USING THE BALANCED SCORECARD AS A SAFETY MANAGEMENT TOOL IN CONSTRUCTION COMPANIES: A QFD APPROACH

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Approval of the Graduate School of Natural and Applied Sciences

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ABSTRACT

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The aim of this thesis is to propose a safety management framework for construction companies. A literature review was performed to identify significant factors that would improve safety performance. Two management tools are used within the scope of this study: the balanced scorecard and quality function deployment (QFD). Strategic goals are established for each perspective of the

balanced scorecard: financial and cultural, employee, process and learning and growth. Afterwards, a questionnaire was prepared using the QFD approach. The goals in the financial and cultural perspective were defined as the needs of the organization related to safety ("customer requirements" in the original QFD approach). The goals in the remaining perspectives formed the actions that the organization could do to achieve its needs ("product how's" in the original QFD). Results of the questionnaire were used to form the final strategic goals in balanced scorecard. Safety performance measures and initiatives were defined for the accomplishment of the goals in the balanced scorecard.

Keywords: Safety management, balanced scorecard, quality function deployment

ÖZ

ÖLÇÜM KARTI TEKNİĞİ'NİN BİR İŞ SAĞLIĞI VE GÜVENLİĞİ YÖNETİM METODU OLARAK İNŞAAT ŞİRKETLERİNDE KULLANILMASI: BİR KALİTE FONKSİYON AÇILIMI YAKLAŞIMI

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Bu tezin amacı, inşaat şirketlerine iş sağlığı ve güvenliği konusunda bir yönetim metodu önermektir. İş güvenliği performansını etkileyen önemli faktörleri tespit etmek için bir literatür taraması yapıldı. Bu çalışmada iki yönetim metodu

kullanılmıştır: ölçüm kartı tekniği ve kalite fonksiyon açılımı (QFD). Ölçüm kartı tekniği perspektifleri için stratejik hedefler belirlenmiştir: finansal ve kültürel, çalışanlar, işlem ve öğrenme ve büyüme perspektifleri. Daha sonra, QFD metoduyla bir anket düzenlendi. Finansal ve kültürel perspektifdeki hedefler, şirketin iş sağlığı ve güvenliği konusundaki gereksinimleri (orijinal QFD'de "müşteri istekleri") olarak tanımlandı. Diğer perspektifteki hedefler, şirketin iş sağlığı ve güvenliği konusundaki gereksinimlerine ulaşmak için yapması gerekenleri (orijinal QFD'de "ürün çözümleri") oluşturdu. Anket sonuçları ölçüm kartı tekniğindeki nihai stratejik hedefleri belirlemek için kullanıldı. Ölçüm kartı tekniğindeki bu hedefler için performans ölçümleri önerildi ve bu hedeflere ulaşmak için insiyatifler tanımlandı.

Anahtar Kelimeler: İş sağlığı ve güvenliği yönetimi, ölçüm kartı tekniği, kalite fonksiyon açılımı.

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BSC	Balanced Scorecard
EMF	Experience Modification Factor
QFD	Quality Function Deployment
SSK	Social Security Institution
CPM	Critical Path Method
STD	Standard Deviation

CHAPTER 1

INTRODUCTION

1.1 General

According to the statistics by Social Security Institution (SSK) of Turkey, construction accidents rank second right after metal works with an average yearly rate of 9.6%. If we take into consideration the number of injuries that are not notified to SSK, these numbers will increase even more.

Before anything else, human life must be taken under protection. On the other side, work injuries can turn out to be significantly costly for firms. In addition to direct costs such as legal punishments, firms incur indirect costs. These hidden expenses may include the costs of replacing and training a new employee during injured worker's recovery period, reduced productivity of the crew, overtime to make up for lost productivity and possible project delays.

1.2 A Strategic Management View

Organizations perform various activities. These activities consume resources and resources have costs. Firms operating in various industries have limited resources and have to weigh the benefits and the costs associated with performing a certain activity. Costs and benefits can be easily identified if they are quantifiable in monetary terms. However, not all costs and benefits can be easily identified and

measured. What is the benefit and cost of an accident prevention program? What is the cost of an accident? Financial implications may be assessed but how about the cost of an injured or killed worker? As far as the safety issue is concerned, not only financial factors, but also human factors have to be taken into consideration.

As mentioned above resources have costs and no firm has unlimited resources. So, resources have to be allocated effectively and efficiently through strategic planning. This will enable an organization to be pro-active rather than re-active. The appropriate way to start is to perform an industry analysis and understand the requirements of the industry in which the organization is operating. The next step is to formulate, implement and evaluate strategies.

1.2.1 Strategy Formulation

An organization has to respond to the diverse needs of its stakeholders. Stakeholders are owners, employees, customers, creditors, government, and the general public. From a strategic management perspective, the first step to appeal to an organization's diverse stakeholders is to establish a vision and a mission. Especially the mission statement of an organization should intend to include the relevant points, which the industry it is operating in necessitates. The construction industry is one of the most vulnerable industries to accidents. So, the concern for employee safety should start by including this issue in the development of the mission statement. The mission statement will establish a general tone about the organizational climate, ensure unanimity of purpose within the organization and provide a basis for allocating organizational resources. Having analyzed the industry requirements and established a mission, the next step is to generate, evaluate and select appropriate strategic goals.

1.2.2 Strategy Implementation

Even the best strategic plans have no strategic value if they are not properly implemented. To achieve strategic goals, a strategy supportive culture has to be established. Strategy implementation includes the management functions of organizing, motivating and staffing. Organizing is the assignment of responsibilities. Motivating involves efforts to influence people to establish specific tasks. Staffing is the assignment of people to various tasks and their compensation.

Strategy implementation requires an organization to establish milestones for strategic goals and develop initiatives for their accomplishment.

1.2.3 Strategy Evaluation

All strategies have to be controlled in order to see whether actual performance deviates from the planned one. If there is deviation, corrective action has to be taken. A common saying is that, anything that is not measured can not be improved. So, performance measures for each strategic goal have to be established. Performance must be continuously assessed through these performance measures so that any shortcoming is identified in a timely manner and appropriate response can be made.

1.3 Objective and Scope

The aim of this research is to propose a safety management framework for construction companies. The proposed framework is illustrated in Figure 1.1. Two management tools are used within the scope of this study: the balanced scorecard and quality function deployment (QFD).

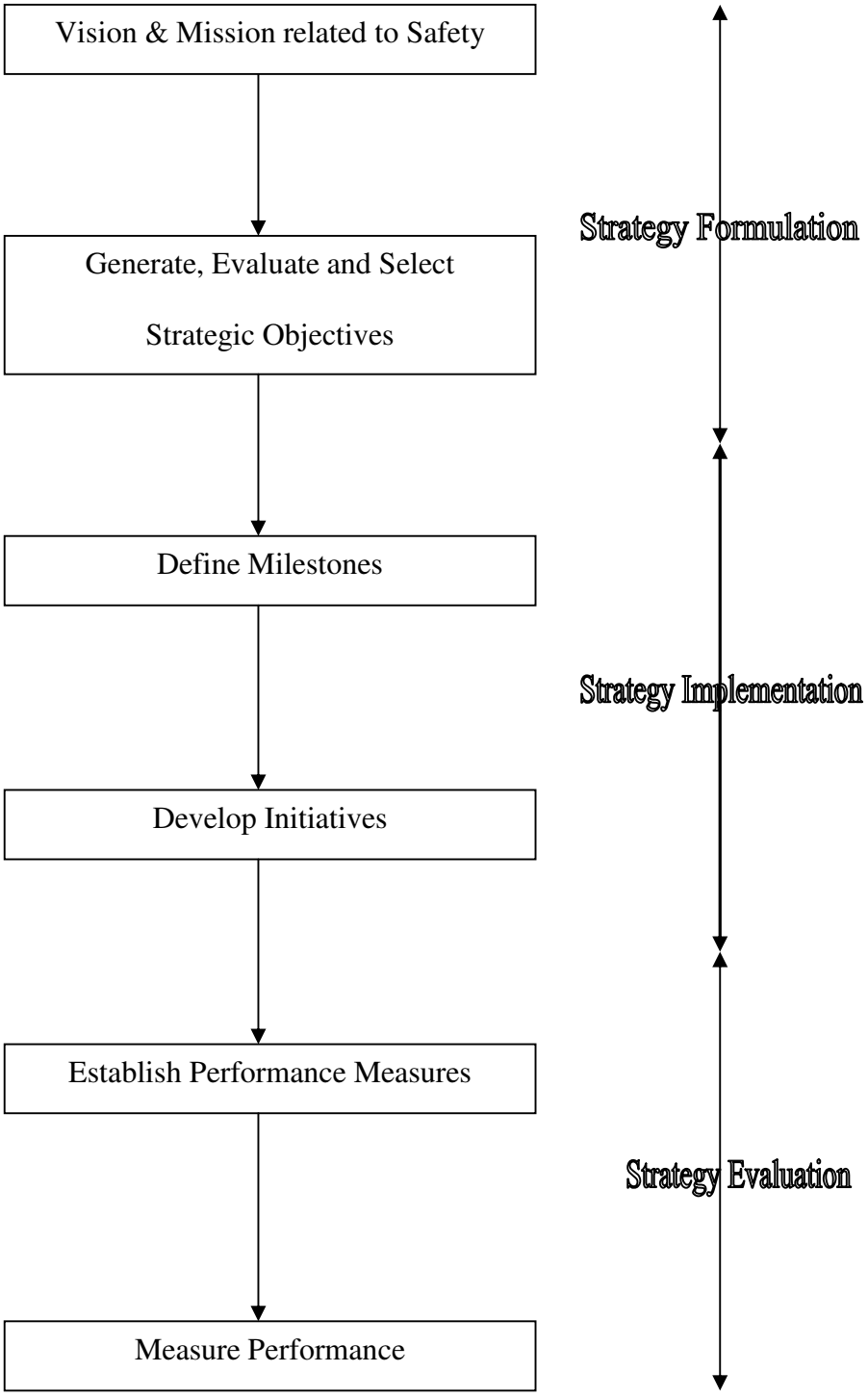


Figure 1.1 A Framework for Safety Management

Having performed an industry analysis with regard to safety issues and having its foundation from the organizations vision and mission, strategic goals are established for each perspective of the balanced scorecard: financial and cultural, employee, process, and learning and growth. Since it is not feasible to deal with all of them, QFD is used to evaluate and select the most important and relevant goals. The next step is to further utilize the balanced scorecard by deciding on appropriate safety performance measures for each goal. Defining the milestones for each of the goals in the balanced scorecard should be next considered. However, within the scope of this study, this part is left to companies willing to implement it, since these targets would change from one company to the other. The final stage within the scope of this study is to develop initiatives for the accomplishment of these goals. However, it is strongly recommended that companies continuously evaluate their strategy by comparing actual performance with the milestones by using performance measures set for each strategic goal.

1.4 Methodology

The research methodology involved the following steps:

- A literature review was performed to identify significant factors related to improved safety performance and measures of safety programs.
- The balanced scorecard was studied and slightly modified. 4 perspectives were identified: financial and cultural, employee, process and learning and growth. Findings in Step 1 were used to establish strategic goals for all the perspectives in the balanced scorecard.
- A questionnaire was prepared using the QFD approach. The goals in the financial and cultural perspective were defined as the needs and desires of the organization related to safety ("customer requirements" in the original QFD approach). The goals in the remaining perspectives formed the actions that the organization could do to achieve its needs and desires.

