the response frequency distribution is shown in Figure 8-21.

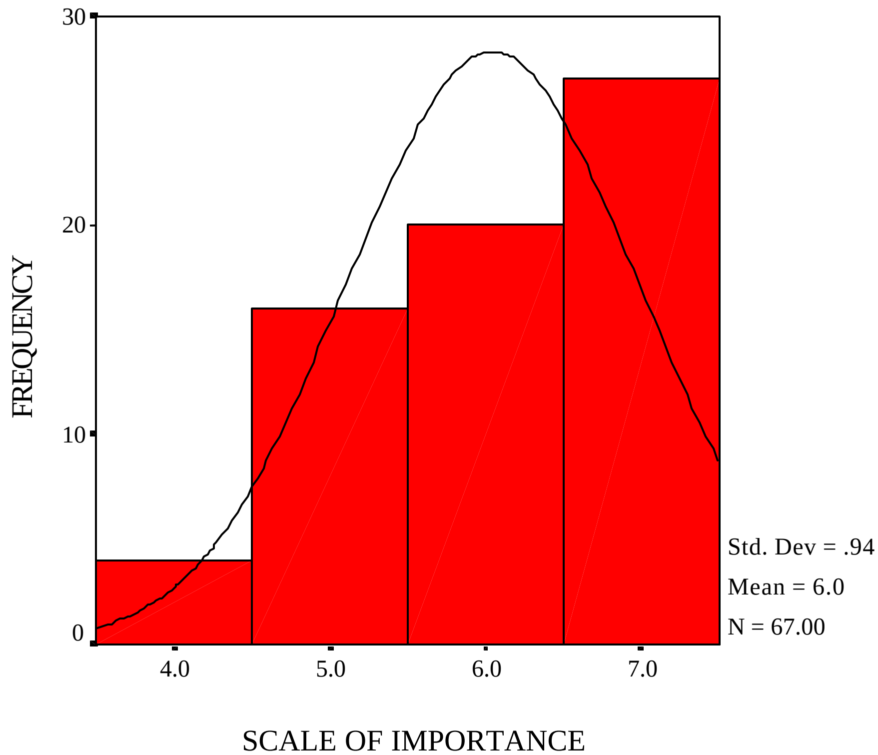

Figure 8-21 Frequency distribution of ease of understanding compliance requirements

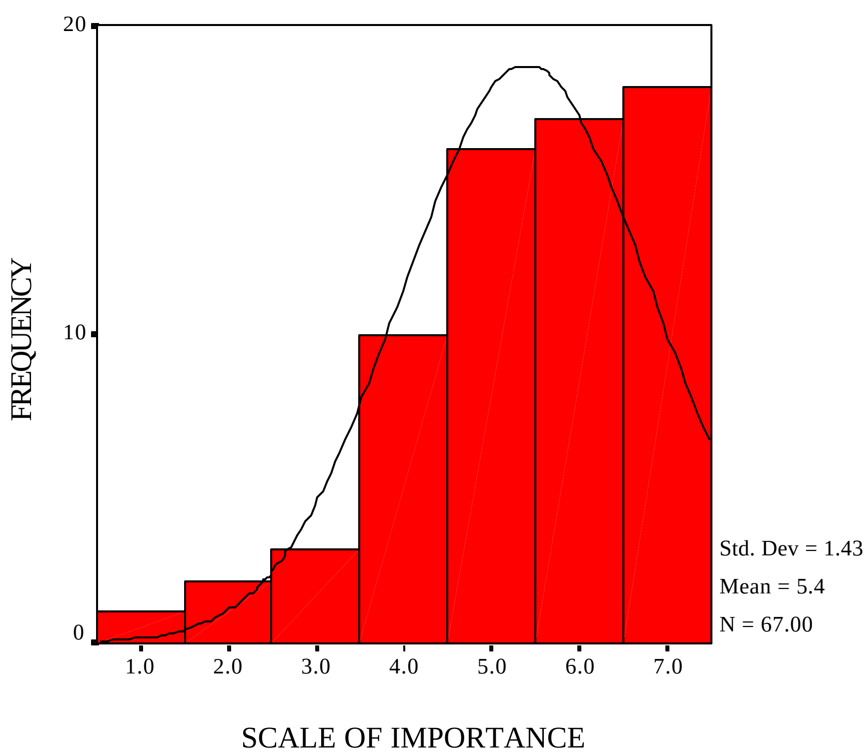

Figure 8-22 Distribution of support for innovation, new materials and technology

– **Support for innovation, new materials and technology**. As before, a large proportion of the respondents regarded the support for innovation, new materials and technology that an approach to safety management would provide as important. Some 18 respondents (26.9%) felt that the issue was very important (7), 17 respondents (25.4%) stated that it was slightly less important (6), while 16 respondents (23.9%) that it was important (5). Only 1 respondent (1.5%) regarded the issue as not important at all (1). The histogram of the response frequency distribution is shown in Figure 8-22.

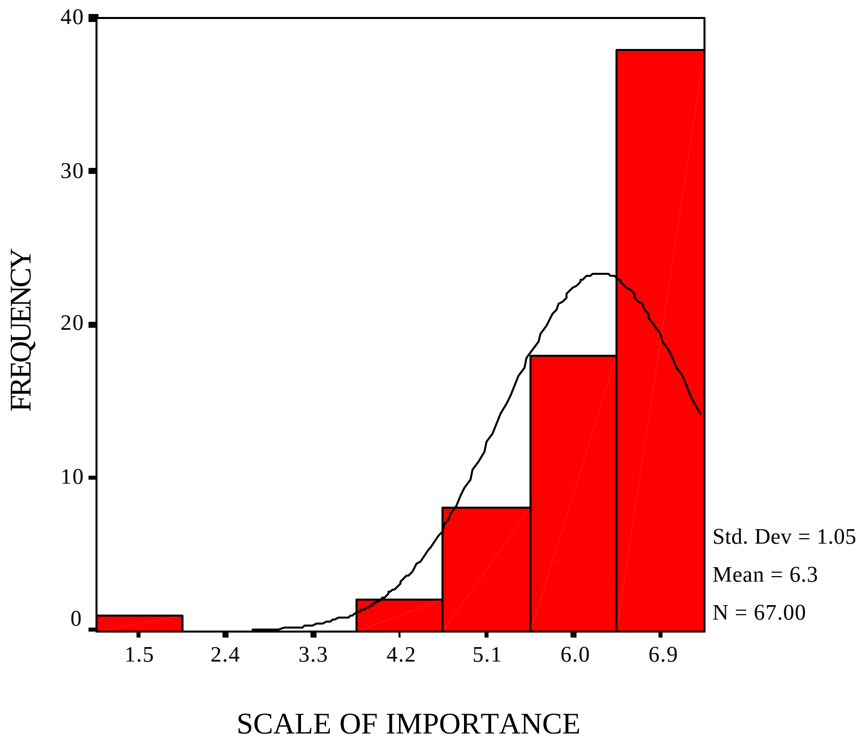

Figure 8-23 Frequency distribution of potential to improve safety performance on sites

– **Potential to improve safety performance on sites.** As might have been expected, only 1 respondent regarded the potential of the approach to improve safety management on sites to be not important. The sample mean (6.31), median (7.00) and mode (7.00) indicate that this issue is regarded as extremely important to respondents. In fact, 38 respondents (56.7%) regarded the issue as very important, 18 respondents (26.9%) saw the issue as slightly less important while 8 respondents (11.9%) regarded it as important. The histogram of the response frequency distribution is shown in Figure 8-23. While the scales seem different due to the way SPSS selected to graphically represent the data, they represent 1 to 7 as before.

Comparing Means to Rank Responses

By comparing the means of the various frequency distributions, it was possible to rank the 5 issues regarding how important they were regarded by the respondents. The 7-point scale of importance suggested that the greater the importance of the issue the closer the mean value would be to the upper end of the scale, namely, 7. This ranking in order of importance is reflected in Table 8-4. The importance of the potential to improve safety performance on sites ranked the highest, while the importance of cost effectiveness ranked the lowest.

Table 8-4 Importance of issues affecting construction safety management

Rank	Issue	N	Mean	Std. Deviation
1.	The potential to improve safety performance on sites	66	6.32	1.05
2.	The ease of understanding compliance requirements	66	6.05	.95
3.	The ease of implementation of the approach	66	5.83	1.13
4.	Support for innovation, new materials and technology	66	5.39	1.43
5.	The cost effectiveness of approach	65	4.77	1.77

Preference for Either Approach

To determine whether the preference for an approach would have any effect on the ranking, the means were compared based on their preference. The results of this comparison yielded the same ranking in Table 8-5. The result of the comparison revealed that preference for either the performance or prescriptive approach had no effect on the ranking of the issues.

Table 8-5 Importance of construction safety management issues by approach

Sample Rank	Issue	Perform. Rank	Mean	Std. Dev.	Prescript. Rank	Mean	Std. Dev.
1	The potential to improve safety performance on sites	1	6.32	.84	1	6.29	1.30
2	The ease of understanding compliance requirements	2	5.92	1.00	2	6.18	.86
3	The ease of implementation of the approach	3	5.79	1.26	3	5.93	.94
4	Support for innovation, new materials and technology	4	5.50	1.41	4	5.29	1.49
5	The cost effectiveness of approach	5	4.97	1.71	5	4.64	1.87
	Valid N (listwise)	38			27		

Change Management

13. **Who usually sponsors major change within your organization?** Regarding who usually sponsors major change within the firms of respondents, the breakdown of their responses were 53.52% top management, 16.12% middle management, 19.05% site management, 6.00% workers and 5.03% supervisors. The top management of 58 firms (89.2%), middle management of 45 firms (69.2%), site management of 44 firms (67.7%), workers of 27 firms (42.5%), and supervisors of 22 firms (33.8%) sponsored some of the major changes in those firms. The top management of 8 firms (12.3%) and the site management of 3 firms (4.6%) sponsored 100% of the major changes that took place in those firms. The distribution of sponsors of major change is shown in Figure 8-24.
14. **How influential are the following in driving change within your organization?** The respondents were asked to rate on a 7-point Likert scale of influence[42] how influential they regarded 13 issues in driving change within their organizations. The closer to the upper end of the scale the response, the greater the influence the issue had on driving change. Conversely, the closer to the lower end of the scale of 1, the weaker the influence of the issue on driving changes.

– **Financial performance.** The measures of central tendency of the sample, namely, the mean (6.00), median (6.00) and mode (7.00), indicated that most of the respondents (93.8%) regarded financial performance as influential in driving change within their firms. Only 2 respondents (3.1%) regarded financial performance as not influential (1.0). Further, 26 respondents (40.0%) regarded this issue as extremely important in driving change (7.0) (Figure 8-25).

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[42] The scale used to indicate the level of influence is a 7-point Likert scale with 1 representing not influential at all, 4 representing a neutral attitude, and 7 representing very or extremely influential. This form of scale of measurement is used in all histograms

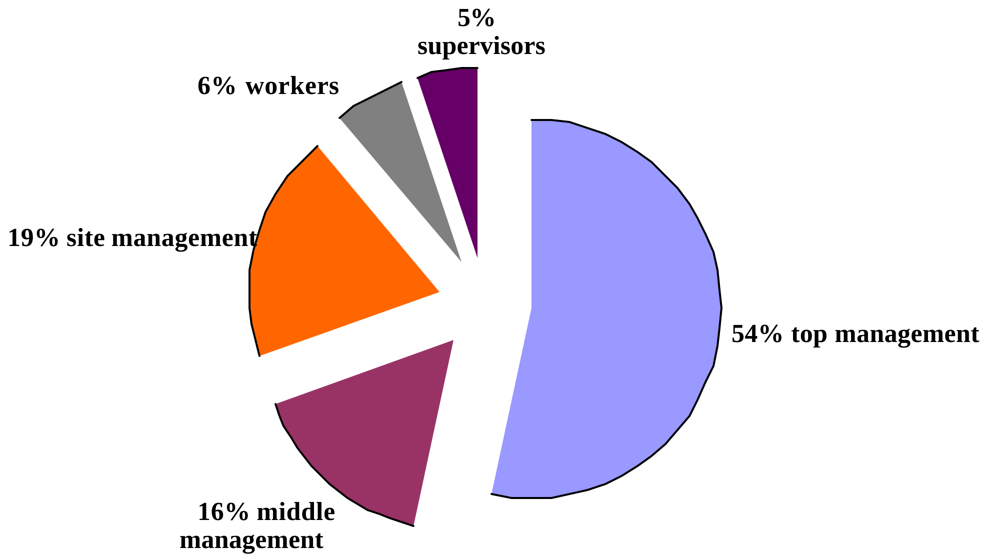

Figure 8-24 Distribution of major change sponsorship within organizations

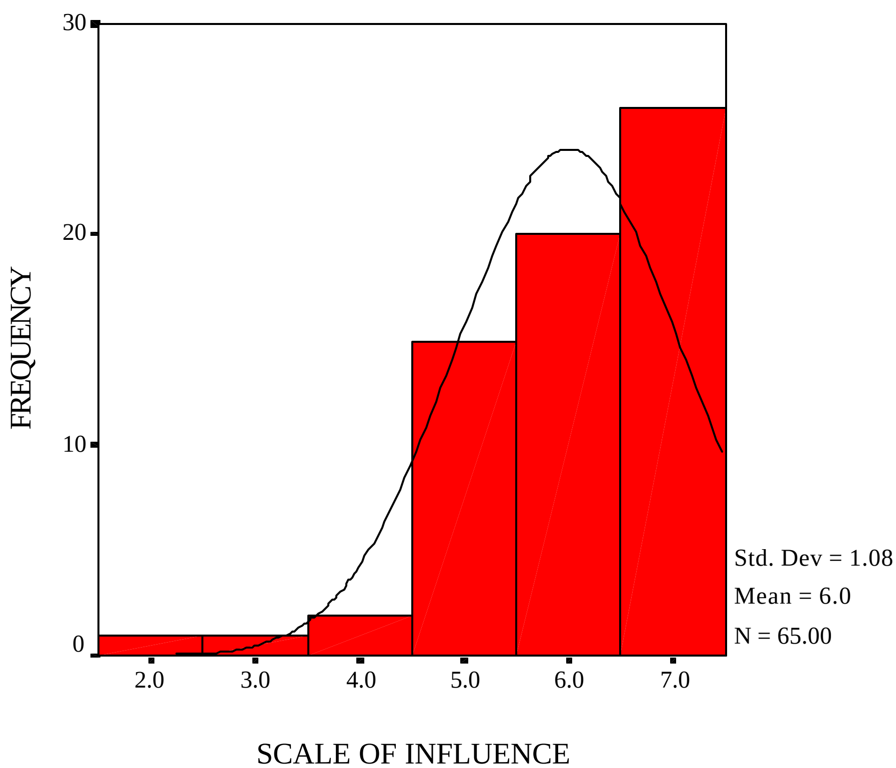

Figure 8-25 Frequency distribution of financial performance

- **Staff turnover.** The sample mode (4.00) indicated that 20 respondents (30.3%) were undecided about the influence that staff turnover had in driving change within their organizations. The sample mean (3.21) and median (3.00) indicated that 36 respondents (54.5%) regarded this issue as not being influential to varying degrees. While only 2 respondents (3.0%) regarded staff turnover as extremely influential, 10 respondents (15.2%) regarded it as not influential in driving change. The histogram of the response frequency distribution is depicted in Figure 8-26.
- **Introduction of new technology.** Only 6 respondents (9.1 %) regarded the introduction of new technology as not being influential in driving change within their firms. While 13 respondents (19.7%) were undecided, 47 respondents (71.2%) regarded the issue as being influential. Further, 6 respondents (9.1%) regarded the introduction of new technology as extremely influential in driving change. The histogram of the response frequency distribution is depicted in Figure 8-27.
- **Keeping up with competitors.** More respondents (77.3%) regarded keeping up with competitors as being influential to varying degrees in driving change in their firms. While only 5 respondents (7.6%) regarded this issue as not influential at all, 13 respondents (19.7%) regarded it as extremely influential. The histogram of the response frequency distribution is depicted in Figure 8-28.

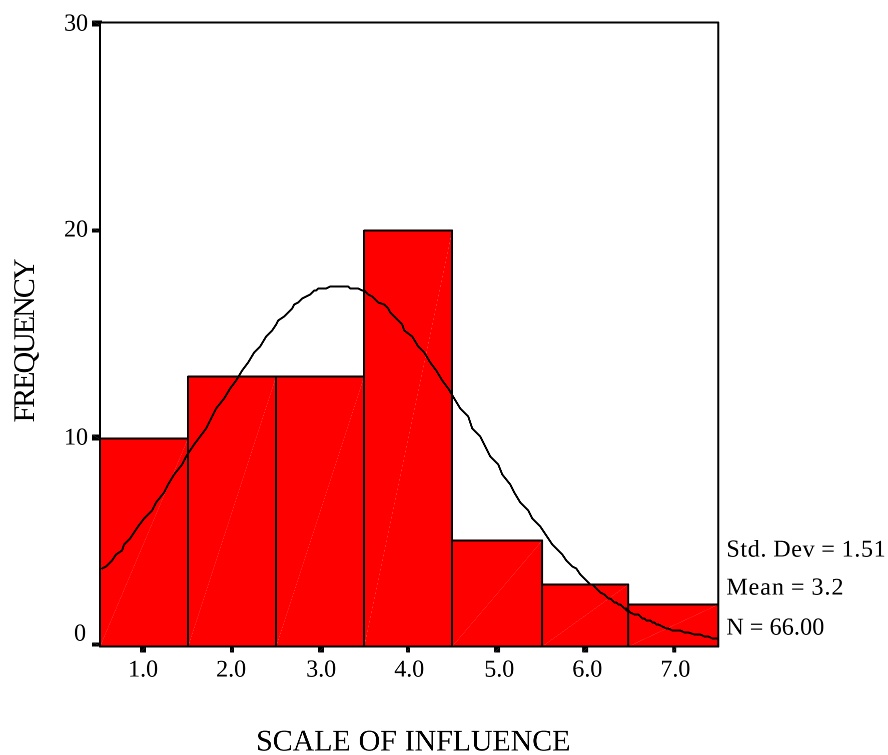

Figure 8-26 Frequency distribution of staff turnover

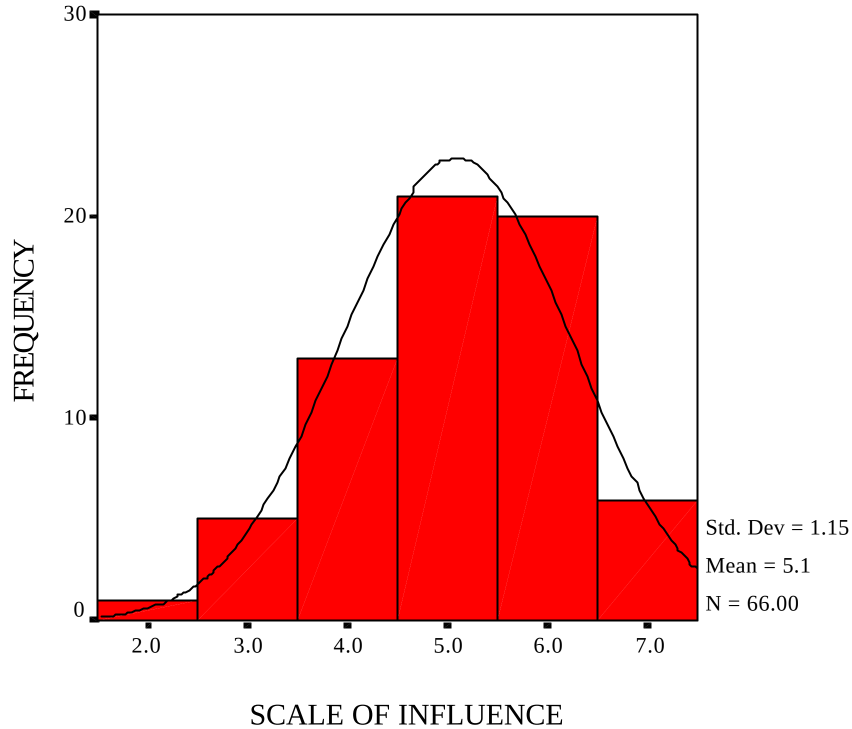

Figure 8-27 Frequency distribution of introduction of new technology

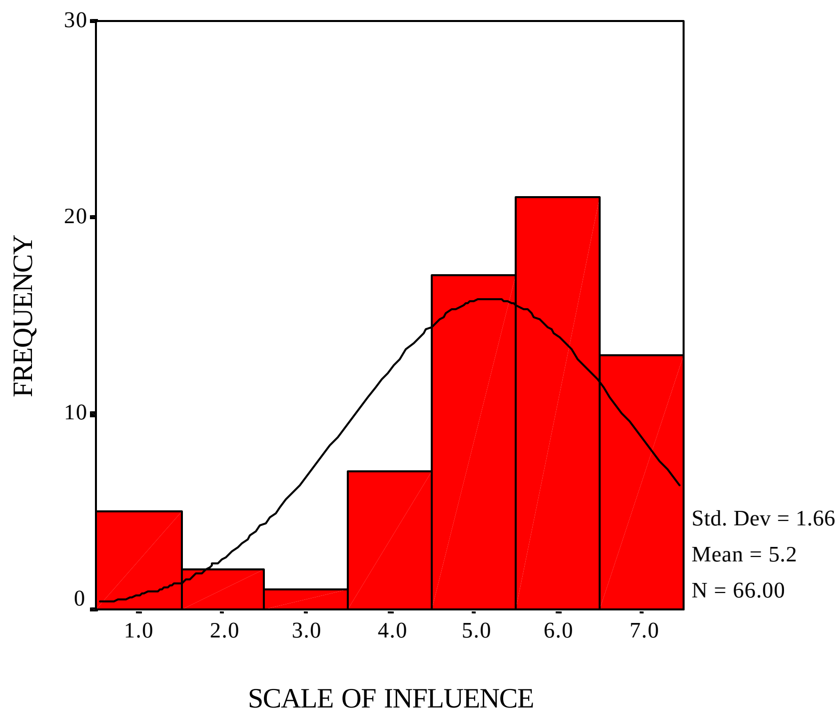

Figure 8-28 Frequency distribution of keeping up with competitors

- **Improvement of your safety record.** Not unexpectedly, most of the respondents (86.4%) regarded the improvement of their safety record as being influential in driving change in their organizations. While only 3 respondents (4.5%) regarded this issue as not being influential to varying degrees, 21 respondents (31.8%) regarded it as extremely influential. The histogram of the response frequency distribution is depicted in Figure 8-29.

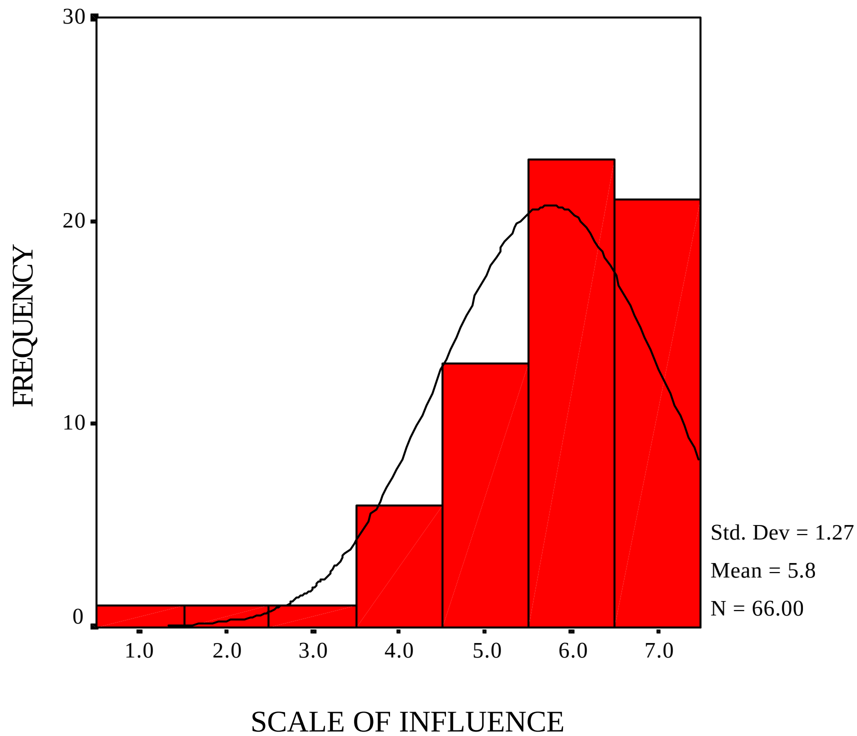

Figure 8-29 Frequency distribution of improvement of safety record

- **Occurrence of accidents.** Surprisingly, the sample mean (3.83), the median (4.00), and the mode (4.00) indicated that a large proportion of the respondents (25.8%) were undecided about the influence that the occurrence of accidents had in driving change within their organizations. Further, 30 respondents (45.5%) regarded this issue as not being influential, while 19 respondents (28.8%) regarded it as having some influence. While 2 respondents (3.0%) regarded the occurrence of accidents as not being influential at all, 6 respondents (9.1%) regarded it as being extremely influential (Figure 8-30).

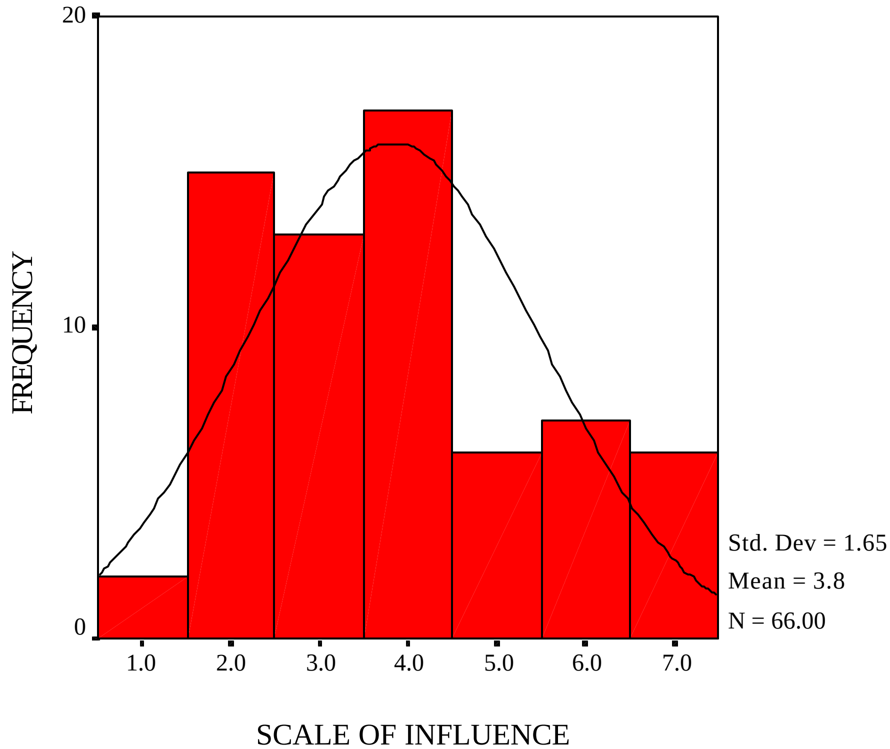

Figure 8-30 Frequency distribution of occurrence of accidents

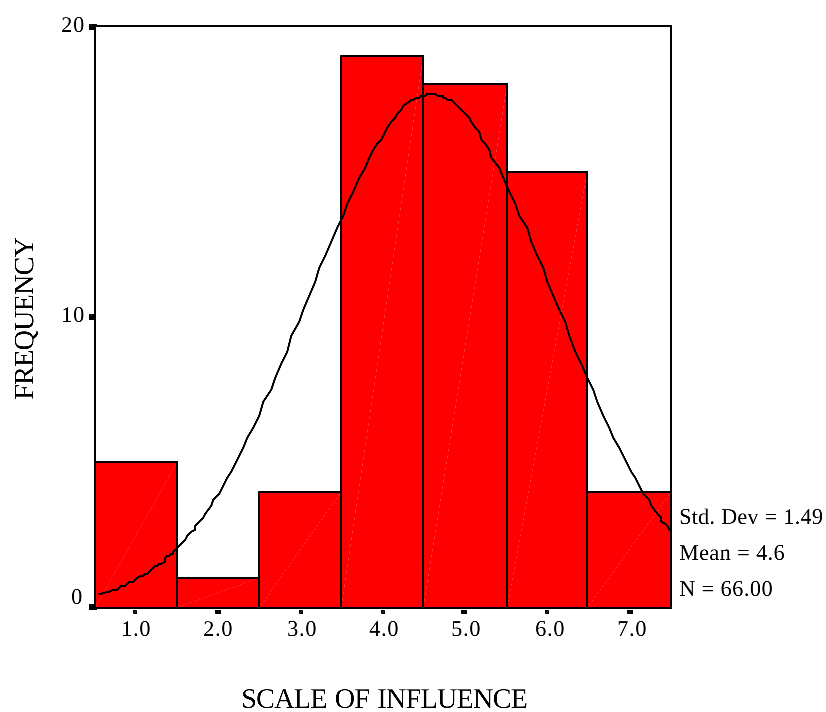

Figure 8-31 Frequency distribution of meeting worker demands

– **Meeting worker demands.** The sample mean (4.59), the median (5.00), and the mode (4.00), indicated that a large proportion of the respondents (28.8%) were concentrated around being undecided about the influence of this issue in driving change in their firms. However, only 10 respondents (15.2%) regarded meeting worker demands as not being influential to varying degrees. Further, 4 respondents (6.1%) regarded the issue as being extremely influential. The histogram of the response frequency distribution is shown in Figure 8-31.

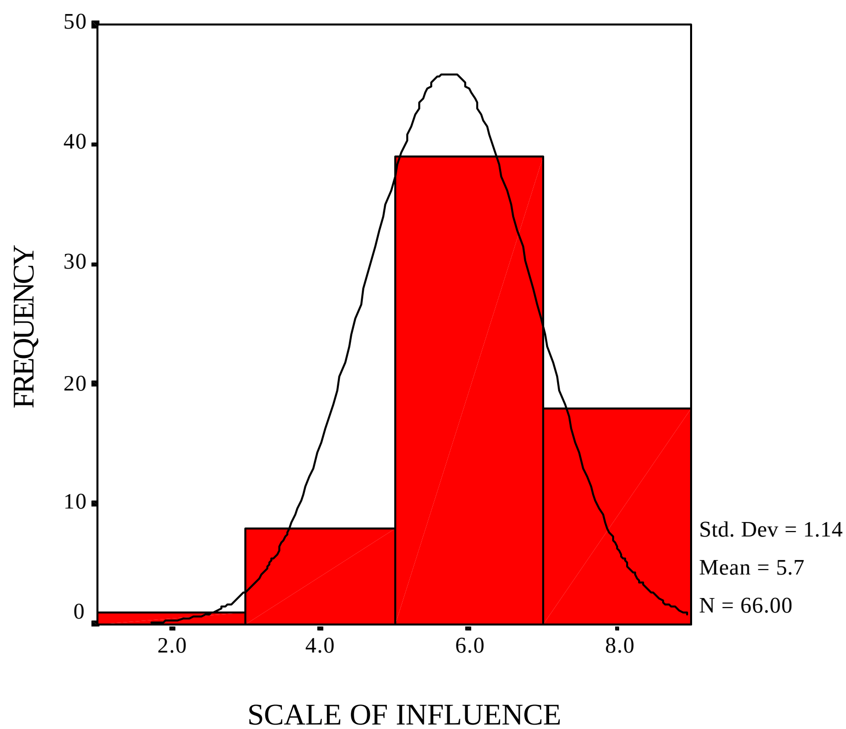

Figure 8-32 Frequency distribution of generating of quality improvements

– **Generating of quality improvements.** The sample mean (5.73), the median (6.00), and the mode (6.00) indicated that most of the respondents (86.4%) regarded the generating of quality improvements as being influential in driving change in their firms. Only 1 respondent (1.5%) regarded this issue as not being influential at all, while 18 respondents (27.3%) regarded it as being extremely influential in driving change. The histogram of the response frequency distribution is shown in Figure 8-32.
– **Exploitation of new market opportunities.** Most respondents (72.7%) regarded the exploitation of new market opportunities as being influential in driving change, while 9 respondents (13.6%) regarded it as not being influential. Further, while 2 respondents (3.0%) regarded the issue as not being influential at all, 14 respondents (21.2%) regarded it as extremely important. The sample mean was 5.29. The histogram of the response frequency distribution is shown in Figure 8-33.

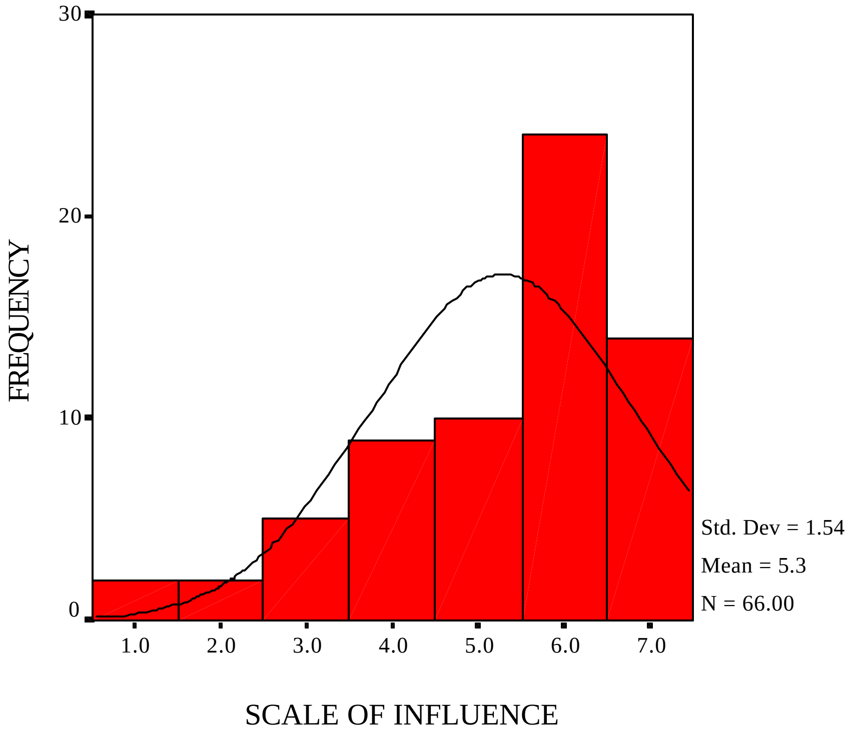

Figure 8-33 Frequency distribution of exploitation of new market opportunities

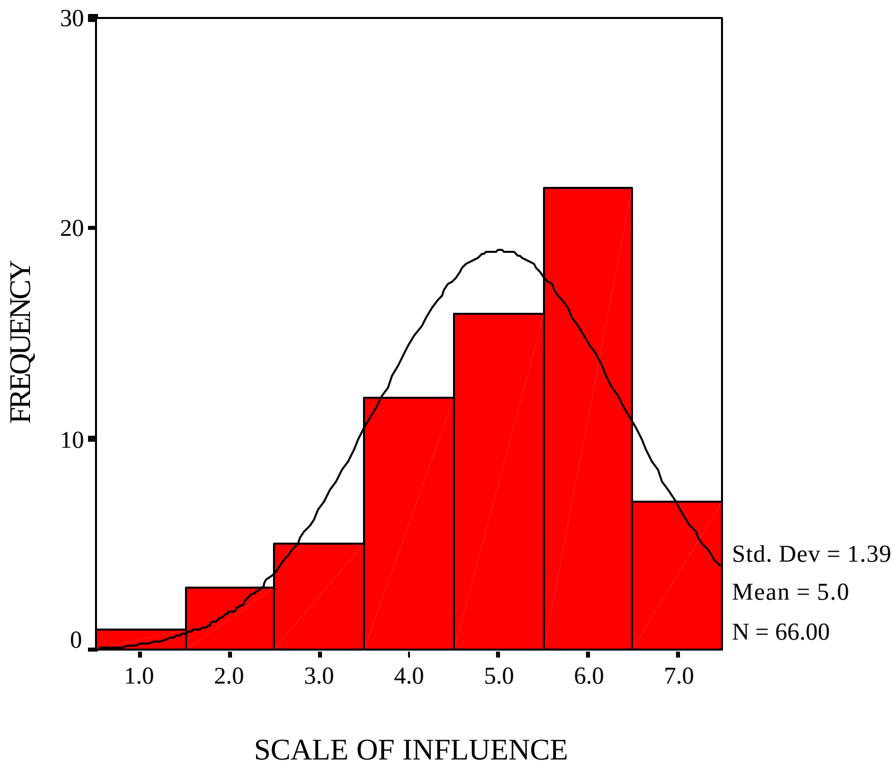

Figure 8-34 Frequency distribution of responding to management initiatives

– **Responding to management initiatives.** The sample mean (5.02), the median (5.00) and the mode (6.00) indicated that a large proportion of the respondents (68.2%) regarded response to management initiatives as being influential in driving change. Only 9 respondents (13.6%) regarded it as not being influential. Further, 1 respondent (1.5%) regarded the issue as not being influential at all, while 7 respondents (10.6%) regarded it as being extremely influential in driving change. The histogram of the response frequency distribution is shown in Figure 8-34.
– **Responding to third party claims.** The frequency distribution of the sample indicated that respondents were generally evenly divided between whether responding to third party claims was influential or not in driving change in their firms. The sample mean (4.12), the median (4.00) and the mode (4.00) indicated that a large number of respondents (28.8%) were undecided on the issue. While 5 respondents (7.6%) regarded the issue as not being influential at all, 7 respondents (10.6%) regarded it as extremely influential. The histogram of the response frequency distribution is shown in Figure 8-35.

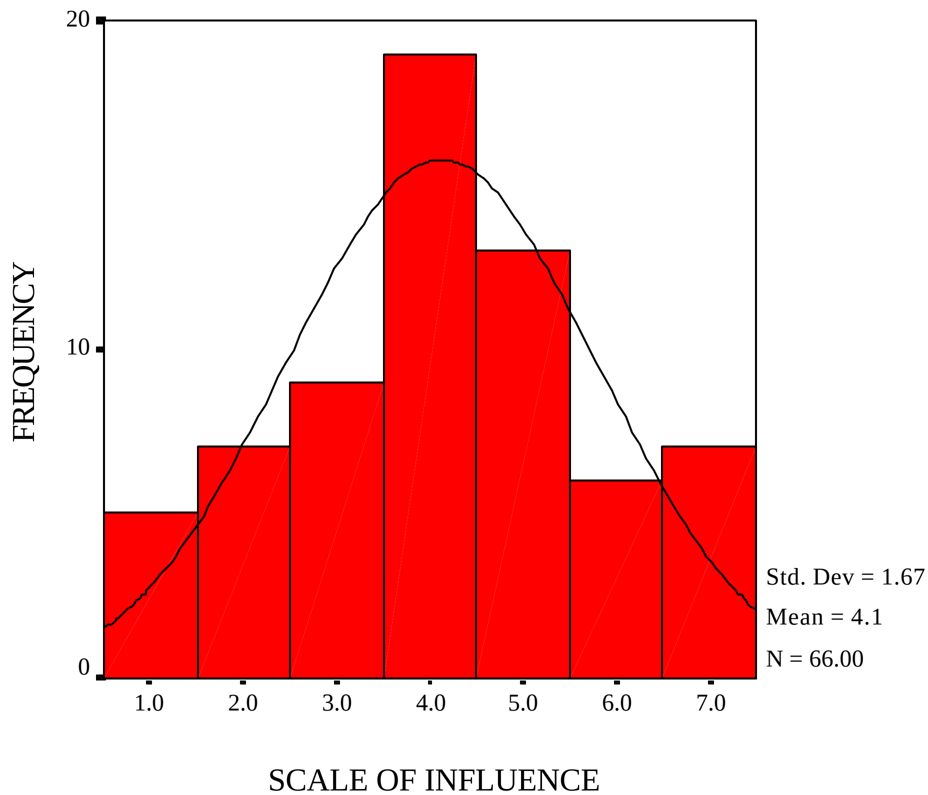

Figure 8-35 Frequency distribution of responding to third party claims

– **Complying with owner/client requirements.** The frequency distribution of responses of the sample indicated that complying with owner or client requirements was influential in driving change. The sample mean (5.58), the median (6.00) and the mode (6.00) were indicative of this influence. Only 3 respondents (4.5%) regarded this issue as not being influential, while 54 respondents (81.8%) regarded it as being influential. Further, 15 respondents (22.7%) regarded it as being extremely influential in driving change (7.0). The histogram of the response frequency distribution is shown in Figure 8-36. While the scales seem different due to the way SPSS selected to graphically represent the data, they represent 1 to 7 as before.

