

QUALITY MANAGEMENT IN THE TURKISH CONSTRUCTION INDUSTRY

76464

by

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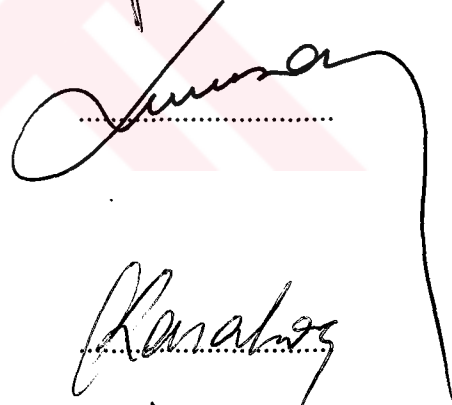
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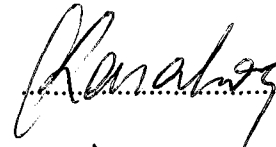
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ABSTRACT

A detailed survey is conducted with Turkish construction firms to gather information about construction industry and quality management procedures. The questions in the questionnaire are prepared to have complete information about companies' current status and future plans on quality management. The survey is applied to consultant, designer, contractor, and subcontractor firms, since these groups cover almost all-different sub sectors of the construction industry. Twenty-two of the targeted companies answered the questionnaire. The results indicate that almost all of the companies are aware of the relevance and importance of quality management and interested in quality improvement, whereas they are not experienced enough to implement quality management properly and they have problems in documentation, communication, training, and process improvement. The companies can apply ISO 9000 quality assurance system in order to have good start for quality management implementation because it provides a good foundation for quality management.

ÖZET

İnşaat sektörü ve kalite yönetimi yöntemleri ile ilgili bilgi edinmek amacıyla, Türk inşaat sektöründeki firmalara detaylı bir anket uygulaması yapıldı. Soru formundaki sorular, şirketlerin şu anki durumlarını ve gelecek için planlarını tam olarak yansıtabilecek şekilde hazırlandı. Anket, inşaat sektörünün hemen hemen tüm alt sektörlerini kapsamı sebebiyle, danışman, tasarımcı, müteahhit ve taşeron firmalara uygulandı. Hedef olarak belirlenen şirketlerden yirmi iki tanesi soru formunu cevapladı. Sonuçlara göre, hemen hemen bütün şirketlerin kalite yönetiminin öneminin farkında olduğu, kalite iyileştirme konusuna ilgi duymakla beraber deneyimlerinin kalite yönetimi uygulaması için yeterli olmadığı ve dökümantasyon, iletişim, eğitim ve süreç geliştirme alanlarında eksikleri olduğu ortaya çıkmıştır. Şirketler kalite yönetimi uygulamasına iyi bir başlangıç yapmak için bu uygulamaya iyi bir temel oluşturan ISO 9000 kalite güvence sistemini uygulayabilirler.

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1. INTRODUCTION

Construction industry is a crucial field of activity for the economy of a country. The sector is a major employer. The percentage of population in total civil employment working in construction sector including construction material production varies between 6 per cent to 10 per cent with respect to years. Construction industry is directly linked to other industrial sectors and it is a leading industry in developing countries.

Construction companies are usually functioning under the following categories:

- (1) General contractors,
- (2) Designers,
- (3) Consultant firms,
- (4) Specialized subcontractor firms, which work for contractors.

There are some uncertainties about the future of the sector, as the future directly depends on the economical growth rate as well as the level of public expenditures. As a result of privatization, the share of public sector in construction sector will decrease. It is a common belief that the future of the sector will be determined by R&D, quality of human resources, and quality management (QM).

The present technologies of construction industry cover a range from traditional human-force dependent, construction site focused methods to the latest technologies. Projects in a firm are developed utilizing latest technologies with the general contractors and consultant firms contributing to the technical and managerial aspects of projects.

The main clients of the sector are the following:

- (1) Small scale firms and individuals,
- (2) Clients who are not specialized in construction and work with consultant firms,
- (3) Public sector clients who are experienced in utilizing an appropriate contractor-consultant group.

Europe, USA, and Japan are the largest construction markets of the world. In the future, the construction market in China and in former Soviet Republics are going to grow faster.

The construction activities in Turkey are divided mainly into two sectors, i.e. building and non-building sectors. Non-building construction sector mostly comprises social and economic infrastructure investments. The most important branch of the building construction sector is residence construction. According to 1990 data, seventy-six per cent of the construction investments is in building constructions, and the remaining twenty-four per cent is in non-building constructions [1].