- Data was collected and analyzed. Data collection and data analysis are explained in a detailed manner in the fourth chapter.
- Results of the questionnaire were used to form the final strategic goals in the balanced scorecard.
- Findings in Step 1 were used to define safety performance measures and initiatives for the accomplishment of the goals in the balanced scorecard.

In the last chapter results are summarized and recommendations to contractors are provided.

CHAPTER 2

LITERATURE REVIEW

As mentioned in the Introduction part, a literature review on previous safety research is performed to identify significant factors related to improved safety performance and measures on safety programs. Next, a brief history on the management tools, balanced scorecard and QFD, used in our model will be given.

2.1 Previous Safety Research

In 1976, Levitt and Parker stated that top management involvement reduced construction accidents. The following findings were obtained:

- Top managers pointedly talking about safety when they visited jobs had experience modification rates (EMR) lower than companies in which this was not mentioned during interviews (EMR is an adjustment that is made to the workers' compensation insurance premium of companies that meet or exceed a certain size threshold. Companies with better safety track record will pay less insurance premium for their workers).
- Companies that conducted formal safety orientation for all new hires had an average EMR lower than companies that had no formal orientation for newly hired workers.
- Crews were found to perform work quicker, better, and more safely when managers insisted on detailed work planning (including materials,

equipment, man power, and safety requirements) prior to the start of the job.

In 1978, Hinze identified safety impact of new worker and turnover rates. The following findings were obtained:

- Superintendents whose crews had fewer injuries were those having larger percentages of workers transferring with them from one job to the next.
- Safety increases when companies retain their employees for more than one year, and there are additional benefits when employees are kept for even longer periods of time (five years in his study).

In 1978, Hinze and Pannullo showed that increased job control led to better safety performance. The following findings were obtained:

- Injuries tended to be lower in those firms engaging in projects in close proximity to the home office.
- Safer companies employed the same workers for a longer duration.
- Safety performance improved when same more workers visited the home office regularly.

In 1978, Hinze and Parker investigated superintendent characteristics associated with improved safety performance. The following findings were obtained:

- Increased job related pressure on superintendents led to increased injuries.
- Superintendents who were under pressure to complete the job from the home office had higher injury frequencies.

In 1979, Hinze and Gordon investigated supervisor-worker relationships and how they affect injury rates. The following findings were obtained:

- Supervisors who are more flexible in dealing with subordinate conflicts have better safety records compared to their more rigid counterparts.

- Safety performance is worse when foremen have full firing authority.

In 1981, Hinze and Harrison identified safety program practices in large companies associated with reduced injury frequency rates. The practices are as follows:

- The corporate safety director hired the field safety representative.
- Filed safety directors trained their subordinate workers.
- The safety director reported to the president or vice president of the company.
- New workers received formalized safety orientation.
- Safety awards were given to workers.
- Safety awards were given to foremen.

In 1982, Samelson and Levitt identified owner's guidelines for selecting safe contractors. The following findings were obtained:

- Owners who involve themselves actively in selecting and monitoring safety performance of contractors have significantly lower accident rates on their construction projects.
- Actions such as requiring contractors to delegate safety to on-site personnel, examination of safety at jobsite meetings, and investigation of accidents were initiated by both safety and average owners.
- Placement of considerable emphasis on selection of safe contractors by the owner is necessary for fewer monitoring and control actions.

In 1988, Hinze and Raboud identified appropriate means of achieving or maintaining acceptable safety performance on large projects. The findings are as follows:

- A full time company safety officer.
- Strong top-management support for safety.
- Safety meeting were conducted for supervisors.

- Supervisor safety performance was monitored.
- Specific jobsite safety tours were conducted.
- Safety issues were included in regularly held coordination meetings.
- Lower incident rates occurred on projects that employed sophisticated scheduling techniques.
- Better safety results occurred when owner or owner's representatives was included in coordination meetings.
- Job pressures (particularly those imposed by budgetary constraints) were found to adversely affect safety performance.

In 1988, Hinze and Figone investigated specialty contractor safety as influenced by general contractors. The findings are as follows:

- Superintendents who felt less project pressure had safer projects.
- Projects on or ahead of schedule were safer.
- Companies that emphasized other goals in addition to profits had safer projects than companies only seeking to maximize profits.
- Several variables related to job coordination affected safety positively: smaller projects; projects with fewer specialty contractors; companies that negotiated a majority of their subcontracts; and companies that use the same specialty contractors.
- Two variables related to company safety emphasis result in safer projects: companies whose home offices monitor project safety, and concern by top management.
- Two variables related to superintendents concern for workers result in safer projects; superintendents who show concern for workers and superintendents who provide new worker orientation.
- Two variables related to job cleanliness result in safer projects: good housekeeping, and daily specialty contractor safety inspections.

- Significant factors correlated with general contractor injury rates: conducting special safety meetings fro filed supervisors, and employing full-time safety professionals.

In 1993, Liska et al. identified zero accident techniques. The key factors associated with safety success are as follows:

- Safety pre-project/pre-task planning included safety goals, safety person/personnel, hiring employees, safety policies and procedures, fire protection program, accountability/responsibility, and safety budget concerns.
- Safety training and orientation required.
- Safety incentives provided.
- Alcohol and substance abuse program in place.
- Accident and near miss investigation conducted.
- Record keeping and follow-up undertaken.
- Safety meetings held.
- Personal protective equipment employed.

Kibert and Coble (1995) worked on integrating safety and environmental regulation of construction industry. Jaselkis et. al. (1996) provided the industry with stategies for improving construction safety performance through the analysis of numerical profiles of companies and projects with varying levels of safety performance. Kartam (1997) tried to integrate safety and health performance into construction CPM. Elbeltagi et al. (2004) presented a layout planning approach that considers both safety and productivity as opposed to considering only productivity issues during site planning. Huang and Hinze (2006a, 2006b) presented a model that evaluated the impact of different owner practices on project safety performance.

2.2 Measures of Safety Performance

All strategies have to be controlled in order to see whether actual performance deviates from the planned one. As safety becomes important to a company, it will be necessary to have a reliable measure for safety performance. There are several types of safety performance measures that can be utilized on a construction site, some of which are jobsite safety inspections, behavior based worker observations and worker safety perception surveys.

2.2.1 Jobsite Safety Inspections

The aim of this type of inspection is to assess physical working conditions on construction sites and to evaluate worker safety behavior. The common tool used is a checklist, which includes the most important parameters for the specific project of concern. They are done in specific time intervals and provide a comparison between successive inspections.

Jobsite safety inspection that collects the appropriate and consistent information can be a valuable resource for making safety management decisions. They may point to trends that identify areas of concern and/or indicate whether changes implemented at the project level are having an influence on improving safety conditions. However, if there is no consistency between successive inspections, i.e. different inspectors with different rating standards, the value of the information collected will decrease.

2.2.2 Behavior Based Worker Observations

The aim of this type of inspection is to observe worker behavior on the site. After a specific observation time, ranging from minutes to hours, the observer discusses

the review with the worker. Both safe and unsafe behavior is reviewed and it is discussed how unsafe behavior can be improved.

Behavior based worker inspections can be valuable if they point to trends regarding to unsafe behavior. In fact, in big projects where there are many different observers, the data obtained can be inconsistent, reducing the value of the information when there is no special trend related to an unsafe behavior. Also, it is important not to include the name of the observed person in order to prevent bias.

2.2.3 Worker Safety Perception Surveys

The aim of this type survey is to get a sense of how workers feel on the project. Workers are asked various questions about the procedures in the site and above the commitment of their supervisors in promoting safety.

The information obtained through these types of surveys give a good sense of the nature of the safety culture achieved at the jobsite and the quality of the efforts of safety management. This type of survey is different from other types of safety surveys in the sense that they do not provide specific unsafe behavior on the jobsite, but rather an indication of the success of management to instill a safety consciousness on the jobsite.

2.3 Balanced Scorecard

The Balanced Scorecard was developed by Robert Kaplan, a professor at Harvard University, and David Norton, a consultant from the Boston area, as a performance management tool, following a one-year multi company study in 1990. *"It provides a medium to translate the vision into a clear set of objectives. These objectives are then further translated into a system of performance*

measurements that effectively communicate a powerful, forward-looking, strategic focus to the entire organization" (Kaplan and Norton, 1989). Kaplan and Norton have presented the Balance Scorecard Concept in a series of articles published in the Harvard Business Review. They have argued that traditional financial accounting measures offer a narrow and incomplete picture of business performance, and that reliance on such data hinders the creation of future business value. As a result, they suggest that financial measures be supplemented with additional ones that reflect customer satisfaction, internal business process, and the ability to learn and grow. Balance is used in the name of their concept to reflect the intent to maintain balance between financial & non financial measures and between short- and long-term objectives.

Initially the Balanced Scorecard was developed with the intention to create a **performance measurement system** that is not merely based on financial outcome. However, later, other usages evolved. It is also a **strategic management** system in the sense that it provides a medium; to translate vision and strategy into a set of objectives (strategy formulation); to define measures for strategic objectives (strategy evaluation); to select targets and initiatives for the accomplishment of these objectives (strategy implementation). Besides, it is used as **communication tool** in the sense that vision and strategy is clarified and translated in to a set of objectives, which are easily communicated to the relevant stakeholders such us employees, customers, shareholders, creditors etc.

As mentioned earlier, financial performance measures are inadequate in addressing the real value creating mechanisms in today's organization. The balanced scorecard allows an organization to translate its vision and strategies by providing a framework that clarifies the organization's strategy through the objectives and measures chosen. Rather than focusing only on short-term performance it provides guidance for long term goals. While Balanced Scorecard keeps the financial measures, it complements them with three other perspectives: Customer, Internal Control, Learning and Growth. The Balanced Scorecard Framework is shown in Figure 2.1.