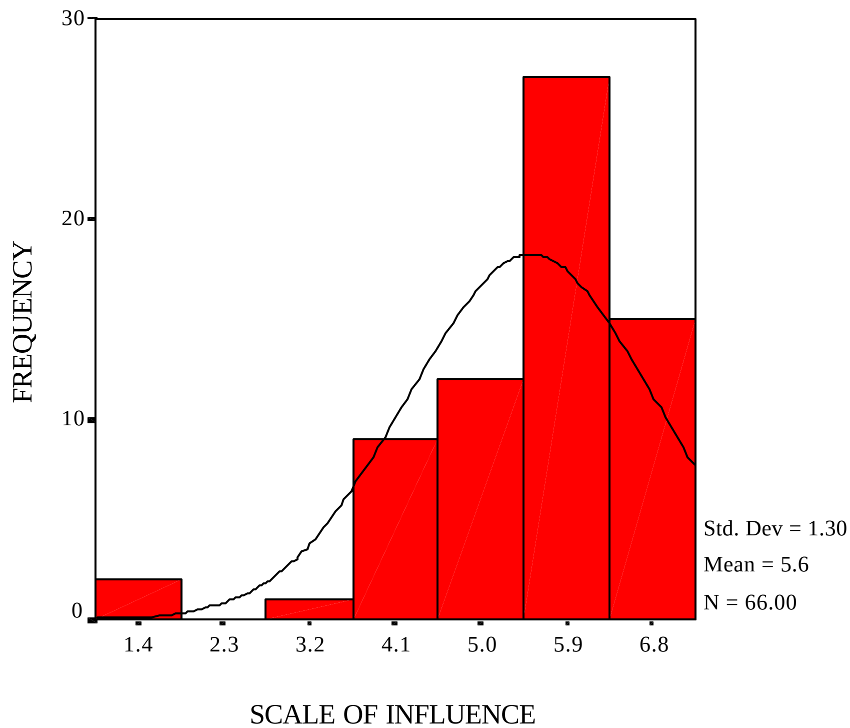

Figure 8-36 Frequency distribution of complying with owner/client requirements

– **Meeting new insurance requirements.** While 17 respondents (26.2%) were undecided about the influence of meeting new insurance requirements in driving change within their firms, most of the respondents (64.6%) regarded the issue as influential. Only 6 respondents (9.2%) regarded it as not being influential, while 12 respondents (18.5%) regarded it as extremely influential. The histogram of the response frequency distribution is shown in Figure 8-37.

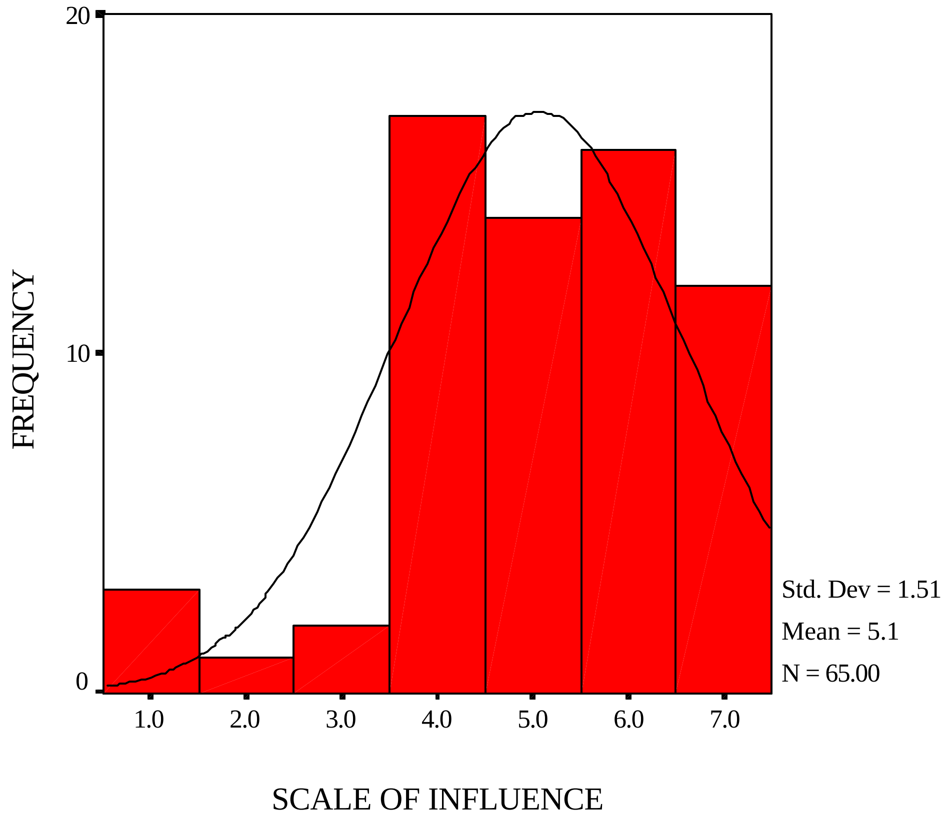

Figure 8-37 Frequency distribution of meeting new insurance requirements

Ranking of Responses Comparing Means

By comparing the means of the various frequency distributions, it was possible to rank the 13 issues regarding how influential they were regarded by the respondents in driving change within their organizations. This ranking in order of importance is reflected in Table 8-6. The improvement of financial performance of the organization ranked the highest, followed by the improvement of the safety record of the organization.

Staff turnover ranked the lowest in driving change in their organizations. Surprisingly, the occurrence of accidents ranked 12th.

Table 8-6 Influence of issues in driving change within organizations

Rank	Issue	N	Mean	Std. Deviation
1	The improvement of financial performance	64	6.0000	1.0838
2	The improvement of your safety record	65	5.7385	1.2659
3	The generating of quality improvements	65	5.7077	1.1419
4	Complying with owner/client requirements	65	5.5692	1.3106
5	The exploitation of new market opportunities	65	5.2615	1.5338
6	Keeping up with competitors	65	5.1538	1.6605
7	The introduction of new technology	65	5.0769	1.1498
8	Meeting new insurance requirements	64	5.0469	1.5164
9	Responding to management initiatives	65	5.0000	1.3919
10	Meeting worker demands	65	4.6000	1.4979
11	Responding to third party claims	65	4.1077	1.6782
12	The occurrence of accidents	65	3.8462	1.6605
13	Staff turnover	65	3.2000	1.5227

Group Preferring the Performance Approach

To determine whether the preference for the performance approach, instead of the prescriptive approach, would have any effect on the ranking, the group of respondents who preferred the performance approach was selected and the means compared based on this preference. The results of this comparison yielded slightly different results in Table 8-7. The financial performance of their firms was the primary change-driving issue for all groups. Similarly, meeting worker demands and responding to third party claims were issues that all respondents regarded as marginally influential in driving change. Further, the occurrence of accidents and staff turnover were issues that all respondents regarded as being of little importance in driving change in their firms. While those preferring the performance approach reported that exploitation of new market opportunities was the 5th most influential change-driving issue in their firms, those preferring the prescriptive approach regarded it as the 8th most influential issue. The introduction of technology was regarded as more influential in driving change (5th) by those preferring the prescriptive approach than those preferring the performance approach (9th).

Table 8-7 Influence of issues in driving change within organizations according to preference of approach

Sample Rank	Issue	Perform Rank	Mean	Std. Dev.	Prescript Rank	Mean	Std. Dev.
1	Financial performance	1	5.86	1.25	1	6.19	.79
3	Generating of quality improvements	2	5.81	1.08	3	5.57	1.23
2	Improvement of your safety record	3	5.78	1.23	2	5.68	1.33
4	Complying with owner/client requirements	4	5.59	1.34	4	5.57	1.29
5	Exploitation of new market opportunities	5	5.43	1.57	8	5.04	1.48
6	Keeping up with competitors	6	5.27	1.68	7	5.11	1.69
9	Responding to management initiatives	7	5.05	1.47	9	4.96	1.32
8	Meeting new insurance requirements	8	5.03	1.54	6	5.11	1.52
7	Introduction of new technology	9	5.00	1.18	5	5.21	1.13
10	Meeting worker demands	10	4.46	1.48	10	4.75	1.53
11	Responding to third party claims	11	4.03	1.74	11	4.18	1.59
12	Occurrence of accidents	12	3.89	1.70	12	3.71	1.63
13	Staff turnover in driving change	13	3.00	1.49	13	3.57	1.48
	Valid N (listwise)	37			28		

Generating quality improvements and improvement of safety records ranked 2nd and 3rd respectively for the group preferring the performance approach. Similarly, improvement of safety records and generating quality improvements ranked 2nd and 3rd respectively for the group preferring the prescriptive approach.

Top Management Structure Position

To determine whether the position within the top management structure of firms had any effect on the ranking, the means were compared. The results of this comparison yielded slightly different results for each major management position category as shown in Table 8-8.

Table 8-8 Influence of issues according to top management position

	Sample	CEO/President/ Vice-president/MD/ General Manager	Project/ Contracts Manager	Safety Director/ Manager
Issue	Rank	Rank	Rank	Rank
Improvement of financial performance	1	2	1	1
Improvement of your safety record	2	3	2	2
Generating of quality improvements	3	1	4	4
Complying with owner/client requirements	4	5	3	3
Exploitation of new market opportunities	5	4	9	9
Keeping up with competitors	6	8	5	5
Introduction of new technology	7	6	8	8
Meeting new insurance requirements	8	7	7	7
Responding to management initiatives	9	9	6	6
Meeting worker demands	10	10	10	10
Responding to third party claims	11	11	11	11
Occurrence of accidents	12	12	12	12
Staff turnover	13	13	13	13

CEOs, Presidents, Vice-presidents and general managers ranked the generation of quality improvements as most influential in driving change within their organizations. Further, they regarded the improvement of the financial performance of their firms, improvement of the firm's safety record, and the exploitation of new market opportunities as the 2nd, 3rd, and 4th most influential.

On the other hand, project managers, contracts managers, safety directors and safety managers ranked the improvement of financial performance as the most influential in driving change in their organizations. Additionally, they regarded the improvement of their firms' safety record, complying with owner/client requirements, generating quality improvements, and keeping up with competitors as the 2nd, 3rd, 4th and 5th most influential change drivers. They did not regard the exploitation of new market opportunities (9th) as being as influential as did the CEO group (4th). This is not entirely surprising since marketing issues would be expected to feature fairly highly on the agenda of CEOs. Meeting the demands of workers, responding to third party claims, the occurrence of accidents, and staff turnover were consistently regarded by all the groups as not being the major drivers of change in their organizations. The rankings were 10th, 11th, 12th and 13th respectively.

Management Preferring the Performance Approach

The results are represented in Table 8-9 of examining whether the top management position within the group preferring the performance approach influenced the ranking order. The resultant rankings were somewhat different from those in Table 8-8 for all management groupings. The rankings in this latter table are shown in parentheses for ease of comparison.

CEOs, Presidents, Vice-presidents and general managers ranked the improvement of the firm's safety record as most influential in driving change within their organizations. Further, they regarded the improvement of the financial performance of their firms, complying with owner/client requirements, and generating quality improvements, as the 2nd, 3rd, and 4th most influential.

Table 8-9 Influence according to top management preferring performance approach

	Sample	CEO/President/ Vice-president/MD/ General Manager[43]	Project/ Contracts Manager[44]	Safety Director/ Manager[45]
Issue	Rank	Rank	Rank	Rank
Improvement of financial performance	1	2 (2)	1 (1)	2 (1)
Improvement of your safety record	2	1 (3)	7 (2)	1 (2)
Generating of quality improvements	3	4 (1)	2 (4)	4 (4)
Complying with owner/client requirements	4	3 (5)	4 (3)	3 (3)
Exploitation of new market opportunities	5	8 (4)	5 (9)	8 (9)
Keeping up with competitors	6	6 (8)	3 (5)	6 (5)
Introduction of new technology	7	9 (6)	6 (8)	9 (8)
Meeting new insurance requirements	8	7 (7)	10 (7)	7 (7)
Responding to management initiatives	9	5 (9)	8 (6)	5 (6)
Meeting worker demands	10	10 (10)	9 (10)	10 (10)
Responding to third party claims	11	11 (11)	11 (11)	11 (11)
Occurrence of accidents	12	12 (12)	12 (12)	12 (12)
Staff turnover	13	13 (13)	13 (12)	13 (12)

[43] N=14

[44] N=6

[45] N=14

The exploitation of new market opportunities and introduction of new technology dropped in the ranking from 4th to 8th and 6th to 9th respectively. Keeping up with competitors rose in the rankings from 8th to 6th and responding to management initiatives from 9th to 5th. It would seem that issues that surround safety performance and expectations were regarded as more influential. Project and contracts managers were more concerned about the competitive environment and ranked those issues highly. For instance, keeping up with competitors, exploiting new market opportunities and introducing new technology rose in the rankings. The improvement of the firm's safety record dropped in rank from 2nd to 7th. This is a surprising result. Meeting new insurance requirements, complying with owner/client requirements, and responding to management initiatives dropped from their previous rankings.

Safety directors and managers predictably regarded the improvement of the firm's safety record as the most influential change driver. There was very little change from the previous rankings for this group. The last 3 rankings for all groups remained unchanged.

Management Preferring the Prescriptive Approach Compared

The results are represented in Table 8-10 of examining whether the top management position within the group preferring the prescriptive approach influenced the ranking order. The resultant rankings were somewhat different from those in Table 8-9 for all management groupings. The rankings for those preferring the performance approach are shown in parentheses for ease of comparison.

In contrast to the CEOs group that preferred the performance approach, those preferring the prescriptive approach regarded the influence of several change-driving issues differently. For example, they regarded generating quality improvements as being the most influential issue. The performance group stated this issue as being the 4^{th} most influential.

Table 8-10 Influence according to top management preferring prescriptive approach

	Sample	CEO/President/ Vice-president/MD/ General Manager[46]	Project/ Contracts Manager[47]	Safety Director/ Manager[48]
Issue	Rank	Rank	Rank	Rank
Improvement of financial performance	1	2 (2)	1 (1)	1 (2)
Improvement of your safety record	2	3 (1)	6 (7)	3 (1)
Generating of quality improvements	3	1 (4)	5 (2)	4 (4)
Complying with owner/client requirements	4	5 (3)	2 (4)	2 (3)
Exploitation of new market opportunities	5	9 (8)	3 (5)	9 (8)
Keeping up with competitors	6	7 (6)	7 (3)	6 (6)
Introduction of new technology	7	4 (9)	9 (6)	5 (9)
Meeting new insurance requirements	8	6 (7)	4 (10)	8 (7)
Responding to management initiatives	9	8 (5)	8 (8)	7 (5)
Meeting worker demands	10	10 (10)	11 (9)	10 (10)
Responding to third party claims	11	11 (11)	10 (11)	11 (11)
Occurrence of accidents	12	12 (12)	12 (12)	13 (12)
Staff turnover	13	13 (13)	13 (13)	12 (13)

While the CEOs who preferred the performance approach regarded the introduction of new technology as being 9^{th} most influential, the prescriptive group regarded it as 4^{th} most important. Complying with owner/client requirements and

[46] N=10

[47] N=4

[48] N=14

responding to management initiatives were regarded by the CEOs group who preferred the prescriptive approach as being less influential (5th and 8th respectively) than their counterparts who preferred the performance approach (3rd and 5th respectively).

The Project Managers group who preferred the prescriptive approach regarded complying with owner/client requirements, exploitation of new market opportunities, meeting new insurance requirements, and generating of quality improvements as being 2nd, 3rd, 4th, and 5th most influential change-driving issues. Their counterparts who preferred the performance approach regarded these same issues as being 4th, 5th, 10th, and 2nd most influential.

Safety directors who preferred the prescriptive approach regarded the improvement of the safety record of their firms, introduction of new technology, and responding to management initiatives as being 3rd, 5th, and 7th respectively most influential issues driving change within their firms. Their counterparts who preferred the performance approach viewed the influence of these issues differently, namely, most influential, 9th, and 5th influential respectively.

15. **Have you observed the introduction of any major changes in your firm?** In response to this question, most of the respondents (89.1%) had observed the introduction of major changes within their organizations. Only 7 respondents (10.9%) had not observed any such changes. With response of 'yes' being given a value of 1.0 and 'no' being given a value of 2.0, the sample mean was 1.11. The response frequency distribution is shown in Figure 8-38.
16. **How important would be the willingness of workers to accept the change before the change is implemented?[49]** Most of the respondents (66.7%) regarded the willingness of workers to accept the change before it was implemented as an important issue. Only 14 respondents (21.2%) regarded it as not important, while 18

[49] The scale used to indicate the level of importance is a 7-point Likert scale with 1 representing not important at all, 4 representing a neutral attitude, and 7 representing very or extremely important. This form of scale of measurement is used in all histograms

respondents (27.3%) regarded it as very important. The sample mean was 5.11. The response frequency distribution is shown in the histogram in Figure 8-39.

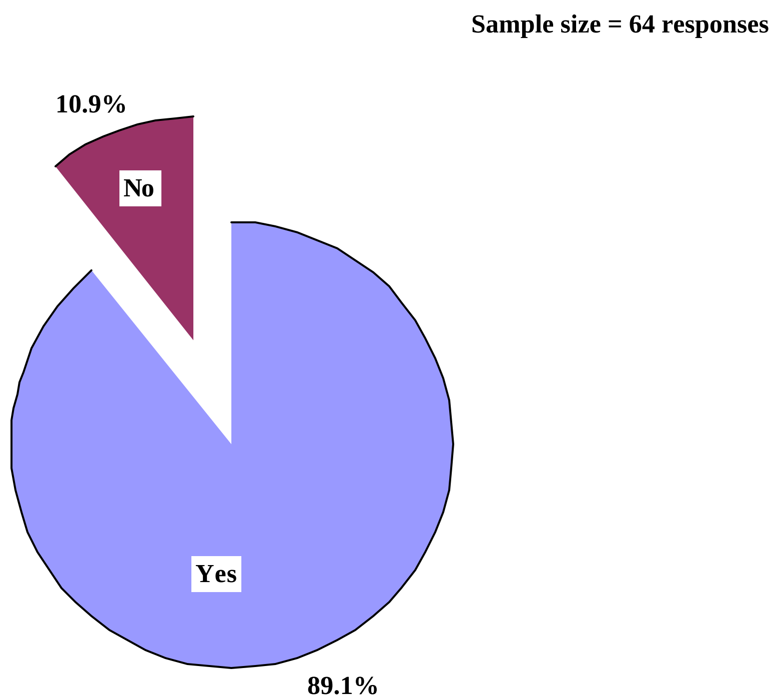

Figure 8-38 Frequency distribution of observation of major changes

17. **How important would it be to break down the resistance of workers to change by convincing them to accept the change?** Similarly, most of the respondents (84.8%) regarded breaking down the resistance of workers to change by convincing them to accept it as an important issue. While 17 respondents (25.8%) regarded this issue as very important, only 1 respondent (1.5%) regarded it as not important. The response frequency distribution is shown in the histogram in Figure 8-40.
18. **How important would it be to build credibility and trust with the workers before implementing a change?** Most of the respondents (93.9%) regarded as an important issue the building of credibility and trust with workers before implementing a change. Only 3 respondents (4.5%) were undecided about its importance, while 29 respondents (43.9%) regarded it as very important. The response frequency distribution is shown in the histogram in Figure 8-41.

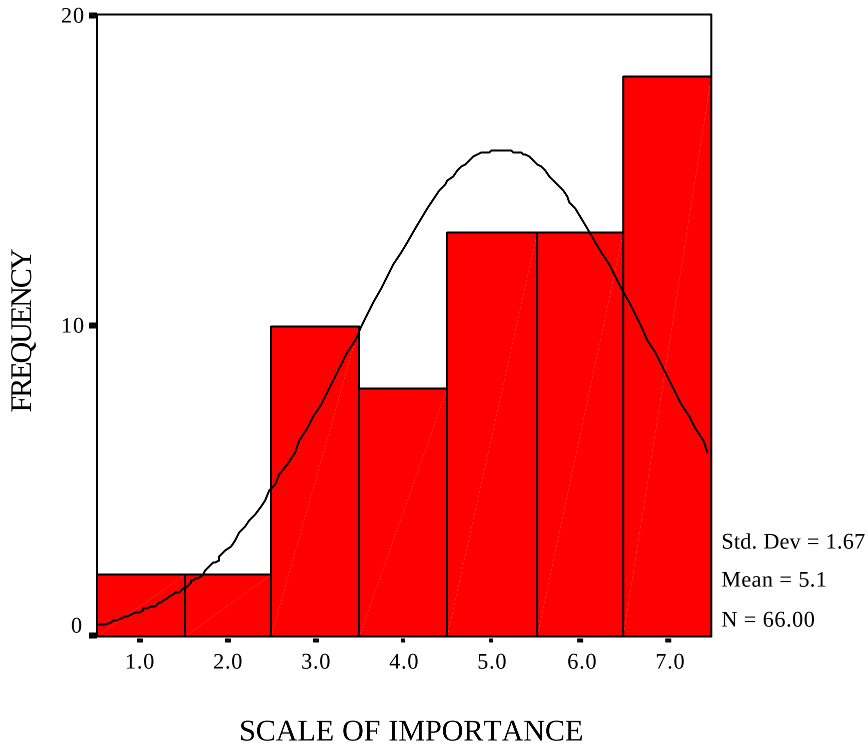

Figure 8-39 Distribution of importance of willingness of workers to accept change

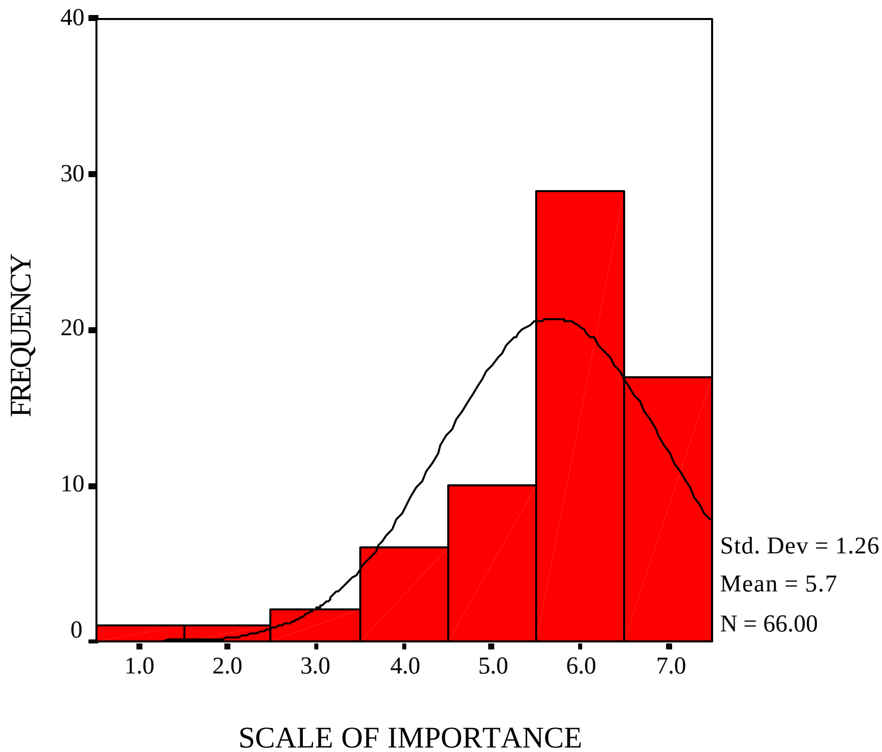

Figure 8-40 Importance of breaking down the resistance of workers to change

19. **How important would it be to enlist the opinions of workers on a proposed change before it is implemented?** The sample mean (5.74), median (6.00) and mode (6.00) indicated that most of the respondents (84.8%) regarded the opinions of workers on a proposed change as being important. In fact, 20 respondents (30.3%) regarded the issue as very important (7.0 on the scale) and 22 respondents (33.3%) as only slightly less important (6.0 on the scale). No respondents regarded the opinions of workers as being not important at all. Only 7 respondents (10.6%) were undecided about the importance of this issue. The response frequency distribution is shown in the histogram in Figure 8-42.
20. **How important do you regard the receptiveness of first-line supervisors (foremen) to change**? No respondents regarded the receptiveness of foremen or first-line supervisors to change as not being important. While 35 respondents (53.8%) regarded the issue as very important (7.0 on the scale), 14 respondents (21.5%) regarded it as only slightly less important (6.0 on the scale). Only 6 respondents (9.2%) were undecided about the importance of the receptiveness to change of foremen. The response frequency distribution is shown in Table 8-28 and the histogram of the distribution in Figure 8-43.

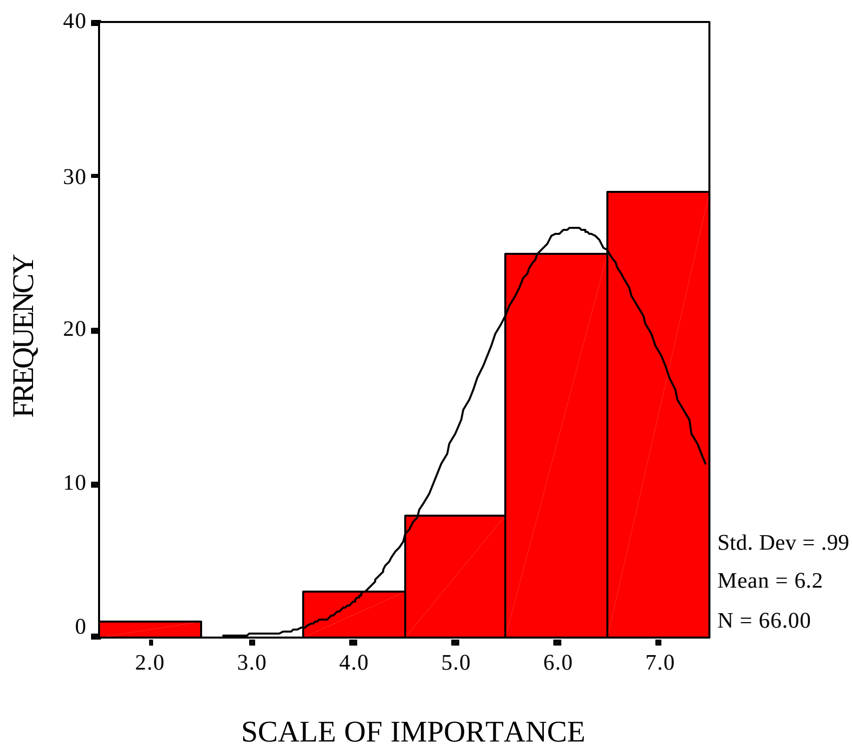

Figure 8-41 Importance of building credibility and trust with workers

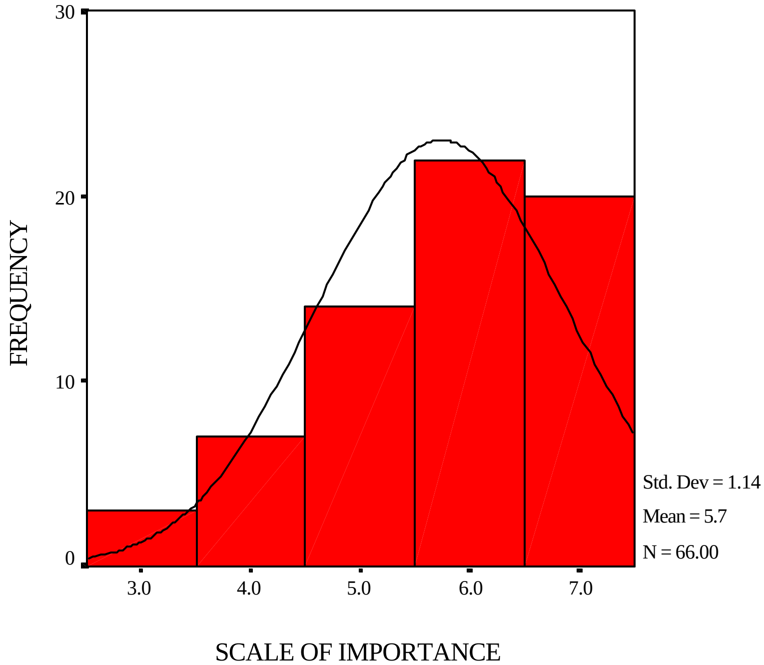

Figure 8-42 Importance of enlisting the opinions of workers

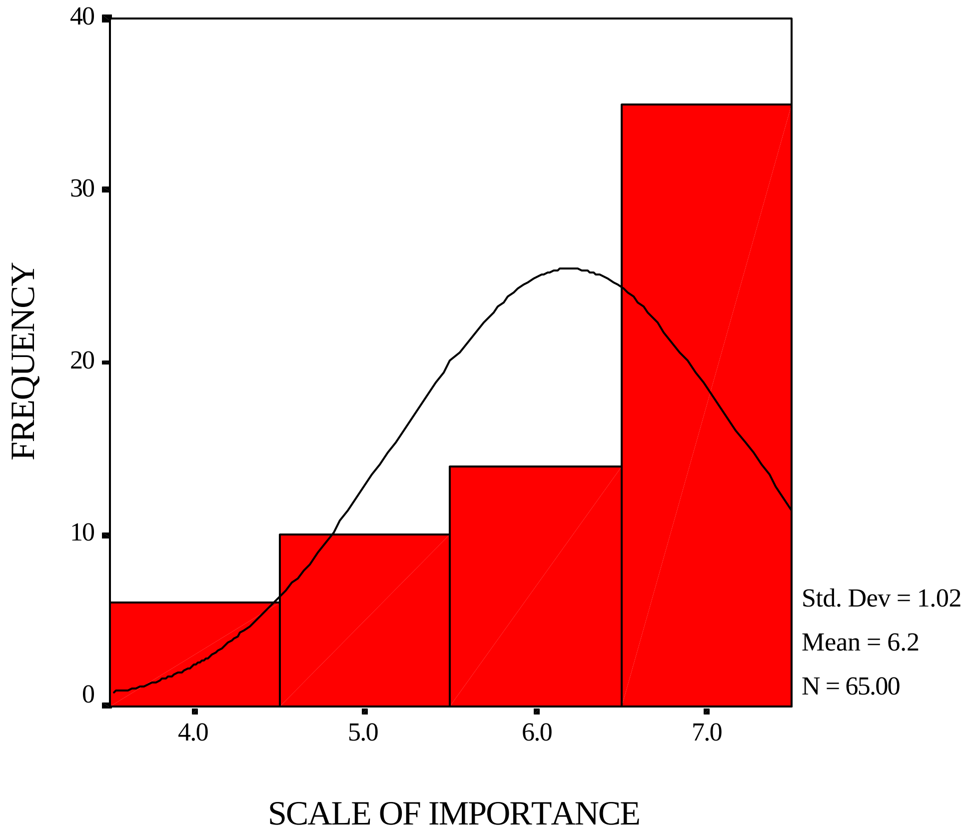

Figure 8-43 Importance of the receptiveness of foremen

21. How important do you regard the following factors to be for the implementation of new approaches? The respondents were asked to rate on a 7-point Likert scale of importance[50] how important they regarded each of 10 factors to be for the implementation of new approaches within their organizations.

– **Top management support.** The sample mean (6.55), the median (7.00) and the mode (7.00) indicated that a large proportion of the respondents (96.9%) regarded the support of top management as important for the implementation of new approaches within their firms. Further, 44 respondents (68.8%) regarded this support as very important. The histogram of the response frequency distribution is shown in Figure 8-44.

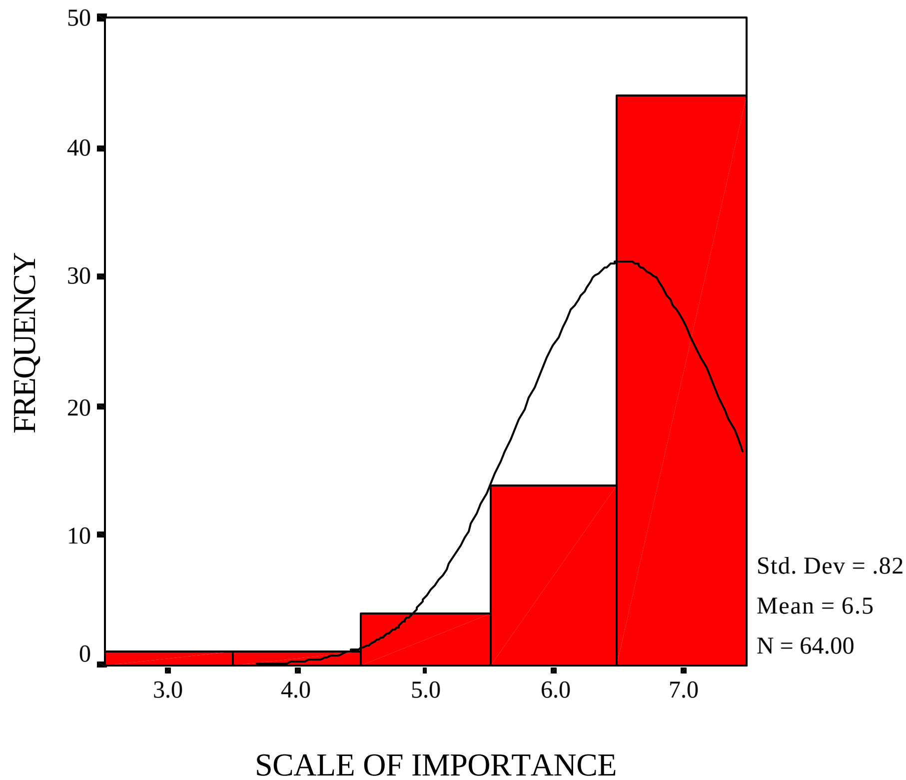

Figure 8-44 Importance of top management support

– **Mutual trust between workers and management**. Similarly, the sample mean (6.12), the median (6.00) and the mode (7.00) indicated that a large proportion of the respondents (92.4%) regarded mutual trust between workers and management as important for the implementation of new approaches within their firms. Further, 31 respondents (47.0%) regarded this support as very important. The histogram of the response frequency distribution is shown in Figure 8-45.

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[50] The scale used to indicate the level of importance is a 7-point Likert scale with 1 representing not important at all, 4 representing a neutral attitude, and 7 representing very or extremely important. This form of scale of measurement is used in all histograms

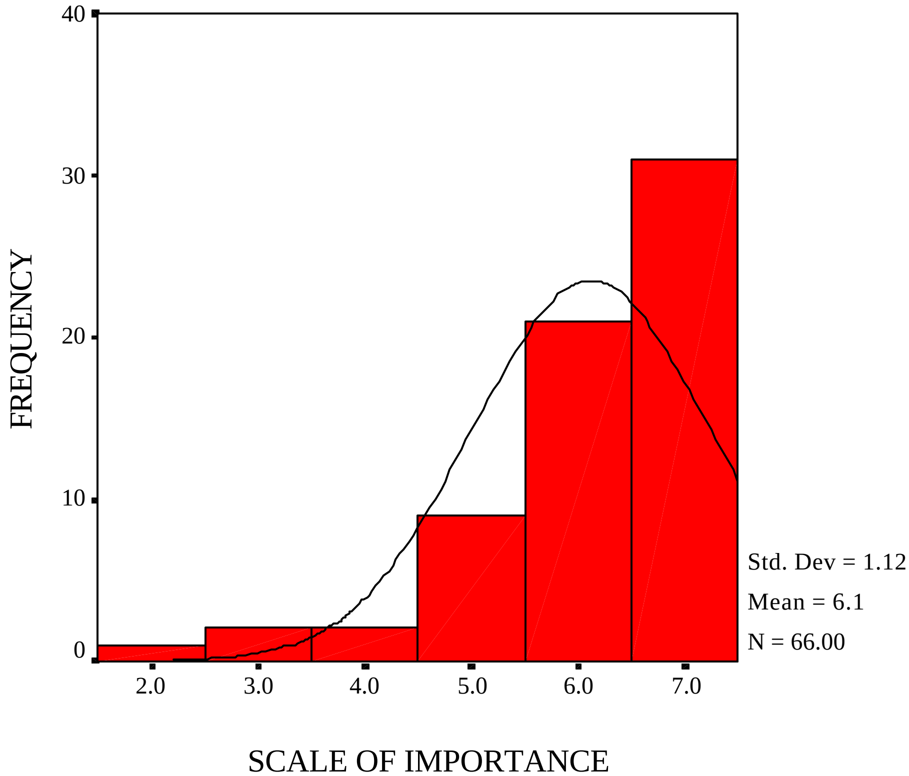

Figure 8-45 Importance of mutual trust between workers and management

- **Incentives and rewards for supporting the change.** The responses from a large proportion of the respondents (31.8%) tended to be distributed around the central value of the 7-point scale. This trend indicated that these respondents had no strong opinions about the importance of incentives and rewards for supporting change. However, 29 respondents (43.9%) regarded the issue as important, with 9 respondents (13.6%) regarding it as very important for the implementation of new approaches. On the other hand, 16 respondents (24.2%) regarded the issue as being not important, with 3 respondents (4.5%) regarding it as being not important at all. The histogram of the response frequency distribution is shown in Figure 8-46.
- **Continuous improvement of safety performance.** Most of the respondents (87.9%) regarded the continuous improvement of safety performance as important for the implementation of new approaches. Further, 25 respondents (37.9%) regarded the issue as very important with a further 21 respondents (31.8%) regarding it as only slightly less important. The histogram of the response frequency distribution is shown in Figure 8-47.
- **Open communication.** No respondents regarded open communication as not being important. While 42 respondents (63.6%) regarded the issue as very important, 15 respondents (22.7%) regarded it as only slightly less important. Only 2 respondents (3.1%) were undecided about the importance of open communication for the implementation of new approaches. The histogram of the response frequency distribution is shown in Figure 8-48.