The development in construction sector has started with the application of the Five-Year Industrial Plan in 1930. Initially, the Turkish firms worked as the subcontractors of foreign firms. They started to develop their own technologies in 1950s.

In the international market, the Turkish firms have taken place first in 1973 during the oil crisis and then they continued to expand. Especially after 1979, with the encouragement of the government for deals bringing in foreign currency; and the development of economical power and the expansion of markets of oil rich countries, Turkish firms grew stronger in those markets [1].

The construction industry differs from other industries in the following ways [2].

- Unique and non repetitive nature of construction activities,
- Long term projects,
- Dynamic physical environment of sites,
- High competition and low margins,
- Short-term employment and high turnover,
- Limited time for training,
- Lack of experienced staff,
- Financing problems.

In today's highly competitive world, quality management program implementation is necessary for the survival of construction companies. Organizations should have an effective management technique to lower costs and increase productivity. Quality management should not be viewed as replacing the traditional management functions, but only as presenting a new approach by which they are continually improved. Total quality management (TQM) is a company-wide effort that involves everyone in an organization in an effort to increase customer satisfaction by continuously improving performance. It permeates every aspect of a company and makes quality a primary strategic objective [3].

In this thesis work, first a detailed survey is conducted on selected 25 Turkish construction firms to obtain information about construction industry and quality management procedures, since it would not be correct to make a future plan before determining the present assessment of the sector. By means of this survey, management structure and quality management systems of Turkish construction companies are determined.

The thesis is composed of four chapters; Chapter 2 gives information about the methodology and implementation of the survey. A brief explanation of the survey parts is also included. Chapter 3 covers the evaluation of the survey results. Chapter 4 is conclusion. The questionnaire is given in Appendix A. Appendix B contains the answers to the survey questions given by participating firms. Appendix C provides the graphical representation of the answers.

2. METHOD OF APPROACH AND IMPLEMENTATION

2.1. General

The objective of the survey is to determine the present assessment of quality management in construction industry and to define policies for the future. To utilize elements of quality management implementation procedures a detailed information about the construction industry is required. The construction industry differs from other industries in many ways. The differences must be recognized in detail to adapt quality management system.

The questions in the questionnaire are prepared to have a complete information about the companies' current status and future plans.

The questions are easy to answer and especially chosen to avoid any misunderstanding. There are four types of questions:

- (1) Fill in the blank type of questions. Usually short answers are required. They are especially designed to obtain information about the organization.
- (2) The questions to which the set of possible answers are already provided. One or more of the given choices can be chosen to answer. There is also extra space for answers other than those indicated.
- (3) The questions in which a set of items is given and only arranging the choices in order of priority is required (1 equals to the most important).
- (4) The questions prepared to determine the application extent of the indicated situation within the organization. There are five choices from 1 to 5, 1 being the most positive and 5 being the most negative.

Appendix A provides the original questionnaire.

2.2. Parts of the Questionnaire

The questionnaire is composed of thirteen parts:

- (1) Business Profile,
- (2) Strategic Planning,
- (3) Leadership,
- (4) Human Resources,
- (5) Current Status of Quality Management Program,
- (6) Organization and Communication,
- (7) Customer Relations,
- (8) Supplier Relations,
- (9) Subcontractor Relations,
- (10) Engineering and Design,
- (11) Production,
- (12) Benchmarking,
- (13) Post-Project Analysis.

2.2.1. Business Profile

This part is composed of a brief information about the company. In this part, information is sought for the company's field of activities, date of foundation, number of employees, duration being in service, geographical location of the activities, type of client groups, and whether any performance measurement is carried out, and if so, whether this is performed with a documented procedure or not.

2.2.2. Strategic Planning

This part is organized to determine the level of planning and execution of the strategic plans — mission, policies, goals, and objectives. Declaration and evaluation level of the plans is examined. Organizations' most important performance objectives are also asked in order to understand their long-term strategies. In addition, the companies' action plans, which are being applied and will be applied, are examined to realize their short-term plans.

2.2.3. Leadership

Quality management begins with top management. The company survives and succeeds only with the proper distribution of responsibilities at that level. Implementation of refined or new work processes will not succeed without total top level commitment [4].

In this part, questions are prepared to determine the level of participation of the top management in QM efforts. The top management must communicate its policy and strategy to the employees. Also the employees could communicate their ideas and views to the top management. In a quality organization, in crisis, a continuous improvement with interaction is preferred instead of instantaneous actions. All the employees should be informed by the top management about the quality values prevalent in the company.