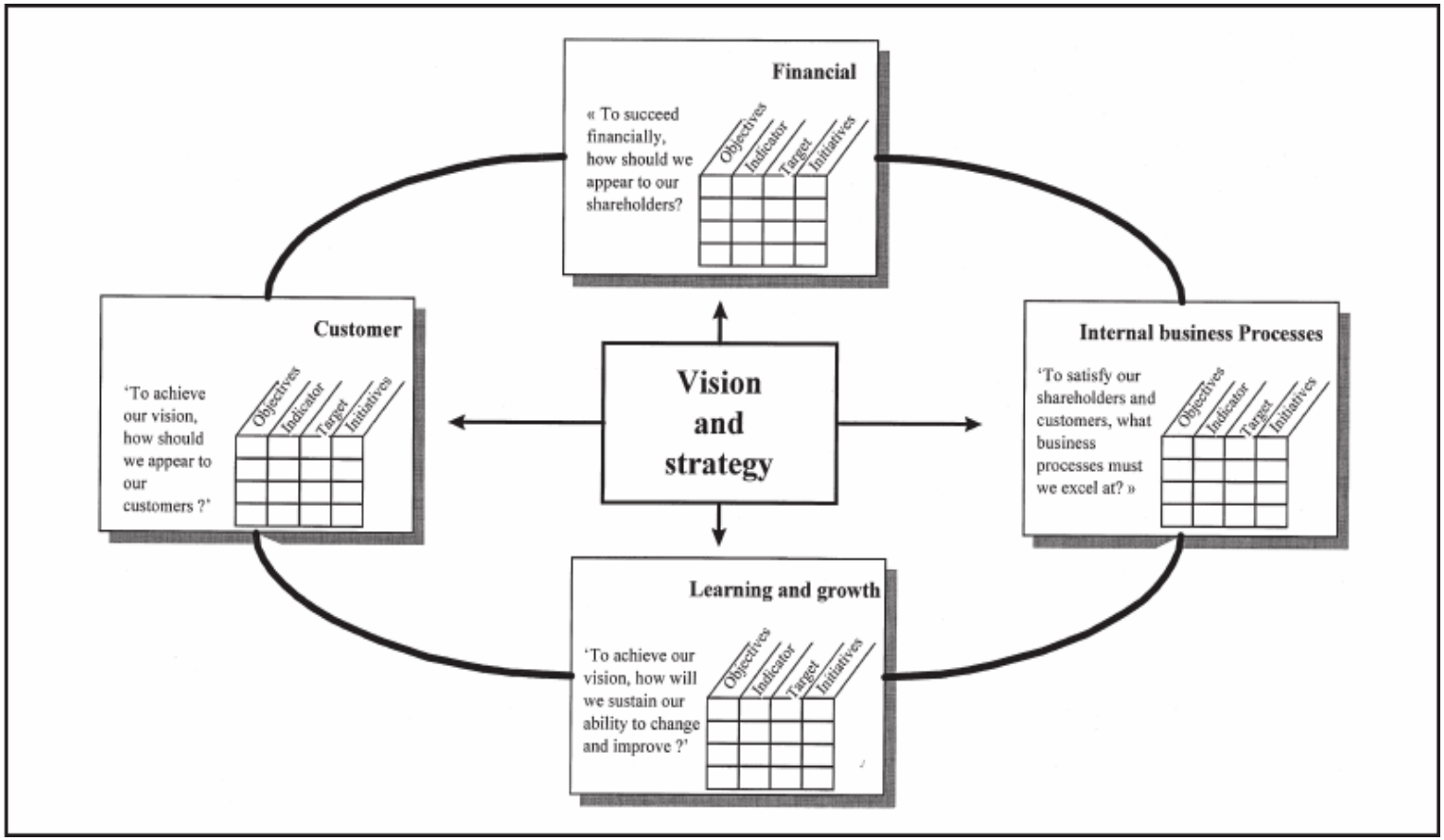


Figure 2.1 The Balanced Scorecard Framework (Kaplan and Norton 1996a)

2.3.1 Safety and Balanced Scorecard

In his paper named "Adaptation of the Balanced Scorecard to Measure Organizational Safety Culture", Sherif (2003) investigated the possibility of adapting the strategic management tool known as the balanced scorecard (BSC) to measure organizational safety culture with a believe that a much wider perspective, as traditional safety performance measures, is required; one which allows organizations to swerve away from only considering the accident-related statistics. He modified the balanced scorecard as shown in Figure 2.2.

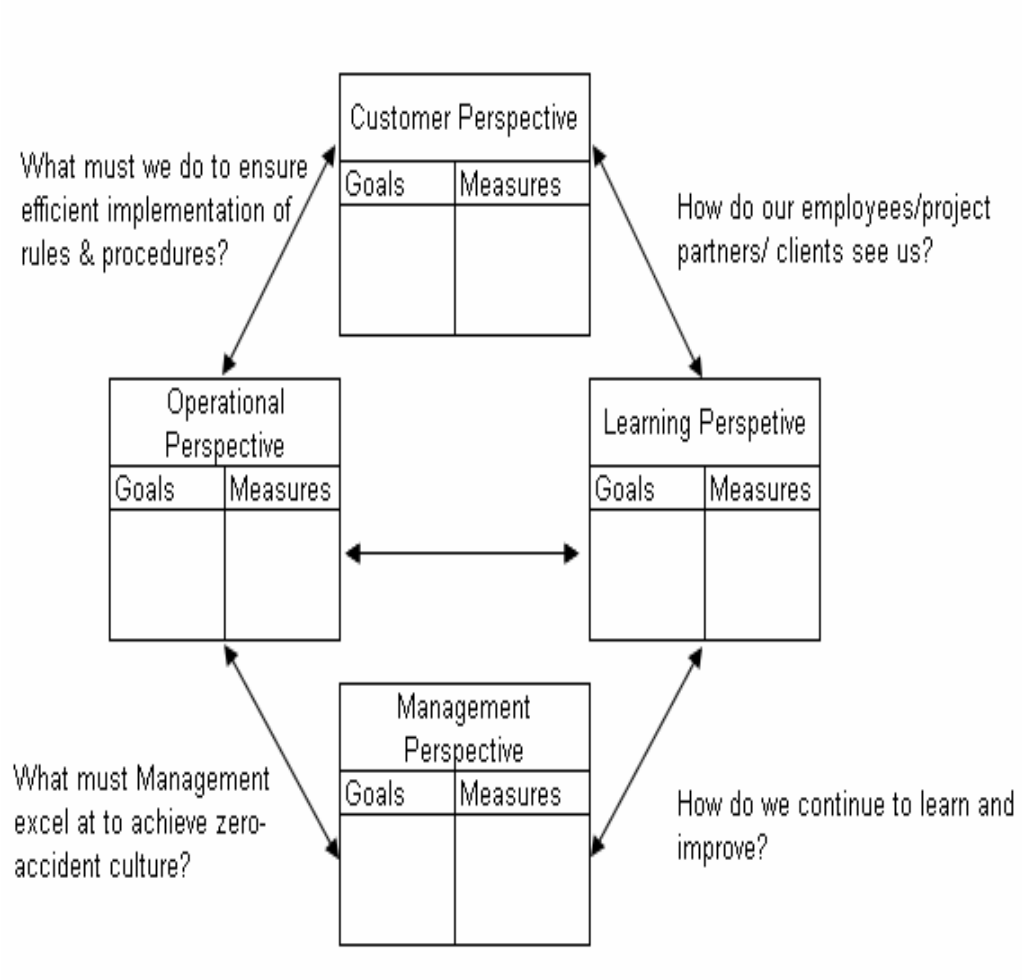


Figure 2.2 The Safety Management Scorecard (Sherif, 2003)

The management perspective in his model is concerned with the overall strategic objective of achieving a zero-accident culture and relates to elements such as management safety policy, commitment, accountability, and leadership. The operational perspective is concerned with the efficient implementation of safety rules and procedures on site, and relates to elements such as process improvement, safety meetings, plan reviews, extent of accident analysis etc. The customer perspective is used to assess how employees and external parties perceive safety on construction sites as a product of prevailing organizational safety culture and relates to elements such as customer satisfaction, employee attitude and response to management. The learning perspective is concerned with the future as opposed to current safety performance and relates to elements such individuals' skills and capabilities, information systems, and enhanced organizational procedures.

2.4 Quality Function Deployment (QFD)

The evolution of the Quality Function Deployment (QFD) Approach was driven by the aim to assess customer needs and to translate these needs into target design. The basis of the current QFD-style matrices (quality tables) was first proposed and used by Mitsubishi Heavy Industry's Kobe Shipyards to design supertankers. The concept of quality deployment was first proposed by Yoji Akao in 1966 and expanded upon in an article published in 1969. Akao published the idea as a system in 1972 under the name Hintshitsu Tenkai System (quality deployment). The publication in 1972, in separate magazines, of Akao's Quality Deployment and Mitsubishi Heavy Industry's Quality Table was followed in 1976 by Akao's system known as QC Process Table. In 1978, Shigeru Mizuno, together with Akao, published the first book on QFD. The most common matrices system is the house of quality shown in Figure 2.3.

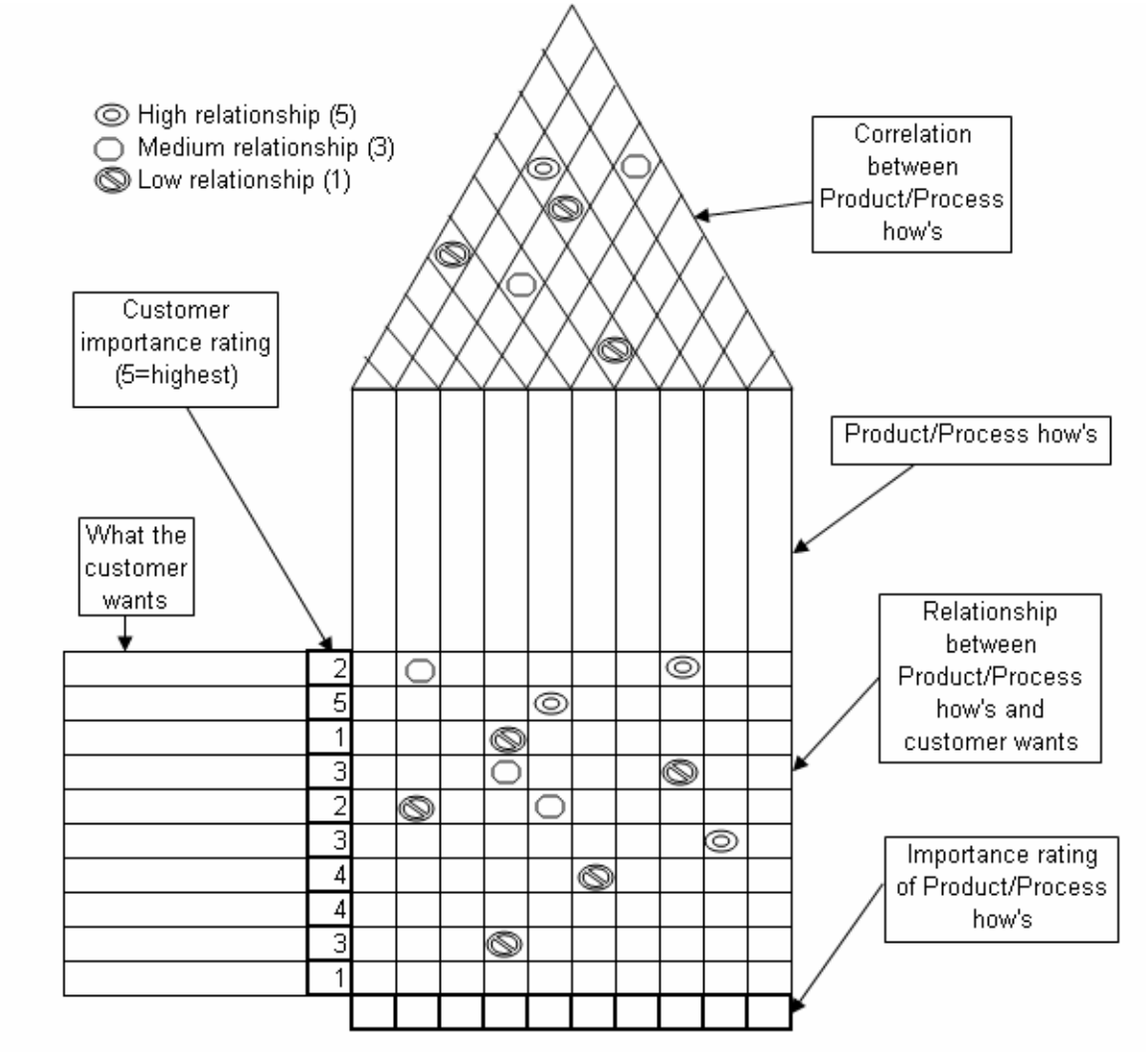


Figure 2.3 House of Quality.