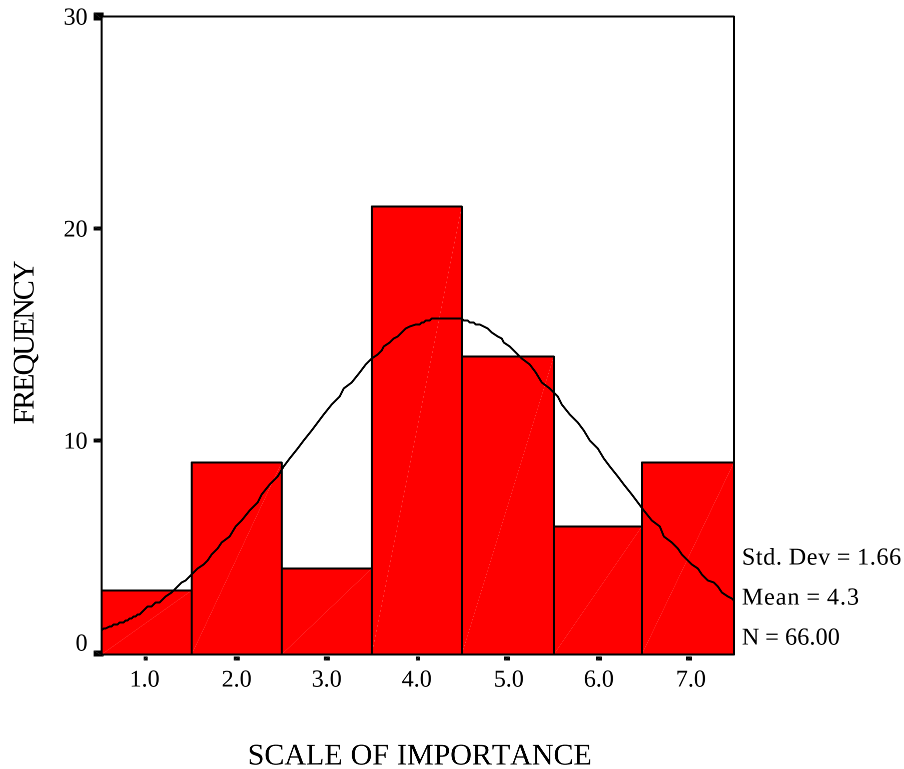

Figure 8-46 Importance of incentives and rewards for supporting change

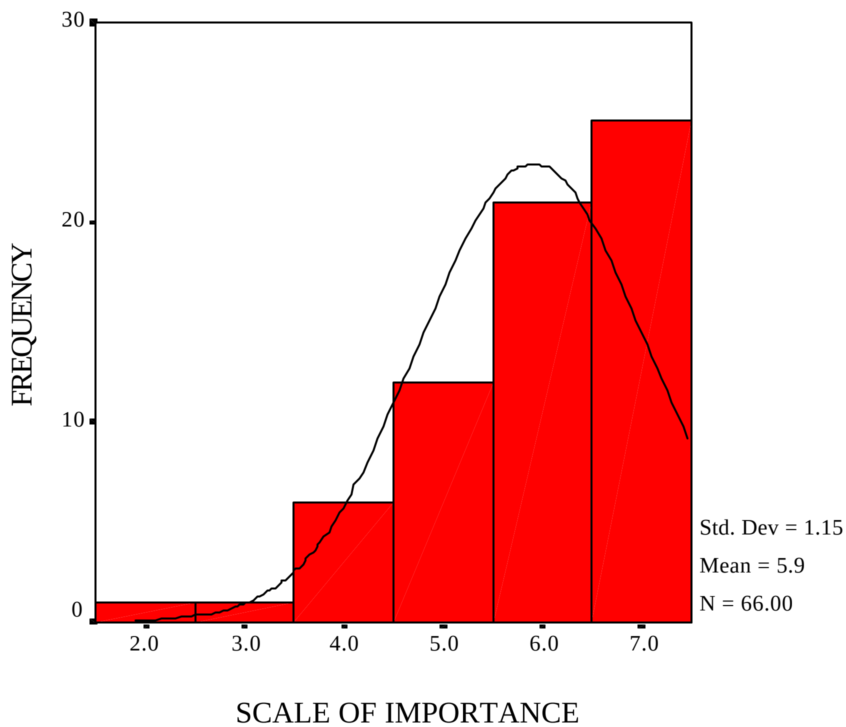

Figure 8-47 Importance of continuous improvement of safety performance

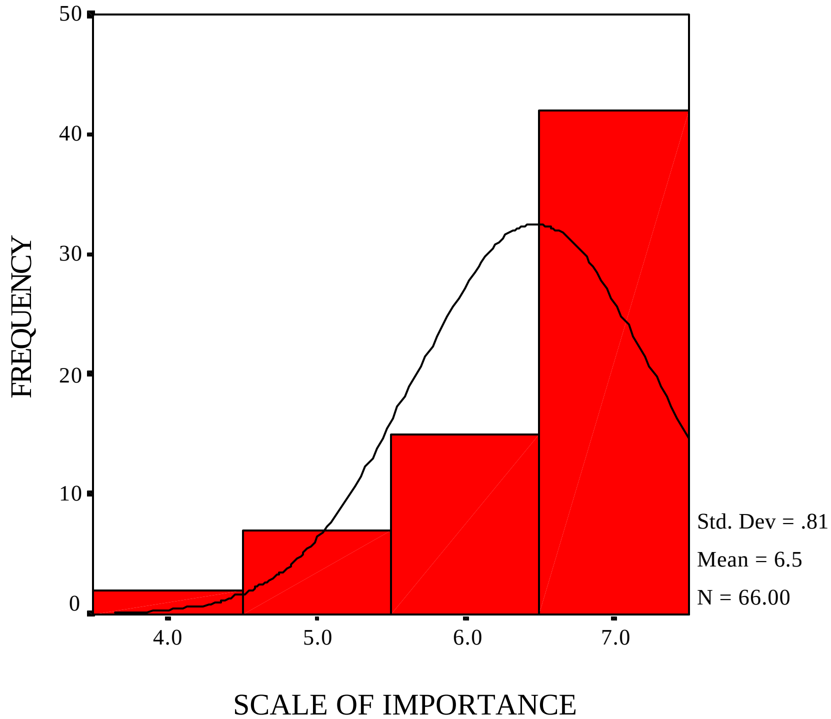

Figure 8-48 Importance of open communication

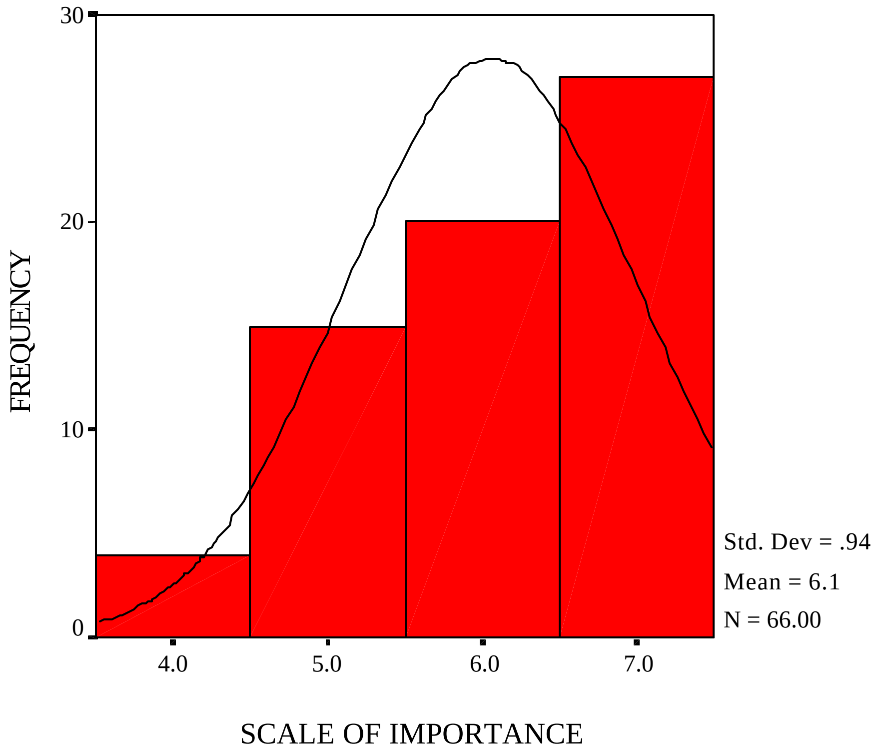

Figure 8-49 Importance of effective coordination

– **Effective coordination.** Similarly, no respondents regarded effective coordination as not being important. While 27 respondents (40.9%) regarded the issue as very important, 20 respondents (30.3%) regarded it as only slightly less important. Only 4 respondents (6.1%) were undecided about the importance of effective coordination for the implementation of new approaches. The histogram of the response frequency distribution is shown in Figure 8-49.

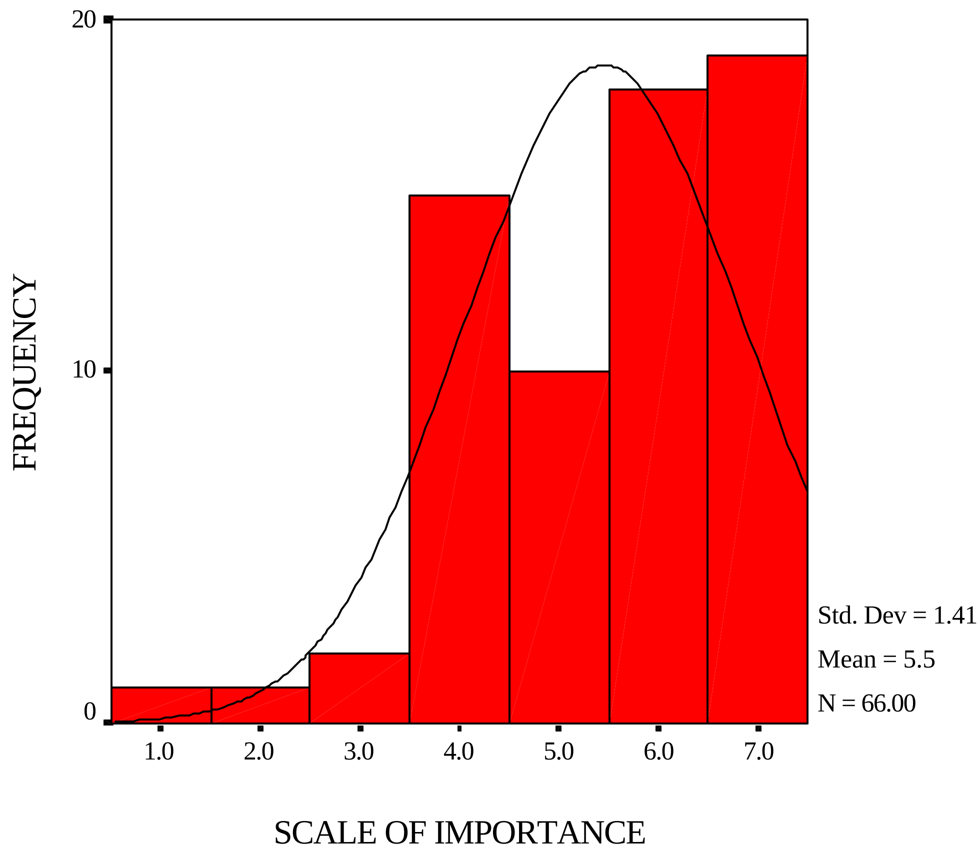

Figure 8-50 Importance of joint labor/management problem solving

– **Joint labor/management problem solving.** Several respondents (23.1%) were undecided about the importance of joint labor/management problem solving to the implementation of new approaches within their firms. While only 1 respondent (1.5%) regarded this issue as not important at all, 19 respondents (29.2%) regarded it as very important. Further, 18 respondents (27.7%) regarded joint problem solving as only slightly less important. The histogram of the response frequency distribution is shown in Figure 8-50.

- **Adequate resources.** While 8 respondents (12.1%) were undecided about the importance of adequate resources for the implementation of new approaches, 25 respondents (37.9%) regarded it as being very important. Further, 19 respondents (28.8%) regarded the provision of adequate resources as being only slightly less important. The histogram of the response frequency distribution is shown in Figure 8-51.
- **Creativity.** Similarly, while 11 respondents (16.7%) were undecided about the importance of creativity for the implementation of new approaches, 19 respondents (28.8%) regarded it as being very important. Further, 16 respondents (24.2%) regarded creativity as being only slightly less important. The histogram of the response frequency distribution is shown in Figure 8-52.
- **Workshops and training.** The sample mode (7.00) was positioned at the extremity of the frequency distribution. This observation indicated that these 22 respondents (33.3%) regarded workshops and training as being very important for the implementation of new approaches within their organizations. The histogram of the response frequency distribution is shown in Figure 8-53.

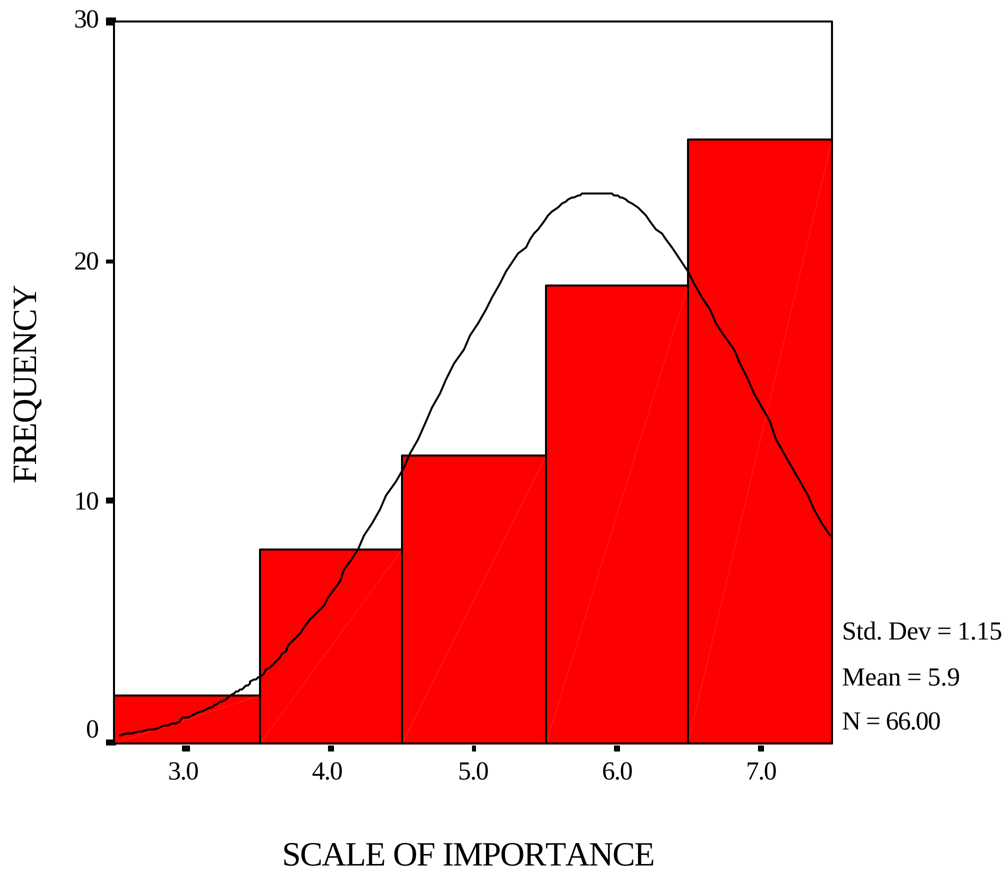

Figure 8-51 Importance of adequate resources

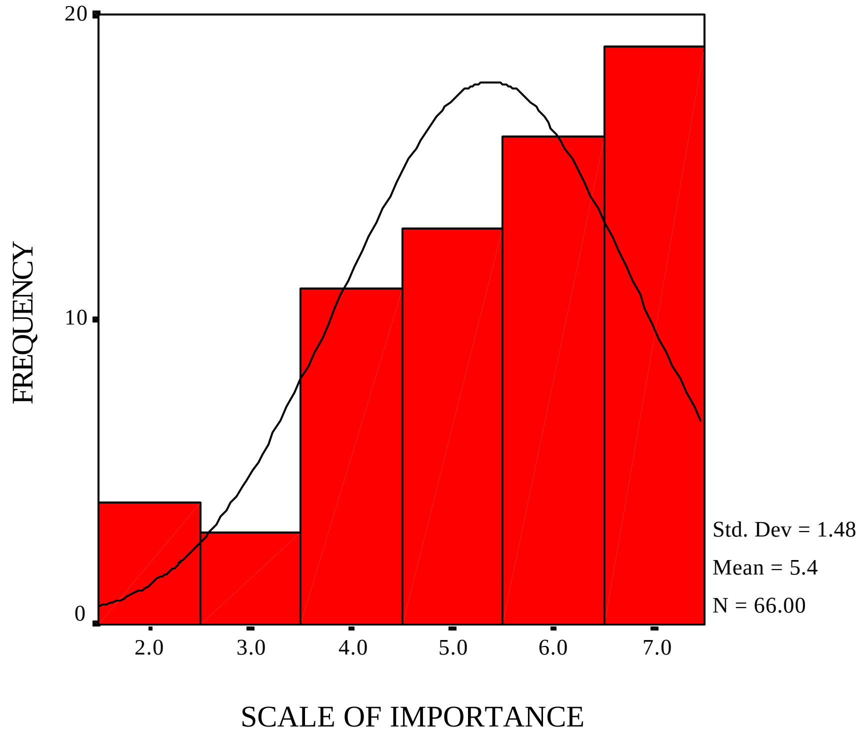

Figure 8-52 Importance of creativity

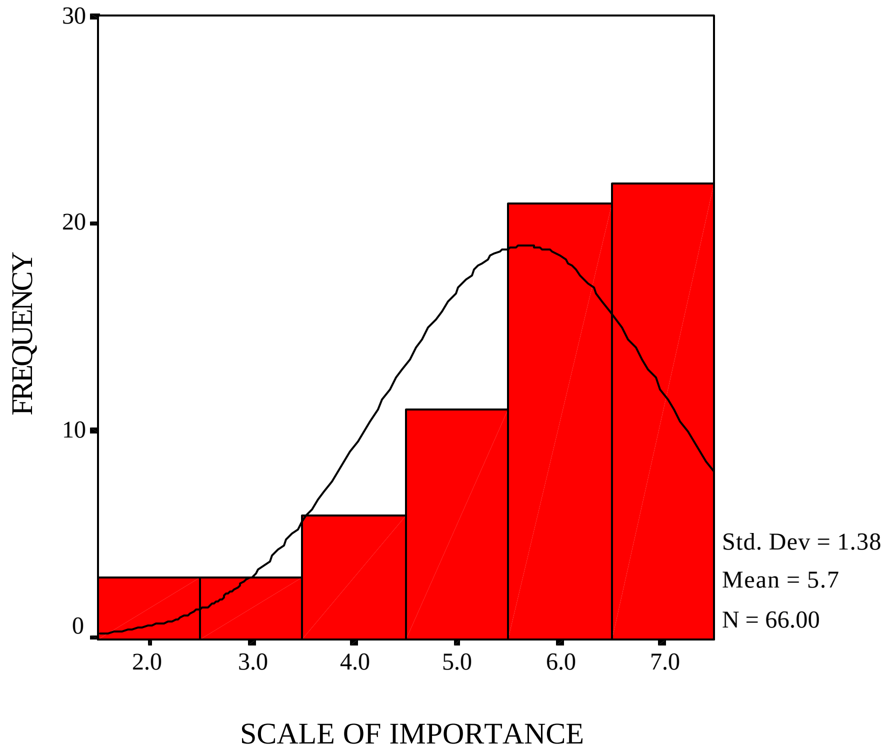

Figure 8-53 Importance of workshops and training

Ranking Means of Responses

By comparing the means of the various frequency distributions, it was possible to rank the 10 issues regarding how important they were regarded by the respondents for the implementation of new approaches within their organizations. This ranking in order of importance is shown in Table 8-11. The support of top management within the firm ranked the highest, open communication ranked 2nd, and mutual trust between management and workers ranked 3rd.

Table 8-11 Importance of issues for the implementation of new approaches

Rank	Issue	N	Mean	Std. Deviation
1	Top management support	63	6.5397	.8196
2	Open communication	65	6.4615	.8116
3	Mutual trust between workers and management	65	6.1231	1.1251
4	Effective coordination of construction activities	65	6.0615	.9499
5	Continuous improvement of safety performance	65	5.8923	1.1473
6	Adequate resources	65	5.8462	1.1488
7	Workshops and training	65	5.6462	1.3855
8	Joint labor/management problem solving	65	5.4615	1.4151
9	Creativity	65	5.3692	1.4850
10	Incentives and rewards for supporting the change	65	4.3077	1.6576

Incentives and rewards for supporting the change ranked the lowest in importance for the implementation of new approaches within their organizations, namely, 10th. Joint labor/management problem solving ranked 8th and creativity ranked 9th, respectively. Continuous improvement of safety performance ranked 5th.

Means of Group Preference of Approach

To determine whether the preference for either the prescriptive or the performance approach would have any effect on the ranking, the means were compared. The results of this comparison yielded only slightly different rankings in Table 8-12.

These results suggest that preference for either the performance or the prescriptive approach did not severely effect the importance with which the issues were regarded regarding the implementation of a new approach within construction firms.

Table 8-12 Importance of issues for new approaches by approach preference

Sample Rank	Issue	Perform Rank[51]	Mean	Std. Dev.	Prescript Rank[52]	Mean	Std. Dev.
1	Top management support	1	6.57	.90	1	6.52	.70
2	Open communication	2	6.53	.69	2	6.39	.96
3	Mutual trust between workers and management	3	6.18	.98	4	6.04	1.29
4	Effective coordination of construction activities	4	6.08	.91	3	6.04	1.00
6	Adequate resources	5	5.97	1.08	6	5.71	1.24
5	Continuous improvement of safety performance	6	5.87	1.19	5	5.96	1.10
7	Workshops and training	7	5.68	1.30	7	5.64	1.52
8	Creativity	8	5.47	1.41	9	5.25	1.58
9	Joint labor/management problem solving	9	5.42	1.24	8	5.50	1.62
10	Incentives and rewards for supporting the change	10	4.13	1.53	10	4.61	1.81

[51] N=38

[52] N=28

Top Management Position

To determine whether the position of the respondents within the management structure of their firms would have any effect on the ranking, the means were compared. The results of this comparison yielded different rankings for each major category of management position as evidenced in Table 8-13.

While the CEO group ranked the importance of the 10 issues in the same order as the sample, the other groups ranked the issues in different orders. As an important issue with regard to implementing new approaches, incentives and rewards for supporting change ranked lowest (10^{th}) consistently across all groups. Of particular interest was the mid-table ranking (5^{th} or 6^{th}) of continuous improvement of safety performance as an important issue

While the other groups ranked top management support as being most important to implement new approaches, project and contracts managers regarded open communication as the most important issue. They ranked adequate resources and joint labor/management problem solving as being the next most important issues, namely, 2^{nd} and 3^{rd} respectively. They ranked top management support as being 5^{th} important while ranking mutual trust between workers and management only 7^{th}. This suggests that issues involving management did not rank as highly as others.

Safety directors and managers ranked effective coordination of construction activities and workshops and training as being 3^{rd} and 4^{th} important respectively. The ranking of top management support and open communication as being the most and next important was predictable since these are generally regarded as being essential for the success of any safety initiative.

Respondents Preferring the Performance Approach

To determine whether the management positions of respondents preferring the performance approach had any effect on the ranking of the importance of issues, the means were compared. The results of this comparison yielded slightly different rankings for each major category of management position as evidenced in Table 8-14. The rankings from Table 8-13 are shown in parentheses.

While the whole CEO group previously ranked the importance of the 10 issues in the same order as the sample, those preferring the performance approach ranked them differently. For example, open communication was regarded as the most important issue. Workshops and training were regarded as much more important moving from 8th to 4th rank.

Table 8-13 Importance of new approaches based on top management position

	Sample	CEO/President/ Vice-president/ MD/ General Manager	Project/ Contracts Manager	Safety Director/ Manager
Issue	Rank	Rank	Rank	Rank
Top management support	1	1	5	1
Open communication	2	2	1	2
Mutual trust between workers and management	3	3	7	5
Effective coordination of construction activities	4	4	4	3
Continuous improvement of safety performance	5	5	6	6
Adequate resources	6	6	2	7
Workshops and training	7	8	9	4
Joint labor/management problem solving	8	7	3	9
Creativity	9	9	8	8
Incentives and rewards for supporting the change	10	10	10	10

Project and contracts managers favoring the performance approach regarded open communication as the most important issue. They ranked adequate resources and effective coordination of construction activities as being the next most important issues, namely, 2nd and 3rd, respectively. They ranked top management support as being 4th important while ranking mutual trust between workers and management only 6th. This suggests that issues involving management did not rank as highly as others.

Table 8-14 Importance of new approaches to management preferring the performance approach

	Sample	CEO/President/ Vice-president/ MD/ General Manager[53]	Project/ Contracts Manager[54]	Safety Director/ Manager[55]
Issue	Rank	Rank	Rank	Rank
Top management support	1	2 (1)	4 (5)	2 (1)
Open communication	2	1 (2)	1 (1)	1 (2)
Mutual trust between workers and management	3	3 (3)	6 (7)	3 (5)
Effective coordination of construction activities	4	5 (4)	3 (4)	5 (3)
Continuous improvement of safety performance	5	7 (5)	8 (6)	7 (6)
Adequate resources	6	6 (6)	2 (2)	6 (7)
Workshops and training	7	4 (8)	9 (9)	4 (4)
Joint labor/management problem solving	8	9 (7)	5 (3)	9 (9)
Creativity	9	8 (9)	7 (8)	8 (8)
Incentives and rewards for supporting the change	10	10 (10)	10 (10)	10 (10)

[53] N=14

[54] N=6

[55] N=14

Safety directors and managers that favored the performance approach ranked open communication as most important. They ranked top management support, mutual trust between workers and management, and workshops and training as being 2nd, 3rd and 4th important respectively. All groupings regarded the continuous improvement of safety performance as less important than before.

Respondents Preferring the Prescriptive Approach

To determine whether the management positions of respondents preferring the prescriptive approach had any effect on the ranking of the importance of issues, the means were compared. The results of this comparison yielded slightly different rankings for each major category of management position as evidenced in Table 8-15. The ranking of the group preferring the performance approach are shown in parentheses.

The CEOs group that preferred the prescriptive approach reported that continuous improvement of safety performance, joint labor/management problem solving, and workshops and training as being the 5th, 6th and 8th most important issues regarding the implementation of new approaches within their firms. Their counterparts who preferred the performance approach regarded these issues as 7th, 4th and 9th most important. Generally there were no major differences in the level of importance with which either group regarded other issues.

Project and contracts managers favoring the prescriptive approach regarded the continuous improvement of safety performance, workshops and training, effective coordination of construction activities, top management support, and creativity as 2nd, 5th, 6th, 8th, and 9th respectively most important issues affecting the implementation of new approaches. Their counterparts who favored the performance approach regarded the importance of these issues differently, namely, 8th, 9th, 3rd, 4th, and 7th respectively. Interestingly, the prescriptive group regarded the continuous improvement of safety performance highly. Further, they regarded workshops and training as more important than top management support.

Table 8-15 Importance of new approaches to management preferring the prescriptive approach

	Sample	CEO/President/ Vice-president/ MD/ General Manager[56]	Project/ Contracts Manager[57]	Safety Director/ Manager[58]
Issue	Rank	Rank	Rank	Rank
Top management support	1	1 (2)	8 (4)	1 (2)
Open communication	2	2 (1)	1 (1)	2 (1)
Mutual trust between workers and management	3	3 (3)	7 (6)	6 (3)
Effective coordination of construction activities	4	4 (5)	6 (3)	3 (5)
Continuous improvement of safety performance	5	5 (7)	2 (8)	4 (7)
Adequate resources	6	7 (6)	3 (2)	7 (6)
Workshops and training	7	8 (4)	5 (9)	5 (4)
Joint labor/management problem solving	8	6 (9)	4 (5)	8 (9)
Creativity	9	9 (8)	9 (7)	9 (8)
Incentives and rewards for supporting the change	10	10 (10)	10 (10)	10 (10)

Safety directors and managers that favored the prescriptive approach regarded effective coordination of construction activities, continuous improvement of safety performance, and mutual trust between workers and management, as being the 3rd, 4th,

[56] N=10

[57] N=4

[58] N=14

and 6th respectively most important issues affecting the implementation of new approaches. On the other hand, their counterparts who favored the performance approach regarded these same issues as 5th, 7th, and 3rd most important.

All groupings preferring the prescriptive approach regarded the continuous improvement of safety performance as a more important issue than their counterparts preferring the performance approach.

22. **How important do you regard the following actions for the successful implementation of a new approach to construction worker safety and health?** The respondents were asked to rate on a 7-point Likert scale of importance[59] how important they regarded 11 specific actions that could be taken for the successful implementation of a new approach to construction worker safety and health. The frequency distributions of the responses to these issues are discussed in the following sections.

- **Demonstration of consistent and decisive personal leadership.** The sample mean (6.42), median (7.00) and mode (7.00) indicated that the responses of most of the respondents were positioned toward the upper end of the scale. While 40 respondents (60.6%) regarded the demonstration of consistent and decisive personal leadership as very important for the successful implementation of a new approach to construction worker safety and health, 18 respondents (27.3%) regarded it as being only slightly less important. The histogram of the response frequency distribution is shown in Figure 8-54.
- **Allocation of adequate financial, equipment and staff resources.** No respondents regarded as unimportant the allocation of adequate financial, equipment and staff resources for the successful implementation of a new approach to worker safety. While 26 respondents (39.4%) regarded this action as very important, 24 respondents (36.4%) regarded it as being only slightly less important. The histogram of the response frequency distribution is shown in Figure 8-55.
- **Amending the corporate vision and mission.** The sample mean (4.97), the median (5.00) and the mode (5.00) were all concentrated to the right (upper end) of the central value of the scale. While only 3 respondents (4.5%) regarded amending the corporate vision and mission for the successful implementation of a new approach to construction worker safety as not important at all, 13 respondents (19.7%) regarded this action as very important. There were 12 respondents (18.2%) who were undecided about the importance of the action. The histogram of the response frequency distribution is shown in Figure 8-56.

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[59] The scale used to indicate the level of importance is a 7-point Likert scale with 1 representing not important at all, 4 representing a neutral attitude, and 7 representing very or extremely important. This form of scale of measurement is used in all histograms

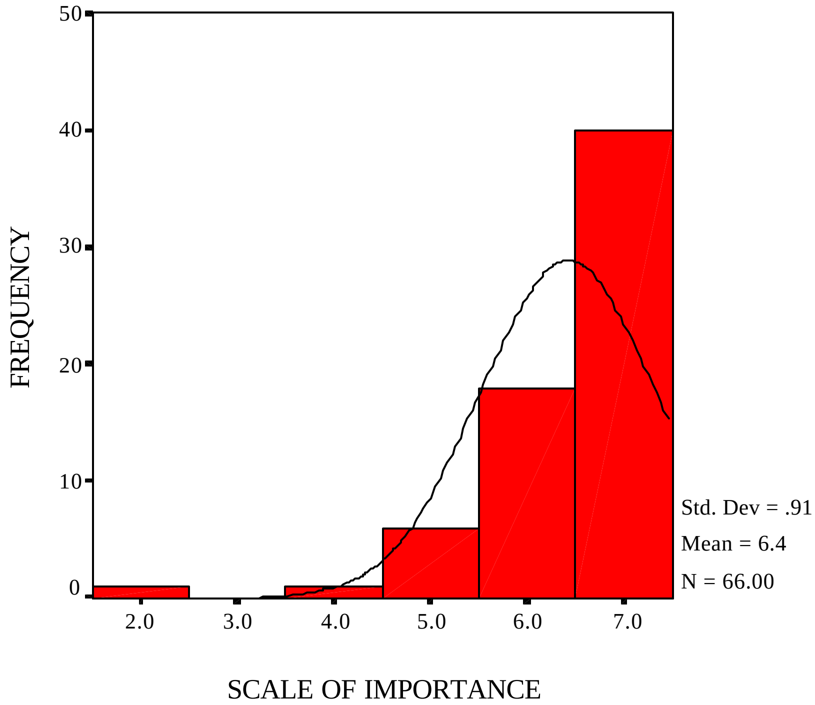

Figure 8-54 Importance of demonstration of consistent and decisive personal leadership

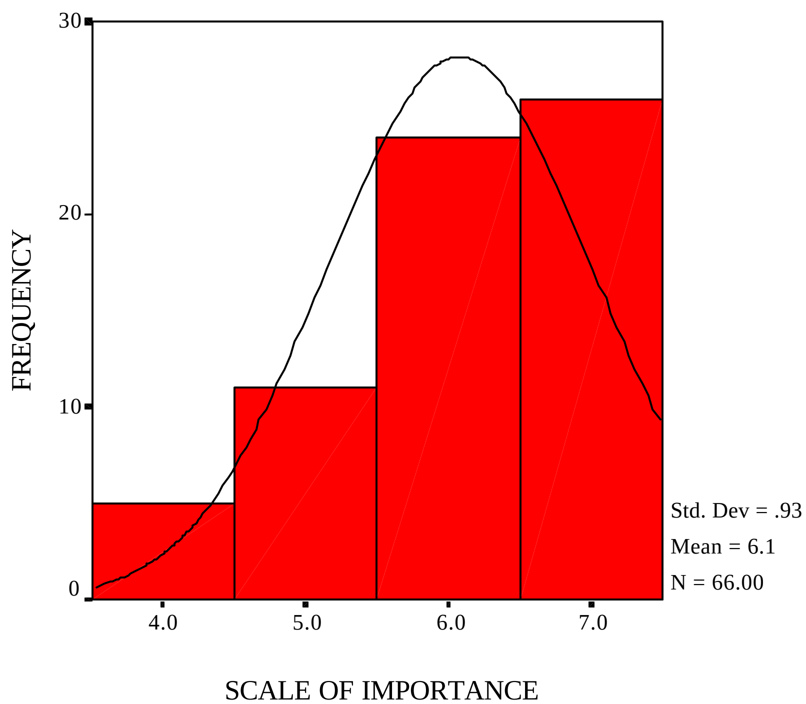

Figure 8-55 Importance of allocation of adequate financial, equipment and staff resources

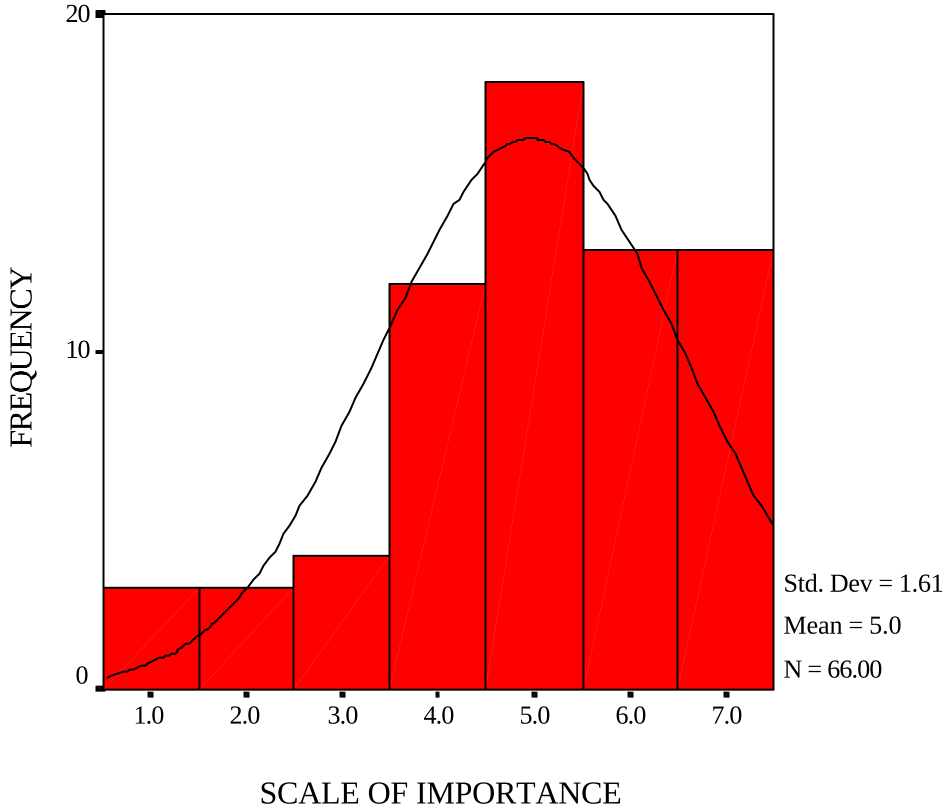

Figure 8-56 Importance of amending the corporate vision and mission

- **Motivation of workers to implement changes for continuous improvement.** The distribution of most of the responses of respondents was concentrated around the upper end of the 7-point scale. The sample mean was 5.83. Some 21 respondents (31.8%) regarded the motivation of workers to implement changes for continuous improvement as very important for the successful implementation of a new approach for worker safety. Another 21 respondents (31.8%) regarded this action as being only slightly less important. The histogram of the response frequency distribution is shown in Figure 8-57.
- **Encouragement of worker participation at all levels.** Similarly, the distribution of most of the responses of respondents was concentrated around the upper end of the 7-point scale, with a sample mean of 5.97. Some 29 respondents (43.9%) regarded the encouragement of worker participation at all levels as very important for the successful implementation of a new approach for worker safety. Another 18 respondents (27.3%) regarded this action as being only slightly less important. The histogram of the response frequency distribution is shown in Figure 8-58.