2.2.4. Human Resources

By focusing on people's behavior, organizations are able to mobilize and manage their employees to produce quality products and services. An effective and company wide human resource management planning improves the quality management implementation

program. The transient construction work force is quite different from the relatively stable manufacturing work force [5].

The training program is very important. There is a Japanese axiom that quality begins with training and ends with training. Under QM, quality becomes everyone's responsibility and the training plan must be targeted for every level of the company. There should be customized training plans for management, engineers, technicians, home and field office staff, support personnel, and field labor [5].

This part of the questionnaire determines the way the company manages its human resources. Information about employee relations is also gathered. Furthermore, the status of the training programs is examined.

2.2.5. The Current Status of the Quality Management Program

This part is prepared to determine the current status of the QM program that is practiced in the company. The organization's quality perception, the areas in which problems are encountered frequently and the barriers for reaching higher quality levels are examined. If a quality management program is formally applied, the aim of the program and the extent to which the employees participate in the program are questioned. Furthermore, the utilization level of certain QM tools is explored.

2.2.6. Organization and Communication

The purpose of this part is to determine the status of the organizational hierarchy and the level of communication within the company. The communication procedure between construction site management and central management is examined. The authority and responsibility levels of all officers within the organization are analyzed.

2.2.7. Customer Relations

The function of the construction industry is to provide customers with facilities that meet their needs and expectations. For a company to remain in business, this service must be provided at a competitive cost.

In this part, questions are designed to examine a company's approach to serve an external customer. The levels of customer satisfaction and communication are analyzed. In addition, the level of performance measurement is also determined in detail.

2.2.8. Supplier Relations

One of the keys to obtain high quality products and services is to work with suppliers in a partnership atmosphere. The higher the supplier's quality level, the stronger will be the long-term partnership between the supplier and the company [6].

This part is prepared to investigate the material management practices of the firm. Questions are asked to identify the supplier relations of the company. Topics such as supplier selection criteria, equipment selection strategy and performance measurement criteria are examined.

2.2.9. Subcontractor Relations

Subcontractors play a vital role in the construction industry. Subcontractors are specialty contractors who are hired to perform specific tasks on a project. To analyze some

major aspects of the subcontractor relationships with the general contractors, questions are addressed to such topics as subcontractor characteristic, involvement in directing and planning subcontractor's work, bidding duration, and performance measurement of subcontractors [7].

2.2.10. Engineering and Design

In this part, aspects of the engineering and design processes are analyzed. The budget and expenditure control and work schedule procedures are analyzed. Their application status are examined.

2.2.11. Production System

The purpose of this part is to determine general information about the production system. Production motivation reasons are examined. Utilization of the produced material is determined. Performance measurement procedure and criteria of the organization are also defined.

2.2.12. Benchmarking

Benchmarking is a systematic method by which organizations can measure themselves against the best industry practices. It promotes superior performance by providing an organized framework through which organizations learn how the “best-in-class” do things, understand how these best practices differ from their own, and implement change to close the gap. The essence of benchmarking is the process of borrowing ideas

and adapting them to gain competitive advantage. It is a tool for continuous improvement [7].

In this part, the questions are prepared to find out whether the organization measures its performance against that of the best-in-class organizations. The presence of a special benchmarking team for this purpose that increases the success level of the application is questioned. The condition of the follow-up procedure of the competitors is also asked.

2.2.13. Post-Project Analysis

This part is prepared to determine whether the firms analyze their completed projects to determine best practices in order to improve the management of their future projects. Selection criteria of the projects to be analyzed, criteria utilized for analysis, and analysis team selection topics are examined in detail. Utilization of post-project analysis results that can be interpreted as an essential part of the continuous improvement efforts of the company is also questioned.

2.3. Implementation of the Survey

2.3.1. Selection of the Companies

Twenty-five construction companies were selected. The survey was applied to consultant, designer, contractor, and subcontractor firms, since these groups cover almost all different sub-sectors of the construction industry. Firms were chosen from various sizes

to reflect sector completely. The number of employees varies between 10 to 4,500. Most of the firms are in service in the sector long enough to have a reputation.

The targeted companies were contacted by telephone. Interview engagements were then scheduled with those who were willing to participate. Only three of the companies did not want to participate the survey. Twenty-two of the targeted companies answered the survey questionnaire.