CHAPTER 3

BALANCED SCORECARD

As mentioned in the literature review part, financial performance measures are inadequate in addressing the real value-creating mechanisms in today's organization. The balanced scorecard allows an organization to translate its vision and strategies by providing a framework that clarifies the organization's strategy through the objectives and measures chosen. Rather than focusing only on short-term performance, it provides guidance for long term goals. While Balanced Scorecard keeps the financial measures, it complements them with three other perspectives: Customer, internal control, learning and growth. The Balanced Scorecard Framework is shown in Figure 2.2.

3.1 Perspectives of the Balanced Scorecard

3.1.1 Customer Perspective

The customer perspective consists of the measures relating to target customer groups. It includes several standard measures such as customer satisfaction and customer retention though in each case these should be tailored to meet the organizational requirements. Market share, customer value and customer profitability are other key measures that enable an organization to create a clear vision of the customers whom it should target together with an identification of their needs and expectations from the company.

3.1.2 Internal Process Perspective

The focus of the Internal Process perspective is on the internal processes required by the company to excel at continuing to add the value expected by the customer and, ultimately, shareholders both productively and efficiently. These can include the improvement of any process on the value chain such as product design and engineering, manufacturing, delivery, and customer service or the elimination of non-value added activities such as checking quality, holding inventory, and moving inventory.

3.1.3 Learning and Growth Perspective

The measures in the Learning and Growth perspective of the Balanced Scorecard are the enablers of the other three perspectives. Having identified strategic objectives for the other perspectives, the Balanced Scorecard process will often identify some gaps between the required and existing skills and capabilities such as employee skills, employee motivation etc. These gaps can then be addressed and closed by initiatives such as staff training and development.

3.1.4 Financial Perspective

It is stated by Kaplan and Norton (1992) that the Financial Perspective represents the long-run objectives of the company. The measures indicate whether the strategy execution contribute to bottom-line improvements. In order to determine if economic value is added through the other perspectives, the balance sheet and income statements of the company are periodically investigated to observe profitability and asset growth.

3.2 Cause and Effect Relationships in the Balanced Scorecard

The strategic objectives determined for each perspective may be interrelated; the accomplishment of one objective may enhance another objective within the same perspective or another one. For example, if employees are better trained, then the service quality will increase. So, links are established between objectives. These links aid management in decision making. It provides the indicators for the achievement of several other goals. In this way management is able to give priorities to objectives which are more important. An example is shown in Figure 3.1.

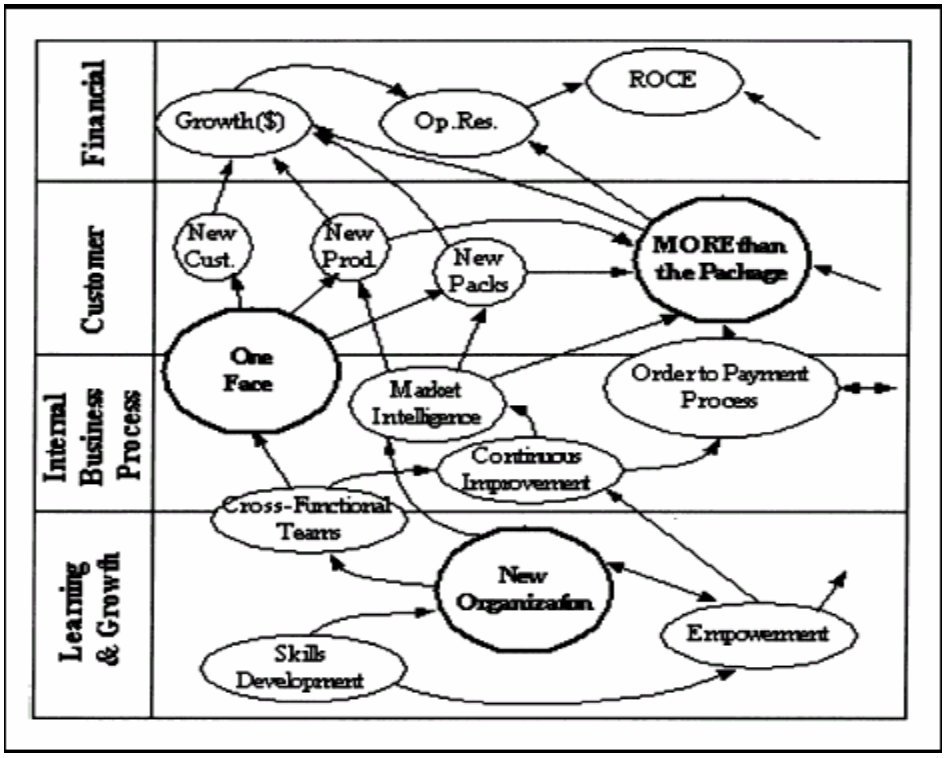


Figure 3.1 An Example of Cause- and Effect Link (Mooraj, Oyon and Hostettler, 1999)

3.3 Project Phases for Introducing the Balanced Scorecard

To guide the work for the preparation of the Balanced Scorecard, it is important to develop project plans. Microsoft Project or MS Excel may be used for outlining and tracking the processes. The key steps for developing the Balanced Scorecard can be considered in three phases: planning, development and communication phases (Niven, 2002). The steps for these phases are given below. The information regarding the phases is given as a reference to guide companies willing to implement it.

3.3.1 The Planning Phase

- **Step 1: Developing objectives for The Balanced Scorecard.**

  The organization must have the precise reasons to launch the Balanced Scorecard tool. If the organization hasn't developed clear objectives, this may limit the effectiveness of the Balanced Scorecard. When the objectives are purely defined, even if they are achieved, it may come out that the gains are less than the effort spent for them.

- **Step 2: Determining the appropriate organizational unit.**

  In large organizations the Balanced Scorecard approach should be used for different units. It is recommended to start at top units, since it is easier to communicate strategic objectives and measures across the entire organization. Other criteria that should be considered in the selection of the unit are:

  1. the need for Balanced Scorecard,
  2. whether the unit has the necessary resources to support the Balanced Scorecard,
  3. whether the unit contributes actively to the organizations goals.

- **Step 3: Gaining executive sponsorship.**

In order to be successfully developed, the Balanced Scorecard program must gain executive sponsorship. Including senior executive support, the project will be considered and respected more seriously by employees. Besides, since senior executives posses more information about the organization's strategy and they have greater decision rights, strategy will be better understood and decisions will be made easier.

- **Step 4: Building the Balanced Scorecard team.**

The choice of individual workers is an important issue in order to effectively accomplish tasks. For this, a capable person from each function related with the unit is included in the team to combine different skills and experiences.

- **Step 5: Formulating the project plan.**

A plan is established by determining how the project should be developed, what responsibilities should be given to individuals of the team and which type of data could be needed.

- **Step 6: Developing a communication plan for the Balanced Scorecard.**

It is determined, how the team members should communicate and how the employees are made aware of the Balanced Scorecard. Workshops may be planned to bring team members together and meetings can be organized for employees.

3.3.2 The Development Phase

- **Step 1: Gathering and distributing background material.**

Team members are provided with background materials on the organization's mission, vision, values, strategy, competitive position, and employee core competencies.

- **Step 2: Developing or confirming mission, values, vision, and strategy.**

Team members must work out all goals and the relevant ones must be picked out in a consensus. If some of the raw materials (mission, values…) of the Scorecard are missing, they must be established.

- **Step 3: Conducting executive interviews.**

Information about the organization's competitive position and key success factors for the future should be learned and studied. The necessary information can be obtained from senior management.

- **Step 4: Developing objectives and measures in each of the organization's scorecard perspective.**

The perspectives which suit the organization are determined. Then the goals are clarified by translating them into objectives according to the perspectives. After that, a relevant measurement system must be determined, which is able to quantify the benefit of a goal achievement and can serve as a feedback for employees by having motivating effect on them.

- **Step 5. Developing cause-and effect linkages.**

Cause-and effect linkages were previously defined. Links are established between the identified goals. They show the relationship between the objectives, in other words the effect of an established objective on another one, both within a perspective and between different perspectives.

- **Step 6: Establishing targets for the measures.**

Targets must be established for each measure, so that we can track how close we are to our desired outcomes, and so that we can know if we are performing good and doing the right things. Targets provide standards against which the process of the company can be measured.

- **Step 7: Developing the ongoing Balanced Scorecard implementation plan.**

Now, our objectives, measures and targets are established, but another important part is the implementation. To encourage creative participation in the process, strategic programs are established for the necessary perspectives. Making advertisements, training of staff, aligning reward systems for employees are some examples of strategic programs. They are also referred as initiatives (Kaplan and Norton, 1992).

3.3.3 The Communication Phase

Everyone who is involved in the achievement of the targets set, must have a clear understanding of his/ her part in the achievement of the target. This will create motivation among employees and will lead to a more effective and efficient work, since everyone is directed to certain tasks.

A good communication plan must be created to inform all employees about the elements of the balanced scorecard. It is also necessary to inform stakeholders about the balanced scorecard, and convince them about the positive outcomes of it.

3.4 Balanced Scorecard as a Safety Management Tool

For the purpose of this study the perspectives of the original balanced scorecard are slightly modified. The perspectives used in this study are financial and cultural, learning, process, and employee perspectives. As mentioned in the methodology part in Chapter 1, the objectives that are selected for each perspective are determined from previous safety research in the literature.

Significant factors related to improved safety performance were investigated during literature review. These factors are used to construct the perspectives of our balanced scorecard. However, since organizations have limited resources, the remaining part of the balanced scorecard will be developed later on. Instead, as will be explained in the next chapter, an analysis will made to determine the most important objectives and some of the objectives found will be eliminated. Afterwards the balanced scorecard will be continued to be constructed. In this

way, no extra effort will be spent for developing measures and initiatives for objectives that have the possibility to be eliminated.