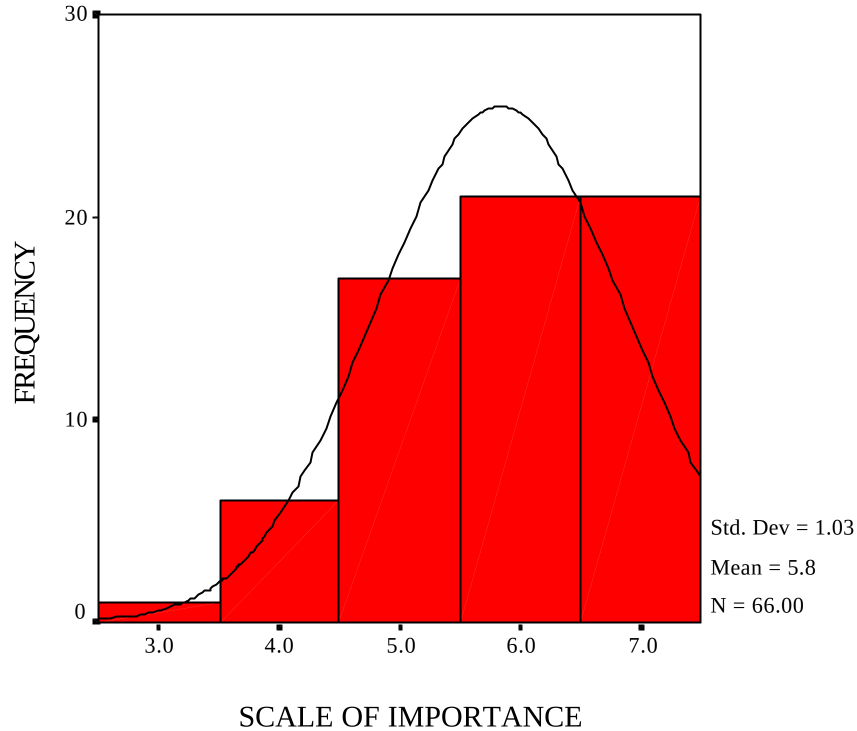

Figure 8-57 Importance of motivation of workers to implement changes

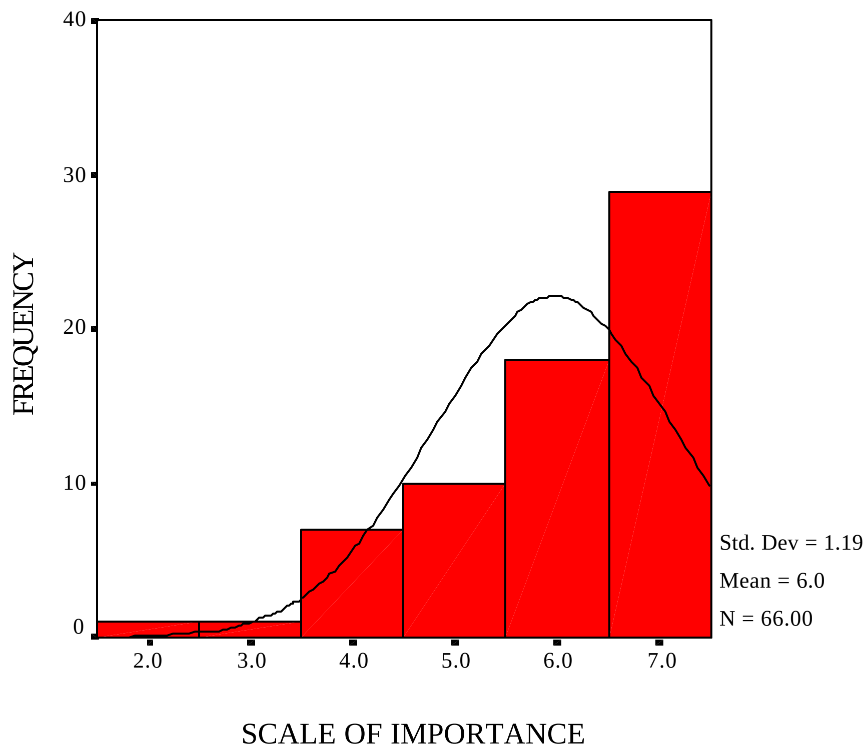

Figure 8-58 Importance of encouragement of worker participation at all levels

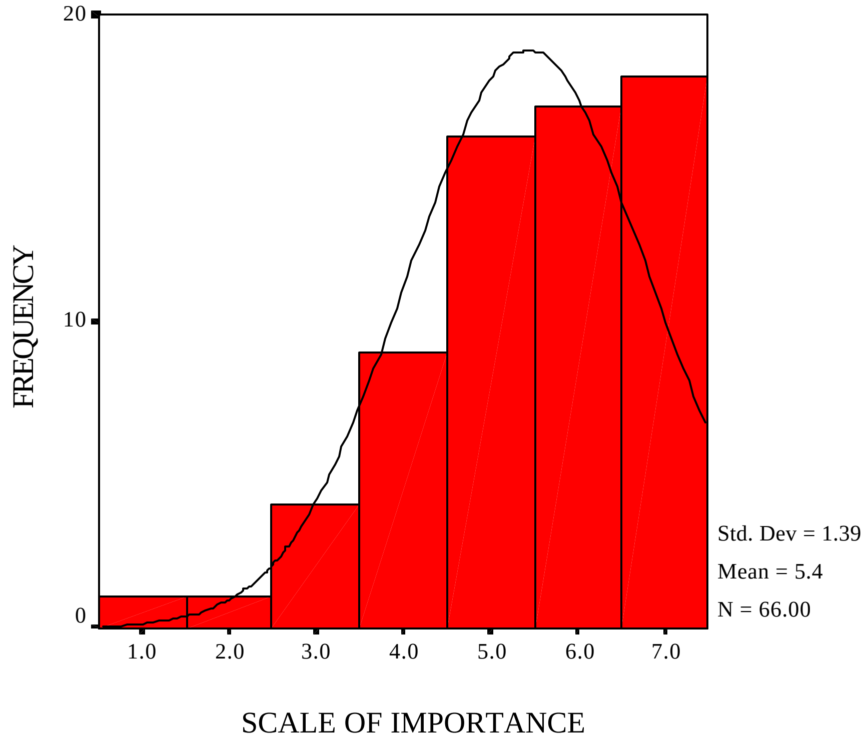

Figure 8-59 Importance of changing the organization's systems, policies and procedures

- **Changing the organization's systems, policies and procedures to augment the changes.** The distribution of most of the responses of respondents was concentrated around the upper end of the 7-point scale. The sample mean was 5.44. Some 18 respondents (27.3%) regarded changing the firm's systems, policies and procedures as very important for the successful implementation of a new approach for worker safety. This change had to augment the changes that will be necessary for a new approach to work well. A further 17 respondents (25.8%) regarded this action as being only slightly less important. Only 1 respondent (1.5%) regarded the action as not important at all. The histogram of the response frequency distribution is shown in Figure 8-59.
- **Introduction and support of appropriate training programs.** The distribution of most of the responses of respondents was concentrated around the upper end of the 7-point scale, with a sample mean of 6.12. Some 32 respondents (48.5%) regarded the introduction and support of appropriate training programs as very important for the successful implementation of a new approach for worker safety, and another 19 respondents (28.8%) regarded this action as being only slightly less important. There were no respondents who regarded the action as not important at all. The histogram of the response frequency distribution is shown in Figure 8-60.

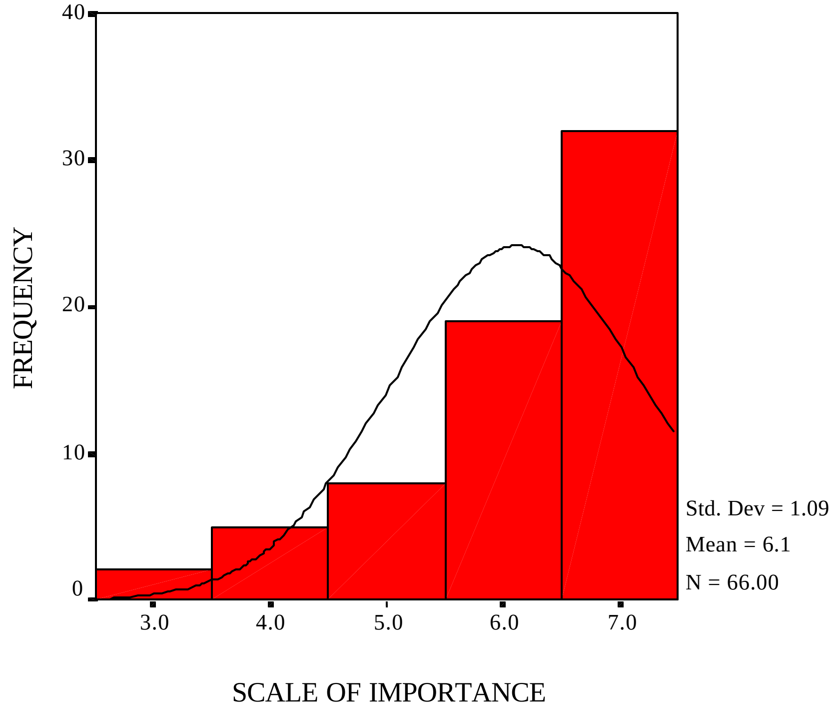

Figure 8-60 Importance of the introduction and support of appropriate training programs

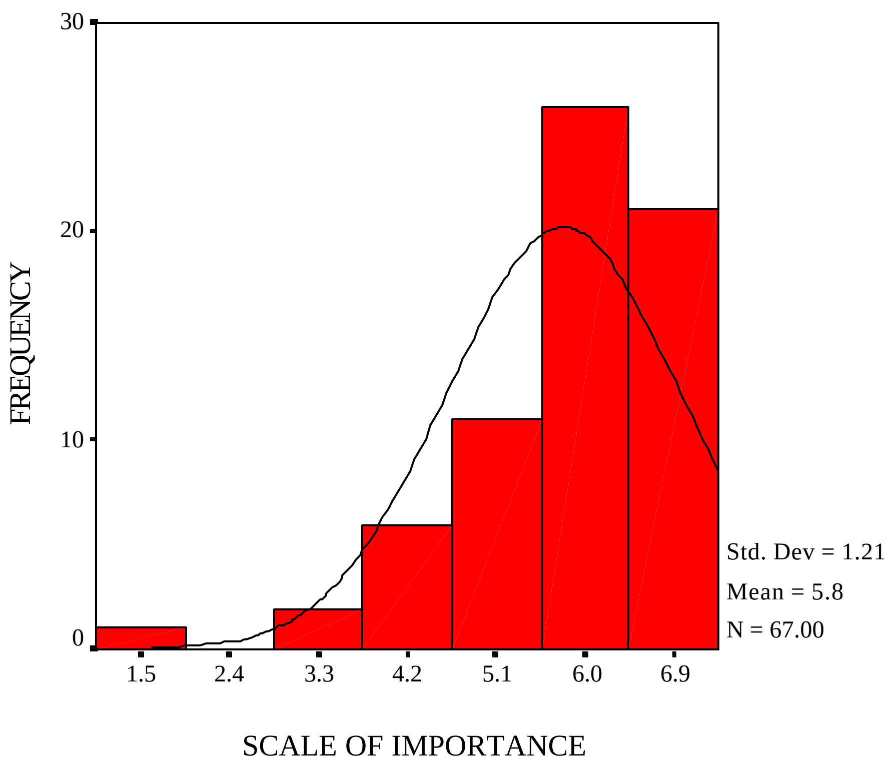

Figure 8-61 Importance of regularly measuring and evaluating progress of changes

- **Measuring and evaluating progress of the changes regularly introducing new plans of action if necessary.** The distribution of most of the responses of respondents was concentrated around the upper end of the 7-point scale with the sample mean being 5.81. Some 21 respondents (31.3%) regarded as very important measuring and evaluating progress regularly of changes for the successful implementation of a new approach for worker safety. Further, new plans of action had to be introduced if necessary if progress was unsatisfactory. Another 26 respondents (38.8%) regarded this action as being only slightly less important. There was 1 respondent (1.5%) who regarded the action as not important at all. The histogram of the response frequency distribution is shown in Figure 8-61. While the scales seem different due to the way SPSS selected to graphically represent the data, they represent 1 to 7 as before.
- **Comparing the performance of the company with competitors.** Several respondents (27.3%) were undecided about the importance of comparing the performance of the company with competitors for the successful implementation of a new approach to construction worker safety and health. While only 3 respondents (4.5%) regarded this action as not important at all, 11 respondents (16.7%) regarded it as very important. Further, 10 respondents (15.2%) regarded comparing company performance with competitors as only slightly less important. The histogram of the response frequency distribution is shown in Figure 8-62.

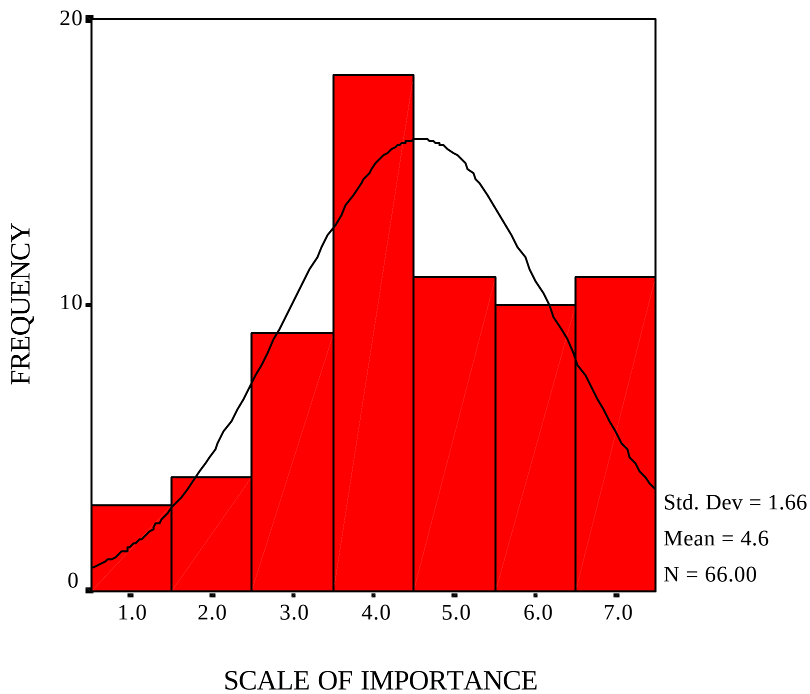

Figure 8-62 Importance of comparing the performance of the company with competitor

- **Rewarding workers for being innovative, and looking for new solutions.** The distribution of most of the responses of respondents was concentrated around the upper end of the 7-point scale, with a sample mean of 5.16. These measures indicated that 76.1% of respondents regarded rewarding workers for being innovative and looking for new solutions as being of some importance (5.0 to 7.0 on the scale). In fact, most of the respondents, namely, 31.3%, regarded it as important (5.0 on the scale). Some 14 respondents (20.9%%) regarded the action as very important and. 16 respondents (23.9%) regarded this action as being only slightly less important (6.0 on the scale). There was 1 respondent (1.5%) who regarded the action as not important at all. The histogram of the response frequency distribution is shown in Figure 8-63.
- **Changing the organizational structure and hierarchy to make it more flexible and responsive to change.** Several respondents (25.4%) were undecided about the importance of changing the organizational structure and hierarchy for the successful implementation of a new approach to construction worker safety and health. The intent of this change would be to make the firm more flexible and responsive to change. Some 8 respondents (11.9%) regarded this action as very important. A further 18 respondents (26.9%) regarded this action as being only slightly less important. There were 2 respondents (3.0%) who regarded the action as not important at all. The histogram of the response frequency distribution is shown in Figure 8-64.

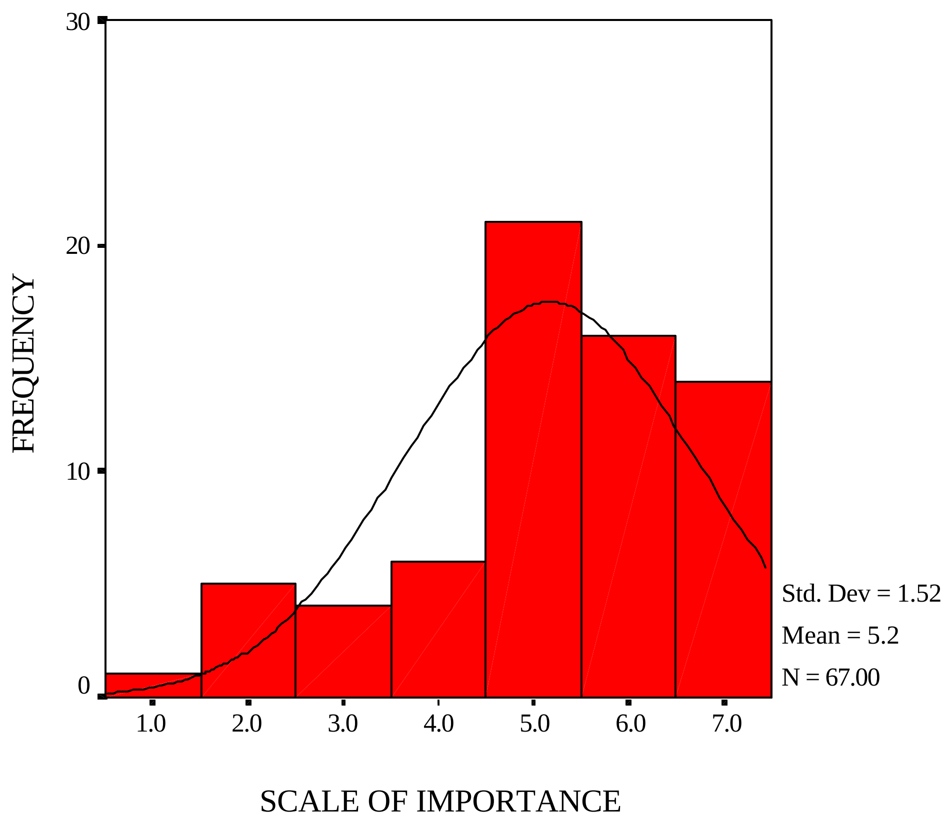

Figure 8-63 Importance of rewards for being innovative and looking for new solutions

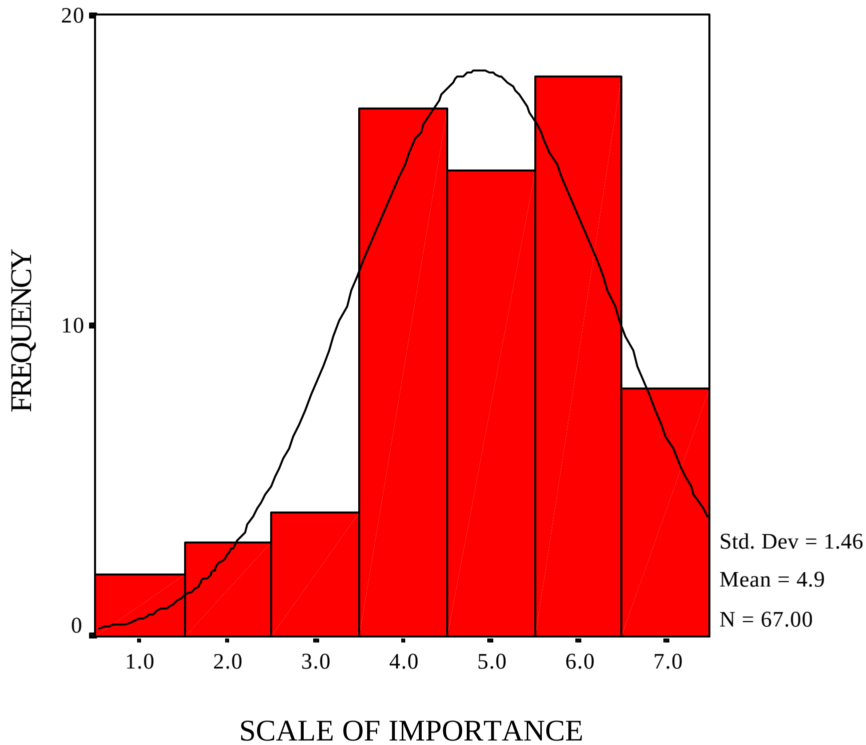

Figure 8-64 Importance of changing the organizational structure and hierarchy

Ranking Responses by Means

The result of comparing the means is reflected in Table 8-16. From the comparison of the sample means of the various frequency distributions, it was possible to rank the 11 actions regarding how important they were regarded by the respondents for the successful implementation of a new approach to construction safety and health within their organizations.

The demonstration of consistent and decisive personal leadership ranked the highest; the introduction and support of appropriate training programs ranked 2nd; and the allocation of adequate financial, equipment and staff resources ranked 3rd. Comparing the performance of the company with competitors ranked the lowest in importance, namely, 11th. Amending the corporate vision and mission ranked 9th and changing the organizational structure and hierarchy to make it more flexible and responsive to change ranked 10th.

Table 8-16 Importance of actions for the successful implementation of a new approach

Rank	Action	N	Mean	Std. Deviation
1	The demonstration of consistent and decisive personal leadership	65	6.4154	.9167
2	The introduction and support of appropriate training programs	65	6.1077	1.0915
3	The allocation of adequate financial, equipment and staff resources	65	6.0769	.9405
4	The encouragement of worker participation at all levels	65	5.9538	1.1915
5	The motivation of workers to implement changes for continuous improvement	65	5.8154	1.0291
6	Measuring and evaluating progress of the changes regularly introducing new plans of action if necessary	66	5.7879	1.2091
7	Changing the organization's systems, policies and procedures to augment the changes	65	5.4308	1.4028
8	Rewarding workers for being innovative, and looking for new solutions	66	5.1515	1.5316
9	Amending the corporate vision and mission	65	4.9538	1.6147
10	Changing the organizational structure and hierarchy to make it more flexible and responsive to change	66	4.8485	1.4491
11	Comparing the performance of the company with competitors	65	4.5692	1.6768

Approach Preference

To determine whether the preference for either the prescriptive approach or the performance approach would have any effect on the ranking, the means were compared. The results of this comparison yielded only slightly different rankings in Table 8-17.

Table 8-17 Importance of actions for implementation of a new approach by approach

Sample Rank	Issue	Perform Rank[60]	Mean	Std. Dev.	Prescript Rank[61]	Mean	Std. Dev.
1	Demonstration of consistent and decisive personal leadership	1	6.39	1.03	1	6.46	.74
2	Introduction and support of appropriate training programs	2	6.13	1.12	4	6.11	1.07
3	Allocation of adequate financial, equipment and staff resources	3	6.05	.96	3	6.11	.92
6	Measuring and evaluating progress of the changes regularly introducing new plans of action if necessary	4	5.82	1.09	6	5.79	1.40
4	Encouragement of worker participation at all levels	5	5.79	1.28	2	6.21	1.03
5	Motivation of workers to implement changes for continuous improvement	6	5.76	1.05	5	5.93	1.02
7	Changing the organization's systems, policies and procedures to augment the changes	7	5.34	1.34	7	5.57	1.48
8	Rewarding workers for being innovative, and looking for new solutions	8	5.32	1.49	10	4.93	1.59
10	Changing the organizational structure and hierarchy to make it more flexible and responsive to change	9	4.76	1.30	9	5.04	1.69
9	Amending the corporate vision and mission	10	4.74	1.66	8	5.29	1.51
11	Comparing the performance of the company with competitors	11	4.63	1.67	11	4.56	1.69

Respondents who favored the prescriptive approach regarded the encouragement of worker participation at all levels, introduction and support of appropriate training programs, and measuring and evaluating progress regularly as being 2nd, 4th, and 6th respectively in importance for the successful. Those who preferred the performance approach regarded these same issues as 5th, 4th, and 2nd respectively in importance. All

[60] N=38

[61] N=28

respondents regardless of approach preference regarded comparing the performance of their firms with competitors as being the least important issue. Further, they also regarded the demonstration of consistent and decisive personal leadership as being the most important issue.

Management Position

To determine whether the position of respondents within the top management structure of their firms would have any effect on the ranking, the means were compared. The results of this comparison yielded different results for each major position category as evidenced in Table 8-18.

While the CEOs group generally ranked the actions for the successful implementation of a new approach to construction safety and health similarly to the sample, the other groups ranked them differently. The CEO group regarded the allocation of adequate financial, equipment and staff resources as being more important (2^{nd}) than the sample (3^{rd}).

All the groups regarded as most important the demonstration of consistent and decisive personal leadership. This ranking is consistent with the findings of research about the importance of management support and commitment to programs for its eventual success.

Project and contracts managers regarded the allocation of adequate financial, equipment and staff resources, motivation of workers to implement changes for continuous improvement, and regularly measuring and evaluating progress of the changes while introducing new plans of action if necessary, as being 2^{nd}, 3^{rd} and 4^{th}, respectively. Surprisingly, they ranked lower the encouragement of worker participation at all levels as being 7th important. The other groups ranked this action as high as 3rd or 4th in importance. Also surprising was the high ranking (6th) given to comparing the performance of the company with competitors. The other groups ranked this action as being the least important, namely, 11th.

Table 8-18 Importance of actions for implementation by management position

	Sample	CEO/President/ Vice-president/MD/ General Manager	Project/ Contracts Manager	Safety Director/ Manager
Issue	Rank	Rank	Rank	Rank
Demonstration of consistent and decisive personal leadership	1	1	1	1
Introduction and support of appropriate training programs	2	3	5	2
Allocation of adequate financial, equipment and staff resources	3	2	2	4
Encouragement of worker participation at all levels	4	4	7	3
Motivation of workers to implement changes for continuous improvement	5	5	3	6
Measuring and evaluating progress of the changes regularly introducing new plans of action if necessary	6	6	4	5
Changing the organization's systems, policies and procedures to augment the changes	7	7	9	7
Rewarding workers for being innovative, and looking for new solutions	8	8	8	9
Amending the corporate vision and mission	9	10	11	8
Changing the organizational structure and hierarchy to make it more flexible and responsive to change	10	9	10	10
Comparing the performance of the company with competitors	11	11	6	11

Safety directors and managers ranked the introduction and support of appropriate training programs and encouragement of worker participation at all levels as being 2nd and 3rd. This appears to be consistent with the traditional concerns of this group, namely, having workers properly trained in construction safety and health.

Management Favoring the Performance Approach

To determine whether the top management position of respondents favoring the performance approach would have any effect on the ranking, the means were compared. The results of this comparison yielded different results for each major position category as evidenced in Table 8-19. The ranking of the entire sample of these management position categories is shown in parentheses.

The CEO group favoring the performance approach regarded the introduction and support of appropriate training programs as the most important action for the successful introduction of a new approach to construction safety. They regarded the demonstration of consistent and decisive personal leadership as next important. Measuring and evaluating progress of the changes regularly introducing new plans of action if necessary ranked 3rd, up from 6th. The allocation of adequate financial, equipment and staff resources was regarded as a less important action, dropping to 6th from 2nd rank.

The ranking of importance for project and contracts managers that favored the performance approach was only marginally different from before.

Safety directors and managers regarded the introduction and support of appropriate training programs as the most important action for the successful introduction of a new approach to construction safety. They regarded the demonstration of consistent and decisive personal leadership as next important. Measuring and evaluating progress of the changes regularly introducing new plans of action if necessary ranked 3rd, up from 5th.

The allocation of adequate financial, equipment and staff resources was regarded as a less important action, dropping to 6th from 4th rank.

Management Favoring the Prescriptive Approach

To determine whether the top management position of respondents favoring the prescriptive approach would have any effect on the ranking, the means were compared. The results of this comparison yielded different results for each major position category as evidenced in Table 8-20. The ranking of the management position categories that favored the performance approach is shown in parentheses.

The CEOs group favoring the prescriptive approach regarded measuring and evaluating progress of the changes regularly, and rewarding workers for being innovative, and looking for new solutions as being the 7th and 10th most important actions to be taken.

Their counterparts who favored the performance approach regarded these issues as being 3rd and 8th most important. There were no major differences between the groups based on approach preference regarding the importance of the other actions to be taken.

Project and contracts managers that favored the prescriptive approach regarded the importance of the actions to be taken for the successful implementation of a new approach differently from their counterparts who favored the performance approach. For example, they regarded the introduction and support of appropriate training programs as being the most important action to be taken. Their counterparts regarded this action as being 6th most important. Further, they regarded the demonstration of consistent and decisive personal leadership, motivation of workers to implement changes for continuous improvement, rewarding workers for being innovative and looking for new solutions, comparing the performance of their companies with competitors, amending the corporate vision and mission, and changing their organizations' systems, policies and procedures as being 3rd, 5th, 6th, 7th, 9th, and 10th most important actions respectively.

Table 8-19 Importance of implementation to management favoring the performance approach

	Sample	CEO/President/ Vice-president/MD/ General Manager[62]	Project/ Contracts Manager[63]	Safety Director/ Manager[64]
Issue	Rank	Rank	Rank	Rank
Demonstration of consistent and decisive personal leadership	1	2 (1)	1 (1)	2 (1)
Introduction and support of appropriate training programs	2	1 (3)	6 (5)	1 (2)
Allocation of adequate financial, equipment and staff resources	3	6 (2)	2 (2)	6 (4)
Encouragement of worker participation at all levels	4	4 (4)	8 (7)	4 (3)
Motivation of workers to implement changes for continuous improvement	5	5 (5)	3 (3)	5 (6)
Measuring and evaluating progress of the changes regularly introducing new plans of action if necessary	6	3 (6)	4 (4)	3 (5)
Changing the organization's systems, policies and procedures to augment the changes	7	7 (7)	7 (9)	7 (7)
Rewarding workers for being innovative, and looking for new solutions	8	8 (8)	9 (8)	8 (9)
Amending the corporate vision and mission	9	10 (10)	11 (11)	10 (8)
Changing the organizational structure and hierarchy to make it more flexible and responsive to change	10	9 (9)	10 (10)	9 (10)
Comparing the performance of the company with competitors	11	11 (11)	5 (6)	11 (11)

[62] N=14

[63] N=6

[64] N=14

Their counterparts regarded the same actions as being the most important, 3rd, 9th, 5th, 11th, and 7th most important respectively.

Table 8-20 Importance of implementation to management favoring the prescriptive approach

	Sample	CEO/President/ Vice-president/MD/ General Manager[65]	Project/ Contracts Manager[66]	Safety Director/ Manager[67]
Issue	Rank	Rank	Rank	Rank
Demonstration of consistent and decisive personal leadership	1	2 (2)	3 (1)	1 (2)
Introduction and support of appropriate training programs	2	1 (1)	1 (6)	4 (1)
Allocation of adequate financial, equipment and staff resources	3	5 (6)	2 (2)	3 (6)
Encouragement of worker participation at all levels	4	4 (4)	8 (8)	2 (4)
Motivation of workers to implement changes for continuous improvement	5	6 (5)	5 (3)	6 (5)
Measuring and evaluating progress of the changes regularly introducing new plans of action if necessary	6	7 (3)	4 (4)	5 (3)
Changing the organization's systems, policies and procedures to augment the changes	7	8 (7)	10 (7)	7 (7)
Rewarding workers for being innovative, and looking for new solutions	8	10 (8)	6 (9)	10 (8)
Amending the corporate vision and mission	9	9 (10)	9 (11)	8 (10)
Changing the organizational structure and hierarchy to make it more flexible and responsive to change	10	8 (9)	11 (10)	9 (9)
Comparing the performance of the company with competitors	11	11 (11)	7 (5)	11 (11)

[65] N=10

[66] N=4

[67] N=14

Safety directors and managers preferring the prescriptive approach regarded the encouragement of worker participation at all levels, allocation of adequate financial, equipment and staff resources, introduction and support of appropriate training programs, and measuring and evaluating progress of the changes regularly as being the 2nd, 3rd, 4th and 5th most important actions respectively to be taken.

On the other hand, safety directors and managers who favored the performance approach regarded these same actions as being 4th, 6th, 1st, and 3rd in importance respectively.

23. **How many recordable injuries did the company have last year?** The range of response values was 0 to 330 with a sample mean of 19.00. The median was 7.00. The most commonly reported response (mode) was 1.00. The histogram of the response frequency distribution is shown in Figure 8-65. Because of the wide range of responses the data were recoded to facilitate better analysis. From the responses, there were 8 firms with no recordable injuries; 9 firms with 1 recordable injury; 11 firms with between 2 and 5 recordable injuries; 10 firms with between 6 and 10 recordable injuries; and 10 firms with more than 50 recordable injuries.

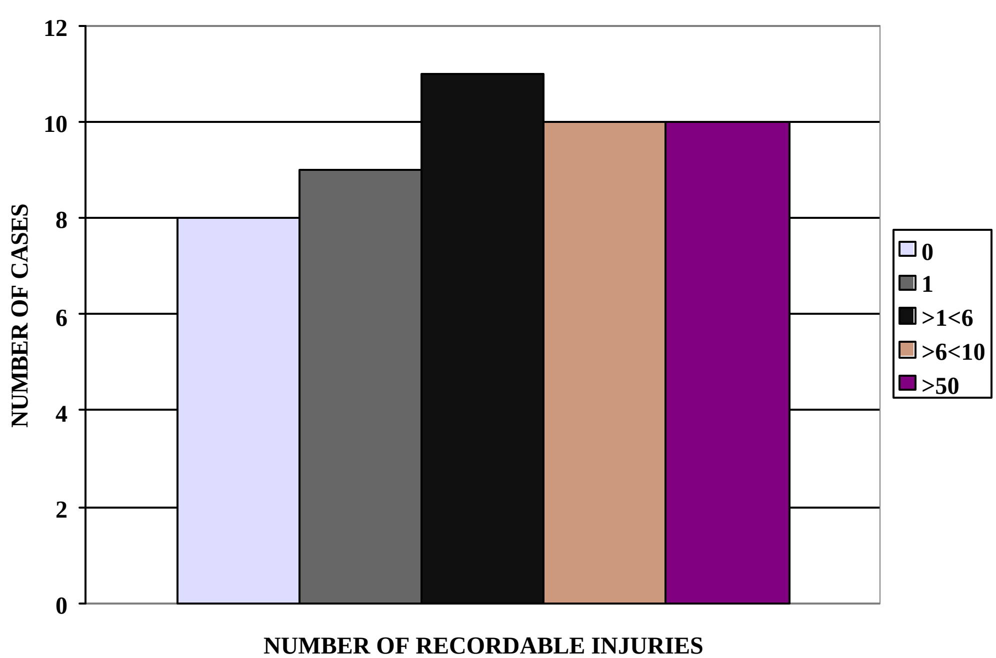

Figure 8-65 Distribution of the number of recordable injuries

Injury Rate (IR)

Injury data can be used for comparison very readily when the measure of safety performance is normalized for companies of different sizes. The injury rate is such a measure. The injury rate for the firm of each respondent was calculated as follows:

IR = (No. of injuries * 100)/no. of employees

The mean injury rate of the sample is 6.42 and the median injury rate is 3.70. By normal industry standards, injury rates < 2.0 are exceptional while injury rates >2 and <8 are still below the national average. The measures of central tendency of the sample appear to be representative of the industry norms. Of the sample of 58 firms,

- 17 (29.3%) had IR’s ⇒ 2.0;
- 15 (25.9%) had IR’s > 2.0 and ⇒ 4.0;
- 14 (24.1%) had IR’s > 4.0 and ⇒ 8.0; and
- 12 (20.7%) had IR’s > 8.0.

Cross tabulation and Measures of Association

Preference for the Performance Approach by Top Management Position

To determine the variability in the preference for the performance approach the responses of the participants to Questions 1(a) and Q3 were cross tabulated. The null hypothesis to be tested is that preference and management positions are independent of each other. The Pearson chi-square statistic was used to test the independence of the preference (PREFER) for either the performance or prescriptive approaches and the management position. The guideline was adhered to recommended by many researchers when dealing with cross tabulations that no cell had to have an expected value less than 1.0 and not more than 20% of the cells could have expected values less than 5 (SPSS, 1999). Accordingly, only the 3 major groupings were selected for examination, namely, CEOs (JOBTITLE=1), Project Managers (JOBTITLE=2) and Safety Directors (JOBTITLE=3). The other groupings did not satisfy the guidelines.

The total number of cases for each of PREFER, JOBTITLE=1, JOBTITLE=2 and JOBTITLE=3 was 67. However, the valid number of cases for each was 66 (98.5%) due to 1 missing value (1.5%). The cross tabulations and chi-square tests for each management grouping are shown in separate tables.

JOBTITLE=1

In this sample of 66 respondents, 25 were CEOs, Presidents, Vice-presidents, Managing Directors, or General Managers of their respective firms. Of these 10 (40%) were observed to prefer the prescriptive approach, while 15 (60%) preferred the performance approach. The expected counts shown in parentheses were only marginally different, namely, 10.6 preferring the prescriptive approach and 14.4 the performance approach. These results are shown in Table 8-21.

Table 8-21 Cross tabulation of JOBTITLE=1 with PREFER

	(PREFER)	
	Prescriptive approach	Performance approach
Jobtitle=1 (FILTER)	10 (10.6)	15 (14.4)

The computed chi-square statistic for this table is 0.097 and has an associated probability (*p* value) or significance level of 0.756. The very small size of the statistic suggests that there is some association but it is not significant between JOBTITLE=1 and the preference for the performance approach. The null hypothesis as it relates to JOBTITLE=1 cannot be rejected. The result of the chi-square test is shown in Table 8-22.

Table 8-22 Chi-Square Tests of JOBTITLE=1 and PREFER

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	.097	1	.756
N of Valid Cases	66		

a Computed only for a 2x2 table
b 0 cells (.0%) have expected count less than 5. The minimum expected count is 10.61.

JOBTITLE=2

In this sample of 66 respondents, 10 were Project or Contracts Managers of their respective firms. Of these 4 (40%) were observed to prefer the prescriptive approach, while 6 (60%) preferred the performance approach. The expected counts were only marginally different, namely, 4.2 preferring the prescriptive approach and 5.8 the performance approach. These results are shown in Table 8-23

Table 8-23 Cross tabulation of JOBTITLE=2 with PREFER

	(PREFER)	
	Prescriptive approach	Performance approach
Jobtitle=2 (FILTER)	4 (4.2)	6 (5.8)

Table 8-24 Chi-Square Tests of JOBTITLE=2 and PREFER

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	.028	1	.866
N of Valid Cases	66		

a Computed only for a 2x2 table
b 1 cells (25.0%) have expected count less than 5. The minimum expected count is 4.24.

The computed chi-square statistic for this table is 0.028 and has an associated probability (*p* value) or significance level of 0.866. The small size of the statistic suggests that there is some association but it is not significant between JOBTITLE=2 and the preference for the performance approach. The null hypothesis as it relates to JOBTITLE=2 cannot be rejected. The result of the chi-square test is shown in Table 8-24.

JOBTITLE=3

In this sample of 66 respondents, 28 were Safety Directors or Managers of their respective firms. Of these 14 (50%) reported that they preferred the prescriptive approach, while 14 (50%) preferred the performance approach. The expected counts were different, namely, 11.9 preferring the prescriptive approach and 16.1 the performance approach. These results are shown in Table 8-25

Table 8-25 Cross tabulation of JOBTITLE=3 with PREFER

	(PREFER)	
	Prescriptive approach	Performance approach
Jobtitle=3 (FILTER)	14 (11.9)	14 (16.1)

The computed chi-square statistic for this table is 1.143 and has an associated probability (*p* value) or significance level of 0.285, suggesting that there is some association but it is not significant between JOBTITLE=3 and the preference for the performance approach. The null hypothesis as it relates to JOBTITLE=3 cannot be rejected. The result of the chi-square test is shown in Table 8-26.

Table 8-26 Chi-Square Tests of JOBTITLE=3 and PREFER

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	1.143	1	.285
N of Valid Cases	66		

a Computed only for a 2x2 table
b 0 cells (.0%) have expected count less than 5. The minimum expected count is 11.88.

Preference for the Performance Approach Based on Number of Employees

To determine the variability based on the size of firms according to number of employees the responses of the participants to Questions 2(a) and Q3 were crosstabulated. The null hypothesis to be tested is that preference and size of construction firm are independent of each other. The Pearson chi-square statistic was used to test the independence of the preference (PREFER) for either the performance or prescriptive approaches and the size of firm (EMPLOYNO). As before, the guideline was adhered to that no cell could have an expected value less than 1.0 and not more than 20% of the cells could have expected values less than 5 (SPSS, 1999). The 501-1000 and >1000 groupings were eliminated from the examination since they had expected values of less than 5 and accordingly, failed to satisfy the guidelines.

In this sample of 40 respondents, within EMPLOYNO 11 (27.5%) of the firms employed 0-25 employees, 16 (40%) employed 26-100 employees and 13 (32.5%) employed 101-250 employees. Of the 0-25 group, 4 (36.6%) were observed to prefer the prescriptive approach, while 7 (63.6%) preferred the performance approach. Of the 26-100 group, 7 (43.8%) were observed to prefer the prescriptive approach, while 9 (56.3%) preferred the performance approach. Of the 101-250 group, 7 (53.8%) were observed to prefer the prescriptive approach, while 6 (46.2%) preferred the performance approach.

The expected counts were slightly different, namely, 5.0, 7.2, and 5.9 preferring the prescriptive approach and 6.1, 8.8, and 7.2 preferring the performance approach respectively. These results are shown in Table 8-27.