2.3.2. Interview Method

The contact person at each company was carefully briefed by telephone on the nature of the interview. Each visit and interview lasted about two hours—one and a half-hour for the interviews and half hour for the comments. In 15 of 22 companies, the interview was at the level of either the chairman, the member of the board, general manager, the assistant general manager, or the project coordinator. In the companies, which had a quality management coordinator, the interview was conducted with him/her.

3. EVALUATION OF THE RESULTS

Result of the survey is summarized in the following parts. No company or individuals' names are mentioned in this study, to preserve confidentiality. Appendix A provides the survey form. The answers to the survey are given in Appendix B. The graphical representation of the answers are displayed in Appendix C.

3.1. Business Profile

Eleven of the firms are functioning in completely one field. Ten of these are contractors and the remaining one is a consultant firm. Other firms are active in two or more fields in various percentages of revenues. The field of activities and percentages in revenues are shown in the Figure 3.1. Table 3.1 gives the number of firms active in each field of activity. Forty-five per cent of the selected firms' sole activity is in contract work. Twenty-three per cent of the companies is functioning as a designer and consultant. Fourteen per cent of them is active in all fields of activities.

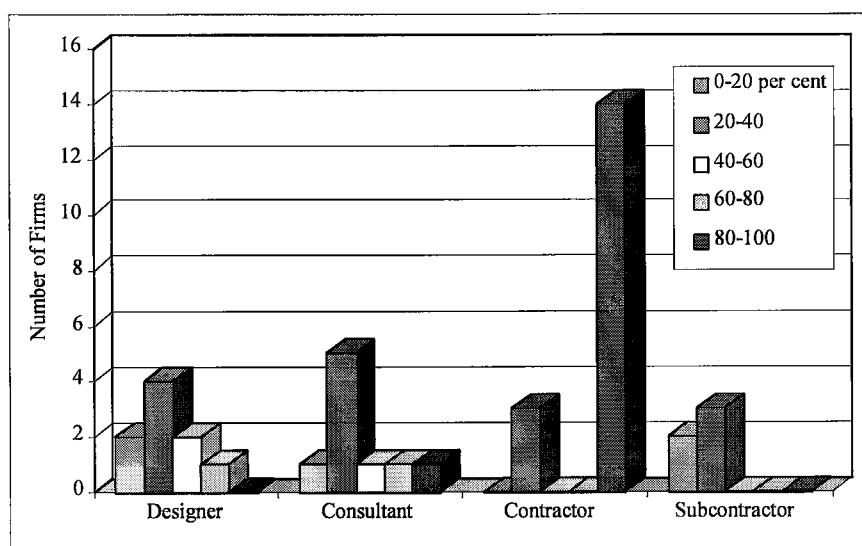


FIGURE 3.1. Rate of companies' field of activities

TABLE 3.1. Companies' field of activities.

Field of Activity	Number of Firms
Designer	9
Consultant	9
Contractor	17
Subcontractor	5

Sixty-four per cent is independent company, eighteen per cent is a branch of a big company, and eighteen per cent is a company within a holding (Figure 3.2).

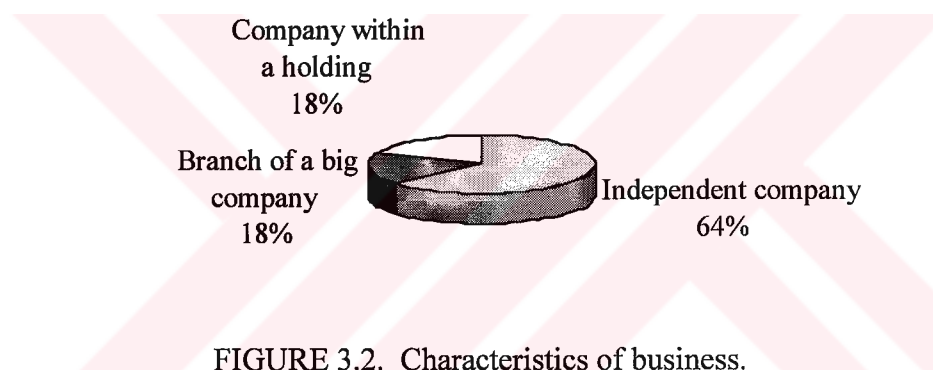


FIGURE 3.2. Characteristics of business.

The Service Duration of Firms

The service duration of the firms varies. Fifty-seven per cent of the companies have been in service in the construction sector for more than twenty years. Figure 3.3 shows the age distribution of the companies. The average service duration of the companies is 22.9 years.