3.4.1 Financial and Cultural Perspective

This is the perspective which is the mirror of the organization's mission regarding safety. As mentioned in the Introduction part, safety has both financial and humanitarian impacts, so this perspective is both concerned with the financial effects of safety related issues and tries to incorporate cultural aspects so as to include the firm's commitment regarding a safety conscious policy. The possible objectives regarding this perspective are as follows:

- Encourage strong safety values within the company
- Reduce accidents
- Reduce occupational diseases
- Reduce legal fees (direct costs)
- Reduce indirect costs (replacing the injured worker, his training, reduced productivity, overtime required due to reduced productivity, and delay in project duration)
- Improve productivity
- Eliminate human suffering and disruption it can bring in to a person's life
- Create subcontractor safety awareness

3.4.2 Employee Perspective

The customer perspective in the original balanced scorecard is replaced with employee perspective. The reason is that, in our case our target is employees and not customers. So, although the objectives in the original scorecard were towards more satisfied customers, the objectives in our scorecard are towards more satisfied employees. Related objectives are as follows:

- Improve employee satisfaction
- Increase staff retention
- Attract competent workforce
- Reward employees

3.4.3 Process Perspective

This perspective is concerned with the operational aspects to ensure a safer workplace and create a safety conscious climate. The objectives determined for this perspective are as follows:

- Improve workplace climate
- Create mutual trust between workers and management
- Create joint management –labor problem solving
- Create an effective pre-job safety plan
- Improve follow up inspections
- Install record keeping and documentation of accidents
- Investigate root causes to prevent reoccurrence
- Plan for allocation of adequate financial, equipment and staff resources

- Establish and maintain a safe work environment
- Comply with safety codes and standards
- Enhance safety meetings to discuss hazards, accidents and prevention

3.4.4 Learning Perspective

As mentioned previously, having identified strategic objectives for the other perspectives, the balanced scorecard process will often identify some gaps between the required and existing skills and capabilities such as employee skills, employee motivation etc. This perspective includes the objectives aimed to fill these gaps. The following objectives are determined:

- Continuous improvement of safety performance
- Enable open communication with workers
- Improve employee skills
- Involve employee in decision making
- Provide new employee orientation and safety training for each new hire
- Create an employee feedback system
- Increase administrative support and involvement

CHAPTER 4

DATA COLLECTION & DATA ANALYSIS

4.1. Quality Function Deployment (QFD)

QFD is a process for determining customer requirements and translating them into product attributes that each functional area can understand and act on. The process involves constructing one or more matrices through which the customer perspective is converted into product/process how's. The most common matrices system is the house of quality shown in Figure 2.3 in Chapter 2.4. To construct the matrix the following steps have to be followed:

1. Determine customer needs and list them on the left of the house of quality.
2. Specify the customer importance rating for each customer want, placed in the right column next to the customer needs. 5 is the highest and 1 is the lowest rating.
3. Determine the product/process how's, which indicate how you are going to satisfy customer needs. They are placed at the top of the house of quality, directly below the roof.
4. Relate how capable each product/process is in meeting each customer need.
5. Identify the correlation between various product/process how's.
6. From the above steps calculate the importance ratings of product/process how's using the weighted average of the importance rating of customer

needs and weights used in the relationship matrix of product/process how's and customer wants (The process will be explained in detail in the following sections).

4.1.1 Why QFD?

In order to eliminate any non-value adding processes, QFD is used early in the design process to help determine what will satisfy the customer and where to deploy quality efforts. As can be noted in the previous chapter, the objectives for each perspective of the balanced scorecard were defined, but the scorecard wasn't further utilized for the time being. The reason is that there are a lot of objectives, which all will consume resources. Now the QFD comes into the picture in order to determine the most important objectives, so that less important ones will be eliminated at the beginning.

4.1.2 Questionnaire

QFD is used as questionnaire in this study. As mentioned above, the QFD Approach has two dimensions. For the purpose of this questionnaire, the first dimension (customer needs in the original QFD) will be the financial and cultural perspective of the balanced scorecard and will include the objectives established for this perspective in the previous chapter. The second dimension (product/process how's in the original QFD) will include the objectives of the remaining perspectives (employee, process, learning perspectives), since these perspectives are the enablers of the financial and cultural perspective. Note that the financial and cultural perspective actually compromises the ultimate goals regarding safety. So, in our house of quality, the first dimension will be called 'safety objectives' and the second dimension will be named 'enablers'.

In Table 4.1, the QFD used as questionnaire can be seen. To avoid complexity for respondents, the roof part is omitted. However, while establishing cause- and effect relationships for the balanced scorecard in the next chapter, it will be mentioned how the roof part can be utilized to support that step. Also note in Table 4.1 that the dimensions of the house of quality are reversed for convenience, i.e. the enablers (product how's in the original QFD) are placed on the left of the house of quality, while the safety objectives (customer wants in the original QFD) are placed at the top of the house of quality.

The questionnaire in Table 4.1 is filled as followed:

- Specify the importance rating for each safety objective, in the row below the safety objectives. 5 is the highest and 1 is the lowest rating.
- Relate how capable each enabler, placed on the left of the house of quality, is in meeting each safety objective. The table is filled with Y for high relationship, with O for medium relationship and or with D for low relationship. If there is no relationship, the blank is left empty.

4.1.3 Data Collection

Different sizes of construction companies and the safety department of Ministry of Labor and Social Security were asked to complete this survey. The list of companies was developed by suggestions of the manager of Ministry of Labor and Social Security and personal contacts of the researcher. Approximately 200 mails were mailed and 50 hard copies were distributed to potential respondents. 35 surveys were completed, representing a response rate of %14. Questionnaires were filled by civil engineers working for both domestic and foreign construction companies of different sizes. It should be noted that the data does not represent or models a certain segment of the construction sector. Rather, randomly selected people were asked to fill the questionnaire with the aim to demonstrate how the questionnaire is filled and analyzed.

Table 4.1 QFD used as Questionnaire

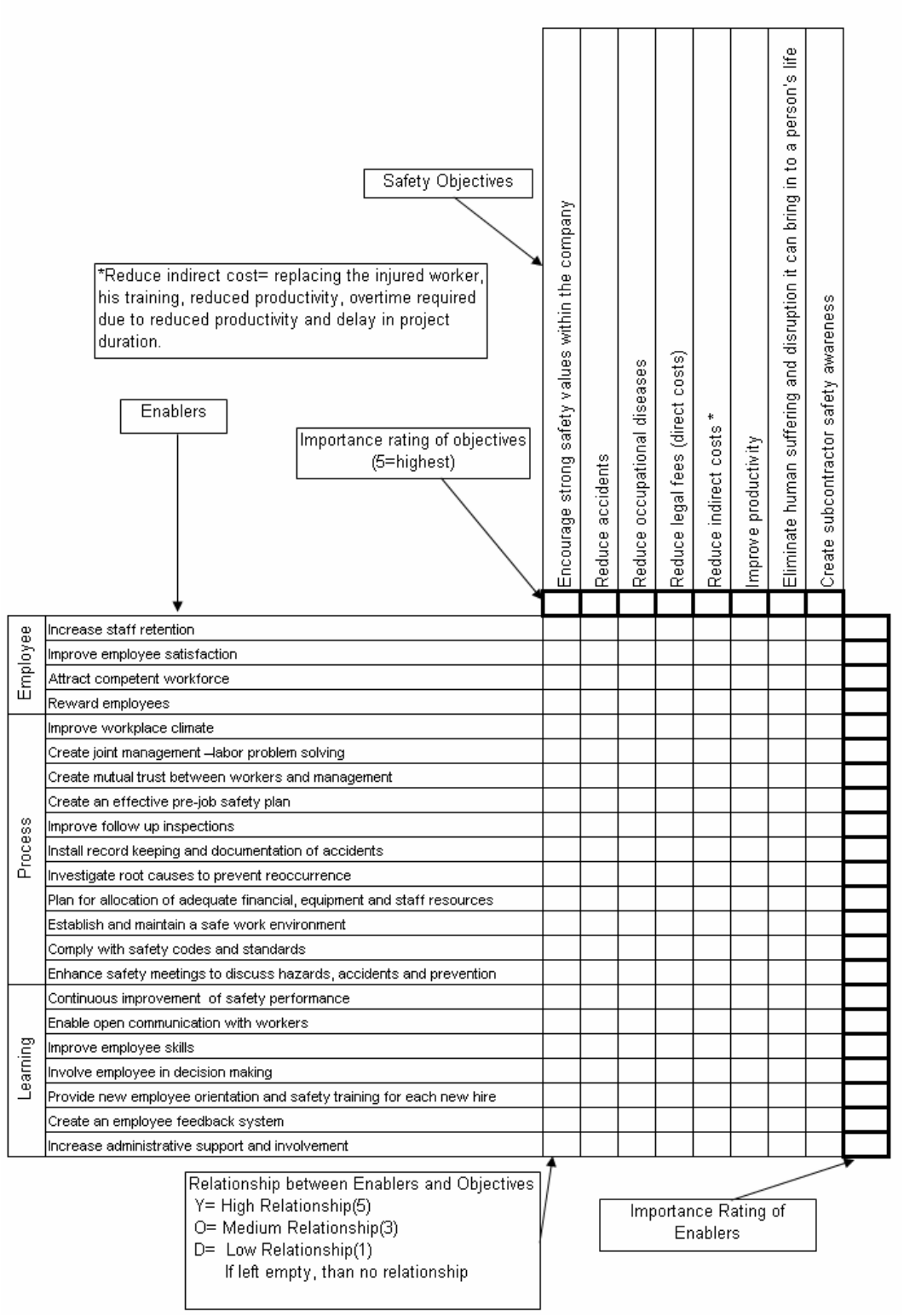
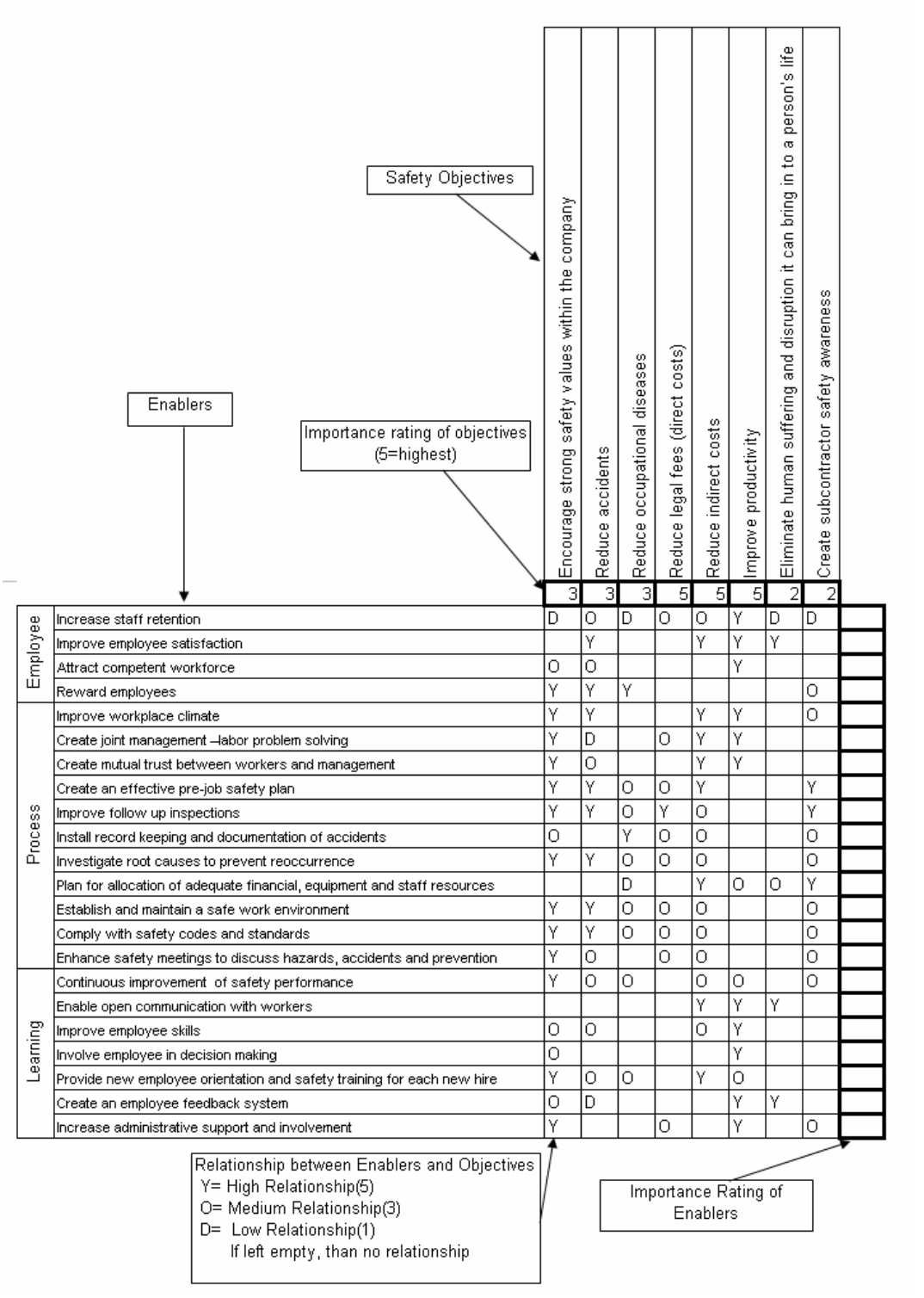


Table 4.2 Questionnaire filled by a Respondent



4.1.4 Data Analysis

The procedure for evaluating the questionnaire through matrix evaluations is explained below in a step wise manner.