Table 8-27 Cross tabulation of EMPLOYNO with PREFER

	EMPLOYNO		
PREFER	0-25	26-100	101-250
Prescriptive approach	4 (5.0)	7 (7.2)	7 (5.9)
Performance approach	7 (6.1)	9 (8.8)	6 (7.2)

The computed chi-square statistic for this table is 0.753 and has an associated probability (*p* value) or significance level of 0.686, suggesting that there is some association but it is not significant between EMPLOYNO and the preference for the performance approach. The null hypothesis as it relates to EMPLOYNO cannot be rejected. The result of the chi-square test is shown in Table 8-28.

Table 8-28 Chi-Square Tests of EMPLOYNO and PREFER

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	.753	2	.686
N of Valid Cases	40		

a 1 cells (16.7%) have expected count less than 5. The minimum expected count is 7.52.

Preference for the Performance Approach Based on Contracts Value

In order to determine the variability according to the value of construction contracts the responses of the participants to Questions 2(b) and Q3 were cross tabulated. The null hypothesis to be tested is that preference and size of construction firm are independent of each other. The Pearson chi-square statistic was used to test the independence of the preference (PREFER) for either the performance or prescriptive approaches and the size of firm (CONTVALU). All categories within CONTVALU were included despite 3 cells (30%) having expected count of less than 5. The minimum expected value was however greater than 1.0.

The total number of cases for each of PREFER and CONTVALU was 67. However, the valid number of cases for each was 63 (94.0%) due to 4 missing values (6.0%).

In this sample of 63 respondents, within CONTVALU 12 (19.0%) of the firms had approximate annual values of construction contracts $10m, 14 (22.2%) had contracts > $10m $50m, 11 (17.5%) had contracts > $50m $100m, 12 (19.0%) had contracts > $100m $250m, and 14 (22.2%) had contracts > $250m.

Of the $10m group, 4 (33.3%) were observed to prefer the prescriptive approach, while 8 (66.7%) preferred the performance approach. Of the > $10m $50m group, 5 (35.7%) were observed to prefer the prescriptive approach, while 9 (64.3%) preferred the performance approach. Of the > $50m $100m group, 5 (45.5%) were observed to prefer the prescriptive approach, while 6 (54.5%) preferred the performance approach. Of the > $100m $250m group, 4 (33.3%) were observed to prefer the prescriptive approach, while 8 (66.7%) preferred the performance approach. Of the > $250m group, 7 (50.0%) were each observed to prefer the prescriptive approach and the performance approach. The expected counts were slightly different. These results are shown in Table 8-29.

Table 8-29 Cross tabulation of CONTVALU with PREFER

	CONTVALU				
PREFER	$10m	> $10m $50m	> $50m $100m	> $100m $250m	> $250m
Prescriptive approach	4 (4.8)	5 (5.6)	5 (4.4)	4 (4.8)	7 (5.6)
Performance approach	8 (7.2)	9 (8.4)	6 (6.6)	8 (7.2)	7 (8.4)

The computed chi-square statistic for this table is 1.272 and has an associated probability (*p* value) or significance level of 0.866, suggesting that there is some association but it is not significant between CONTVALU and the preference for the performance approach. The null hypothesis as it relates to CONTVALU cannot be rejected. The result of the chi-square test is shown in Table 8-30.

Table 8-30 Chi-Square Tests of CONTVALU and PREFER

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	1.272	4	.866
N of Valid Cases	63		

a 3 cells (30.0%) have expected count less than 5. The minimum expected count is 4.37.

Preference for the Performance Approach Based on Level of Understanding

To answer this question, the responses of the participants to Questions 5 and Q3 were cross tabulated. The null hypothesis to be tested is that understanding of the concepts of the prescriptive and performance approaches and approach preference are independent of each other. The Pearson chi-square statistic was used to test the independence of the preference (PREFER) for either the performance or prescriptive approaches and the level of understanding (UNDSTAND). Only those responses were included in the examination within UNDSTAND where the level of understanding was greater than 4 on the 7-point Likert scale of understanding. This step was taken to comply with the guidelines stated earlier. The total number of cases for each of PREFER and UNDSTAND was 61 after filtering.

In this sample of 61 respondents, 9 (14.8%) measured 5 within UNDSTAND, 21 (34.4%) measured 6, and 31 (50.9%) measured. 7.

Of the 5 group, 4 (44.4%) were observed to prefer the prescriptive approach, while 5 (55.6%) preferred the performance approach. Of the 6 group, 6 (28.6%) were observed to prefer the prescriptive approach, while 15 (71.4%) preferred the performance approach. Of the 7 group, 17 (54.8%) were observed to prefer the prescriptive approach, while 14 (45.2%) preferred the performance approach.

The expected counts were slightly different, namely, 4.0, 9.3, and 13.7 preferred the prescriptive approach and 5.0, 11.7, and 17.3 the performance approach within UNDSTAND. These results are shown in Table 8-31.

Table 8-31 Cross tabulation of UNDSTAND with PREFER

	UNDSTAND		
PREFER	5.00	6.00	7.00
Prescriptive approach	4 (4.0)	6 (9..3)	17 (13.7)
Performance approach	5 (5.0)	15 (11.4)	14 (17.3)

The computed chi-square statistic for this table is 3.501 and has an associated probability (*p* value) or significance level of 0.174. The size of the statistic suggests that there is some association but it is not significant between UNDSTAND and the preference for the performance approach. The null hypothesis as it relates to UNDSTAND cannot be rejected. The result of the chi-square test is shown in Table 8-32.

Table 8-32 Chi-Square Tests of UNDSTAND and PREFER

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	3.501	2	.174
N of Valid Cases	61		

a 1 cells (16.7%) have expected count less than 5. The minimum expected count is 3.98.

Chapter Summary

The responses to the top management survey were analyzed. It was observed that 54.5% of the respondents held positions within their firms that are traditionally regarded as being upper or top management positions that were not directly related to safety and health. The median length that these positions had been held was 5 years. The median number of employees employed by the firms was 175 employees. The median annual value of construction contracts was $61 million. Most of the respondents (51.66%) derived their revenue from general contracting activities, 14.22% from subcontracting, and 11.47% from design-build contracting arrangements. Close to half of the firms (42.62%) derived their contractual revenue from local operations, 37.62% from regional operations, and 21.92% from national operations. The median injury rate per firm was 3.7 during the past year.

Most of the respondents (57.6%) preferred the performance approach when faced with the hypothetical position where they could select either the prescriptive or performance approach to satisfy compliance requirements. Common reasons given for selecting the performance approach over the prescriptive approach included 'differing conditions require different approaches,' 'provides contractor with flexibility,' and 'contractor takes responsibility for choice of solution' to deal with hazards.

The majority of respondents (78.5%) felt they understood very well both the prescriptive and performance approaches. Respondents had no clear conceptual preference for either approach with the median being 4.00 on the 7-point Likert scale of preference in terms of which 1.00 represented very strong preference for the performance approach, and 7.00 represented very strong preference for the prescriptive approach.

By ranking of the means, it was possible to rank the responses to 11 definitive issues regarding the level of influence that the performance approach would have on each of them. The top 3 issues that would be most influenced by the performance approach were flexibility, support for innovation, and ease of introduction of new materials. The potential to improve safety performance only ranked 7^{th}.

The means of responses to the importance of 5 issues regarding their importance to an approach to construction safety and health management were ranked. The 3 issues that respondents regarded as being most important were potential to improve safety performance on sites, ease of understanding compliance requirements, and ease of implementation of the approach.

Top management of 53.52% of the firms usually sponsored major changes within their organizations. The middle management and site management sponsored 16.12% and 19.05%, respectively. Workers sponsored 6.00% of major changes while supervisors accounted by 5.03%.

By comparing the means of the various frequency distributions, it was possible to rank 13 issues regarding how influential they were regarded by the respondents in driving change within their organizations. The improvement of financial performance of the organization was most influential, followed by the improvement of the safety record of the organization. The generating of quality improvements ranked 3rd. Staff turnover ranked the lowest in driving change in their organizations. However, when ranking the influence of these issues in driving change according the top management position of respondents within the group preferring the performance approach, the rankings changed.

For example, CEOs and Safety Directors regarded improvement of their safety record, improvement of financial performance, and complying with owner/client requirements as being 1st, 2nd and 3rd, respectively. Project Managers seemed to be more concerned about the competitive environment and regarded improvement of financial performance, generating of quality improvements, and keeping up with competitors as being 1^{st}, 2^{nd} and 3^{rd}, respectively. CEOs and Safety Directors regarded generating of quality improvements as being 4^{th} important.

Most of the respondents (88.9%) had observed the introduction of major changes within their organizations. Most of them (66.7%) regarded the willingness of workers to accept changes before they were implemented as an important issue. Similarly, most of the respondents (84.8%) regarded as an important issue breaking down the resistance of workers to change by convincing them to accept it. Most of the respondents (93.9%) regarded as an important issue the building of credibility and trust with workers before implementing a change. A large proportion of the respondents (84.8%) regarded the opinions of workers on a proposed change as being important. More than half of the respondents, namely, 35 (53.8%), regarded the receptiveness of foremen or first-line supervisors to change as very important.

The mean responses to 10 issues were ranked regarding their importance as perceived by the respondents for the implementation of new approaches within their organizations. The support of top management within the firm ranked the highest, open communication ranked 2^{nd}, and mutual trust between management and workers ranked 3^{rd}. Continuous improvement of safety performance ranked 5^{th}.

When ranking the importance of these issues according to the top management position of respondents within the group preferring the performance approach, the rankings changed. Open communication was ranked by all groups as being the most important issue. CEOs and Safety Directors ranked top management support, mutual trust between workers and management, and workshops and training as being 2^{nd}, 3^{rd} and 4^{th} in importance. For Project Managers the ranking was different. This group ranked adequate resources, effective coordination of construction activities, and top management support as being 2nd, 3rd and 4th in importance. Out of the 10 issues, continuous improvement of safety performance ranked either 7th or 8th.

Similarly, regarding the importance of 11 specific actions for the successful implementation of a new approach to construction worker safety and health, the mean responses were ranked. The demonstration of consistent and decisive personal leadership ranked the highest; the introduction and support of appropriate training programs ranked 2nd; and the allocation of adequate financial, equipment and staff resources ranked 3rd.

The ranking was slightly different by those in the top management structure who preferred the performance approach. CEOs ranked the introduction and support of appropriate training programs, allocation of adequate financial, equipment and staff resources, and encouragement of worker participation at all levels as being 2nd , 3rd and 4th most important actions to be taken respectively. Project Managers ranked the allocation of adequate financial, equipment and staff resources, motivation of workers to implement changes for continuous improvement, and measuring and evaluating progress of changes regularly as 2nd, 3rd and 4th most important respectively. Safety Directors ranked the introduction and support of appropriate training programs, demonstration of consistent and decisive personal leadership, measuring and evaluating progress of changes regularly, and encouragement of worker participation at all levels as being the 4 most important actions in order of importance.

Of CEOs and Project Managers, 60% preferred the performance approach while 50% of Safety Directors preferred it. However, there was no association between the preference for the performance approach and the category of position within the top management structure of the organization.

The size of the organization by number of employees and value of construction contracting revenue were not associated with preference for the performance approach. There were no significant linear relationships between preference of the performance approach and other variables.

There was no linear relationship between the level of understanding of the prescriptive and performance concepts and the preference for the performance approach.

The injury rates of most of the firms in the sample compared favorably with the industry norm of 8.0 with 29.3% with IR's $\Rightarrow$ 2.0. There were no linear relationships between IR and other variables.

In the next chapter the results of regression modeling and analysis are discussed using the data from the top management questionnaire survey.

CORRELATION, REGRESSION ANALYSIS AND MODELING

Introduction

To predict typical values of one variable given the value of another variable expressed as a mathematical equation of basic form

$Y = \hat{a}_0 + \hat{a}_1X + \mathring{a}$,

regression analysis is necessary (SPSS, 1999).

In this equation, $\hat{a}_0$ is known as the intercept, and represents the expected value of *Y* when all independent variables equal 0; å represents the error term; $\hat{a}_1$ represents the change in the expected value of *Y* associated with 1 unit increase in *X* when all other independent variables are held constant.

Regression models help to assess how well the dependent variable can be explained by knowing the value of the independent variable or a set of independent variables. They are also useful to identify which subset from several measures is most effective for estimating the dependent variable.

In this chapter single-step simple and multiple linear regression analysis are employed to test several hypotheses. Further, stepwise multiple regression analysis is used to identify key independent variables from the above hypotheses. The chapter is concluded with a summary of the analysis.

Correlation and Regression Analysis

Does Understanding Predict Preference for the Performance Approach?

It was expected that respondents with a greater understanding of the performance and prescriptive approaches (UNDSTAND) would be more likely to prefer the performance approach[68]. The null hypothesis to be tested is that there is no relationship between UNDSTAND and PREFAPPR. The correlation between these variables is shown in Table 9-1.

Table 9-1 Correlation between PREFAPPR and UNDSTAND

Pearson Correlation	-.016
Sig. (1-tailed)	.450
N	66

The correlation between PREFAPPR and UNDSTAND is negative (-.016) and not statistically significant, suggesting that should level of understanding of the approaches increase, the value of PREFAPPR would decrease negligibly. The *p* value associated with a correlation co-efficient of -.016 is 0.45 indicating that the correlation does not differ significantly from 0. Accordingly, the null hypothesis cannot be rejected.

Evidently, from the regression model summary in Table 9-2, there is no linear relationship between the level of understanding of the approaches and the preference of respondents for either the prescriptive or performance approaches since the value of R^2 is 0.

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[68] On the Likert 7-point scale, values of PREFAPPR <4 would indicate a preference for the performance approach with PREFAPPR=1 indicating a strong preference for the performance approach

Table 9-2 Regression Model Summary of PREFAPPR and UNDSTAND

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.016	.000	-.015	2.0345

a Predictors: (Constant), How well do you feel that you understand the concepts of prescriptive and performance standards?(UNDSTAND)
b Dependent Variable: Conceptually, which approach to construction worker safety do you prefer?(PREFAPPR)

Does Preference Predict the Influence on Certain Defining Issues?

It was expected that respondents with a preference for the performance approach (PERFORM) would be likely to regard that approach as being more influential to each of 10 defining issues. On the 7-point Likert scale used to measure the level of influence, values <4 (decreasing values) of each of the defining issues such as NEWTECH, for example, indicated that respondents opined that the performance approach would be more influential. A value of 1 would indicate that the performance approach would be very strongly influential. The null hypothesis to be tested is that there is no relationship between PERFORM and each of these issues.

Ease of introduction of new technologies (NEWTECH)

The correlation between preference for the performance approach (PERFORM) and NEWTECH is shown in Table 9-3. The correlation between PERFORM and NEWTECH is negative (-.401), suggesting that as preference for the performance approach (PERFORM) increases, the value of NEWTECH decreases. Decreasing values of NEWTECH indicate increasingly that respondents regard the performance approach as being the more influential approach regarding the ease of introducing new technologies. The p value is 0.001 indicating that the correlation is statistically significant. Accordingly, the null hypothesis is rejected.

Table 9-3 Correlation between PERFORM and NEWTECH

Pearson Correlation	-.401**
Sig. (2-tailed)	.001
N	63

** Correlation is significant at the 0.01 level (2-tailed).

The regression model summary in Table 9-4 suggests that there is a linear relationship between PERFORM and NEWTECH since the value of R^2 is 0.161, suggesting that PERFORM accounts for 16.1% of the variability of NEWTECH.

Table 9-4 Regression Model Summary of PERFORM and NEWTECH

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.401	.161	.147	1.9994

a Predictors: (Constant), prefer=2 (FILTER) (PERFORM)
b Dependent Variable: How influential are the types of approaches to ease of introduction of new technologies? (NEWTECH)

Cost effectiveness of approach (COSTEFF)

The correlation between preference for the performance approach (PERFORM) and COSTEFF is shown in Table 9-5. The correlation between PERFORM and COSTEFF is negative (-.437). This correlation co-efficient suggests that as preference for the performance approach (PERFORM) increases, the value of COSTEFF decreases, indicating that respondents increasingly regarded the performance approach as being more influential regarding the cost effectiveness of an approach to construction worker safety.

The *p* value is 0.000 (or less than 0.0005) and is statistically significant indicating that the correlation does differ significantly from 0. Accordingly, the null hypothesis is rejected.

Table 9-5 Correlation of PERFORM and COSTEFF

Pearson Correlation	-.437**
Sig. (2-tailed)	.000
N	65

** Correlation is significant at the 0.01 level (2-tailed).

From Table 9-6, it is evident that there is a linear relationship between PERFORM and COSTEFF since the value of R^2 is 0.191. This value suggests that PERFORM accounts for 19.1% of the total variability of COSTEFF.

Table 9-6 Regression Model Summary of PERFORM and COSTEFF

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.437	.191	.178	1.8770

a Predictors: (Constant), prefer=2 (FILTER) (PERFORM)
b Dependent Variable: How influential are the types of approaches to cost effectiveness of approach? (COSTEFF)

Flexibility (FLEXIBLE)

The correlation between preference for the performance approach (PERFORM) and FLEXIBLE is shown in Table 9-7. The correlation between PERFORM and FLEXIBLE is negative (-.119). This value suggests that should preference for the performance approach (PERFORM) increase, the value of FLEXIBLE would decrease. Decreasing values indicate that respondents increasingly regard the performance approach as being the more influential regarding the flexibility of an approach to construction worker safety. The *p* value is 0.344 (2-tailed) indicating that the correlation does not differ significantly from 0. Accordingly, the null hypothesis is not rejected.

From the regression model summary in Table 9-8, it is evident that there is no strong linear relationship between PERFORM and FLEXIBLE since the value of R^2 is

0.014, suggesting that PERFORM accounts for 1.4% of the total variability of FLEXIBLE.

Table 9-7 Correlation of PERFORM and FLEXIBLE

Pearson Correlation	-.119
Sig. (2-tailed)	.344
N	65

Table 9-8 Regression Model Summary of PERFORM and FLEXIBLE

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.119	.014	-.001	1.8828

a Predictors: (Constant), prefer=2 (FILTER) (PERFORM)
b Dependent Variable: How influential are the types of approaches to flexibility? (FLEXIBLE)

Ease of implementation (IMPLEMEN)

The correlation between preference for the performance approach (PERFORM) and IMPLEMEN is shown in Table 9-9. The correlation between PERFORM and IMPLEMEN is negative (-.344), suggesting that as preference for the performance approach (PERFORM) increases, the value of IMPLEMEN decreases.

Table 9-9 Correlation of PERFORM and IMPLEMEN

Pearson Correlation	-.344**
Sig. (2-tailed)	.005
N	65

** Correlation is significant at the 0.01 level (2-tailed).

This correlation co-efficient shows that respondents regarded the performance approach increasingly as being more influential regarding the ease of implementing an approach to construction worker safety. The *p* value is 0.005 (2-tailed) and is statistically significant. This value shows that the correlation does differ significantly from 0. The null hypothesis is therefore rejected.

From Table 9-10, it is evident that there is a linear relationship between PERFORM and IMPLEMEN. The value of R^2 is 0.118, suggesting that PERFORM accounts for 11.8% of the total variability of IMPLEMEN.

Table 9-10 Regression Model Summary of PERFORM and IMPLEMEN

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.344	.118	.104	1.8663

a Predictors: (Constant), prefer=2 (FILTER) (PERFORM)
b Dependent Variable: How influential are the types of approaches to ease of implementation? (IMPLEMEN)

Ease of understanding compliance requirements (COMPREQ)

The correlation between the preference for the performance approach (PERFORM) and COMPREQ is shown in Table 9-11. The correlation between PERFORM and COMPREQ is negative (-.406). This co-efficient suggests that as preference for the performance approach (PERFORM) increases, values of COMPREQ would decrease, indicating that respondents would increasingly regard the performance approach as being more influential regarding the ease of understanding the compliance requirements of an approach to construction worker safety. The *p* value associated with the correlation coefficient of -.406 is 0.001 (2-tailed) and is statistically significant. The correlation does differ significantly from 0. The null hypothesis is rejected.

There is a linear relationship between PERFORM and COMPREQ since the value of R^2 is 0.165 (Table 9-12). This value suggests that PERFORM accounts for 16.5% of the total variability of COMPREQ.

Table 9-11 Correlation of PERFORM and COMPREQ

Pearson Correlation	-.406**
Sig. (2-tailed)	.001
N	65

** Correlation is significant at the 0.01 level (2-tailed).

Table 9-12 Regression Model Summary of PERFORM and COMPREQ

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.406	.165	.152	1.8613

a Predictors: (Constant), prefer=2 (FILTER) (PERFORM)
b Dependent Variable: How influential are the types of approaches to ease of understanding compliance requirements? (COMPREQ)

Support for innovation (INNOVATE)

The correlation between preference for the performance approach (PERFORM) and INNOVATE is shown in Table 9-13. The correlation between PERFORM and INNOVATE is negative (-.045), suggesting that should preference for the performance approach (PERFORM) increase, the value of INNOVATE would decrease. Decreasing values of INNOVATE indicate that respondents increasingly regard the performance approach as more influential than the prescriptive approach regarding the support for innovation in an approach to construction worker safety. The *p* value is 0.723 indicating that the correlation does not differ significantly from 0. The null hypothesis is not rejected.

Table 9-13 Correlation of PERFORM and INNOVATE

Pearson Correlation	-.045
Sig. (2-tailed)	.723
N	65

The regression model summary in Table 9-14 suggests that there is no strong linear relationship between PERFORM and INNOVATE since the value of R^2 is 0.002, suggesting that PERFORM accounts for 0.2% of the total variability of INNOVATE.

Table 9-14 Regression Model Summary of PERFORM and INNOVATE

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.045	.002	-.014	1.9977

a Predictors: (Constant), prefer=2 (FILTER) (PERFORM)
b Dependent Variable: How influential are the types of approaches to support for innovation? (INNOVATE)

Ease of introduction of new materials (NEWMATLS)

The correlation between preference for the performance approach (PERFORM) and NEWMATLS is shown in Table 9-15. The correlation between PERFORM and NEWMATLS is negative (-.386), suggesting that as preference for the performance approach (PERFORM) increases, values of NEWMATLS would decrease. This trend suggests that respondents regarded the performance approach increasingly as more influential regarding the ease of introducing new materials. The *p* value associated with the correlation coefficient of -.386 is 0.002 (2-tailed) and is statistically significant. The correlation does differ significantly from 0. The null hypothesis is rejected.

Table 9-15 Correlation of PERFORM and NEWMATLS

Pearson Correlation	-.386**
Sig. (2-tailed)	.002
N	65

** Correlation is significant at the 0.01 level (2-tailed).

From the regression model summary in Table 9-16, it is evident that there is a linear relationship between PERFORM and NEWMATLS since the value of R^2 is 0.149.

This value suggests that PERFORM accounts for 14.9% of the variability of NEWMATLS.

Table 9-16 Regression Model Summary of PERFORM and NEWMATLS

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
	.386	.149	.135	1.8366

a Predictors: (Constant), prefer=2 (FILTER) (PERFORM)
b Dependent Variable: How influential are the types of approaches to ease of introduction of new materials? (NEWMATLS)

Supported by corporate culture, vision and mission of the organization (CULTURE)

The correlation between preference for the performance approach (PERFORM) and CULTURE is shown in Table 9-17. The correlation between PERFORM and CULTURE is negative (-.326). This value of the correlation coefficient suggests that as preference for the performance approach (PERFORM) increases, values of CULTURE would decrease. This tendency shows that respondents would increasingly regard the performance approach as the more influential approach regarding whether an approach to construction worker safety supported the corporate culture, vision and mission of their firms. The *p* value is 0.008 (2-tailed) and is statistically significant. The correlation does differ significantly from 0. Accordingly, the null hypothesis is rejected.

Table 9-17 Correlation of PERFORM and CULTURE

Pearson Correlation	-.326**
Sig. (2-tailed)	.008
N	65

** Correlation is significant at the 0.01 level (2-tailed).

From Table 9-18, it is evident that there is a linear relationship between PERFORM and CULTURE. The value of R^2 is 0.106. This value suggests that PERFORM accounts for 10.6% of the total variability of CULTURE.

Table 9-18 Regression Model Summary of PERFORM and CULTURE

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.326	.106	.092	1.8916

a Predictors: (Constant), prefer=2 (FILTER) (PERFORM)
b Dependent Variable: How influential are the types of approaches to corporate culture, vision and mission of your organization? (CULTURE)

Potential to improve safety performance on sites (SAFETY)

The correlation between preference for the performance approach (PERFORM) and SAFETY is shown in Table 9-19. The correlation between PERFORM and SAFETY is negative (-.388), suggesting that as preference for the performance approach (PERFORM) increases, values of SAFETY would decrease. This trend shows that respondents increasingly regarded the performance approach as being the more influential approach with regard to the potential of an approach to improve safety performance on construction sites. The *p* value 0.001 (2-tailed) and statistically significant indicating that the correlation does differ significantly from 0. The null hypothesis is rejected.

Table 9-19 Correlation of PERFORM and SAFETY

Pearson Correlation	-.388**
Sig. (2-tailed)	.001
N	65

** Correlation is significant at the 0.01 level (2-tailed).

Evidently, that there is a linear relationship between PERFORM and SAFETY (Table 9-20) since the value of R^2 is 0.151, suggesting that PERFORM accounts for 15.1% of the total variability of SAFETY.

Table 9-20 Regression Model Summary of PERFORM and SAFETY

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.388	.151	.137	1.9476

a Predictors: (Constant), prefer=2 (FILTER) (PERFORM)
b Dependent Variable: How influential are the types of approaches to potential to improve safety performance on sites? (SAFETY)

Simplicity of interpretation (SIMPLE)

The correlation between preference for the performance approach (PERFORM) and SIMPLE is shown in Table 9-21. The correlation between PERFORM and SIMPLE is negative (-.377). This value of the correlation coefficient suggests that as preference for the performance approach (PERFORM) increases, values of SIMPLE would decrease. Respondents would regard the performance approach increasingly as the more influential approach. The *p* value associated with the correlation coefficient of -.377 is 0.002 (2-tailed) and statistically significant. This value shows that the correlation does differ significantly from 0. The null hypothesis is rejected.

Table 9-21 Correlation of PERFORM and SIMPLE

Pearson Correlation	-.377**
Sig. (2-tailed)	.002
N	65

** Correlation is significant at the 0.01 level (2-tailed).

From the regression model summary in Table 9-22, it is evident that there is a linear relationship between PERFORM and SIMPLE since the value of R^2 is 0.142. This value suggests that PERFORM accounts for 14.2% of the total variability of SIMPLE.

Table 9-22 Regression Model Summary of PERFORM and SIMPLE

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.377	.142	.129	2.0885

a Predictors: (Constant), prefer=2 (FILTER) (PERFORM)
b Dependent Variable: How influential are the types of approaches to simplicity of interpretation? (SIMPLE)

Ease of compliance (COMPEASE)

The correlation between preference for the performance approach (PERFORM) and COMPEASE is shown in Table 9-23. The correlation between PERFORM and COMPEASE is negative (-.486), suggesting that as preference for the performance approach (PERFORM) increases, values of COMPEASE decrease. This trend shows that respondents increasingly regarded the performance approach as the more influential approach regarding the ease of complying with an approach to construction worker safety. The *p* value is 0.000 (2-tailed) and is statistically significant. The correlation differs significantly from 0. The null hypothesis is rejected.

Table 9-23 Correlation of PERFORM and COMPEASE

Pearson Correlation	-.486**
Sig. (2-tailed)	.000
N	64

** Correlation is significant at the 0.01 level (2-tailed).

From Table 9-24, it is evident that there is a strong linear relationship between PERFORM and COMPEASE since the value of R^2 is 0.236. This value is interpreted as the proportion of the total variation in COMPEASE accounted for by PERFORM. It suggests that PERFORM accounts for 23.6% of the total variability of COMPEASE.

Table 9-24 Regression Model Summary of PERFORM and COMPEASE

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.486	.236	.224	1.7847

a Predictors: (Constant), prefer=2 (FILTER) (PERFORM)
b Dependent Variable: How influential are the types of approaches to ease of compliance? (COMPEASE)

Does Preference Predict Importance of Safety Management Issues?

It was expected that respondents with a preference for the performance approach (PERFORM) would be more likely to regard as very important the 5 issues identified as being associated with why the performance approach should be the preferred approach to construction safety and health management. The null hypothesis to be tested is that there is no relationship between PERFORM and the 5 dependent variables. However, there were no significant correlations with the dependent variables. For example, the correlation between PERFORM and COST is shown in Table 9-25.

Table 9-25 Correlation of PERFORM and COST

Pearson Correlation	.118
Sig. (2-tailed)	.354
N	64

The correlation between preference for the performance approach (PERFORM) and the cost effectiveness of an approach to construction safety and health management (COST) is positive (0.354), suggesting that as PERFORM increases, COST would increase marginally. This tendency shows a statistically insignificant increase in the importance of cost effectiveness (COST) regarding an approach to construction safety. The *p* value associated with COST is 0.118 indicating that the correlation does not differ significantly from 0. The null hypothesis that there is no relationship between PERFORM and COST is not rejected.

From the regression model summary in Table 9-26, it is evident that there is no linear relationship between PERFORM and COST since the value of R^2 is 0.014. This value suggests that PERFORM accounts for 1.4% of the total variability of COST.

Table 9-26 Regression Model Summary of PERFORM and COST

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.118	.014	-.002	1.7673

a Predictors: (Constant), prefer=2 (FILTER) (PERFORM)
b Dependent Variable: How important do you regard the cost effectiveness of approach regarding an approach to construction safety and health management? (COST)

Does Management Position Predict Preference?

Similarly, it was expected that positions of respondents within the management structures of their firms, namely, CEO, PROJECT, and SAFEDIR, would be predictors of the preference of for the performance approach (PERFORM). The null hypothesis to be tested is that there is no relationship between job position and preference for the performance approach. There were no significant correlations with the dependent variables. The null hypothesis is not rejected. The R^2 value of 0.041 from the regression analysis model suggests that CEO, PROJECT, and SAFEDIR together predict 4.1% of the total variability of PERFORM.

Does Firm Size Predict Preference for the Performance Approach?

It was expected that size of firms, namely, EMPLOYNO and CONTVALU, would be predictors of the preference for the performance approach (PERFORM). The null hypothesis to be tested is that there is no relationship between the size of the firm and preference for the performance approach. There were no significant correlations with the dependent variables. Accordingly, the null hypothesis is not rejected. The R^2 value of 0.011 from the regression analysis model suggests that EMPLOYNO and CONTVALU together predict 1.1% of the total variability of PERFORM.

Regression Modeling

Measures for each of questions 7, 8, 10, 17 and 18 were obtained by recoding the responses into different variables. The score of each case in these variables was calculated by adding up each response to a sub-part of a question and then dividing by the number of sub-parts. For example, for question 8 the scores of the responses to each of the 5 sub-parts were added for each respondent, and then divided by 5 to give the score for that case. In the same way the scores to questions 12 through 16 were combined to give a single score for a different recoded variable.

Using these recoded variables, the correlations measured with Pearson Correlation with significance at the 0.05 level (2-tailed) and 0.01 level (2-tailed) were helpful in assessing which of them might indicate the tendency of top management to involve workers in bringing about change to improve safety performance. These correlations were also used to assess which variables might indicate the tendency of top management to regard as important, actions to be taken for the successful implementation of a new approach to construction worker safety and health. The frequency distributions of each variable are shown in Figures 9.1 to 9.6 and correlations in Table 9-27.

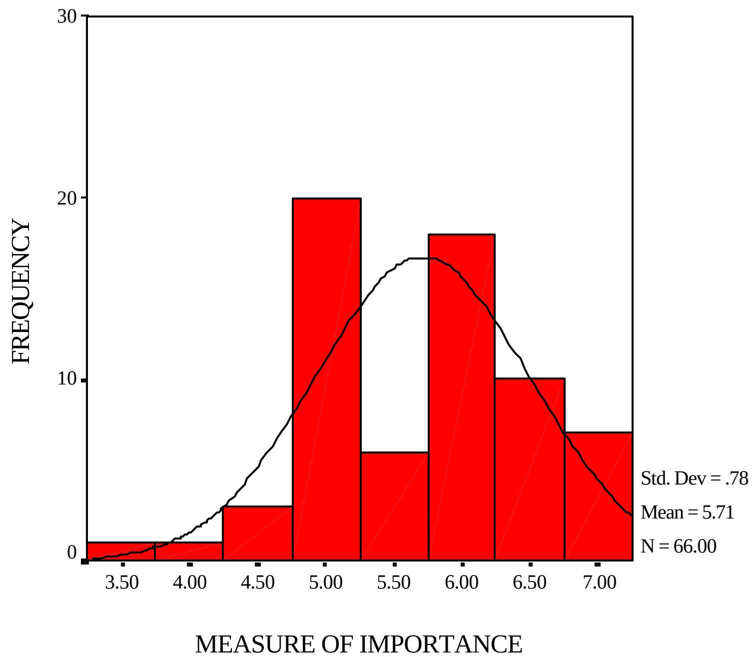


Figure 9-1 Importance of safety management issues (SAFEMAN)

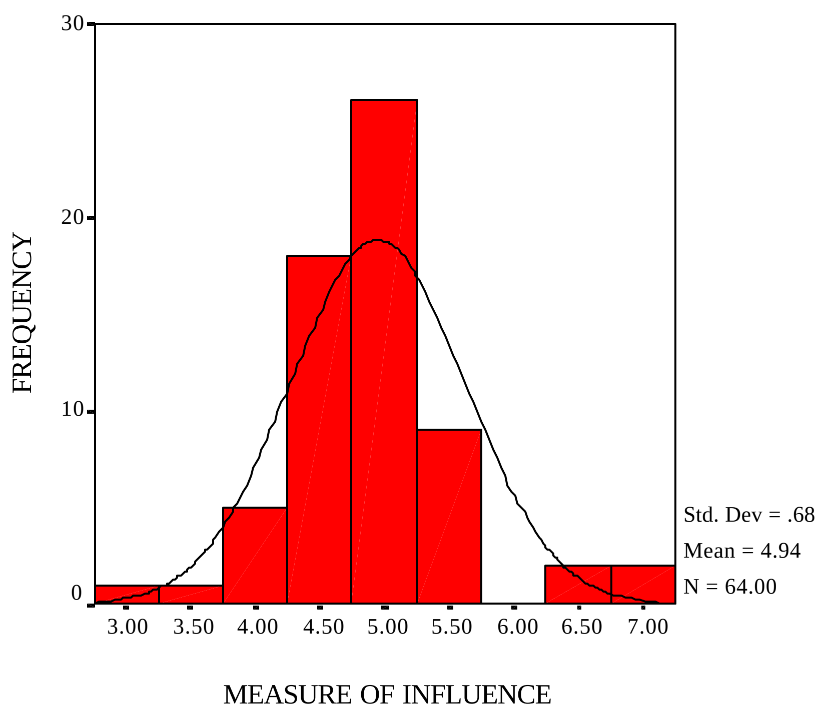
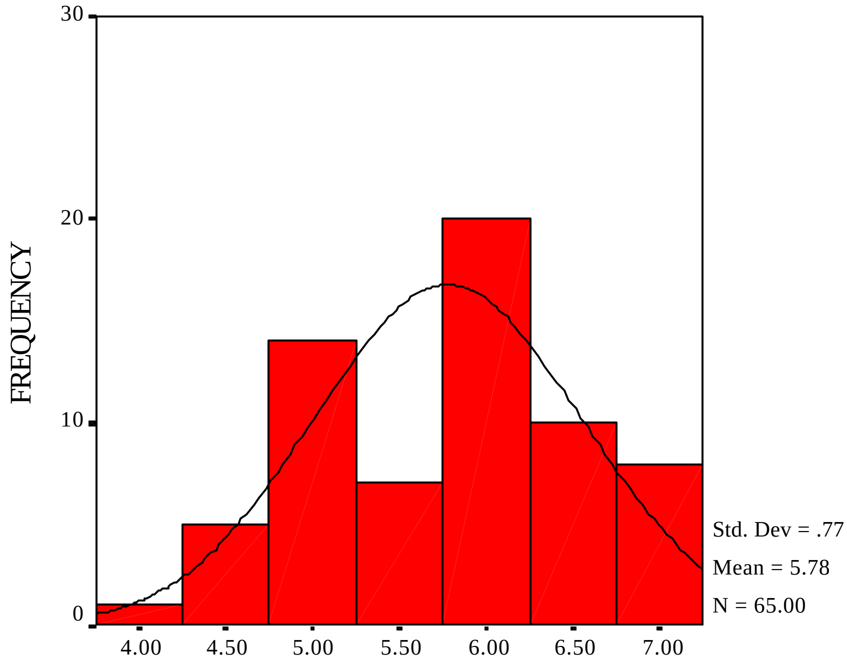
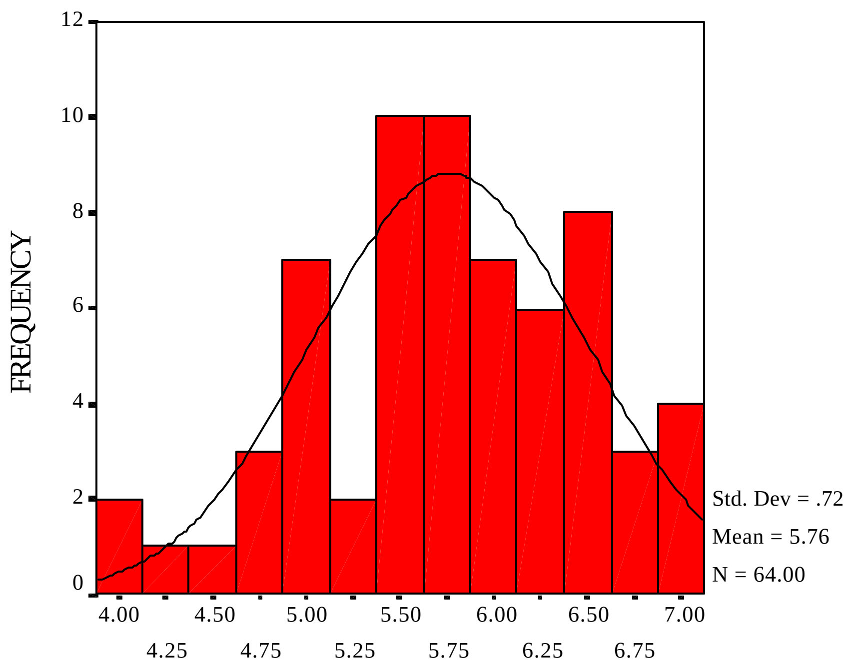


Figure 9-2 Influence of change-driving issues (CHGDRIVS)



MEASURE OF IMPORTANCE

Figure 9-3 Importance of worker participation in change (WKRPART)



MEASURE OF IMPORTANCE

Figure 9-4 Importance of implementation factors (IMPLFACT)

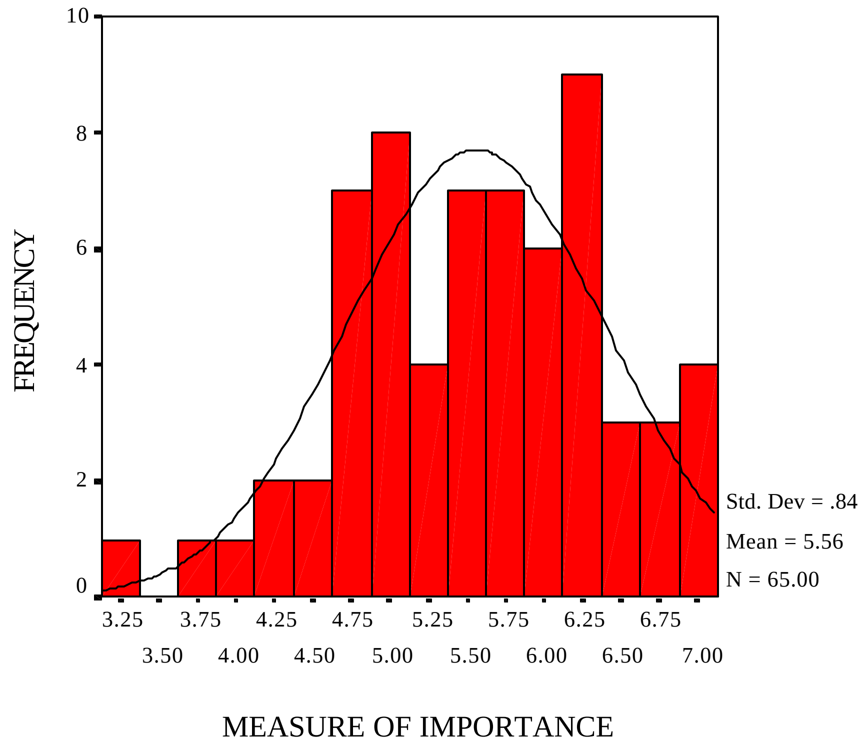


Figure 9-5 Importance of actions for successful implementation (SUCSACTS)

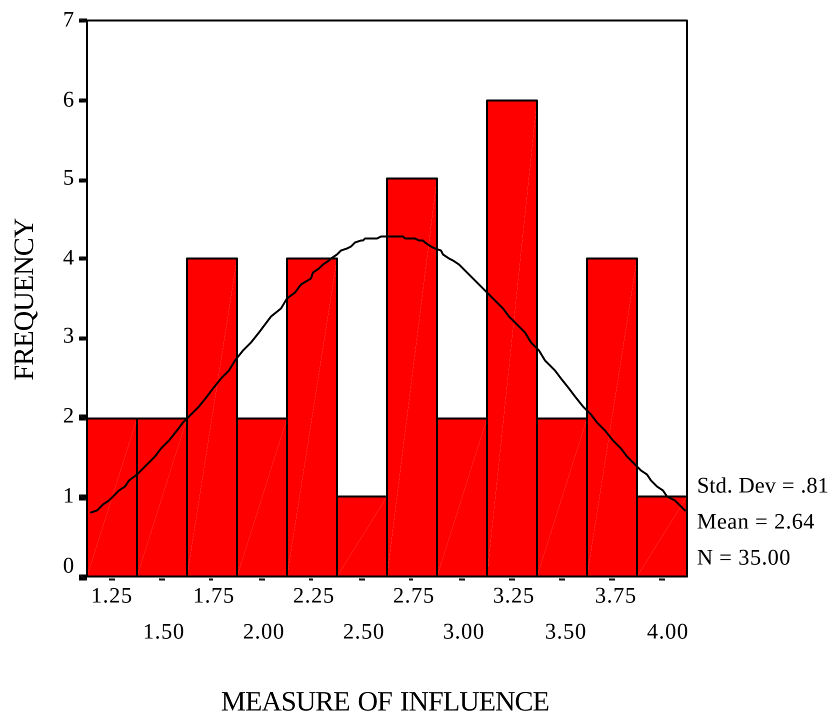


Figure 9-6 Influence of performance approach (PERFINFL)

Table 9-27 Correlations of recoded variables

	SAFEMAN	CHGDRIVS	WKRPART	IMPLFACT	SUCSACTS	PERFINFL
Pearson Correlation	1.000	.251*	.387**	.410**	.381**	-.378*
Sig. (2-tailed)	.	.047	.002	.001	.002	.027
N	66	63	64	63	64	34
Pearson Correlation	.251*	1.000	.384**	.541**	.516**	-.183
Sig. (2-tailed)	.047	.	.002	.000	.000	.308
N	63	64	62	61	62	33
Pearson Correlation	.387**	.384**	1.000	.368**	.243	-.222
Sig. (2-tailed)	.002	.002	.	.003	.053	.200
N	64	62	65	63	64	35
Pearson Correlation	.410**	.541**	.368**	1.000	.668**	-.147
Sig. (2-tailed)	.001	.000	.003	.	.000	.416
N	63	61	63	64	63	33
Pearson Correlation	.381**	.516**	.243	.668**	1.000	-.177
Sig. (2-tailed)	.002	.000	.053	.000	.	.316
N	64	62	64	63	65	34
Pearson Correlation	-.378*	-.183	-.222	-.147	-.177	1.000
Sig. (2-tailed)	.027	.308	.200	.416	.316	.
N	34	33	35	33	34	35

* Correlation is significant at the 0.05 level (2-tailed).