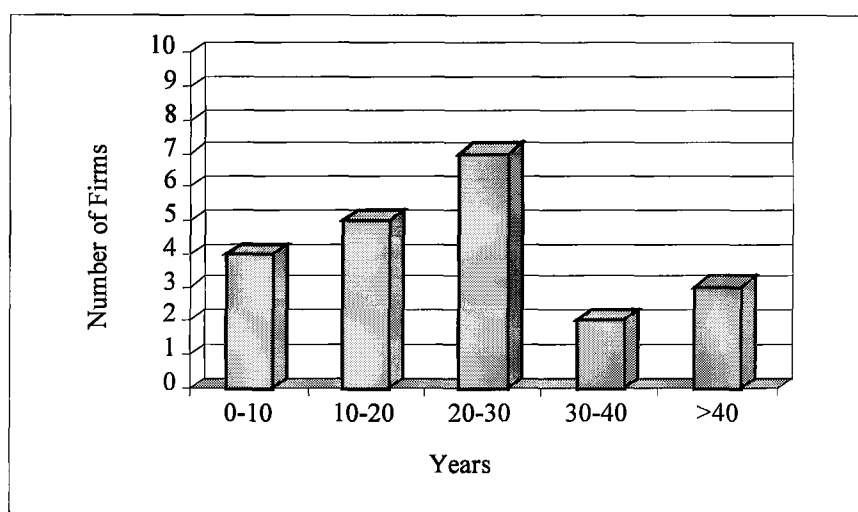


FIGURE 3.3. The age distribution of companies.

Number of Employees Distribution among Companies

The company sizes with respect to the number of employees vary between 8 and 4,500. Thirty per cent of the firms employ more than 1,000 personnel, and all of these firms are contractors. Thirty-five per cent of the companies employ less than 100 people. Forty-five per cent has stated the number of workers and foremen. Sixty-seven per cent of these employ more than 250 unskilled workers, sixty-seven per cent employ more than 250 skilled workers, and eleven per cent employs more than 250 foremen. Figure 3.4 represents the distribution. For more detailed information, refer to Appendix C graphic number 1.4.

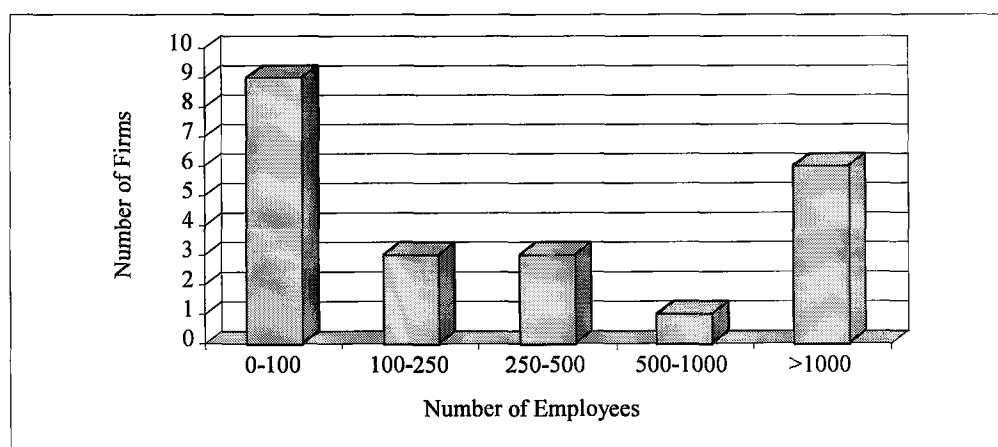


FIGURE 3.4. Number of employees.

Eight of the firms could not state the average distribution of full time equivalent people being assessed according to the place of employment. Five of the firms employ more than eighty per cent and seven firms employ sixty to eighty per cent of their personnel at construction site. Two of the firms have all of the employees in the head office and both of these firms work as a consultant and as a design firm. Only one of these two firms employs its personnel at the construction site since this firm is consulting a project which is under construction. Figure 3.5 shows the average distribution of the personnel that is employed at the construction site.



FIGURE 3.5. Distribution of the employees at the construction site.

Fields of Sub-Activity within Construction

Table 3.2 shows companies active in different construction fields. The companies are basically active in building and residential projects. Infrastructure and industrial building projects are also among the main fields of activities of the selected companies. Only the twenty per cent of the participating companies conduct harbor, subway, and waste water treatment projects. The participating companies manage almost all kinds of construction works.

TABLE 3.2. Companies work scope.