- Respondents evaluate the importance of each safety objective by assigning a value from 5 to 1 , 5 being the highest grade, and specify how capable each enabler is in meeting the safety objectives by entering Y, O, and D into the cells or leaving them empty in case they find no relationship. A filled questionnaire is seen Table 4.2.
- The values of Y, O and D are replaced with 5, 3, and 1, respectively. The empty spaces have a value equal to 0. Table 4.2 is modified accordingly and shown in Table 4.3.
- The values entered into the cells by each respondent are added up and divided by the number of respondents, which is equal to 31 (Table 4.4).
- The importance rating for each enabler is determined, by the weighted average of the importance ratings of the safety objectives and the relationship value of the related enabler. The results and an example summarizing the process are shown in Table 4.5.

Table 4.3 Questionnaire filled by Assigned Values

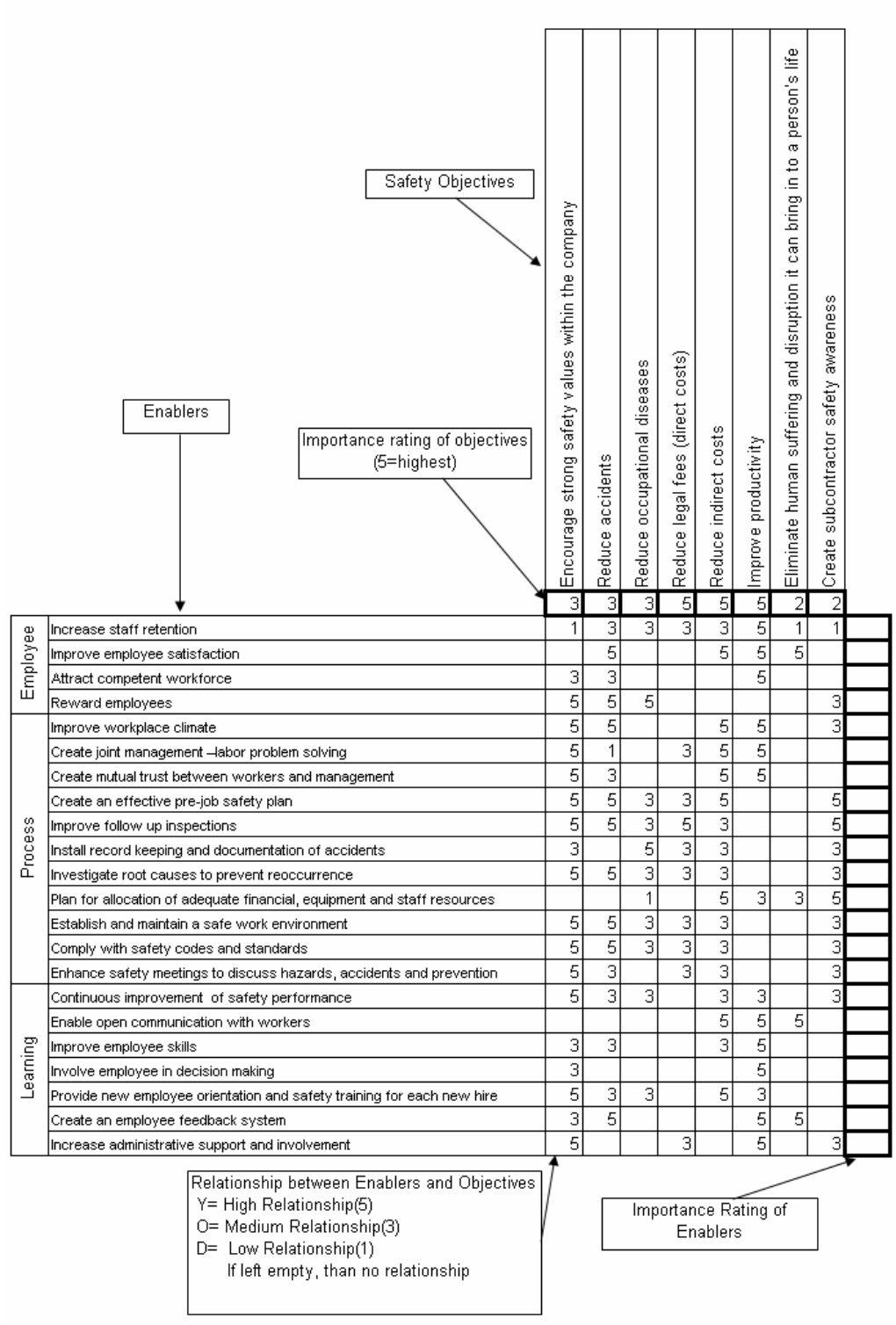


Table 4.4 Average Results of Questionnaire

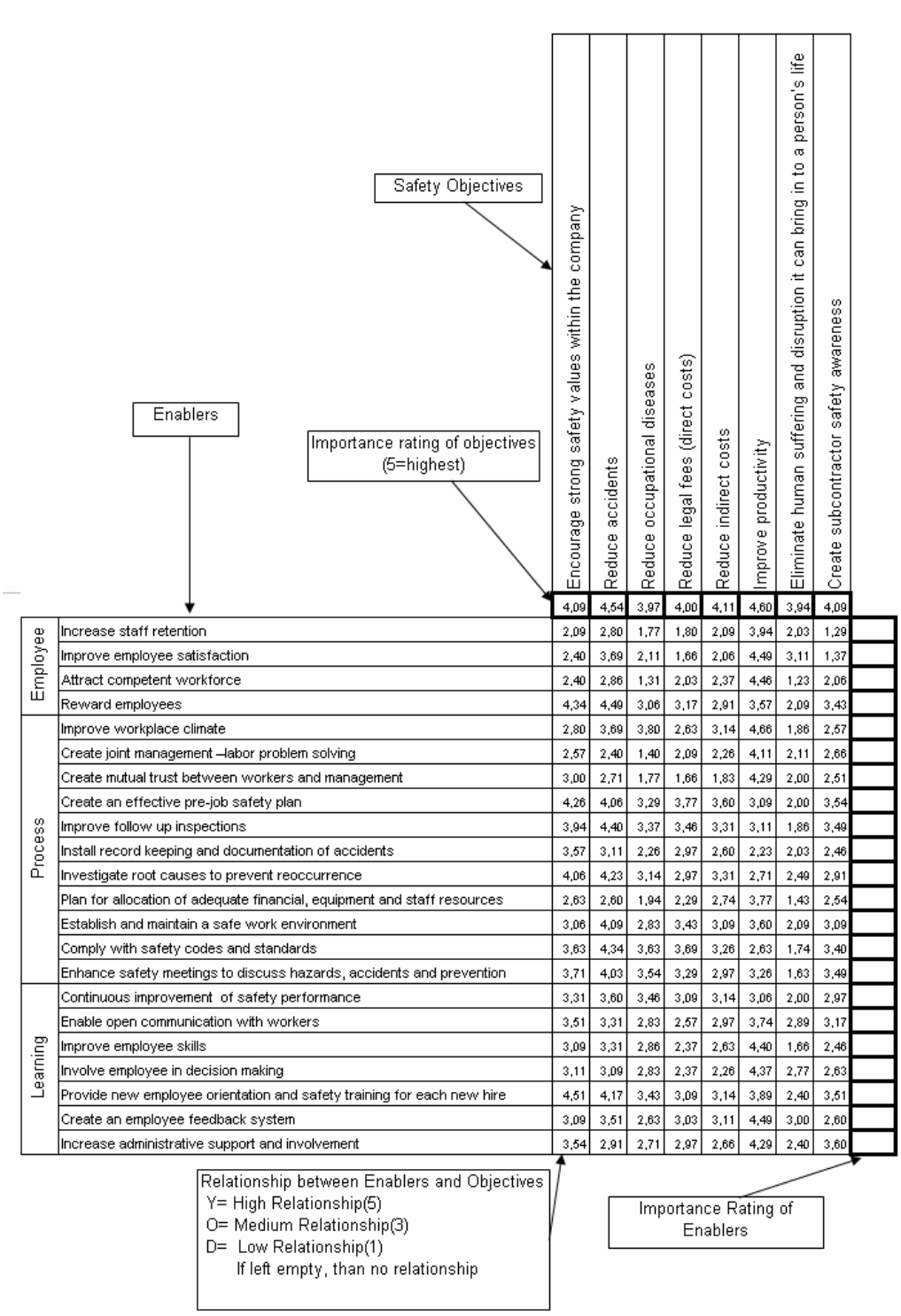
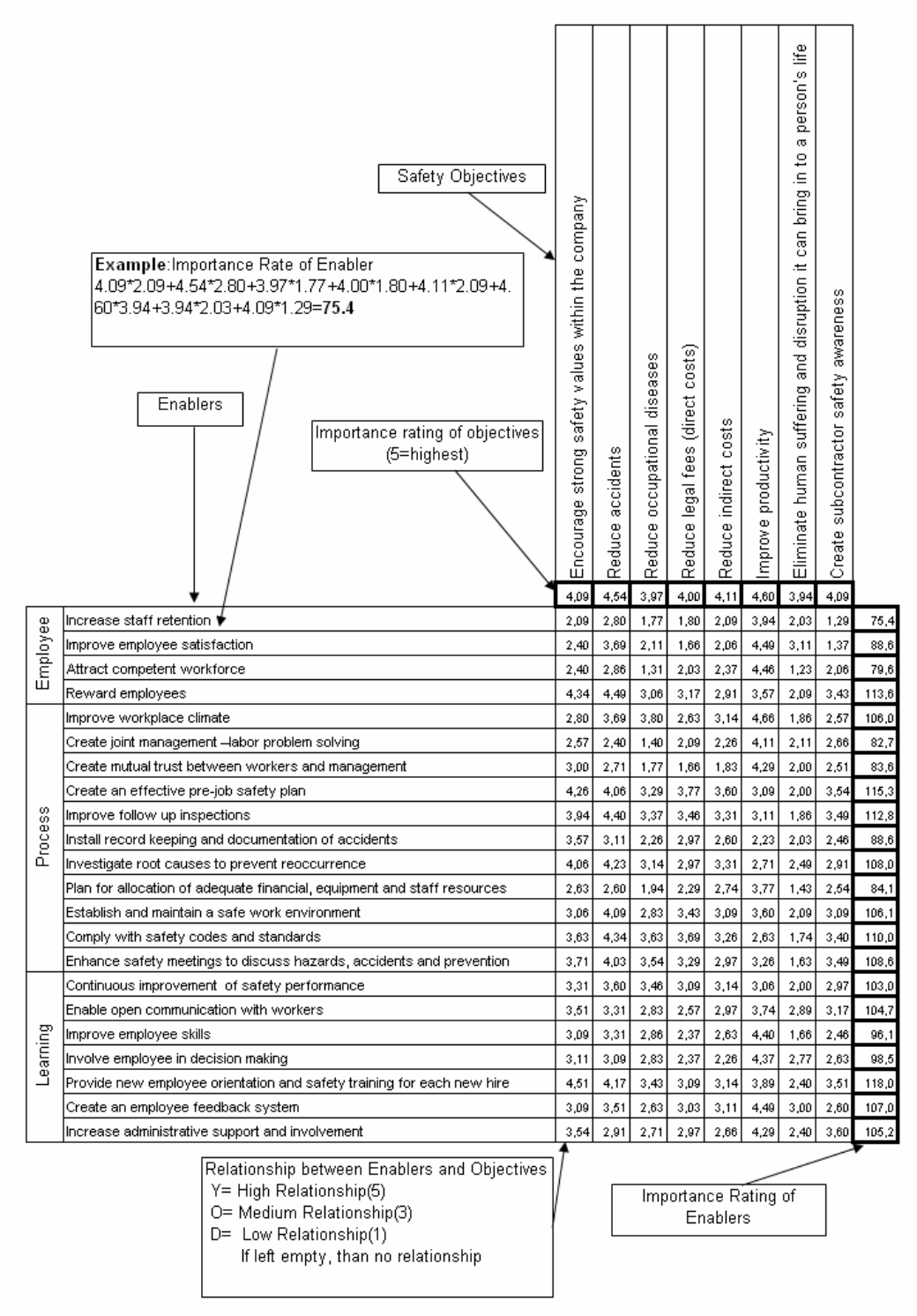