** Correlation is significant at the 0.01 level (2-tailed).

The following hypotheses were tested with single-step multiple linear regression analysis:

- H1: The demographic characteristics of management position (JOBTITLE), size of organization, (EMPLOYNO and CONTVALU) and source of contracting income (CMAGENCY + GENCON + SUBCONT + CMATRISK + SPECIAL+ DESIGNB) are predictors of determining the importance accorded to actions to be taken for the successful application of a new approach to construction worker safety and health (SUCSACTS).
- H2: The influence of the performance approach (PERFINFL) is a negative predictor of determining the importance accorded to actions to be taken for the successful application of a new approach to construction worker safety and health (SUCSACTS).
- H3: The importance of construction safety and health management issues (SAFEMAN) is a positive predictor of determining the importance accorded to actions to be taken for the successful application of a new approach to construction worker safety and health (SUCSACTS).

- H4: The importance of worker participation in bringing about change (WKRPART) is a positive predictor of determining the importance accorded to actions to be taken for the successful application of a new approach to construction worker safety and health (SUCSACTS).
- H5: The importance of implementation factors for new approaches (IMPLFACT) is a positive predictor of determining the importance accorded to actions to be taken for the successful application of a new approach to construction worker safety and health (SUCSACTS).
- H6: The importance of change-driving issues (CHGDRVS) is a positive predictor of determining the importance accorded to actions to be taken for the successful application of a new approach to construction worker safety and health (SUCSACTS).
- H7: The demographic characteristics of management position (JOBTITLE), size of organization, (EMPLOYNO and CONTVALU) and source of contracting income (CMAGENCY + GENCON + SUBCONT + CMATRISK + SPECIAL+ DESIGNB) are predictors of determining the importance accorded to worker participation in bringing about change (WKRPART).
- H8: The influence of the performance approach (PERFINFL) is a negative predictor of determining the importance accorded to worker participation in bringing about change (WKRPART).
- H9: The importance of construction safety and health management issues (SAFEMAN) is a positive predictor of determining the importance accorded to worker participation in bringing about change (WKRPART).
- H10: The importance of implementation factors for new approaches (IMPLFACT) is a positive predictor of determining the importance accorded to worker participation in bringing about change (WKRPART).
- H11: The importance of change-driving issues (CHGDRVS) is a positive predictor of determining the importance accorded to worker participation in bringing about change (WKRPART).
- H12: The importance of change-driving issues (CHGDRIVS) is a positive predictor of determining the importance of construction safety and health management issues (SAFEMAN).
- H13: The importance of implementation factors for new approaches (IMPLFACT) is a positive predictor of determining the importance of construction safety and health management issues (SAFEMAN).
- H14: The influence of the performance approach (PERFINFL) is a negative predictor of determining the importance of construction safety and health management issues (SAFEMAN).
- H15: The importance of change-driving issues (CHGDRIVS) is a positive predictor of determining the importance of implementation factors for new approaches (IMPLFACT).
- H16: The importance given to construction safety and health management issues (SAFEMAN) is a positive predictor of the importance of building trust and credibility with workers before implementing a change (WKRTRUST).
- H17: The importance given to the receptiveness of first-line supervisors (foremen) to change (FOREMEN) is a positive predictor of the importance of enlisting the opinions of workers on a proposed change before it is implemented (WKROPIN).

Importance of Actions for (SUSACTS)

Demographic characteristics (H1)

H1 is not supported by multiple linear regression. There are no significant correlations between the independent variables (predictors) and the dependent variable SUCSACTS. From the regression model summary in Table 9-28, it is evident that knowing management position (JOBTITLE), size of organization, (EMPLOYNO and CONTVALU) and source of contracting income (CMAGENCY + GENCON + SUBCONT + CMATRISK + SPECIAL+ DESIGNB) together only explain 0.1% (using adjusted R^2[69]) of the total variability in SUCSACTS.

Table 9-28 Regression model summary of demographic characteristics and SUCSACTS

Model	R	R^2	Adjusted R^2	Std. Error of the Estimate
1	.409	.167	.001	.8443

a Predictors: (Constant), % other, % specialty contracting, % design-build, What is the approximate annual value of construction contracts?, % construction management at risk, % construction management (agency), % subcontracting, What is your position within your organization, Approximately what is the average number of employees in your firm?, % general contracting
b Dependent Variable: Importance of actions for successful implementation (SUCSACTS)

They are statistically weak predictors of determining the importance accorded to actions to be taken for the successful application of a new approach to construction worker safety and health (SUSACTS) such as the performance approach.

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[69] For multiple regression models the sample estimate of R^2 tends to be an overestimate of the population parameter. Adjusted R^2 is designed to compensate for the optimistic bias of R^2 and reflects more closely how well the model fits the population. It is a function of R^2 adjusted by the number of variables in the model and the sample size (SPSS, 1999).

From Table 9-29, it is evident that the F statistic is very small (1.004) and not statistically significant, indicating that the simultaneous test that each coefficient is 0 is not rejected. The hypothesis H1 is rejected.

Table 9-29 ANOVA of demographic characteristics and SUCSACTS

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	7.154	10	.715	1.004	.454
	Residual	35.644	50	.713		
	Total	42.798	60			

a Predictors: (Constant), % other, % specialty contracting, % design-build, What is the approximate annual value of construction contracts?, % construction management at risk, % construction management (agency), % subcontracting, What is your position within your organization, Approximately what is the average number of employees in your firm?, % general contracting
b Dependent Variable: Importance of actions for successful implementation (SUCSACTS)

Influence of the performance approach (H2)

Similarly, H2 is not supported by simple linear regression. Of the sample of 34 respondents, the mean value of the importance of actions for the successful implementation of a new approach to construction worker safety and health SUCSACTS) was 5.67,[70] and the mean value of the influence of the performance approach (PERFINFL) was 2.64.[71] From the regression model summary in Table 9-30, it is evident

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[70] A 7-point Likert scale of importance was used, with 1 = not important at all; 4 = neutral; and 7 = very important

[71] In this case, values at the lower end of the 7-point Likert scale of influence represent an increasing influence of the performance approach. Similarly, values at the higher end of the 7-point Likert scale of influence represent an increasing influence of the prescriptive approach. The value 4 represents neutral influence.

that PERFINFL is a statistically weak predictor of SUCSACTS. The R^2 value[72] is 0.031 and accounts for 3.1% of the total variability in SUCSACTS. The standard error of the estimate (.8148) compares favorably[73] with the standard deviation of SUCSACTS (.8153).

From Table 9-31, it is evident that the *F* statistic is 1.038 and therefore not statistically significant, indicating that the test that each coefficient is 0 is not rejected.

Table 9-30 Regression Model Summary of SUCSACTS and PERFINFL

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.177	.031	.001	.8148

a Predictors: (Constant), Influence of performance approach (PERFINFL)
b Dependent Variable: Importance of actions for successful implementation (SUCSACTS)

Table 9-31 ANOVA of SUCSACTS and PERFINFL

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	.689	1	.689	1.038	.316
	Residual	21.245	32	.664		
	Total	21.934	33			

a Predictors: (Constant), Influence of performance approach (PERFINFL)
b Dependent Variable: Importance of actions for successful implementation (SUCSACTS)

From Table 9-32, it is evident that the predictor (PREFINFL) is not useful since the *t* value (-1.019) is not below -2. On the other hand, the *t* value of SUCSACTST is above 2, satisfying the usefulness guidelines. However, it is necessary for both *t* values to

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[72] The R^2 value is used in this case because there are only 2 variables in the regression model and simple regression is used. If R^2 is 0 or very small, there is no linear relation between the dependent and the independent variable.

[73] If the standard error of the estimate is not less than the standard deviation, then the regression model is no better than the mean as a predictor of the dependent variable (SPSS, 1999)

satisfy the guidelines to be useful (SPSS, 1999). The hypothesis H2 is rejected that the influence of the performance approach is a negative predictor of determining the importance accorded to actions to be taken for the successful application of a new approach to construction worker safety and health (SUSACTS) such as the performance approach.

Table 9-32 Coefficients of SUCSACTS and PERFINFL

		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
Model		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	6.135	.476		12.879	.000		
	PERFINFL	-.175	.172	-.177	-1.019	.316	1.000	1.000

a Dependent Variable: Importance of actions for successful implementation

Importance of construction safety and health management (H3)

Of the sample of 64 respondents, the mean value[74] of the importance of actions for the successful implementation of a new approach to construction worker safety and health (SUCSACTS) was 5.54 and the mean value of the importance[75] of issues to safety management was 5.72.

Table 9-33 Regression Model Summary of SAFEMAN and SUCSACTS

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.381	.145	.131	.7783

a Predictors: (Constant), Importance of issues to safety management (SAFEMAN)
b Dependent Variable: Importance of actions for successful implementation (SUCSACTS)

[74] A 7-point Likert scale of importance was used, with 1 = not important at all; 4 = neutral; and 7 = very important

[75] A 7-point Likert scale of importance was used, with 1 = not important at all; 4 = neutral; and 7 = very important

The correlation between SAFEMAN and SUCSACTS is positive (.381) (2-tailed) and statistically significant, suggesting that as the importance of safety management issues (SAFEMAN) increases, the importance of actions for the successful implementation of a new approach to worker safety (SUCSACTS) also increases. The *p* value is .002 indicating that the correlation differs significantly from 0. From the regression model summary in Table 9-33, it is evident that SAFEMAN is a strong predictor of SUCSACTS. The R^2 value is significant (0.145) and accounts for a significant portion (14.5%) of the total variability in SUCSACTS. The standard error (.7783) compares favorably with the standard deviation of SUCSACTS (.8350).

From Table 9-34, it is evident that the *F* statistic is not small (10.509) and therefore, statistically significant, indicating that the test that each coefficient is 0 is rejected. The independent variable SAFEMAN explains a significant portion of the variation of the dependent variable SUCSACTS. The linear relationship is highly significant (.002).

Table 9-34 ANOVA of SAFEMAN and SUCSACTS

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	6.366	1	6.366	10.509	.002
	Residual	37.558	62	.606		
	Total	43.924	63			

a Predictors: (Constant), Importance of issues to safety management (SAFEMAN)
b Dependent Variable: Importance of actions for successful implementation (SUCSACTS)

Using the coefficients from Table 9-35, the estimated model is:

SUCSACTS = 3.248 + .401 SAFEMAN

Evidently the predictors are useful since the *t* values of 4.550 and 3.242 satisfy the usefulness guidelines of either being above +2 or well below -2.

The hypothesis H3 is accordingly not rejected that the importance of construction safety and health management issues is a positive predictor of determining the importance accorded to actions to be taken for the successful application of a new approach to construction worker safety.

Table 9-35 Coefficients of SAFEMAN and SUCSACTS

		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
Model		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	3.248	.714		4.550	.000		
	SAFEMAN	.401	.124	.381	3.242	.002	1.000	1.000

a Dependent Variable: Importance of actions for successful implementation (SUCSACTS)

Importance of worker participation (H4)

Of the sample of 64 respondents, the mean value of the importance of actions for the successful implementation of a new approach to construction worker safety and health (SUCSACTS) was 5.54 and the mean value[76] of the importance of worker participation (WKRPART) was 5.80. The correlation between WKRPART and SUCSACTS is positive (.243) and statistically insignificant. The *p* value is .053. The correlation does not differ significantly from 0.

From Table 9-36, it is evident that WKRPART is a weak predictor of SUCSACTS. The R^2 value is very small (0.059) and accounts for a very small portion (5.9%) of the total variability in SUCSACTS. The standard error (.8199) compares favorably with the standard deviation of SUCSACTS (.8385).

[76] A 7-point Likert scale of importance was used, with 1 = not important at all; 4 = neutral; and 7 = very important

Table 9-36 Regression Model Summary of WKRPART and SUCSACTS

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.243	.059	.044	.8199

a Predictors: (Constant), Importance of worker participation in change (WKRPART)
b Dependent Variable: Importance of actions for successful implementation (SUCSACTS)

It is evident from Table 9-37 that the *F* statistic is 3.878 and statistically insignificant, indicating that the test that each coefficient is 0 is not rejected. The independent variable WKRPART does not explain a significant portion of the variation of the dependent variable SUCSACTS. The linear relationship is not statistically significant (.053).

Table 9-37 ANOVA of WKRPART and SUCSACTS

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	2.607	1	2.607	3.878	.053
	Residual	41.682	62	.672		
	Total	44.289	63			

a Predictors: (Constant), Importance of worker participation in change (WKRPART)
b Dependent Variable: Importance of actions for successful implementation (SUCSACTS)

From Table 9-38 , it is evident that the predictor WKRPART is not useful since the *t* value is not above +2 (1.969). On the other hand, the *t* value of SUCSACTST is above 2 (4.999), satisfying the usefulness guidelines. However, it is necessary for both *t* values to satisfy the guidelines to be useful.

The hypothesis H4 is rejected that the importance of worker participation in bringing about change is a positive predictor of determining the importance accorded to actions to be taken for the successful application of a new approach to construction worker safety.

Table 9-38 Coefficients of WKRPART and SUCSACTS

		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
Model		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	3.987	.797		4.999	.000		
	WKRPART	.269	.136	.243	1.969	.053	1.000	1.000

a Dependent Variable: Importance of actions for successful implementation (SUCSACTS)

Importance of implementation factors (H5)

Of the sample of 64 respondents, the mean value of the importance of actions for the successful implementation of a new approach to construction worker safety and health (SUCSACTS) was 5.54 and the mean value[77] of the importance of implementation factors for new approaches (IMPLFACT) was 5.75. The correlation between IMPLFACT and SUCSACTS is positive (.668) (2-tailed) and highly statistically significant. The *p* value is less than .0005 indicating that the correlation does differ significantly from 0.

Evidently, from Table 9-39, IMPLFACT is a strong predictor of SUCSACTS. The R^2 value is 0.446 and accounts for a significant portion (44.6%) of the total variability in SUCSACTS. The standard error (.6283) compares favorably with the standard deviation of SUCSACTS (.8376).

Table 9-39 Regression Model Summary of IMPLFACT and SUCSACTS

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.668	.446	.437	.6283

a Predictors: (Constant), Importance of factors on implementation (IMPLFACT)
b Dependent Variable: Importance of actions for successful implementation (SUCSACTS)

[77] A 7-point Likert scale of importance was used, with 1 = not important at all; 4 = neutral; and 7 = very important

From Table 9-40, the *F* statistic is large (49.172) and therefore highly statistically significant, indicating that the test that each coefficient is 0 is rejected. The independent variable IMPLFACT explains a significant portion of the total variation of the dependent variable SUCSACTS. The linear relationship is highly significant (p>.0005).

Table 9-40 ANOVA of IMPLFACT and SUCSACTS

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	19.412	1	19.412	49.172	.000
	Residual	24.081	61	.395		
	Total	43.493	62			

a Predictors: (Constant), Importance of factors on implementation (IMPLFACT)
b Dependent Variable: Importance of actions for successful implementation (SUCSACTS)

Using the coefficients from Table 9-41, the estimated model is:

SUCSACTS = 1.087 + .774 IMPLFACT

Table 9-41 Coefficients of IMPLFACT and SUCSACTS

		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
Model		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	1.087	.640		1.699	.094		
	IMPLFACT	.774	.110	.668	7.012	.000	1.000	1.000

a Dependent Variable: Importance of actions for successful implementation (SUCSACTS)

The hypothesis H5 is not rejected that the importance of implementation factors is a positive predictor of determining the importance accorded to actions to be taken for the successful application of a new approach to construction worker safety.

Importance of change-driving issues (H6)

Of the sample of 62 respondents, the mean value of the importance of actions for the successful implementation of a new approach to construction worker safety and health (SUCSACTS) was 5.53 and the mean value of the importance of change-driving issues (CHGDRIVS) was 4.94. The correlation between CHGDRIVS and SUCSACTS is positive (.516) (2-tailed) and statistically significant. The *p* value associated with the correlation coefficient of .516 is less than .0005 indicating that the correlation does differ significantly from 0.

From the regression model summary in Table 9-42, CHGDRIVS is a strong predictor of SUCSACTS. The R^2 value is large (0.266) and accounts for a significant portion (26.6%) of the total variability in SUCSACTS. The standard error (.7168) compares favorably with the standard deviation of SUCSACTS (.8300).

Table 9-42 Regression Model Summary of CHGDRIVS and SUCSACTS

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.516	.266	.254	.7168

a Predictors: (Constant), Influence of change-driving issues in organizations (CHGDRIVS)
b Dependent Variable: Importance of actions for successful implementation (SUCSACTS)

From Table 9-43, the *F* statistic is large (21.783) and highly significant, indicating that the test that each coefficient is 0 is rejected. The independent variable CHGDRIVS explains a significant portion of the variation of the dependent variable SUCSACTS. The linear relationship is highly significant (p>.0005).

Using the coefficients from Table 9-44, the estimated model is:

SUCSACTS = 2.451 + .623 CHGDRIVS

The predictors are useful since the *t* values of 3.679 and 4.667 satisfy the usefulness guidelines of either being above +2 or well below -2. The hypothesis H6 is not rejected that the importance of change-driving issues is a positive predictor of determining the importance accorded to actions to be taken for the successful application of a new approach to construction worker safety.

Table 9-43 ANOVA of CHGDRIVS and SUCSACTS

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	11.192	1	11.192	21.783	.000
	Residual	30.828	60	.514		
	Total	42.020	61			

a Predictors: (Constant), Influence of change-driving issues in organizations (CHGDRIVS)
b Dependent Variable: Importance of actions for successful implementation (SUCSACTS)

Table 9-44 Coefficients of CHGDRIVS and SUCSACTS

		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
Model		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	2.451	.666		3.679	.001		
	CHGDRIVS	.623	.134	.516	4.667	.000	1.000	1.000

a Dependent Variable: Importance of actions for successful implementation (SUCSACTS)

The various variables were ranked in order of their strength of prediction of the importance of actions for the successful application of a new approach to safety (SUCACTS), namely, the importance of implementation factors (IMPLFACT), change-driving issues (CHGDRIVS), safety and health management issues (SAFEMAN), worker participation (WKRPART), and influence of the performance approach (PERFINFL). To identify the key predictors of SUCSACTS, the independent variables were tested with stepwise multiple linear regression.

Stepwise regression produced 2 models. Of the 16 candidate predictors, 2 were included in the final model, namely, IMPLFACT and JOBTITLE. From the regression model summary in Table 9-45, it is evident that IMPLFACT is a strong predictor of SUCSACTS.

Table 9-45 Stepwise Regression Model Summary for predictors of SUCSACTS

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.603	.364	.338	.6227
2	.710	.505	.463	.5608

a Predictors: (Constant), Importance of factors on implementation (IMPLFACT)
b Predictors: (Constant), Importance of factors on implementation (IMPLFACT), What is your position within your organization (JOBTITLE)
c Dependent Variable: Importance of actions for successful implementation (SUCSACTS)

The R^2 value is 0.364 predicting a significant portion (33.8%) of the total variability in SUCSACTS, using the R^2 value. Together, IMPLFACT and JOBTITLE are stronger predictors of SUCSACTS. The resultant R^2 value is larger (.505) and accounts for a more significant portion (46.3%) of the total variability of SUCSACTS, using the adjusted R^2 value. The standard error decreases from .6227 when IMPLFACT is the only predictor to .5608 when the model includes JOBTITLE.

From Table 9-46, the *F* statistic is large (12.226) for the model including JOBTITLE and therefore statistically significant, indicating that the test that each coefficient is 0 is rejected. The combined independent variables, IMPLFACT and JOBTITLE, explain a significant portion of the total variation of the dependent variable SUCSACTS. The linear relationship is highly significant (p>.0005).

Table 9-46 ANOVA for predictors of SUCSACTS

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	5.545	1	5.545	14.299	.001
	Residual	9.695	25	.388		
	Total	15.240	26			
2	Regression	7.691	2	3.846	12.226	.000
	Residual	7.549	24	.315		
	Total	15.240	26			

a Predictors: (Constant), Importance of factors on implementation (IMPLFACT)
b Predictors: (Constant), Importance of factors on implementation (IMPLFACT), What is your position within your organization (JOBTITLE)
c Dependent Variable: Importance of actions for successful implementation (SUCSACTS)

Using the coefficients from Table 9-47, the final model is

SUCSACTS = .730 + .735 IMPLFACT + .250 JOBTITLE

Table 9-47 Coefficients for predictors of SUCSACTS

		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
Model		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	1.022	1.183		.864	.396		
	IMPLFACT	.777	.205	.603	3.781	.001	1.000	1.000
2	(Constant)	.730	1.071		.682	.502		
	IMPLFACT	.735	.186	.571	3.963	.001	.993	1.007
	JOBTITLE	.250	.096	.377	2.612	.015	.993	1.007

a Dependent Variable: Importance of actions for successful implementation (SUCSACTS)

It is evident that the predictors are useful since their *t* values in each model satisfy the usefulness guidelines of either being above +2. The standard errors are smaller in the final model than when only IMPLFACT is the predictor.

Importance of Worker Participation (WKRPART)

Demographic characteristics (H7)

H7 is not supported by multiple linear regression. There are no significant correlations between the independent variables (predictors) and the dependent variable WKRPART. From Table 9-48, management position (JOBTITLE), size of organization, (EMPLOYNO and CONTVALU) and source of contracting income (CMAGENCY + GENCON + SUBCONT + CMATRISK + SPECIAL+ DESIGNB) are weak predictors of the importance of worker participation (WKRPART). These variables together predict 0.9% of the total variability in WKRPART, using the adjusted R^2 value of .009.

Table 9-48 Regression Model Summary of demographic characteristics and WKRPART

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.421	.177	.009	.7615

a Predictors: (Constant), % other, % construction management (agency), % design-build, % specialty contracting, % construction management at risk, What is the approximate annual value of construction contracts?, % subcontracting, What is your position within your organization, Approximately what is the average number of employees in your firm?, % general contracting
b Dependent Variable: Importance of worker participation in change (WKRPART)

Table 9-49 ANOVA of demographic characteristics and WKRPART

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	6.104	10	.610	1.053	.416
	Residual	28.413	49	.580		
	Total	34.517	59			

a Predictors: (Constant), % other, % construction management (agency), % design-build, % specialty contracting, % construction management at risk, What is the approximate annual value of construction contracts?, % subcontracting, What is your position within your organization, Approximately what is the average number of employees in your firm?, % general contracting
b Dependent Variable: Importance of worker participation in change (WKRPART)

The *F* statistic from Table 9-49 is 1.053 and not statistically significant, indicating that the simultaneous test that each coefficient is 0 is not rejected.

The hypothesis H7 is rejected that demographic characteristics are predictors of worker participation in bringing about change.

Influence of performance approach (H8)

Similarly, H8 is not supported by simple linear regression. Of the sample of 35 respondents, the mean value[78] of the importance of worker participation in bringing about a change in approach to construction worker safety and health (WKRPART) was 5.78 and the mean value[79] of the influence of the performance approach (PERFINFL) was 2.64. The correlation between PERFINFL and WKRPART is -.222 and statistically insignificant. From the regression model summary in Table 9-50, PERFINFL is a weak predictor of WKRPART. The R^2 value is very small (0.049) and accounts for 4.9% of the variability in WKRPART. The standard error of the estimate (.8334) compares favorably with the standard deviation of WKRPART (.8421).

Table 9-50 Regression Model Summary of PERFINFL and WKRPART

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.222	.049	.021	.8334

a Predictors: (Constant), Influence of performance approach (PERFINFL)
b Dependent Variable: Importance of worker participation in change (WKRPART)

From Table 9-51, the *F* statistic is small (1.189) and therefore not statistically significant (.200), indicating that the test that each coefficient is 0 is not rejected.

[78] A 7-point Likert scale of importance was used, with 1 = not important at all; 4 = neutral; and 7 = very important

[79] In this case, values at the lower end of the 7-point Likert scale of influence represent an increasing influence of the performance approach. Similarly, values at the higher end of the 7-point Likert scale of influence represent an increasing influence of the prescriptive approach. The value 4 represents neutral influence.

Table 9-51 ANOVA of PERFINFL and WKRPART

Model		Sum of Squares	df	Mean Square	F	Sig.
	Regression	1.189	1	1.189	1.712	.200
	Residual	22.921	33	.695		
	Total	24.110	34			

a Predictors: (Constant), Influence of performance approach (PERFINFL)
b Dependent Variable: Importance of worker participation in change (WKRPART)

The predictor (PREFINFL) is not useful (Table 9-52) since the *t* value is not below -2 (-1.308). On the other hand, the *t* value of WKRPART is above 2 (13.137), satisfying the usefulness guidelines. However, it is necessary for both *t* values to satisfy the guidelines to be useful. The hypothesis H8 is rejected that the influence of the performance approach is a negative predictor of worker participation in bringing about change.

Table 9-52 Coefficients of PERFINFL and WKRPART

		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
Model		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	6.392	.487		13.137	.000		
	PERFINFL	-.230	.176	-.222	-1.308	.200	1.000	1.000

a Dependent Variable: Importance of worker participation in change (WKRPART)

Importance of construction safety and health management issues (H9)

Of the sample of 64 respondents, the mean value[80] of the importance of worker participation in bringing about a change in approach to construction worker safety and

[80] A 7-point Likert scale of importance was used, with 1 = not important at all; 4 = neutral; and 7 = very important

health (WKRPART) was 5.78 and the mean value[81] of the importance of issues to safety management (SAFEMAN) was 5.71. The correlation between SAFEMAN and WKRPART is .387 (2-tailed), and statistically significant suggesting that as the importance of construction safety issues (SAFEMAN) increases, worker participation (WKRPART) increases. The *p* value is .002 indicating that the correlation differs significantly from 0. From the regression model summary in Table 9-53, SAFEMAN is a strong predictor of WKRPART. The R^2 value is significant (0.149) and accounts for a significant portion (14.9%) of the total variability in WKRPART. The standard error (.7229) compares favorably with the standard deviation of WKRPART (.7776).

Table 9-53 Regression Model Summary of SAFEMAN and WKRPART

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.387	.149	.136	.7229

a Predictors: (Constant), Importance of issues to safety management (SAFEMAN)
b Dependent Variable: Importance of worker participation in change (WKRPART)

Evidently, from Table 9-54, the *F* statistic is not small (10.894) and therefore statistically significant, indicating that the test that each coefficient is 0 is rejected. The independent variable SAFEMAN explains a significant portion of the variation of the dependent variable WKRPART. The linear relationship is highly significant (.002).

From Table 9-55, it is evident that the predictor SAFEMAN is useful since the *t* value is +2 (3.301). On the other hand, the *t* value of WKRPART is also above +2 (5.471), satisfying the usefulness guidelines. The hypothesis H9 is not rejected that the importance of construction safety issues is a positive predictor of worker participation in bringing about change.

[81] A 7-point Likert scale of importance was used, with 1 = not important at all; 4 =

Table 9-54 ANOVA of SAFEMAN and WKRPART

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	5.692	1	5.692	10.894	.002
	Residual	32.397	62	.523		
	Total	38.089	63			

a Predictors: (Constant), Importance of issues to safety management (SAFEMAN)
b Dependent Variable: Importance of worker participation in change (WKRPART)

Using the coefficients from Table 9-55, the estimated model is:

WKRPART = 3.617 + .379 SAFEMAN

Table 9-55 Coefficients of SAFEMAN and WKRPART

		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
Model		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	3.617	.661		5.471	.000		
	SAFEMAN	.379	.115	.387	3.301	.002	1.000	1.000

a Dependent Variable: Importance of worker participation in change (WKRPART)

– **Importance of implementation factors for new approaches (H10)**

Of the sample of 63 respondents, the mean value of the importance of worker participation in bringing about a change in approach to construction worker safety and health (WKRPART) was 5.75 and the mean value of the importance of implementation factors for new approaches (IMPLFACT) was 5.75. The correlation between IMPLFACT and WKRPART is positive (.368) and statistically significant at the 0.01 level (2-tailed), suggesting that as the importance of implementation factors (IMPLFACT) increases, the importance of worker participation (WKRPART) increases. The *p* value is .003 indicating that the correlation differs significantly from 0. From the regression model summary in Table 9-56, it is evident that IMPLFACT is a strong predictor of

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neutral; and 7 = very important

WKRPART. The R^2 value is significant (0.136) predicting a significant portion (13.6%) of the total variability in WKRPART. The standard error (.7179) compares favorably with the standard deviation of WKRPART (.7660).

Table 9-56 Regression Model Summary of IMPLFACT and WKRPART

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.368	.136	.122	.7179

a Predictors: (Constant), Importance of factors on implementation (IMPLFACT)
b Dependent Variable: Importance of worker participation in change (WKRPART)

From Table 9-57, the *F* statistic is not small (9.584) but statistically significant, indicating that the test that each coefficient is 0 is rejected. The independent variable IMPLFACT explains a significant portion of the variation of the dependent variable WKRPART. The linear relationship is highly significant (.003).

Table 9-57 ANOVA of IMPLFACT and WKRPART

Model		Sum of Squares	df	Mean Square	F	Sig.
	Regression	4.939	1	4.939	9.584	.003
	Residual	31.438	61	.515		
	Total	36.377	62			

a Predictors: (Constant), Importance of factors on implementation (IMPLFACT)
b Dependent Variable: Importance of worker participation in change (WKRPART)

From Table 9-58, it is evident that the predictor IMPLFACT is useful since the *t* value is +2 (3.096). On the other hand, the *t* value of WKRPART is also above +2 (4.812), satisfying the usefulness guidelines. The hypothesis H10 is not rejected that the importance of implementation factors is a positive predictor of the importance of worker participation in bringing about change.

Using the coefficients from Table 9-58, the estimated model is:

WKRPART = 3.511 + .39 IMPLFACT

Table 9-58 Coefficients of IMPLFACT and WKRPART

		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
Model		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	3.511	.730		4.812	.000		
	IMPLFACT	.390	.126	.368	3.096	.003	1.000	1.000

a Dependent Variable: Importance of worker participation in change (WKRPART)

Importance of change-driving issues (H11)

Of the sample of 63 respondents, the mean value of the importance of worker participation in bringing about a change in approach to construction worker safety and health (WKRPART) was 5.77 and the mean value of the importance of change-driving issues in organizations (CHGDRIVS) was 4.93.

The correlation between CHGDRIVS and WKRPART is positive (.384) and significant at the 0.01 level (2-tailed), suggesting that as CHGDRIVS increases, WKRPART increases. The *p* value is .002 indicating that the correlation differs significantly from 0. From the regression model summary in Table 9-59, it is evident that the importance of change-driving issues (CHGDRIVS) is a strong predictor of the importance of worker participation (WKRPART). The R^2 value is significant (0.147) and accounts for a significant portion (14.7%) of the total variability in WKRPART. The standard error (.7087) compares favorably with the standard deviation of WKRPART (.7612).

Table 9-59 Regression Model Summary of CHGDRIVS and WKRPART

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.384	.147	.133	.7087

a Predictors: (Constant), Influence of change-driving issues in organizations (CHGDRIVS)
b Dependent Variable: Importance of worker participation in change (WKRPART)

From Table 9-60, the *F* statistic is not small (10.377) but statistically significant, indicating that the test that each coefficient is 0 is rejected. The independent variable CHGDRIVS explains a significant portion of the total variation of the dependent variable WKRPART. The linear relationship is highly significant (.002).

Table 9-60 ANOVA of CHGDRIVS and WKRPART

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	5.212	1	5.212	10.377	.002
	Residual	30.136	60	.502		
	Total	35.348	61			

a Predictors: (Constant), Influence of change-driving issues in organizations (CHGDRIVS)
b Dependent Variable: Importance of worker participation in change (WKRPART)

From Table 9-61, the predictor CHGDRIVS is useful since the *t* value is +2 (3.221). On the other hand, the *t* value of WKRPART is also above +2 (5.509), satisfying the usefulness guidelines. The hypothesis H11 is not rejected that the importance of change-driving issues is a positive predictor of the importance of worker participation in bringing about change.

Table 9-61 Coefficients of CHGDRIVS and WKRPART

		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
Model		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	3.654	.663		5.509	.000		
	CHGDRIVS	.430	.133	.384	3.221	.002	1.000	1.000

a Dependent Variable: Importance of worker participation in change (WKRPART)

Using the coefficients from Table 9-61, the estimated model is:

WKRPART = 3.654 + .43 CHGDRIVS

The various variables were ranked in order of their strength of prediction of WKRPART, namely, SAFEMAN, CHGDRIVS, IMPLFACT, SUCSACTS, and PERFINFL. To identify the key predictors of WKRPART, the independent variables were tested with stepwise multiple linear regression.

Stepwise regression produced one model. Of the 16 candidate predictors, one was included in the final model, namely, SAFEMAN. From the regression model summary in Table 9-62, it is evident that SAFEMAN is a strong predictor of WKRPART.

Table 9-62 Regression Model Summary of predictors of WKRPART

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.441	.195	.162	.7682	1.851

a Predictors: (Constant), Importance of issues to safety management (SAFEMAN)
b Dependent Variable: Importance of worker participation in change (WKRPART)

The R^2 value is not small (0.195) and accounts for a significant portion (16.2%) of the variability in WKRPART, using the adjusted R^2 value. The R^2 value in the single step regression model is smaller (0.149) predicting a less significant portion (13.6%) of the variability in WKRPART, using the adjusted R^2 value. In this model SAFEMAN is a stronger predictor of WKRPART. From Table 9-63, it is evident that the *F* statistic is smaller than the single step model (6.041) and still statistically significant, indicating that the test that each coefficient is 0 is rejected. The independent variable, SAFEMAN, explains a significant portion of the total variation of the dependent variable WKRPART. The linear relationship is statistically significant (.021).

Using the coefficients from Table 9-64, the final model is

WKRPART = 2.436 + .564 SAFEMAN

Table 9-63 ANOVA of predictors of WKRPART

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	3.565	1	3.565	6.041	.021
	Residual	14.755	25	.590		
	Total	18.320	26			

a Predictors: (Constant), Importance of issues to safety management
b Dependent Variable: Importance of worker participation in change

In this model the intercept is smaller than in the single step model, namely, 3.617. The *t* value of SAFEMAN is smaller than the single step model but useful (2.458).

Table 9-64 Coefficients of predictors of WKRPART

		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
Model		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	2.436	1.377		1.770	.089		
	SAFEMAN	.564	.230	.441	2.458	.021	1.000	1.000

a Dependent Variable: Importance of worker participation in change (WKRPART)

Does CHGDRIVS Predict SAFEMAN (H12)?

Of the sample of 63 respondents, the mean value of the importance of issues to safety management (SAFEMAN) was 5.71 and the mean value of the importance of change-driving issues in organizations (CHGDRIVS) was 4.95.

The correlation between CHGDRIVS and SAFEMAN is positive (.251) and significant at the 0.05 level (2-tailed), suggesting that as the importance of change-driving issues (CHGDRIVS) increases, the importance of safety management issues (SAFEMAN) increases. The *p* value is .047 indicating that the correlation differs significantly from 0. From the regression model summary in Table 9-65, it is evident that CHGDRIVS is a weak predictor of SAFEMAN. The R^2 value is statistically significant (0.063) and accounts for a significant portion (6.3%) of the total variability in

SAFEMAN. The standard error (.7781) compares favorably with the standard deviation of SAFEMAN (.7973).

Table 9-65 Regression Model Summary of CHGDRIVS and SAFEMAN

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.251	.063	.048	.7781

a Predictors: (Constant), Influence of change-driving issues in organizations (CHGDRIVS)
b Dependent Variable: Importance of issues to safety management (SAFEMAN)

The *F* statistic from Table 9-66, is on the smallish side (4.111) but still statistically significant, indicating that the test that each coefficient is 0 is rejected. The independent variable CHGDRIVS explains a significant portion of the total variation of the dependent variable SAFEMAN. The linear relationship is statistically significant (.047).

From Table 9-67, it is evident that the predictor CHGDRIVS is useful since the *t* value is +2 (2.028). On the other hand, the *t* value of SAFEMAN is also above +2 (5.888), satisfying the usefulness guidelines. The hypothesis H12 is not rejected that the importance of change-driving issues is a positive predictor of determining the importance of construction safety and health issues.

Table 9-66 ANOVA of CHGDRIVS and SAFEMAN

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	2.489	1	2.489	4.111	.047
	Residual	36.928	61	.605		
	Total	39.417	62			

a Predictors: (Constant), Influence of change-driving issues in organizations (CHGDRIVS)
b Dependent Variable: Importance of issues to safety management (SAFEMAN)

Using the coefficients from Table 9-67, the estimated model is:

SAFEMAN = 4.261 + .294 CHGDRIVS

Table 9-67 Coefficients of CHGDRIVS and SAFEMAN

		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
Model		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	4.261	.724		5.888	.000		
	CHGDRIVS	.294	.145	.251	2.028	.047	1.000	1.000

a Dependent Variable: Importance of issues to safety management (SAFEMAN)

Does IMPLFACT Predict SAFEMAN (H13)?

Of the sample of 63 respondents, the mean value of the importance of issues to safety management (SAFEMAN) was 5.73 and the mean value of the importance of factors on implementation of a new approach (IMPLFACT) was 5.75.

The correlation between IMPLFACT and SAFEMAN is positive (.410) and statistically significant at the 0.01 level (2-tailed), suggesting that as IMPLFACT increases, SAFEMAN increases. The *p* value is .001 indicating that the correlation differs significantly from 0. From the regression model summary in Table 9-68, IMPLFACT is a strong predictor of SAFEMAN. The R^2 value is significant (0.168) and accounts for a significant portion (16.8%) of the total variability in SAFEMAN. The standard error (.6698) compares favorably with the standard deviation of SAFEMAN (.7284).

Table 9-68 Regression Model Summary of IMPLFACT and SAFEMAN

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.410	.168	.154	.6698

a Predictors: (Constant), Importance of factors on implementation (IMPLFACT)
b Dependent Variable: Importance of issues to safety management (SAFEMAN)

It is evident from Table 9-69, that the *F* statistic is not small (12.326) and highly significant, indicating that the test that each coefficient is 0 is rejected. The independent variable IMPLFACT explains a significant portion of the total variation of the dependent variable SAFEMAN. The linear relationship is highly significant (.001).

Table 9-69ANOVA of IMPLFACT and SAFEMAN

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	5.529	1	5.529	12.326	.001
	Residual	27.363	61	.449		
	Total	32.893	62			

a Predictors: (Constant), Importance of factors on implementation
b Dependent Variable: Importance of issues to safety management (SAFEMAN)

Using the coefficients from Table 9-70, the estimated model is:

SAFEMAN = 3.363 + .411 IMPLFACT

Table 9-70 Coefficients of IMPLFACT and SAFEMAN

		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
Model		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	3.363	.680		4.948	.000		
	IMPLFACT	.411	.117	.410	3.511	.001	1.000	1.000

a Dependent Variable: Importance of issues to safety management (SAFEMAN)

The correlation between PERFINFL and SAFEMAN is negative (-.378) and statistically significant at the 0.05 level (2-tailed), suggesting that as PERFINFL increases, SAFEMAN decreases. On the scale of influence the smaller the value of PERFINFL, the greater the influence of the performance approach The *p* value is .002 indicating that the correlation differs significantly from 0. From the regression model summary in Table 9-71, PERFINFL is a strong predictor of SAFEMAN. The R^2 value is statistically significant (0.143) and accounts for a significant portion (14.3%) of the total variability in SAFEMAN. The standard error (.7479) compares favorably with the standard deviation of SAFEMAN (.7956).

Table 9-71 Regression Model Summary of PERFINFL and SAFEMAN

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.378	.143	.116	.7479

a Predictors: (Constant), Influence of performance approach (PERFINFL)
b Dependent Variable: Importance of issues to safety management (SAFEMAN)

From Table 9-72, the *F* statistic is on the smallish side (5.343) but still statistically significant, indicating that the test that each coefficient is 0 is rejected. The independent variable PERFINFL explains a significant portion of the total variation of the dependent variable SAFEMAN. The linear relationship is statistically significant (.027).

Table 9-72 ANOVA of PERFINFL and SAFEMAN

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	2.989	1	2.989	5.343	.027
	Residual	17.900	32	.559		
	Total	20.889	33			

a Predictors: (Constant), Influence of performance approach (PERFINFL)
b Dependent Variable: Importance of issues to safety management (SAFEMAN)

From Table 9-73, the predictor PERFINFL is useful since the *t* value is below -2 (-2.312). On the other hand, the *t* value of SAFEMAN is well above +2 (15.76), satisfying the usefulness guidelines. The hypothesis H14 is not rejected that the influence of the performance approach is a negative predictor of determining the importance of construction safety management issues.

Using the coefficients from Table 9-73, the estimated model for predicting SAFEMAN is:

SAFEMAN = 6.883 - .366 PERFINFL

Table 9-73 Coefficients of PERFINFL and SAFEMAN

		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
Model		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	6.883	.437		15.760	.000		
	PERFINFL	-.366	.158	-.378	-2.312	.027	1.000	1.000

a Dependent Variable: Importance of issues to safety management (SAFEMAN)

Does CHGDRIVS Predict IMPLFACT (H15)?

Of the sample of 61 respondents, the mean value of the importance of factors on implementation of a new approach (IMPLFACT) was 5.76 and the mean value of the importance of change-driving issues in organizations (CHGDRIVS) was 4.95.

The correlation between CHGDRIVS and IMPLFACT is .541 (2-tailed) and statistically significant, suggesting that as CHGDRIVS increases, IMPLFACT increases. The *p* value is .000 indicating that the correlation differs significantly from 0. Evidently from the regression model summary in Table 9-74, CHGDRIVS is a strong predictor of IMPLFACT. The R^2 value is significant (0.293) and accounts for a highly significant portion (29.3%) of the total variability in IMPLFACT. The standard error (.6231) compares favorably with the standard deviation of IMPLFACT (.7347).

Table 9-74 Regression Model Summary of CHGDRIVS and IMPLFACT

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.541	.293	.281	.6231

a Predictors: (Constant), Influence of change-driving issues in organizations (CHGDRIVS)
b Dependent Variable: Importance of factors on implementation (IMPLFACT)

It is evident from the ANOVA Table 9-75, that the *F* statistic is not small (24.416) and highly significant, indicating that the test that each coefficient is 0 is rejected. The independent variable CHGDRIVS explains a significant portion of the total variation of the dependent variable IMPLFACT. The linear relationship is highly significant (.0005).

Table 9-75 ANOVA of CHGDRIVS and IMPLFACT

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	9.481	1	9.481	24.416	.000
	Residual	22.910	59	.388		
	Total	32.390	60			

a Predictors: (Constant), Influence of change-driving issues in organizations (CHGDRIVS)
b Dependent Variable: Importance of factors on implementation (IMPLFACT)

From Table 9-76, the predictor CHGDRIVS is useful since the *t* value is above +2 (4.941). On the other hand, the *t* value of IMPLFACT is above +2 (4.971), satisfying the usefulness guidelines. The hypothesis H15 is not rejected that the importance of change-driving issues is a positive predictor of determining the importance of implementation factors for new approaches.

Table 9-76 Coefficients of CHGDRIVS and IMPLFACT

		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
Model		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	2.900	.583		4.971	.000		
	CHGDRIVS	.577	.117	.541	4.941	.000	1.000	1.000

a Dependent Variable: Importance of factors on implementation (IMPLFACT)

Using the coefficients from Table 9-76, the estimated model to predict IMPLFACT is:

IMPLFACT = 2.9 + .577 CHGDRIVS

Does SAFEMAN Predict WKRTRUST (H16)?

Of the sample of 61 respondents, the mean value of the importance of building credibility and trust with workers before implementing a change (WKRTRUST) was 6.15, and the mean value of the importance of safety management issues (SAFEMAN) was 5.71.

The correlation between SAFEMAN and WKRTRUST is positive (.326) and statistically significant (2-tailed), suggesting that as SAFEMAN increases, WKRTRUST increases. The *p* value associated with the correlation coefficient of .326 is .008 indicating that the correlation differs highly significantly from 0. The regression model summary in Table 9-77 shows that SAFEMAN is a strong predictor of WKRTRUST. The R^2 value is statistically significant (0.106) and accounts for a significant portion (10.6%) of the total variability in WKRTRUST. The standard error (.9414) compares favorably with the standard deviation of WKRTRUST (.9879).

Table 9-77 Regression Model Summary of SAFEMAN and WKRTRUST

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.326	.106	.092	.9414

a Predictors: (Constant), Importance of issues to safety management (SAFEMAN)
b Dependent Variable: How important would it be to build credibility and trust with the workers before implementing a change? (WKRTRUST)

It is evident from the ANOVA Table 9-78, that the *F* statistic is on the small side (6.625) but yet statistically significant, indicating that the test that each coefficient is 0 is rejected. The independent variable SAFEMAN explains a significant portion of the total variation of the dependent variable WKRTRUST. The linear relationship is significant (.008).

Table 9-78 ANOVA of SAFEMAN and WKRTRUST

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	6.625	1	6.625	7.474	.008
	Residual	55.837	63	.886		
	Total	62.462	64			

a Predictors: (Constant), Importance of issues to safety management (SAFEMAN)
b Dependent Variable: How important would it be to build credibility and trust with the workers before implementing a change? (WKRTRUST)

From Table 9-79, it is evident that the predictor SAFEMAN is useful since the *t* value is above +2 (2.734). On the other hand, the *t* value of WKRTRUST is also above +2 (4.452), satisfying the usefulness guidelines. The hypothesis H16 is not rejected that the importance of worker safety management issues is a positive predictor of the importance of building worker credibility and trust before implementing any changes.

Table 9-79 Coefficients of SAFEMAN and WKRTRUST

		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
Model		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	3.826	.859		4.452	.000		
	SAFEMAN	.407	.149	.326	2.734	.008	1.000	1.000

a Dependent Variable: How important would it be to build credibility and trust with the workers before implementing a change? (WKRTRUST)

Using the coefficients from Table 9-79, the estimated model to predict WKRTRUST is:

WKRTRUST = 3.826 + .407 SAFEMAN

Does FOREMEN Predict WKROPIN (H17)?

Of the sample of 65 respondents, the mean value of the importance the receptiveness of first-line supervisors (foremen) to change (FOREMEN) was 6.20, and the mean value of the importance of enlisting the opinions of workers on a proposed change before it was implemented (WKROPIN) was 5.74.

The correlation between FOREMEN and WKROPIN is positive (.566) and statistically significant at the 0.01 level (2-tailed), suggesting that as FOREMEN increases, WKROPIN increases. The *p* value is <.0005 indicating that the correlation differs statistically significantly from 0. From the regression model summary in Table 9-80, it is evident that FOREMEN is a strong predictor of WKROPIN. The R^2 value is statistically significant (0.32) and accounts for a significant portion (32.0%) of the total variability in WKROPIN. The standard error (.9552) compares favorably with the standard deviation of WKROPIN (1.1494).

Table 9-80 Regression Model Summary of FOREMEN and WKROPIN

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.566	.320	.309	.9552

a Predictors: (Constant), How important do you regard the receptiveness of first-line supervisors (foremen) to change? (FOREMEN)
b Dependent Variable: How important would it be to enlist the opinions of workers on a proposed change before it is implemented? (WKROPIN)

From the ANOVA Table 9-81, that the *F* statistic is evidently not small (27.675) and highly significant, indicating that the test that each coefficient is 0 is rejected. The independent variable FOREMEN explains a significant portion of the total variation of the dependent variable WKROPIN. The linear relationship is significant (<.0005).

Table 9-81 ANOVA of FOREMEN and WKROPIN

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	27.075	1	27.075	29.675	.000
	Residual	57.479	63	.912		
	Total	84.554	64			

a Predictors: (Constant), How important do you regard the receptiveness of first-line supervisors (foremen) to change? (FOREMEN)
b Dependent Variable: How important would it be to enlist the opinions of workers on a proposed change before it is implemented? (WKROPIN)

From Table 9-82, it is evident that the predictor FOREMEN is useful since the *t* value is above +2 (5.447). On the other hand, the *t* value of WKROPIN is also above +2 (2.417), satisfying the usefulness guidelines. The hypothesis H17 is not rejected that the importance given to the receptiveness of foremen is a positive predictor of the importance of enlisting the views and opinions of workers on proposed changes.

Table 9-82 Coefficients of FOREMEN and WKROPIN

		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
Model		B	Std. Error	Beta			Tolerance	VIF
	(Constant)	1.779	.736		2.417	.019		
	FOREMEN	.639	.117	.566	5.447	.000	1.000	1.000

a Dependent Variable: How important would it be to enlist the opinions of workers on a proposed change before it is implemented? (WKROPIN)

Using the coefficients from Table 9-82, the estimated model is:

WKROPIN = 1.779 + .639 FOREMEN

Other Relationships

There was no linear relationship between the contracting arrangements under which firms acquired their revenue and the preference of respondents for either the prescriptive or performance approaches (PREFAPPR). Correlations were observed to exist between general contracting and the other contracting arrangements, suggesting that general contracting would be a predictor of sub-contracting, for example.

Additionally, there was no linear relationship between the areas of operation of firms and the preference of respondents for either the prescriptive or performance approaches (PREFAPPR). Negative correlations that were significant at the 0.01 level (2-sided) were observed to exist between the amount of work done nationally and that done regionally and locally. These correlations suggest that the amount of work done nationally is a predictor of work done regionally, for example. Further, as the amount of work done nationally increases, the amount of work done regionally decreases.

There was no linear relationship between who usually sponsors major change within firms and the preference of respondents for either the prescriptive or performance approaches (PREFAPPR). However, negative correlations that were significant at the 0.01 level (2-sided) were observed to exist between the sponsorship by top management of major change and the sponsorship by others within the firms. These correlations suggest that the sponsorship be top management is a predictor of sponsorship of change by middle and site management, for example. Further, as the level of sponsorship by top management increases, the level of sponsorship by others decreases.

There was no linear relationship between who usually sponsors major change within firms and the level of influence of 13 issues in driving change within firms. However, positive correlations that were significant at both the 0.01 level (2-sided) and 0.05 level (2-sided) were observed to exist between the influence of some of these issues with others. These correlations suggest that their influence is a predictor of the influence of other issues. Further, as the level of influence of these issues increases, the level of influence of others also increases.

Chapter Summary

Using simple and multiple linear regression it was possible to identify and examine relationships between variables and groups of variables. Both single step and stepwise regression were used to identify variables that were key predictors of others.

The level of understanding of the performance and prescriptive approaches was not a predictor of the preference for the performance approach. However, the preference for the performance approach was a predictor of this approach being more influential to certain defining issues such as the ease of new technologies, cost effectiveness of the approach, ease of implementation, ease of understanding compliance requirements and potential to improve safety performance on sites.

The preference for the performance approach was not a predictor of the importance of key construction safety management issues such as cost effectiveness. Position within the management structure of a construction firm, and size of the firm in terms of number of employees and value of construction executed were not predictors of preference for the performance approach.

Of the 17 hypotheses tested, 5 were rejected. The demographic characteristics of management position, size of organization, and source of contracting income were not predictors of determining the importance of actions to be taken for the successful implementation of a new approach to construction worker safety and health. Neither were they predictors of determining the importance of worker participation in bringing about change. The influence of the performance approach was not a predictor of either the actions to be taken for the successful implementation of a new approach to construction worker safety and health, or determining the importance of worker participation in bringing about change.

The importance of construction safety and management issues, implementation factors for new approaches, and change-driving issues were positive predictors of both the actions to be taken for the successful implementation of a new approach to construction worker safety and health, and determining the importance of worker participation in bringing about change.

The importance of worker participation in bringing about change was not a predictor of the actions to be taken for the successful implementation of a new approach to construction worker safety and health. The importance of change-driving issues, implementation factors for new approaches, and influence of the performance approach were predictors of the importance of construction safety and health management issues. The importance of change-driving issues was a positive predictor of the importance of implementation factors for new approaches. Further, the importance given to safety and health management issues was a positive predictor of the importance of building trust and credibility with workers before implementing a change. Additionally, the importance of the receptiveness of first-line supervisors was a positive predictor of the importance of enlisting the opinions of workers on a proposed change before it was implemented.

The various variables were ranked in order of their strength of their prediction of the actions to be taken for the successful implementation of a new approach to construction worker safety and health. The importance accorded to implementation factors for new approaches, change-driving issues, and safety and health management issues were the strongest predictors. By using stepwise regression, the combination of the importance of implementation factors for new approaches and position within the top management structure of construction firms were the strongest key predictors of the actions to be taken. The final model was

SUCSACTS = .730 +.735 IMPLFACT +.250 JOBTITLE.

The various variables were ranked in order of the strength of their prediction of the importance of worker participation in bringing about change. The importance accorded to safety and health issues, change-driving issues, and implementation factors for new approaches were the strongest predictors. By using stepwise regression, the importance given to construction safety and health issues was the strongest key predictor of worker participation in bringing about change. The final model was

WKRPART = 2.436 + .564 SAFEMAN

In the next chapter, the study is concluded and includes suggestions for further research.

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Summary

The purpose of this exploratory study, as stated in the chapter entitled, Introduction, was to examine whether a performance-based approach to construction safety management was an effective and acceptable approach to improving safety and health on construction sites. The primary objectives of the study were

- To increase the understanding of the performance paradigm and its application to safety and health in construction;
- To determine the feasibility and acceptance of the performance approach as an effective alternative to previous prescriptive approaches to construction safety;
- To develop a model that would permit the implementation of the performance approach to worker safety and health on construction sites anywhere in the world regardless of the prevailing paradigm;
- To establish whether variances to OSHA's prescriptive requirements had arisen due to the nonapplicability of these measures in the particular circumstances, and whether a performance approach would have obviated the need to request these variances; and
- To measure the level of knowledge of the top management structure of construction firms about the performance approach and their attitude toward its implementation within their organizations.

This chapter provides a summary of the findings of the study, and conclusions and recommendations for future study relative to each of these objectives.

Performance Paradigm and its Application to Safety and Health

The seminal literature on the performance approach as it related to building design, materials, elements and components was reviewed. The performance concept as it applies to the construction industry evidently means different things to different people resulting in confusion and misunderstanding. Generally, the performance approach is concerned with what buildings and building products are required to do and not with prescribing how they are to be constructed or manufactured. It refers to defining how a result, outcome or solution should perform, without actually describing the technical means and methods of achieving that result or outcome.

Further, the approach is concerned with meeting and satisfying the requirements of users, particularly end users of facilities. The requirements of construction workers have not been considered, including those relative to safety and health on construction sites. In this study it has been argued that construction workers are users, albeit temporary ones and that their needs can be met by implementing a performance approach.

Consequently, the literature has largely been silent on the practical application of the performance approach to, and implications for, construction worker safety and health. The literature that currently exists relates to aspects of the changes in legislative frameworks in Europe and the United Kingdom. Very little, if anything, has been written comparatively about the performance and prescriptive approaches apart from attempts by this researcher.

While performance has been defined as 'behavior related to use' and 'behavior in construction,' these definitions relate to decisions impacting the end product and end users. Workers are not included. A practical definition was consequently developed in this study to account for this exclusion. The performance approach as it applies to construction worker safety and health would be the identification of broadly-defined goals, ends or targets (user requirements) that must result from applying a safety standard, regulation or rule without setting out the specific technical requirements or methods to do so. As such the approach describes what has to be achieved to comply with the regulations and leaves the means and methods of complying up to the contractor.

Prediction of performance is a key difficulty. It is difficult to assess before the building is constructed whether the performance criteria are going to be met by the proposed solution of dealing with worker exposure to identified hazards. Measurement limitations are a further difficulty, regarding determining if the proposed solutions have met the performance criteria or not. Institutional barriers include lack of resources for designers to develop a variety of solutions to meet the performance criteria, lack of research capability of designers to evaluate these solutions, lack of appropriate tools to determine user needs at the design stage, lack of a prior knowledge base, lack of ability to learn in a cumulative way from successes and failures due to the dispersed nature of the building community, and uncertainty about who should be responsible for evaluating whether the performance criteria have been met.

The increased use of the performance approach in construction worker safety and health is being driven by the accelerating rate of change of building technologies, the availability of improved space-planning and design concepts and techniques, and the demand to improve safety performance on construction sites. Internationally, the use of the approach is driven by the need to make building construction more cost effective, the need to ease the introduction of product or system and process innovation, and the need to establish fair international trade agreements. Since less than 2% of the firms in the sample engaged in international construction operations, it was not possible to determine whether the performance approach was an adequate response to the international needs.

When compared with the prescriptive approach, one of the difficulties relates to the inability of this approach to cover comprehensibly every conceivable situation that arises from construction tasks and activities. Further, concern revolves around potential conflicts between requirements of several agencies each having their own prescriptive requirements. Prescriptive requirements might be simpler to work with since compliance requirements are specifically stated and compliance or noncompliance is visible.

The application of the performance approach to construction safety and health will be enhanced when construction workers and their safety and health needs are given the same serious consideration as all other users of the building facility.

Performance Approach as a Construction Safety Alternative

The international community has responded to the need for a safer and healthier construction industry by introducing several new performance-based legislative frameworks, for example, in the United Kingdom, Europe, Australia and New Zealand as alternatives to previous prescriptive legislative approaches. These countries have responded proactively, consistently and comprehensively to the

- Lack of supervision by line managers on construction sites;
- Inadequate equipping of workers to identify dangers and take appropriate steps to protect themselves against these;
- Lack of coordination between the members of the professional team in the pre-construction phase;
- Lack of involvement by all participants in the construction process, including workers on a consultative and participatory basis;
- Unsatisfactory architectural and/or organizational options;
- Poor planning of the works at the project preparation stage;
- Impossibility to cover each and every situation and circumstance on construction sites;
- Demands from the construction industry for reform in building legislation;
- Reduction of the amount of legislation; and
- Encouragement of innovative design and advance technology applications in the most cost-effective way.

Using the New Zealand response as typical, there were mixed feelings and skepticism that the performance approach would encourage innovation or more cost effective compliance. The introduction of the new legislation has impacted the structure of the industry, especially with the redistribution of the responsibility for construction worker safety to include all participants in the construction process. The cost of transforming the existing legislative framework was significant. The new approach has improved the performance of the industry although the opportunity for improvement is greater than actual. Innovation has been encouraged and alternative solutions have been accepted. There was no large-scale resistance to the introduction of the new approach.

The feasibility and acceptability of the performance approach as an effective alternative approach to construction worker safety and health depends heavily on the involvement of everyone involved in the construction process. For example workers should be involved on a proactive basis, as safety objectives are set. Further, an effective and efficient administrative and legal underpinning must support the fully successful introduction of the performance approach.

Concerns, which have arisen as a result of the introduction of performance-based safety legislation, include

- The cost of implementation of between 0.2 and 2% of total project cost;
- The lack of a standard and simplified system of reporting construction-related accidents, injuries, fatalities and diseases;
- Unclear roles and responsibilities for safety and health of the various participants in the construction process;
- The absence of a systematic analysis of injury patterns;
- The absence of planning of injury prevention activities;
- The insignificance of rewards for safe practices or good safety records; and
- The focus of workers' compensation insurers on claims and injury management rather than on injury prevention; and inadequate information about injury prevention methods regarding equipment and procedures.

However, despite these concerns, the performance approach has reportedly resulted in

- Greater awareness of construction-related risks;
- Detection of an increased amount of chemical-related morbidity in construction;
- More efficient use of hazardous chemicals;
- Improved management of plant and equipment; and
- Improved attitudes toward construction worker safety and health.

OSHA has initiated its own proactive program that includes

- Offering incentives to employers with good safety and health programs;
- Either eliminating or amending outdated and confusing standards;
- Improving consultation with construction industry stakeholders; and
- Establishing performance measures to evaluate programs based on safety and health results and outcomes.

The performance approach requires a culture change that relies on a continuous and long-term commitment to understanding, evaluating and improving construction activities and processes. Construction organizations will have to depart radically from their old ways of doing things.

Top management needs to be totally committed to supporting and driving the approach. They must be committed to removing the largest barriers to managing change, namely, lack of management visibility and support, employee resistance, and inadequate management skills. They need to acknowledge the need for a change in management beliefs and values to support the new cultural reality presented by the performance approach. The extent to which top management supports the program of change toward a performance approach to construction worker safety will determine its ultimate success. This study has demonstrated that the safety and health requirements of workers as end users can be met by using a performance approach. What is needed is the management will to change. This study had further demonstrated that should the performance approach be introduced in the United States, most contractors would be willing to support its introduction and take the necessary actions to ensure its successful implementation. However, the lobbying powers of other participants such as manufacturers and suppliers are a major issue.

Variances to OSHA's Prescriptive Requirements

The analysis of the available on-line records of the Federal Register was inconclusive regarding whether a performance approach would have obviated the need to request variances in the cases examined. The examination confirmed that the number of variances actually granted was extremely small. A more comprehensive examination of all the records of the Federal Register and not only the on-line ones might produce more informative findings.

Level of Knowledge of Management of Construction Firms

This study has shown that most of the respondents in the sample population (78.5%) felt that they understood the performance and prescriptive approaches very well with more than half (57.6%) preferring the performance approach. This approach was regarded as being most influential in the areas of flexibility, support for innovation and ease of introduction of new materials. The most important issues relative to an approach to construction worker safety and health management were its potential to improve safety performance on construction sites, ease of understanding the compliance requirements and ease of implementing it.

Top management (53.5%) drove major change. Workers only sponsored 6.0% of major changes in their organizations. The most important change-driving issues according to the CEO and Safety Director groups were improvement of their safety record, improvement of the financial performance of their firms and complying with the requirements of owners and clients. This finding relates well to the findings of a study (Bonvillian, 1997) that concluded that primary change drivers were the demands of customers (owners and clients), competition (safety record) and cost reduction (financial performance).

The most important issues for the implementation of new approaches generally within their organizations were the support of top management, open communication and mutual trust between management and workers. These issues were found to be positive predictors of the actions that would be taken for the successful implementation of a new approach to construction safety and determining the importance of worker participation. This finding correlates favorably with the findings of studies of effective change management (Bonvillian, 1997; Hensler, 1993; Freda, Arn and Gatlin-Watts, 1999; Saunders and Kwon, 1990; Cartwright, Andrews and Webley, 1999). For instance in one study (Bonvillian, 1997) the support of top management was demonstrated by presidents making themselves visible by informal walk-arounds. In the same study, effective communication included face-to-face interaction. When important people behave in ways that are inconsistent with their words, change efforts can be seriously undermined and compromised (Freda, Arn and Gatlin-Watts, 1999). Saunders and Kwon (1990) identified communication as the most critical activity in a study.

The study indicated that the most important actions for the successful implementation of a new approach to construction safety were the demonstration of consistent and decisive personal leadership, the introduction of appropriate training programs and the allocation of adequate financial, equipment and staff resources. Freda, Arn and Gatlin-Watts (1999), Saunders and Kwon (1990) and Diamond (1998) support this finding.

While only 53.8% of top management recognized that the receptiveness of foremen or first-line supervisors to change was very important, a study (Bonvillian, 1997) suggested that nothing could replace the influence of first-line supervisors on the response of other workers to change. This study supports this suggestion since the importance of the receptiveness of first-line supervisors was a positive predictor of the importance of enlisting the opinions of workers.

Almost all of the respondents (93.9%) regarded building credibility and trust with workers before implementing change as important. The second factor emerging from the study by Bonvillian (1997) was credibility of workers. This study has highlighted that the performance approach promotes the participation of workers in all matters of construction safety. The findings of the survey indicated that a large proportion of the sample population (84.8%) regarded the opinions of workers on proposed changes as being important. In their study, Freda, Arn and Gatlin-Watts (1999), found that it was necessary to break down barriers to change and that the entire work force needed to be involved. Diamond (1998) suggests that workers need to be partners in organizational change such as will be necessary when changing from a prescriptive to a performance approach. This study found that the importance of safety management issues was a positive predictor of the importance of building trust and credibility with workers.

The importance of construction safety and health management issues was the strongest predictor of worker participation in bringing about change. These issues included improvement of safety performance on construction sites, cost effectiveness, ease of implementation and understanding compliance requirements. Similarly, implementation factors such as top management support, mutual trust between workers and management and open communication, were strong positive predictors of the actions that would be taken to implement a new approach such as the performance approach to construction worker safety and health. A further strong predictor was the position within the top management structure of construction firms, endorsing the importance of management in any successful safety program.

Limitations of the Study

Sampling was necessary since it was not possible to examine the entire population of contracting companies in the United States. Consequently, the sample needed to be representative of the population to produce a result of theoretical and practical value (Fellows and Liu, 1997; Salant and Dillman, 1994; Bess and Higson-Smith, 1995). Further, this representativeness is necessary for the results obtained from the sample to approximate as closely as possible to those that would have been obtained if the entire population had been surveyed. The use of systematic or interval sampling relies on the availability of a complete and unbiased population list (Bess and Higson-Smith, 1995). There were difficulties in trying to achieve a sample size of 200 companies due to the requirement that respondents had to have contactable telephone numbers and correct postal address information. Consequently, it is possible that a systematic bias might have been introduced that may have influenced the results. The results of the study should as far as possible be immune to influence of any kind, and should speak for themselves (Leedy, 1993). Non-respondents and those excluded consequent to the sample selection process should not differ from the actual sample of respondents (Sample 1) (Salant and Dillman, 1994; Bess and Higson-Smith, 1995).

Table 10-1 Comparison between the samples

Demographic Variable	Sample 1	Sample 2	Variance
Number of employees per company	175	159	16
Approximate annual value of contracting revenue	$61m	$83m	($22m)
Contracting arrangements:			
Construction management (agency)	4.78%	6.86%	(2.08%)
General contracting	51.66%	58.71%	(7.05%)
Subcontracting	14.22%	24.00%	(9.78%)
Construction management at risk	11.09%	0.00%	11.09%
Specialty contracting	4.69%	6.71%	(2.02%)
Design-build	11.47%	3.71%	7.76%
Areas of operation:			
International	1.86%	0.00%	1.86%
National	21.91%	18.46%	3.45%
Regional	33.62%	37.46%	(3.84%)
Local	42.62%	44.03%	(1.41%)

To determine whether there were any sampling errors due to chance factors, bias in selection and non-response, the demographic profile of the non-respondents and excluded companies was examined by means of a telephonic survey. The number of participants in this survey was 35 companies (Sample 2). The results of the telephone survey are listed in Table 10-1. Demographically, the samples appeared not to differ extensively from each other.

Conclusion

This exploratory study set out to determine whether the performance approach would be accepted as an effective alternative approach to construction worker safety and health. The study showed that the defining characteristics of the approach include its flexible implementation, coverage of all circumstances, ease of introducing amendments, and its global application. The performance approach is driven by the need to make building construction more cost effective, the need to ease the introduction of product or systems and process innovation, and the need to establish fair international trade agreements. The study showed that the performance approach was influential regarding the ease of introduction of new technology, cost effectiveness, ease of implementation, ease of understanding compliance requirements and potential to improve safety performance on construction sites.

The approach is an all-inclusive one regarding construction participants and the construction process. Accordingly, it can be applied to construction workers as end users provided that their safety and health needs are given equitable consideration with the needs of all other end users. The approach requires all construction participants to be involved in the safety effort, including workers on a proactive basis. The study showed that the importance by management given to safety and health issues determined the extent to which they would involve their workers in bringing about change regarding safety and health performance. Further, all phases of the construction process are covered including project inception, execution and maintenance.

For the approach to be effective there is a need for effective and efficient administrative and legal underpinning from enforcement agencies. Further, all construction organizations must be willing to depart radically from their old and traditional way of approaching construction worker safety and health. It is imperative for top management of these organizations to be involved in this effort by improving their visibility, reducing worker resistance, and improving their management skills.

The study showed that even in a largely prescriptive legislative environment the performance approach is appealing to the top management of most contractors. They would support its introduction and implementation.

Recommendations for Future Research

Based on the research findings that emerged from this particular study there are several areas of future research.

Less than 2% of the sample of this study engaged in international construction operations. There is a need to conduct research with construction firms that engage heavily in international construction operations to determine whether the performance approach addressed the international concerns that have arisen due to some of the difficulties presented by prescriptive codes and standards.

The examination of the applications for variances from OSHA requirements was inconclusive in this study as a result of the limited number of applications recorded in the on-line version of the Federal Register. It might be informative to examine all the variance applications from the original source documents.

The sample for this study was drawn exclusively from the construction industry within the United States where the prevailing paradigm is a prescriptive one. As part of a comparative study, it might be useful to conduct a survey of the top management of firms in countries such as the United Kingdom, New Zealand and Europe where the prevailing paradigm is performance-based.

Aspects of the implementation model developed and proposed in this study needs to be researched to determine which elements of the model are already being implemented and with what results.

As a result of the confusion about the content of project-specific safety and health plans in Europe, a further research project could involve the development and design of model safety and health plans that could serve as master documents or standard templates.

There are problems being encountered in Europe with the poorly defined competence and qualification requirements of project supervisors and safety coordinators. A research project could identify the minimum level of appropriate expertise required for the functions of these persons to be conducted successfully and propose an appropriate course of study leading to a recognized qualification.

Worker participation on a consultative and participatory basis is required for the successful implementation of the performance approach. Research needs to be conducted to measure the level of worker participation in all matters of construction safety. Similar areas of research include finding ways to measure the costs of implementing the performance approach on construction projects, and the adequacy of information about injury prevention methods regarding equipment and procedures.

There is a need to develop appropriate tools to determine user needs at the design stage that include the safety needs of construction workers. These could include computer-driven application software tools.

A final area of future research involves the identification of those factors that would prevent the performance approach from being implemented successfully. Allied to this aspect would be the determination of the types of incentives that would drive contractors to go beyond minimum compliance requirements.

APPENDIX A
INTERNATIONAL SURVEY

COUNTRY: ………………………………………………………….

Section 1: Identification of Construction Activity

1. Rank the three (3) specific construction activities (e.g. Falls from scaffolds greater than 1,2 m high) which are most responsible for accidents on construction sites in your country for each of the years indicated below based on available national statistics. Proceed to item 3. (However if the most recent available statistics are pre-1995, continue to item 2.)

RANK	ACTIVITY (1995)		
1st			1
2nd			2
3rd			3
RANK	ACTIVITY (1996)		
1st			4
2nd			5
3rd			6
RANK	ACTIVITY (1997)		
1st			7
2nd			8
3rd			9
RANK	ACTIVITY (1998)		
1st			10
2nd			11
3rd			12

2. Rank the three (3) construction activities, which are most responsible, for accidents on construction sites in your country based on the most recent information available (indicate the year)

RANK	ACTIVITY ( )		
1st			13
2nd			14
3rd			15

3. Other relevant comments

	16
	17
	18
	19

Section 2: Accident Statistics

4. How many workers are employed in your country?

YEAR	ALL INDUSTRIES	IN CONSTRUCTION
1995		
1996		
1997		
1998		

		21
		23
		25
		27
		29

5. Indicate the number of accidents and fatalities in construction in your country

YEAR	TOTAL	FATALITIES
1995		
1996		
1997		
1998		

		31
		33
		35
		37
		39

6. For accidents in construction indicate the incidence index (number of accidents in construction/1000 workers in construction), frequency index (number of accidents in construction/1,000,000 hours worked in construction), severity index (number of lost days in construction /1000 hours worked in construction), and duration index (number of lost days in construction/accident in construction)

YEAR	INCIDENT	FREQUENCY	SEVERITY	DURATION
1995				
1996				
1997				
1998				

				43
				47
				51
				55
				59

7. For fatalities in construction indicate the incidence index (number of fatalities in construction/1000 workers in construction), frequency index (number of fatalities in construction/1,000,000 hours worked in construction), severity index (number of lost days in construction /1000 hours worked in construction), and duration index (number of lost days in construction/fatality in construction)

YEAR	INCIDENT	FREQUENCY	SEVERITY	DURATION
1995				
1996				
1997				
1998				

				83
				87
				91
				95
				99

8. For accidents due to the construction activity indicated in Q1 and Q2 as 1st indicate the incidence index (number of accidents /1000 workers in construction), frequency index (number of accidents /1,000,000 hours worked in construction), severity index (number of lost days in construction /1000 hours worked in construction), and duration index (number of lost days in construction/accident in construction)

YEAR	INCIDENT	FREQUENCY	SEVERITY	DURATION
1995				
1996				
1997				
1998				

				63
				67
				71
				75
				79

9. For fatalities due to the construction activities indicated in Q1 and Q2 as 1st indicate the incidence index (number of accidents /1000 workers in construction), frequency index (number of accidents /1,000,000 hours worked in construction), severity index (number of lost days in construction /1000 hours worked in construction), and duration index (number of lost days in construction/accident in construction)

YEAR	INCIDENT	FREQUENCY	SEVERITY	DURATION
1995				
1996				
1997				
1998				

				103
				107
				111
				115
				119

10. Other relevant statistics

______________________________ 120
______________________________ 121
______________________________ 123
______________________________ 124

Section 3: Legal Framework

11. List the relevant legislation and regulations governing safety and health in construction in your country

______________________________ 125
______________________________ 126
______________________________ 127
______________________________ 128

12. List the relevant safety and health legislation and regulations governing the construction activity indicated as 1st in Q1 and Q2 (If possible, submit/mail a copy of this legislation to: Theo C Haupt, 288 Corry Village #19, GAINESVILLE, Florida 32603-2141 USA)

______________________________ 129
______________________________ 130
______________________________ 131
______________________________ 132

13. Other relevant comments on the legislation or regulations

133
134
135
136

Section 4: General

14. Any other comments

137
138
139

THANK YOU FOR THE OPPORTUNITY TO CONSULT YOU AND FOR YOUR CONTRIBUTION TO THE GLOBAL CONSTRUCTION HEALTH AND SAFETY EFFORT

APPENDIX B
ELECTRONIC INTERVIEW WITH HELEN TIPPETT

Subject: Performance-based codes
Date: Mon, 29 Nov 1999 14:48:44 – 0500
From: Theo C Haupt theoc@ufl.edu
To: helen.tippett@vuw.ac.nz

Dear Helen

Thank you so much for your most informative response. After reading your message I have a few questions to which I would appreciate your response:

1. What prompted NZ to develop and then adopt a performance-based building regulatory system?
2. How was the transition from the old code to the new code received by all participants in the construction process?
3. Has the new code in any way impacted the structure of the industry and organisations?
4. How was the change managed?
5. What was the cost involved in the transformation?
6. Has the code improved the performance of the industry?
7. What is the supporting institutional framework like? How are the provisions of the code monitored?
8. Would such an approach work in the area of construction worker safety and health?
9. Would it be possible to let me have extracts of the old code and new code to demonstrate illustratively the difference between the approaches?
10. Would you be able to let me have or guide me to some of the literature (either your work or that of others) on the subject?
11. What is a more appropriate description of the approach? Performance-based; performance-directed; or performance-oriented?