Table 4.5 Importance Ratings of Enablers



4.2 Discussion of Results

It is seen in Table 4.5 that some enablers came out to be more important. The importance ratings for the objectives in the balanced scorecard model are obtained as seen in Table 4.5. The mean values and standard deviations for the objectives within the related perspectives are shown in Table 4.6.

Table 4.6 Mean and Standard Deviation (STD) of the Objectives within each Perspective

Perspectives	Mean	STD
Financial &Cultural	4,17	0,26
Employee	89,31	17,09
Process	100,52	15,59
Learning	104,65	16,86

Safety objectives, which represent the objectives in the financial and cultural perspective of the balanced scorecard, will all be included in our scorecard since the standard deviation is low. There are possibly two reasons of low standard deviations for the objectives in the financial and cultural perspective:

1. Since these objectives are the ultimate outcome, their effect is better perceived by respondents. Note that objectives in the other perspectives are actually the enablers of the objectives in the financial and cultural perspectives. So, their indirect effect is differently interpreted by respondents.
2. Note that the average of importance ratings is taken in the financial and cultural perspective, whereas to obtain the importance rating of the objectives in the other perspectives, weighted average is used, in other

words, the average score is multiplied by the importance rating of the related objective in the financial and cultural perspective.

Some of the enablers, which represent the objectives of the remaining perspectives of the balanced scorecard, came out to be less important and are eliminated. Since standard deviation is high, the objectives near the mean values, determined in Table 4.6, are chosen. The chosen objectives are as follows:

Employee Perspective

- Reward employees
- Improve employee satisfaction

Process Perspective

- Create an effective pre-job safety plan
- Improve follow-up inspections
- Comply with safety codes and standards
- Enhance safety meetings to discuss hazards, accidents and prevention
- Investigate root causes to prevent reoccurrence
- Establish and maintain a safe work environment
- Improve workplace climate

Learning Perspective

- Provide new employee orientation and safety training for each new hire
- Create an employee feedback system
- Increase administrative support and involvement
- Enable open communication with workers

At this point the question of why these objectives are more important will arise. Perhaps, while establishing cause- and effect linkages between and among the objectives in each perspective in the next chapter, the reason will be better understood.

CHAPTER 5

APPLICATION OF QFD RESULTS TO DEVELOP THE BALANCED SCORECARD

Having determined the objectives to be used for each perspective of the balanced scorecard in the previous chapter, the next step is to further utilize the scorecard with the following steps:

- The objectives for each perspective will be listed
- Cause and effect relationships will be established
- Possible measures for the objectives in each perspective will be proposed
- Possible initiatives will be listed

As mentioned in the introduction part, milestones will not be set for the establishment of the objectives, since the target duration for the accomplishment of these goals would be different from one company to the other. However, it is strongly advised that each company should set targets for the accomplishment of their objectives, so that everyone involved in the accomplishment of these goals has a definite time frame to follow.

5.1 Summary of Strategic Goals

As can be remembered, a list of possible objectives derived form literature survey was selected for all perspectives in the balanced scorecard in Chapter 3. Afterwards, a survey was conducted and the more important objectives were

determined in Chapter 4. The outcomes will form the strategic objectives for the perspectives of the balanced scorecard and are shown in Table 5.1.

5.2 Cause and Effect Relationships

The logic behind determining cause-effect linkages is explained in Chapter 3.2. To summarize, by establishing cause-effect linkages, a company will be able to determine more exact milestones for the accomplishment of the goals, since some objectives are interrelated, i.e. the accomplishment of one objective will aid in the accomplishment of another one. As can be noted in Chapter 4, the roof part of the 'house of quality', which shows the relationship between enablers, was omitted for the sake of simplicity. However, the inclusion of this part would have already constructed the cause-effect linkages between the various objectives in the balanced scorecard. Setting milestones is beyond the scope of this study, but some possible cause-effect linkages are shown in Table 5.2.

Table 5.1 Strategic Objectives

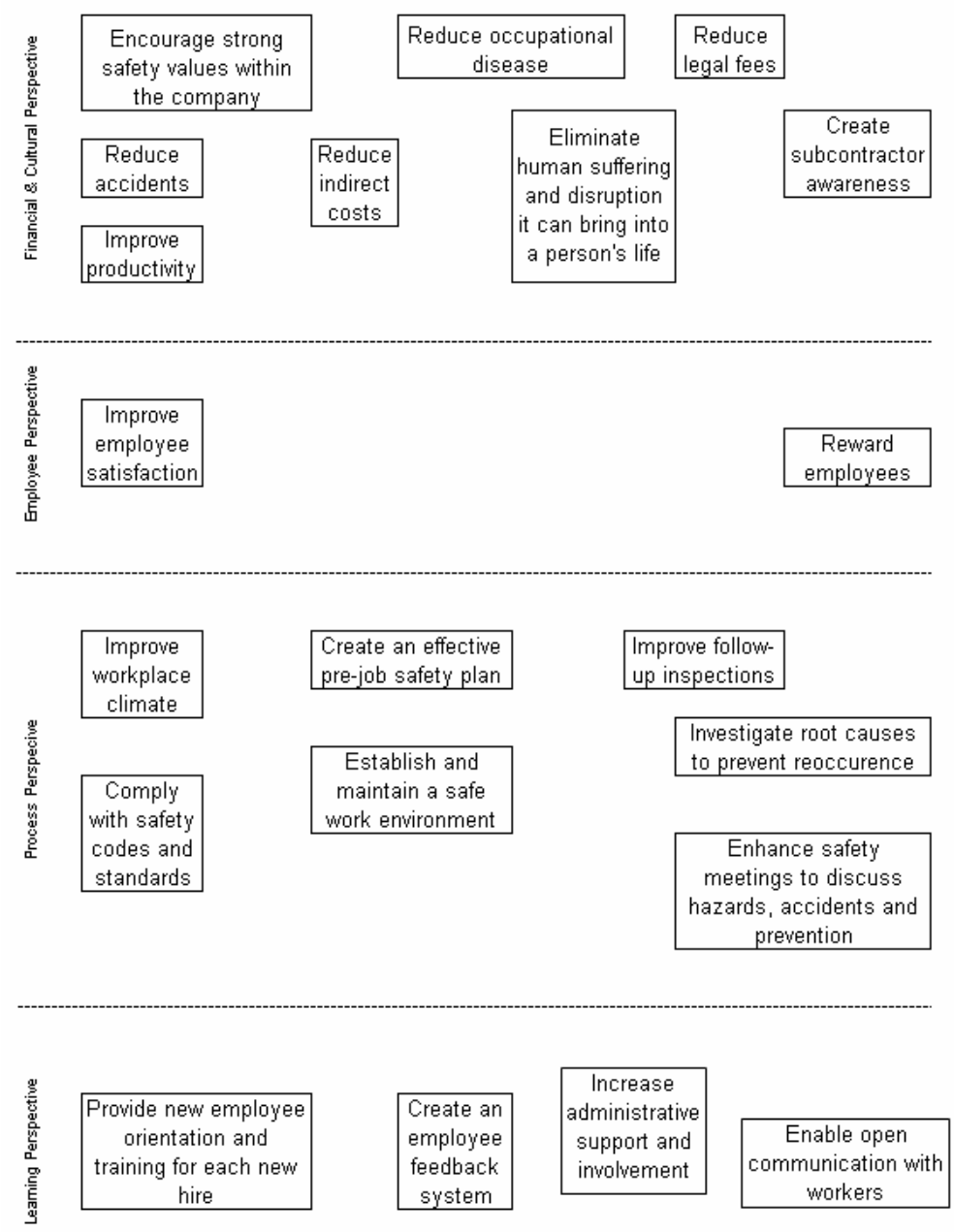
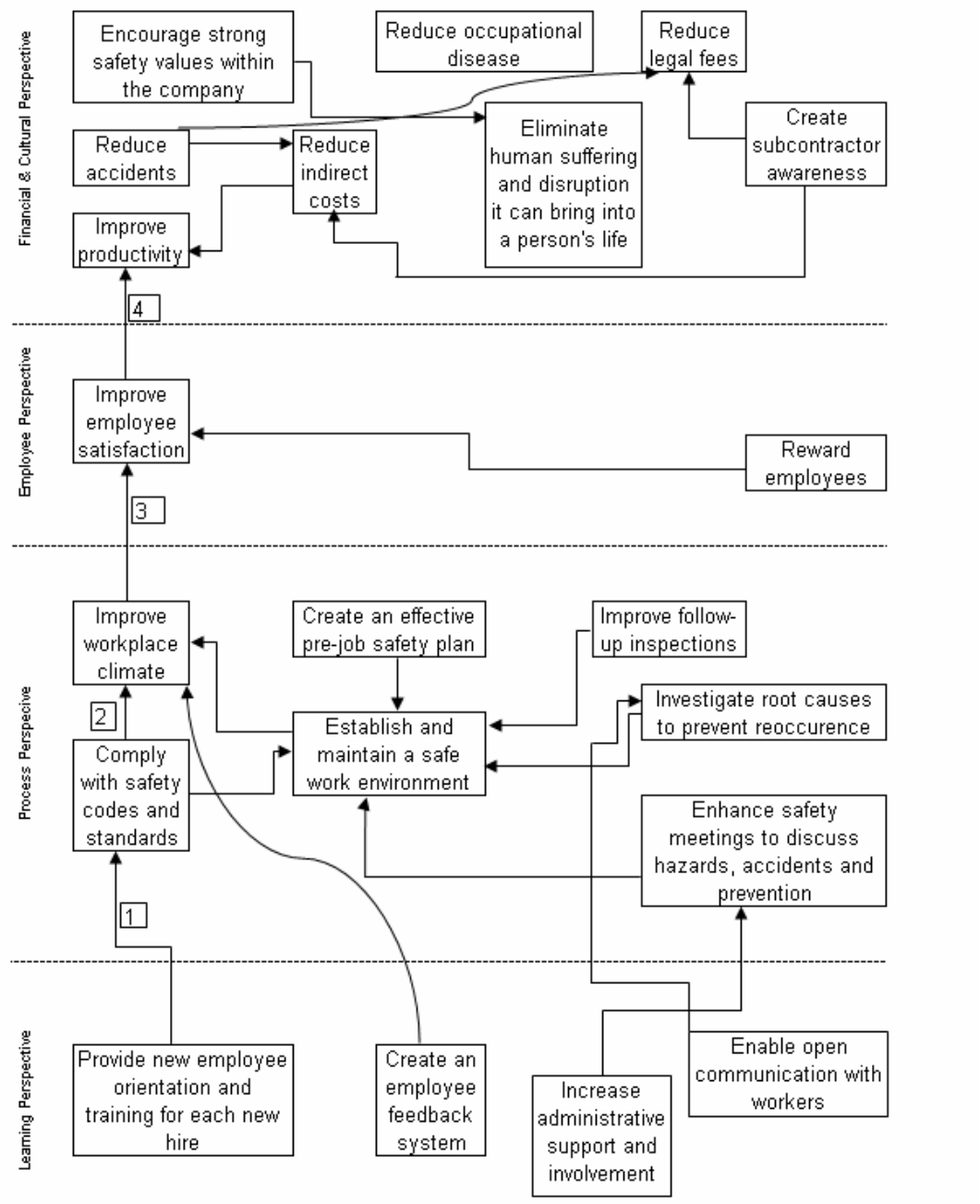