I look forward to hearing from you shortly.

Regards

Theo

Subject: Fwd: Performance-based codes
Date: Thu, 09 Dec 1999 19:20:45 + 1300
From: Helen Tippett Helen.Tippett@vuw.ac.nz
To: theoc@ufl.edu
CC: porteous@bia.co.nz

Dear Dr Haupt

The best person to respond to your questions is Dr. Bill Porteous, CEO of the NZ Building Industry Authority which overviews and monitors the national building control system. His email address in my previous response was not correct. It is porteous@bia.co.nz

Date: Mon, 29 Nov 1999 14:48:44 –0500
From: Theo C Haupt theoc@ufl.edu
X-Mailer: Mozilla 4.7 [en] (Win95; U)
X-Accept-Language: en
To: helen.tippett@vuw.ac.nz
Subject: Performance-based codes

Dear Helen

Thank you so much for your most informative response. After reading your message I have a few questions to which I would appreciate your response:

1. **What prompted NZ to develop and then adopt a performance-based building regulatory system?**
– Industry submission to government in 1981 pointing out the cost of multiple prescriptive regulatory systems was not commensurate with public benefit.
– Change of government in 1985 with a strong deregulation agenda
2. **How was the transition from the old code to the new code received by all participants in the construction process?**
– Mixed feelings and skepticism that it would encourage innovation or more cost effective compliance
3. **Has the new code in any way impacted the structure of the industry and organisations?**
– Yes - accredited private certifiers, accredited products, more consistent territorial authority granting of building consents, responsibility of owner for ongoing compliance – for further details refer BIA
4. **How was the change managed?**
– New Building Act of Parliament and new national authority (BIA)
5. **What was the cost involved in the transformation?**
– Significant – refer BIA for cost and funding of system in operation
6. **Has the code improved the performance of the industry?**
– To some extent – the opportunity for improvement is greater than actual

7. What is the supporting institutional framework like? How are the provisions of the code monitored?

– Refer BIA

8. Would such an approach work in the area of construction worker safety and health?

– Yes refer BIA and subsequent legislation Health and Safety in Employment Act

9. Would it be possible to let me have extracts of the old code and new code to demonstrate illustratively the difference between the approaches?

– Refer BIA – the old plumbing regulations (under a Health Act) and the relevant clauses in the NZBC should illustrate this well. (There are only 36 primary clauses in the NZBC)

10. Would you be able to let me have or guide me to some of the literature (either your work or that of others) on the subject?

– I think BIA has a full set of the research mongrams I wrote 1981-86 and working papers for the Building Industry Commission from 1988-1990. The "primer" was Tippett Helen. Building Controls in New Zealand: The Control System and its Economic Impact (CRP82-21) published by Victoria University of Wellington School of Architecture Oct 1982 ISBN 0-475-10034-4 – now out of print. VUW can arrange to photocopy and mail this to you if you wish.

11. What is a more appropriate description of the approach? Performance-based; performance-directed; or performance-oriented?

– Performance-based is where my research began. BIA may consider performance-oriented best describes the system in action.

I look forward to hearing from you shortly.

Regards

Theo

Professor Helen Tippett
Associate Dean
Faculty of Science
Victoria University of Wellington
PO Box 600 Wellington 6001 New Zealand
Telephone +64 4 463 5749 fax 463 5122

e-mail: Helen.Tippett@vuw.ac.nz

APPENDIX C
TOP MANAGEMENT QUESTIONNAIRE

Survey of Top Management of Construction Firms

Section 1: Demographic Information

1(a)What is your position within your organization?

…………..…………………………………………………………………………………..

1(b)Approximately how long have you held your current position? …………...… years

2(a).Approximately what is the average number of employees in your firm?

…...… employees

2(b).What is the approximate annual value of construction contracts?

$…………..… million

2(c).Under which contracting arrangement are the firm's revenue acquired?

…...…% construction management (agency); …...…% general contracting;
...……% subcontracting; …...…% construction management at risk;
….… % specialty contracting; …...… % design-build;
..… % other (specify) …………………………………………... ………………………

2(d).Describe the firm's area(s) of operation.

…...… % international; …...… % national; …...… % regional; …...… % local

Section 2: Management Attitude to the Prescriptive and Performance Approaches

Before responding to the questions in this section, study the definitions of the prescriptive and performance approaches and the accompanying illustrative examples of each approach as set out below:

Definition of the prescriptive approach:

The prescriptive approach requires strict, and enforced conformity to a safety standard, regulation or rule, and specifies in exacting terms the means or methods of how employers must address given conditions on construction sites.

Definition of the performance approach:

The performance approach identifies important broadly-defined goals, ends or targets that must result from applying a safety standard, regulation or rule without setting out the specific technical requirements or methods for doing so.

Example of a prescriptive code for demolition work:

OSHA 29 CFR 1926 Subpart T 850(k)

Employee entrances to multi-story structures being demolished shall be completely protected by sidewalk sheds or canopies, or both, providing protection from the face of the building for a minimum of 8 feet. All such canopies shall be at least 2 feet wider than the building entrances or openings (1 foot wider on each side thereof), and shall be capable of sustaining a load of 150 pounds per square foot. Employee entrances to multi-story structures being demolished shall be completely protected by sidewalk sheds or canopies, or both, providing protection from the face of the building for a minimum of 8 feet. All such canopies shall be at least 2 feet wider than the building entrances or openings (1 foot wider on each side thereof), and shall be capable of sustaining a load of 150 pounds per square foot.

Example of a performance code for demolition work:

Demolition work

Where the demolition of a building or construction may present a danger:

appropriate precautions, methods and procedures must be adopted;

the work must be planned and undertaken only under the supervision of a competent person.

Example of key provisions of a prescriptive code for scaffolding platforms

OSHA 29 CFR 1926 Subpart L 451 Scaffolding

(b) ‘Scaffold platform construction.’

(b)(1)(ii) …. the platform shall be planked or decked as fully as possible and the remaining open space between the platform and the uprights shall not exceed 9 1/2 inches (24.1 cm).

(b)(2) Except as provided in paragraphs of this section, each scaffold platform and walkway shall be at least 18 inches (46 cm) wide.

(b)(5)(I) Each end of a platform 10 feet or less in length shall not extend over its support more than 12 inches (30 cm) …

(b)(5)(ii) Each platform greater than 10 feet in length shall not extend over its support more than 18 inches (46 cm), unless it is designed and installed so that the cantilevered portion of the platform is able to support employees without tipping, or has guardrails which block employee access to the cantilevered end.

(b)(7) On scaffolds where platforms are overlapped to create a long platform, the overlap shall occur only over supports, and shall not be less than 12 inches (30 cm) unless the platforms are nailed together or otherwise restrained to prevent movement.

Example of a performance code for scaffolding and ladders

Scaffolding and ladders

All scaffolding must be properly designed, constructed and maintained to ensure that it does not collapse or move accidentally.

Work platforms, gangways and scaffolding stairways must be constructed, dimensioned, protected and used in such a way as to prevent people from falling or exposed to falling objects.

Note: No specific dimensions are stipulated

Summary: The prescriptive approach describes the means and methods to comply with the regulations	Summary:The performance approach describes what has to be achieved to comply with the regulations and leaves the means and methods of complying up to the contractor

The following questions concern your understanding, beliefs and opinions on the prescriptive and performance approaches to construction worker safety and health. Please check or circle the answer that best approximates your opinion.

3. Assuming that you were erecting scaffolding on a project in a country where both approaches were acceptable and legitimate, which approach would you prefer?

………..… prescriptive approach ………..… perfomance approach

4. Please explain why you made this choice (in Q3)

...………………………………………..……………………………………………………………

..…………..………………………………………………………………………………………

5. How well do you feel that you understand the concepts of prescriptive and performance standards? (On a scale of 1 (very poorly) through 7 (very well), circle your choice

1 Very poorly	2	3	4	5	6	7 Very well

6. Conceptually, which approach to construction worker safety do you prefer?

1 Performance	2	3	4	5	6	7 Prescriptive

7. How influential are the types of approaches to each of the following issues?

Ease of introduction of new technologies

1 Performance	2	3	4	5	6	7 Prescriptive

Cost effectiveness of approach

1 Performance	2	3	4	5	6	7 Prescriptive

Flexibility

1 Performance	2	3	4	5	6	7 Prescriptive

Ease of implementation

1 Performance	2	3	4	5	6	7 Prescriptive

Ease of understanding compliance requirements

1 Performance	2	3	4	5	6	7 Prescriptive

Support for innovation

1 Performance	2	3	4	5	6	7 Prescriptive

Ease of introduction of new materials

1 Performance	2	3	4	5	6	7 Prescriptive

Q7. Cont'd

Supported by the corporate culture, vision and mission of your organization
1 2 3 4 5 6 7
Performance Prescriptive

Potential to improve safety performance on sites
1 2 3 4 5 6 7
Performance Prescriptive

Simplicity of interpretation
1 2 3 4 5 6 7
Performance Prescriptive

Ease of compliance
1 2 3 4 5 6 7
Performance Prescriptive

8. How important do you regard the following regarding an approach to construction safety and health management?

Cost effectiveness of approach
1 2 3 4 5 6 7
Not important Very important

Ease of implementation of the approach
1 2 3 4 5 6 7
Not important Very important

Ease of understanding compliance requirements
1 2 3 4 5 6 7
Not important Very important

Support for innovation, new materials and technology
1 2 3 4 5 6 7
Not important Very important

Potential to improve safety performance on sites
1 2 3 4 5 6 7
Not important Very important

Section 3: Change Management

The following questions are designed to measure the capacity for change within your organization. Please check or circle the answer that best approximates your opinion.

9. Who usually sponsors major change within your organization?

..…% top management; ..…% middle management; ..…% site management;

..…% first-line supervisors; ..…% workers

10. How influential are the following in driving change within your organization?

To improve financial performance
1 2 3 4 5 6 7
Not influential Very influential

Only as staff turnover occurs
1 2 3 4 5 6 7
Not influential Very influential

When new technology is introduced
1 2 3 4 5 6 7
Not influential Very influential

To keep up with competitors
1 2 3 4 5 6 7
Not influential Very influential

To improve your safety record
1 2 3 4 5 6 7
Not influential Very influential

Only after accidents occur
1 2 3 4 5 6 7
Not influential Very influential

To meet worker demands
1 2 3 4 5 6 7
Not influential Very influential

To generate quality improvements
1 2 3 4 5 6 7
Not influential Very influential

To exploit new market opportunities
1 2 3 4 5 6 7
Not influential Very influential

Respond to management initiatives
1 2 3 4 5 6 7
Not influential Very influential

Respond to third party claims
1 2 3 4 5 6 7
Not influential Very influential

Comply with owner/client requirements
1 2 3 4 5 6 7
Not influential Very influential

Meet new insurance requirements
1 2 3 4 5 6 7
Not influential Very influential

11. Have you observed the introduction of any major changes in your firm?

………..… Yes ………..…No

12. If the company were to consider introducing a change to improve safety performance how important would be the willingness of workers to accept the change before the change is implemented?

1 2 3 4 5 6 7
Not important Very important

13. How important would it be to break down the resistance of workers to change by convincing them to accept the change?

1 2 3 4 5 6 7
Not important Very important

14. How important would it be to build credibility and trust with the workers before implementing a change?

1 2 3 4 5 6 7
Not important Very important

15. How important would it be to enlist the opinions of workers on a proposed change before it is implemented?

1 2 3 4 5 6 7
Not important Very important

16. How important do you regard the receptiveness of first-line supervisors (foremen) to change?

1 2 3 4 5 6 7
Not important Very important

17. How important do you consider the following factors to be for the implementation of new approaches?

Top management support
1 2 3 4 5 6 7
Not important Very important

Mutual trust between workers and management
1 2 3 4 5 6 7
Not important Very important

Incentives and rewards for supporting the change
1 2 3 4 5 6 7
Not important Very important

Continuous improvement of safety performance
1 2 3 4 5 6 7
Not important Very important

Open communication
1 2 3 4 5 6 7
Not important Very important

Effective coordination of construction activities
1 2 3 4 5 6 7
Not important Very important

Q17 Cont'd

Joint labor/management problem solving
1 2 3 4 5 6 7
Not important Very important

Adequate resources
1 2 3 4 5 6 7
Not important Very important

Creativity
1 2 3 4 5 6 7
Not important Very important

Workshops and training
1 2 3 4 5 6 7
Not important Very important

18. How important do you regard the following actions for the successful implementation of a new approach to construction worker safety and health?

Demonstrate consistent and decisive personal leadership
1 2 3 4 5 6 7
Not important Very important

Allocate adequate financial, equipment and staff resources
1 2 3 4 5 6 7
Not important Very important

Amend corporate vision and mission
1 2 3 4 5 6 7
Not important Very important

Motivate workers to implement changes for continuous improvement
1 2 3 4 5 6 7
Not important Very important

Encourage worker participation at all levels
1 2 3 4 5 6 7
Not important Very important

Change the organization's systems, policies and procedures to augment the changes
1 2 3 4 5 6 7
Not important Very important

Introduce and support appropriate training programs
1 2 3 4 5 6 7
Not important Very important

Measure and evaluate progress of the changes regularly introducing new plans of action if necessary
1 2 3 4 5 6 7
Not important Very important

Compare the performance of the company with competitors
1 2 3 4 5 6 7
Not important Very important

Q18. Cont'd

Reward workers for being innovative, and looking for new solutions

1	2	3	4	5	6	7
Not important						Very important

Change the organizational structure and hierarchy to make it more flexible and responsive to change

1	2	3	4	5	6	7
Not important						Very important

19. How many recordable injuries did the company have last year? ………..… injuries

Please offer any additional comments you have on the subject of performance and prescriptive regulations and standards in the space provided below:

Thank you for contributing to the improvement of the safety and health effort on construction sites

Please return your completed questionnaire in the enclosed envelope to:

The Center for Construction Safety and Loss Control
University of Florida
C/o 390 Maguire Village #6
GAINESVILLE, FL. 32603-2023

APPENDIX D
RESULTS OF INTERNATIONAL SAFETY SURVEY

Table D-1 Notes on codes used in tables of data:

Country code	Activity Codes
1 = Hong Kong	A = Stepping on. striking against or struck by object
2 = Spain	B = Handling. lifting or carrying without machinery
3 = New Zealand	C = Fall of person/loss of balance
4 = Portugal	D = Ergonomics
5 = China	E = Run over by plant. caught in/between
6 = United Kingdom	F = Electrical
7 = Turkey	G = Overturning of plant and vehicles
	H = Overhangs and collapses. and cave-ins
	J = Slips. Trip or fall on same level

Table D-2 1995 - Ranking of activity most responsible for accidents on construction sites

	1	2	3	4	5	6	7
1st	A			C	C	B	
2nd	B	A		E	F	J	
3rd	C	C		H	A	A	

Table D-3 1996 -Ranking of activity most responsible for accidents on construction sites

	1	2	3	4	5	6	7
1st	A		C	C	C	B	
2nd	C	A	D	E	F	J	
3rd	B	C	A	H	A	A	

Table D-4 1997 - Ranking of activity most responsible for accidents on construction sites

	1	2	3	4	5	6	7
1st	A	(21.9%)	C	C		B	
2nd	B	A (19.9%)	D	E		J	
3rd	C	C (10.9%)	A	H		A	

Table D-5 1998 - Ranking of activity most responsible for accidents on construction sites

	1	2	3	4	5	6	7
1st				C		B	
2nd				E		J	
3rd				H		A	

Table D-6 1997 - Ranking of activity most responsible for fatalities on construction sites

	1	2	3	4	5	6	7
1st		C (35%)				C	
2nd		E (13.84%)					
3rd		H (11.15%)					
4th		F (6.92%)					
5th		G (3.85%)					

Table D-7 Number of workers employed in all industries

	1	2	3	4	5	6	7
1995	763,900	3,620,600		4,225,200	97,260,000	22,025,000	4,410,744
1996	751,700	3,675,000		4,250,500	99,630,000	22,750,000	4,624,330
1997	750,100	3,823,000		4,331,900		23,250,000	
1998		3,961,100		4,414,200		23,650,000	

Table D-8 Number of workers employed in construction

	1	2	3	4	5	6	7
1995	229,00	1,134,500		340,300	21,580,000	842,000	852,613
	(30.1%)	(31.3%)		(8.1%)	(22.2%)	(3.8%)	(19.3%)
1996	269,600	1,175,500	84,399	343,100	25,540,000	889,000	722,689
	(35.9%)	(32%)		(8.1%)	(25.6%)	(3.9%)	(15.6%)
1997	306,200	1,242,700	85,000	388,400	34,450,000	975,000	
	(40.8%)	(32.5%)		(9.0%)		(4.2%)	
1998		1,307,100		400,400		1,103,000	
		(33%)		(9.1%)		(4.7%)	

Table D-9 Total number of accidents in construction

	1	2	3	4	5	6	7
1995	15,300	125,015				12,084	12,809
1996	16,500	130,732*	3,134			12,289	11,784
1997	18,600	142,894*	+ 3,000			14,125	
1998						14,159	

* with loss

Table D-10 Total number of fatalities in construction

	1	2	3	4	5	6	7
1995	63 (0.41%)	259 (0.21%)	16	119	1,869 (0.01%)	88 (0.73%)	348 (2.72%)
1996	51 (0.31%)	246 (0.19%)	14	176	1,788 (0.01%)	82 (0.67%)	555 (4.7%)
1997	41 (0.22%)	260 (0.18%)	17 (0.O2%)	196		93 (0.66%)	
1998				179		80 (0.57%)	

Table D-11 Incidence indices of accidents (number of accidents/1000 workers in construction)

	1	2	3	4	5	6	7
Pre - 1995				182			
1995	232(66.72)	151.6 (110.19)	36			14.35	15.02
1996	219 (61.20)	158.7 (111.21)	37.13		0.06	13.82	16.31
1997	227 (60.74)	164.0 (114.99)				14.49	
1998						12.89	

Table D-12 Frequency indices of accidents (number of accidents/1,000,000 hours worked in construction)

	1	2	3	4	5	6	7
Pre - 1995				67			6.26
1995		85.7					6.79
1996		90.6			0.03		
1997		93.7					
1998							

Table D-13 Severity indices of accidents (number of lost days/1000 hours worked in construction)

	1	2	3	4	5	6	7
Pre - 1995				3.8			
1995		2.06					
1996		2.28			0.11		
1997		2.14					
1998							

Table D-14 Duration indices of accidents (number of lost days/accident in construction)

	1	2	3	4	5	6	7
Pre - 1995				20			
1995		23.1					
1996		24.4			4,236.1		
1997		22.2					
1998							

Table D-15 Incidence indices of accidents due to activity ranked 1 (number of accidents/1000 workers in construction)

	1	2	3	4	5	6	7
1995						0.10	0.41
1996			8.45		0.03	0.09	0.77
1997		35.89				0.10	
1998						0.07	

Table D-16 Frequency indices of accidents due to activity ranked 1 (number of accidents/1,000,000 hours in construction)

	1	2	3	4	5	6	7
1995							0.17
1996					0.01		0.32
1997		20.5					
1998							

Table D-17 Incidence indices of fatalities (number of fatalities/1000 workers in construction)

	1	2	3	4	5	6	7
1995	0.95 (0.27)	31.4 (0.23)	17				0.41
1996	0.68 (0.19)	29.9 (0.21)	14				0.77
1997	0.50 (0.13)	29.8 (0.21)					
1998							

Table D-18 Frequency indices of fatalities (number of fatalities/1,000,000 hours worked in construction)

	1	2	3	4	5	6	7
1995		17.76		0.350			
1996		17.05		0.513			
1997		17.04		0.505			
1998				0.447			

Table D-19 Incidence indices of fatalities due to activity ranked 1 (number of accidents/1000 workers in construction)

	1	2	3	4	5	6	7
1995							
1996							
1997		10.43					
1998							

Table D-20 Frequency indices of fatalities due to activity ranked 1 (number of fatalities/1,000,000 hours in construction)

	1	2	3	4	5	6	7
1995							
1996							
1997		5.96					
1998							

– Legal Framework - General

– Hong Kong

– Factories and Industrial Undertakings Ordinance
– Factories and Industrial Undertakings (Safety Management) Regulation

- Builder’s Lifts and Tower Working Platforms (Safety) Ordinance
- Occupational Safety Charter. Safety Management Regulation

- Spain

- Real Decreto 1627/1997 (24 October 1997): Transposition Directive EEC
- Ley de Prevencion de Riesgos Laborales 31/95: Transposition Framework Directive EEC

- New Zealand

- Construction (Head Protection) Regulations 1989Health and Safety in Employment Act (1992)
- New Zealand Building Code

- Portugal

- Decret-law nº 155/95 of 1 July 1995

- United Kingdom

- Health and Safety at Work Act 1974
- The Management of Health and Safety at Work Regulations 1992 and 1994
- The Construction (Health Safety and Welfare) Regulations 1996
- The Construction (Design and Management) Regulations 1995
- Construction (Lifting Operations) Regulations 1961: amended 1989. 1992 and 1996
- Confined Spaces regulations 1997
- Control of Substances Hazardous to Health Regulations 1994

- Turkey

- Labour Law
- Rules for Workers’ Health and Work Safety
- Rules for Workers’ Health and Work Safety in Construction Sector

- Legal Framework for Construction Activity Ranked 1

- Hong Kong

- Factories and Industrial Undertakings Ordinance
- Factories and Industrial Undertakings (Safety Management) Regulation
- Builder’s Lifts and Tower Working Platforms (Safety) Ordinance
- Occupational Safety Charter. Safety Management Regulation

- Spain

- Partially in Real Decreto 487/1997 (14 April 1997)
- Partially in Real Decreto 773/1997 (30 May 1997)

- New Zealand

- Health and Safety in Employment Act (1992)
- New Zealand Building Code

- United Kingdom

- Manual Handling Regulations 1992 within the Management of Health and Safety at Work Regulations 1992 and 1994
- Construction (Lifting Operations) Regulations 1961: amended 1989. 1992 and 1996

- General Comments

- Hong Kong

- Also a great deal of subsidiary legislation. See Rowlinson 1997 for more details
- There is a move to self-regulation but this may bring more problems than prescriptive legislation, particularly as much work is sub-contracted to very small firms

- Spain

- The incidence of activities ranked as 4th (fall at same level), 5th (projecting objects) and 6th (stepping over objects) are decreasing over time while those ranked 1st, 2nd and 3rd remain constant
- The basis for calculating indices in Spain are different to that recommended at the XIII International conference in Working Statistics of OIT and uses data supplied by Social Assurance Office

- New Zealand

- Generally information is not available due to it not being collected for the construction industry
- There have been considerable increases in the incidence indices for all trades between 1993 and 1996 - 88% for concreting, bricklaying, steelwork and roofing workers; 66% for plasterers, painters and floorers; 38% for building and carpentry; 22% for plumbing services; 17% for civil engineering; and 14% for electrical services
- There is concern that injury rates are increasing while those in the rest of the world are decreasing
- Fatality rates are also higher than other countries such as Australia. Germany. Sweden and UK

- Portugal

- Indices are based on accidents with more than one day lost
- Severity indices include 7 500 working days for each fatality

- China

- There is a lack of information available even from the Ministry of Construction

United Kingdom

- Finishing processes result in the most accidents. with transport on site being the next major cause
- The activities ranked include fatalities. major accidents and accidents requiring more than 3 days off work with falls from heights above 2 meters being the activity most responsible for fatalities with falling through fragile roofing materials being the chief cause
- Since the introduction of the Health and Safety at Work Act (1974) UK legislation has adopted a self-regulating approach
- Previous regulatory provisions followed a style and pattern which was developed under different social and technological contexts
- This piecemeal development led to a haphazard mass of law which was intricate in detail, unprogressive and difficult to amend and keep up to date
- However non-prescriptive legislation relies heavily on risk assessment and comparison to what is termed 'reasonably practicable.' In providing flexibility the newer approach has introduced elements of uncertainty and bureaucracy which all but larger employers find difficult to implement
- Over the last 25 years the UK construction industry has witnessed a steady decline in the number of fatal and non-fatal accidents. Unfortunately statistics for 1996/7 have seen an increase across the range. with fatal accidents up to 12.2% and major/non-fatal accidents up nearly 17.5% on previous annual figures (HSE 1998)

APPENDIX E
ELECTRONIC INTERVIEW WITH BILL PORTEOUS

From: “Bill Porteous” <porteous@bia.co.nz>
To: <theoc@ufl.edu>
Sent: Monday, October 23, 2000 6:40 PM
Subject: RE: NZBC

Dear Theo

Thank you for your enquiry dated 12 October 2000. I apologise for the delay in replying, but we have had to check a few points before responding to your questions. Our answers are as follows, in the same order as you asked them:

- No measurable effect so far as we are aware.
- No “large scale resistance” was observed.
- Not known. As with any change to the law of the land the cost fell mainly on the taxpayer. The cost of learning to work within the new regime has not been quantified but would have been borne by both local government and the building industry.
- We would say “yes” because innovation has been encouraged and alternative solutions accepted.
- You should put this question to Site Safe New Zealand, an organisation which deals with such matters. Web address is **www.sitesafe.org.nz**. Street address is 22 The Terrace, Wellington, New Zealand. Phone 64 4 994052
- We have posted to you today, by airmail, photocopies of the old Plumbing and Drainage Regulations 1978 and of Clause G12 Water Supplies, together with a copy of the Acceptable Solution G12/AS1

I hope this response is of some help.

Sincerely,

Bill Porteous

Dr. Bill Porteous
Chief Executive

Building Industry Authority
39 The Terrace, Greenock House
PO Box 11846 Wellington New Zealand
Telephone +64 4-471 0794 fax +64 4-471 0798
Email:porteous@bia.co.nz

From: Theo C Haupt [mailto: theoc@ufl.edu]
Sent: Wednesday, 11 October 2000 17:11
To: bia@bia.co.za
Subject: NZBC
Importance: High

Dear Sirs

I am currently reading for a Ph.D. conducting research into the performance approach. I was referred to you by Dr. Helen Tippett with respect to obtaining information on the following:

1. How has the introduction of the new code impacted the structure of the construction industry itself and also construction firms?
2. Was there any large scale resistance to the change in legislative approach?
3. What was the cost involved in bringing about the transformation?
4. Has the code improved the performance of the industry?
5. Would the performance approach work in the area of construction safety and health?
6. Can you provide me with an example of the old code and then the equivalent in the new code?

I look forward to hearing from you.

Regards

Theo C Haupt M.Phil, MSAIB, MASI
Immediate Past-President – African Students Association (ASA)
390 Maguire Village #6, GAINESVILLE
Florida 32603-2023, USA
Voice (352) 846 5453 (h) Fax (775) 306 4193 (352) 392 9606

You cannot win it, unless you are in it!
Safety is everyone's business!
Know safety, no accidents!

APPENDIX F
EXAMPLE OF A SAFETY CHECKLIST

The following selected checklists have been extracted from the New Zealand regulations (Occupational Safety and Health Service, 1995) and present the main points to be considered when checking safety and health on construction sites. The hazards should be identified, assesses and the risks controlled.

SAFE ACCESS

______ Are there arrangements to deal with visitors and workers new to the site?

______ Can everyone reach his or her place of work safely? Are there safe roads, gangways, passageways, ladders and scaffolds?

______ Are all walkways level and free from obstructions?

______ Is protection provided to prevent falls, especially when more than 3 m?

______ Are holes securely fenced or protected with clearly marked fixed covers?

______ Is the site tidy and are materials stored safely?

______ Is waste collected and disposed of properly?

______ Are there enclosed chutes for waste to avoid materials being thrown down?

______ Are nails in timber removed or hammered down?

______ Is safe lighting provided for work in the dark or poor light?

EXCAVATIONS

______ Have all underground services been located (with locators and plans), marked and precautions taken to avoid them?

______ Has an adequate supply of suitable timber, trench sheets, props or other supporting material been delivered to the site before excavation work begins?

______ Is a safe method used for putting in and taking out the timbering, i.e. one that does not rely on people working within an unsupported trench?

______ If the sides of the excavation are sloped back or battered, is the angle of batter sufficient to prevent collapse?

______ Is the excavation inspected daily, and thoroughly examined after using explosives or after unexpected falls of materials?

ROOF WORK

______ Are crawling ladders or crawling boards used on roofs that slope more than 15^o ?

______ If not, do the roof battens provide a safe handhold and foothold?

______ Are there barriers or other edge protection to stop people or materials falling from sloping roofs or flat roofs?

______ Are crawling boards provided and used where people work on fragile materials, such as asbestos cement sheets or glass?

______ Are warning notices posted?

______ Are suitable guard rails, cover, etc. provided where people pass or work near such fragile materials?

______ Are roof lights properly covered or provided with barriers?

______ During sheeting operations, are precautions taken to stop people falling from the edge of the sheet?

______ Are precautions taken to stop debris falling onto others working under the roof work or in the vicinity of the work?

SCAFFOLDS

_______ Is there proper access to the scaffold platform?

_______ Are all uprights properly founded and provided with base plates? Where necessary, are there timber sole plates, or is there some other way in which slipping and/or sinking can be avoided?

_______ Is the scaffold secured to the building in enough places to prevent collapse and are the ties strong enough?

_______ If any ties have been removed since the scaffold was erected, have additional ties been provided to replace them?

_______ Is the scaffold adequately braced to ensure stability?

_______ Are load-bearing fittings used where required?

_______ Have uprights, ledgers, braces or struts been removed?

_______ Are the working platforms fully planked? Are the planks free from obvious defects, such as knots, and are they arranged to avoid tipping and tripping?

_______ Are all planks securely restrained against movement?

_______ Are there adequate guard rails and toe boards at every side from which a person or materials could fall?

_______ If the scaffold has been designed and constructed for loading with materials, are these evenly distributed?

_______ Are there effective barriers or warning notices to stop people using an incomplete scaffold, e.g. one that is not fully planked?

_______ Does a competent person inspect the scaffold at least once a week and always after bad weather?

_______ Are the results of inspections recorded, including defects that were put right during the inspections, and the records signed by the person who carried out the inspection?

APPENDIX G
SAMPLE COVER LETTER

May 19, 2001

XXX YYY ZZZ
1234 ABC Road
MIDWAY, FL. 32343

Attention: John Citizen

Dear Sirs

Graduate Study on Safety

The M.E. Rinker, Sr. School of Building Construction at the University of Florida is conducting a study of safety related to safety standards. The focus of the study is to identify company preferences as they pertain to different types of safety regulations, namely performance and prescriptive standards. To the extent possible, the study will attempt to identify those standards that are most preferred and reasons why. This information will be used to provide some insights on the merits of considering changes in the general nature of safety standards. The ultimate goal is to improve construction worker safety.

The survey questionnaire that is enclosed, contains a variety of questions related to safety standards and company perspectives on various issues. Many of the questions can be answered by simply encircling the applicable answers. The survey can be completed in about ten to fifteen minutes. Naturally, you are asked to answer only those questions that you feel comfortable in answering.

Completed questionnaires should be returned by December 4, 2000 in the self-addressed and stamped envelope provided for this purpose.

The results of this study are part of a doctoral research effort. As a token of our appreciation for your participation, we will be happy to provide a summary report of this research to you at no charge. Should you have any questions please feel free to call us at the telephone numbers provided below.

Responses provided by specific firms will be kept strictly confidential. Research data will be summarized so the identity of individual participants will be concealed. Yoi have our sincere thanks for participating in this valuable study.

Yours truly,

Jimmie Hinze
Professor
(352) 392-4697

Theo Haupt
Ph.D. Candidate
(352) 846-5453

APPENDIX H
FEDERAL REGISTER OF RECORDS OF VARIANCES

Year	Federal Register #	Standard Number	Applicant	Record Type	Variance Type
1973	38:8545-8548	1926.552	Graver Tank & Manufacturing Co.	Granted	Temporary
1973	38:16944	1910.107 1910.108	American Airlines	Granted	Temporary
1974	39:1677-1678	1910.176	Fisher Mills, Inc.	Granted	Temporary
1974	39:11481-11482	1910.37	Rollins College	Granted	Temporary
1974	39:37278	1910.28	Union Electric Company	Granted	Temporary
1976	41:15483-15484	1918.66	T.A. Loving Company	Granted	Temporary
1976	41:56110-56111	1910.22 1910.23	Metalplate Galvanizing, Inc	Granted	Temporary
1977	42:54028	1910.22 1910.23	Clark Grave Vault Co.	Granted	Temporary
1977	42:55291	1910.22 1910.23	Frontier Hot-Dip Galvanizing, Inc	Granted	Temporary
1978	43:2945-47	1910.217	West Pharmaceutical Services	Granted	Temporary
1978	43:9887-9888	1910.106	Minnesota Mining and Manufacturing Co. (3M)	Granted	Temporary
1983	48:40463	1910.261	International Paper-Erie Mill (Hammerhill Papers Group)	Granted	Temporary
1984	49:33755	1910.1043	Graniteville Company	Granted	Interim order
1985	50:6411-13	1910.1043	Graniteville Company	Granted	Temporary
1985	50:10550	1910.1025	28 plants	Granted	Temporary
1985	50:11598	1910.1018 1910.1025	ASARCO, Inc.	Application	Permanent
1985	50:15004	1910.1025	AMAX Lead Company of Missouri	Application	Permanent
1985	50:15654	1910.262	St. Regis Corporation	Granted	Interim order

Year	Federal Register #	Standard Number	Applicant	Record Type	Variance Type
1985	50:20145-20149	1926.552	Zurn Industries, Inc. and Tileman & Co. Ltd	Granted	Temporary
1985	50:24961	1910.1025	ASARCO, Inc.	Granted	Interim Order
1985	50:24963	1910.1025	St. Joe Lead Company	Application	Permanent
1985	50:25343	1910.134	Chlorine Institute, Inc.	Application	Permanent
1985	50:26853-55	1910.261	St. Regis Corporation	Granted	Temporary
1985	50:28128-29	1910.1025	St. Joe Lead Company	Modification	Permanent
1985	50:2983	1910.134	Chlorine Institute, Inc.	Modification	Permanent
1985	50:30033	1910.1025	ASARCO, Inc.	Correction	Temporary
1985	50:31441-5	1926.45 1926.552	Union Boiler Company	Granted	Interim order
1985	50:40625	1910.1047	Midwest Sterilization Corporation	Granted	Interim order
1985	50:40627-31	1926.552	Union Boiler Company	Granted	Temporary
1985	50:41039-45	1910.1025	AMAX Lead Company of Missouri	Hearing Notice	Permanent
1985	50:48281	1910.1025	AMAX Lead Company of Missouri	Hearing Notice	Permanent
1985	50:6329-30	1910.1025	AMAX Lead Company of Missouri	Hearing Notice	Permanent
1986	51:15707	1910.1018 1910.1025	ASARCO, Inc.	Withdrawal Notice	Permanent
1986	51:1708	1910.134	Chlorine Institute, Inc.	Withdrawal Notice	Permanent
1986	51:16596	1910.1025	AMAX Lead Company of Missouri	Hearing Notice	Permanent
1986	51:23859-62	1910.1025	AMAX Lead Company of Missouri	Granted	Permanent
1986	51:32548	1910.1025	Lenox China, Inc.	Withdrawal Notice	Permanent
1987	52:184-87	1926.451 1926.552	Zurn Industries, Inc.	Application	Temporary
1987	52:12629-32	1926.800-804	Tomaro Contractors, Inc.	Application	Permanent
1987	52:22552-57	1926.552	Zurn Industries, Inc.	Granted	Permanent
1987	52:24074-77	1910.1025	ASARCO, Inc.	Application	Permanent
1987	52:30463-68	1910.1025	Interstate Lead Company	Application	Temporary

Year	Federal Register #	Standard Number	Applicant	Record Type	Variance Type
1987	52:30468-72	1910.1025	Sanders Lead Company	Application	Temporary
1987	52:38976-77	1910.1025	Interstate Lead Company	Hearing Notice	Temporary
1987	52:45035	1910.1025	Saunders Lead Company	Hearing Notice	Temporary
1988	53:20912-13	1910.1025	Doe Run Company	Application	Permanent
1988	53:30491-2	1910.1001 1905.10	Bendix Friction Materials Division of Allied-Signal, Inc.	Granted	Interim order
1988	53:47884-5	1926.550	Union Carbide Corp.	Granted	Interim order
1989	54:12692-3	1910.1048	Hoechst Celanese Corporation	Application	Temporary
1989	54:12691-2	1926.550	Broad, Vogt & Conant, Inc.	Application	Temporary
1997	62:58995-59002	1905.11 1910.423 1910.426	Dixie Divers, Inc.	Application	Permanent
1998	63:579	1905.11 1910.423 1910.426	Dixie Divers, Inc.	Comment Notice	Permanent
1999	64:71242-71261	1905.11 1910.423 1910.426	Dixie Divers, Inc.	Granted	Permanent

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BIOGRAPHICAL SKETCH

Theodore (Theo) Conrad Haupt was born on March 18, 1955 in Cape Town, South Africa. He completed the National Higher Diploma in Building Surveying at Peninsula Technikon, Cape Town, South Africa in 1989. He enrolled at The School of the Built Environment, De Montfort University, Leicester, United Kingdom in 1994, where he graduated with a Master of Philosophy in Construction in 1996. In 1996, he also completed the National Higher Diploma in Post School Education at Peninsula Technikon. In the Spring of 1998, Theo was admitted to the University of Florida to pursue his Ph.D. on a fellowship award from the United States Agency for International Development. He was admitted to doctoral candidacy in June, 1999 and has since been working on his dissertation as well as other avenues of research.

Throughout his academic career Theo has received several scholarships, awards and honors. In 1999 and 2000 he received the International Students Academic Performance Award at the University of Florida for earning a cumulative 4.0 GPA. He received a scholarship from the Ernest Oppenheimer Memorial Trust in 1998. Other awards were received from the De Beers Chairman's Educational Trust Fund, Foundation for Research Development, Architects and Surveyors Institute, South African Institute of Building, Building Industries Federation of South Africa, Peninsula Technikon, Association of South African Quantity Surveyors, Fred Harris Trust and Floating Trophy, and Rotary International.

Theo has considerable experience in the construction industry in various capacities. Since 1975, his involvement has included property administration, property development, project management, real estate, financial and building consulting, and staff training. He has been a lecturer (faculty member) since 1989 in the Department of Construction Management and Quantity Surveying at Peninsula Technikon, Cape Town, South Africa.

He has served as the chairperson of the Western Cape branch of the South African Institute of Building (SAIB). He remains a National Council member of SAIB and enjoys membership in Architects and Surveyors Institute (ASI), Chartered Institute of Building (CIOB), and Commonwealth Association of Surveying and Land Economics (CASLE).

Theo's research interests include infrastructure policy and delivery in the context of developing countries. However, his major focus has been on construction safety issues. He has published several safety-related articles and conference papers. He has co-edited several conference proceedings. In 2000, he co-edited 2 books in each of which he co-authored a chapter. He has served as a referee for several international journals.

He is currently the CIB W99 international area coordinator for Africa. He has served on the scientific and technical committees of international conferences, reviewing several of the abstracts and papers submitted.

Theo Haupt is divorced with 2 children, Jamie and Matthew.