Table 5.2 Cause-Effect Linkages



As can be seen in Table 5.2, some cause-effect linkages are established. For example, providing new employee training for each new hire will aid in compliance in safety codes standards (linkage 1), which would improve workplace climate (linkage 2). Improved workplace climate would increase employee satisfaction (linkage 3), which in turn would result in improved productivity. Not all cause-effect linkages are shown to prevent ambiguity of the picture.

5.3 Defining Measures

A relevant measurement system must be determined, which is able to quantify the benefit of a goal achievement and can serve as a feedback for stakeholders by having motivating effect on them. A list of possible performance measurements is listed in Table 5.3, most of which are derived form previous literature survey.

Table 5.3 Suggested Performance Measurements

Perspectives	Objectives	Suggested Measurements
Financial & Cultural Perspective	• Encourage strong safety values within the company	• Perception surveys and site interviews
	• Reduce accidents	• Number of accidents
	• Reduce occupational diseases	• Number of occupational diseases
	• Reduce legal fees	• Amount paid as legal fees

Table 5.3 Suggested Performance Measurements (continued)

Perspectives	Objectives	Suggested Measurements
Financial & Cultural Perspective	• Reduce indirect costs • Improve productivity • Eliminate human suffering it can bring into a person's life • Create subcontractor awareness	• Deviation from actual budget following an accident • Cost of activity per unit of related cost driver • Number of injured workers needing company support • Perception surveys and site interviews
Employee Perspective	• Improve employee satisfaction • Reward employees	• Perception surveys + turnover rate • % of employees being rewarded due to safety awareness
Process Perspective	• Improve workplace climate • Create an effective pre-job safety plan • Improve follow-up inspection	• Perception surveys and site interviews • Inspection and audit • Safety reports of safety audits

Table 5.3 Suggested Performance Measurements (continued)

Perspectives	Objectives	Suggested Measurements
Process Perspective	• Investigate root causes to prevent reoccurrence • Establish and maintain a safe work environment • Comply with safety codes and standards • Enhance safety meetings to discuss hazards, accidents and prevention	• # of accidents occurred more than once • # of actions taken / # of actions in the pre-job safety plan • Using checklists • # of safety meetings
Learning Perspective	• Enable open communication with workers • Provide new employee orientation and safety training for each new hire • Create an employee feedback system • Increase administrative support	• Perception surveys • # of hours of training + accompanied by behavioral observation • Perception surveys • # of hours spent by management on safety issues

5.4 Defining Initiatives

The last step to complete the balanced scorecard is to define initiatives. Initiatives are actually the required action the company has to take in order to accomplish the objectives. The objectives in the financial and cultural perspective will be the outcomes of the objectives in other perspectives. So, initiatives will be defined for the objectives in the employee, process, and learning perspectives. The proposed initiatives, derived mainly from previous literature survey, can be seen in Table 5.4.

Table 5.4 Suggested Initiatives

Perspectives	Objectives	Suggested Initiatives
Employee Perspective	• Improve employee satisfaction • Reward employees	• Informing employees about the company's concern for them • Develop reward programs for individual or group performance basis
Process Perspective	• Improve workplace climate • Create an effective pre-job safety plan	• Providing administrative support • Conducting a project safety analysis to identify major and unique hazards

Table 5.4 Suggested Initiatives (continued)

Perspectives	Objectives	Suggested Initiatives
Process Perspective	• Improve follow-up inspection • Investigate root causes to prevent reoccurrence • Establish and maintain a safe work environment • Comply with safety codes and standards • Enhance safety meetings to discuss hazards, accidents and prevention	• Forming safety audits • Recording all accidents and near misses • Establish an effective site layout plan and monitor • Preparation of checklists • From a safety team to coordinate
Learning Perspective	• Enable open communication with workers • Provide new employee orientation and safety training for each new hire	• Motivate employees to share their views on safety issues • Development of a training program

Table 5.4 Suggested Initiatives (continued)

Perspectives	Objectives	Suggested Initiatives
Learning Perspective	• Create an employee feedback system • Increase administrative support	• Training supervisors (safety awareness) • Linking management's compensation on safety performance

CHAPTER 6

RESEARCH SUMMARY AND CONCLUSION

6.1 Brief Summary of Chapters

In Chapter 1, a safety management framework for construction companies is proposed. The framework includes the following steps: strategy formulation, strategy implementation and strategy evaluation. Strategy formulation includes the steps of establishing a vision and mission related to safety and generating, evaluating and selecting strategic objectives. Strategy implementation includes defining milestones and developing initiatives. Strategy evaluation includes establishing performance measures and measuring performance. Two management tools are used within the scope of this study: balanced scorecard and quality function deployment (QFD).

In Chapter 2, a literature review on previous safety research is performed to identify significant factors related to improved safety performance and measures on safety programs. Additionally, a brief history on the management tools, balanced scorecard and QFD, used in our model is given.

In Chapter 3, the perspectives and the project phases for constructing the balanced scorecard are described. The balanced scorecard is used as a safety management tool, the perspectives of which are financial and cultural, employee, process, and

learning. The objectives that are selected for each perspective are determined from previous safety research in the literature.

In Chapter 4, QFD is used to construct a questionnaire and analyze the data obtained. The objectives determined for each perspectives of the balanced scorecard in the previous chapter are used as inputs for the QFD. QFD is used in order to determine the most important objectives, so that less important ones will be eliminated at the beginning. This will prevent the unnecessary utilization of resources.

In Chapter 5, QFD results are integrated into the balanced scorecard. Measures and initiatives for the strategic objectives in each perspective of the balanced scorecard are proposed.

6.2 Summary of Findings

Actually, Table 4.5 in Chapter 4 wholly summarizes this study. However, in this part the results will be questioned and remarks will be made regarding these results.

It was seen in Chapter 4 that some of the objectives in the employee, process, and learning perspectives came out to be more important. However, it should be noted that a high standard deviation was observed. This is due to the fact that these objectives are actually the enablers of the objectives in the financial and cultural perspective. Their effect is indirectly linked with the ultimate goal of safety improvement and therefore is not easily identified by respondents, because by just filling the questionnaire they are not able to see the whole picture. For this reason,

the project phases for introducing the balanced scorecard are given in Chapter 3 for companies willing to implement it. Cause-and effect linkages are shown in Chapter 5. Actually by building workshops and establishing cause- and effect relationships between these objectives, respondents would be able to see the picture as whole and would be able to better judge their effect on safety improvement.

As far as the learning perspective is concerned, providing new employee orientation and safety training for each new hire had the highest score. This suggests that a new hire should not directly start to work, but rather initially be trained of the type of work performed and the points he should especially be aware and take care while working. Creating an employee feedback system and enabling open communication with worker will increase their morale and commitment for a better safety performance. Increasing administrative support and involvement will result in workers who perceive safety as a prime issue.

In the process perspective, creating an effective pre-job safety plan and improving follow-up inspections have the highest scores. As mentioned in the Chapter 1, planning is an essential part in strategic management, because plans are the tools to guide people. Before starting a project, all possible related risks must be identified in order to establish procedures to mitigate these risks. During construction inspections must be made to control whether procedures are implemented, so that everyone obeys to them. Complying with safety codes and standards will result in better safety performance and prevent possible penalty fees. Enhancing safety meetings to discuss hazards, accidents and prevention is important in order to discuss the performance in maintaining the pre-job safety plan and possible new types of risks that could not have been determined while planning for the project. Investigating root causes of accidents is important for further projects so that next time appropriate action is taken to prevent

reoccurrence. Improving workplace climate will result in more satisfactory workers.

In the employee perspective rewarding employees had a higher score. This is a natural outcome. When people are rewarded for specific behaviors, they tend to repeat that behavior (positive reinforcement). So, employees obeying to safety procedures should be rewarded. Improving employee morale is another important factor (note that improved employee morale is also an outcome of rewarding employees). Employees with higher morale would be more careful while working.

6.3 Recommendation to Contractors

- Each construction company should establish a safety conscious culture.
- Effort spent on safety should not be seen as a cost increasing factor.
- Contractors should handle safety in a strategic manner. They should effectively and efficiently plan and implement safety related issues and evaluate their performance.
- Balanced scorecard is an effective strategic management tool incorporating the management responsibilities of planning, implementing and evaluating, and can be used for the above mentioned points.
- QFD can be used early in the design stage to determine the appropriate and most important objectives regarding safety, so that no unnecessary resources are later spent for the accomplishment of low value adding objectives.

6.4 Contribution of Current Study to Academia

The following contributions have been achieved and some of these are believed by the author to be the first studies in literature.

- QFD is used as a safety management tool. The customer needs dimension in the original QFD is used as the objectives related to safety, whereas the product how's perspective is used as the enablers of the safety objectives.
- QFD and the balanced scorecard are integrated and used together to form a safety management framework.

6.5 Recommendation for Future Research

The following recommendations would benefit future work by the construction companies:

- More data would be collected to support the outcomes.
- The proposed safety management framework would be implemented on a specific project of a construction company.
- The roof part of the house of quality in the QFD matrix would be utilized to get respondents view for the degree of interrelationship between the enablers of the of the safety objectives.
- Workshops would be formed and the members would be first asked to draw the cause-effect relationships between the objectives in each

perspective, so that they would be able to see the whole picture and get a better judgment of the effects of the enablers.

6.6 Last Word

Construction industry is very vulnerable to work accidents. Both from financial and humanitarian points of view, construction companies should consider safety as one of the priority issues. The ultimate aim should be to establish a safety conscious culture. For this purpose, safety should be handled in a strategic manner. The proposed safety management framework integrating QFD and the balanced scorecard could be an appropriate tool and aid companies in effectively selecting their objectives, providing guidance during implementation and evaluating their performance.

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