Work Scope	Number of Firms
Building	20
Residential	19
Infrastructure Works	18
Industrial Buildings	16
Roads, Highways	9
Railways	8
Airports	8
Hospital	8
Harbors	6
Waste Water Treatment Plant	5
Subway	5
Construction Management	2

Geographical Location of Activity

The geographical location of activity of the companies shows similarity. Nineteen of the firms work both in the whole country and abroad. Two of the firms work only in the whole country. Only one firm is working in a certain region. Most of the firms are positioned in the international market.

Eight of the firms have more than eighty per cent of their revenue from local projects. Four of them have sixty per cent of their revenue from in-country projects. Although most of the firms are active both inside and outside the country, only the three of them have eighty per cent of their revenue from abroad projects. Figure 3.6 shows the detailed distribution of the revenue according to the geographical location of activities.

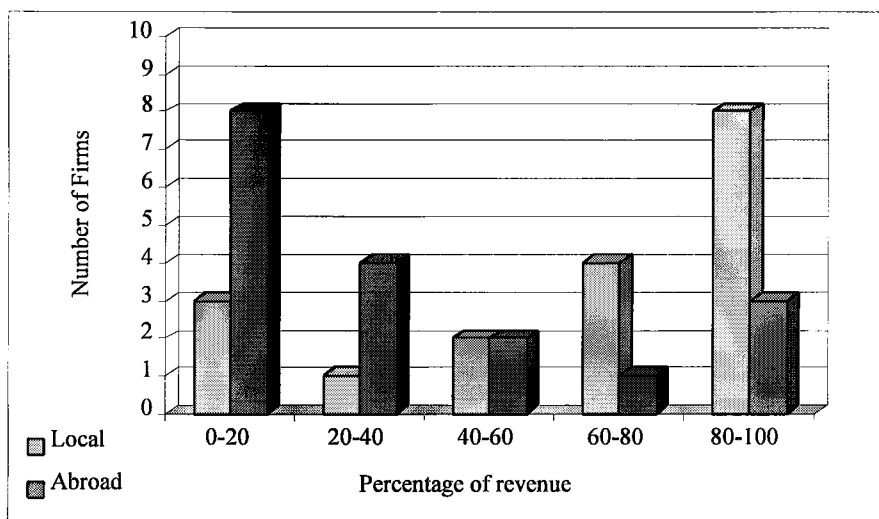


FIGURE 3.6. Distribution of the revenue according to the geographical location of activities.

Client Groups

The firms have both public and private companies as client groups. Nine of the firms have more than eighty per cent of their revenue from private companies. Seven firms have more than sixty per cent of their revenue from public foundations. Three firms have fifty per cent of their revenue from public, fifty per cent from private client groups. Eighty per cent of the companies prefer to have either the public or private client groups. The detailed distribution of revenue according to the client groups is represented on Figure 3.7.

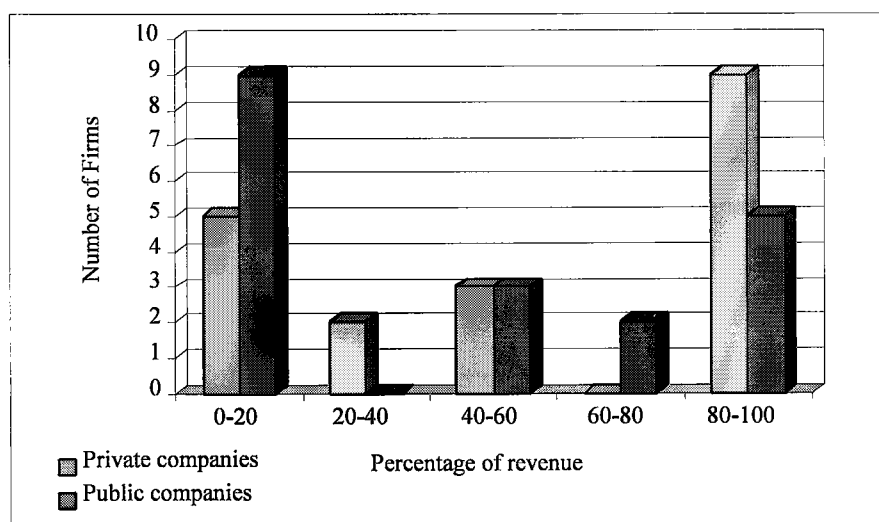


FIGURE 3.7. Distribution of the revenue according to the client groups.

Performance Measurement

Performance measurement plays an important part in the success or failure of an organization. By means of the performance measurement goals are compared with actual performance, information is provided for individual and team evaluation, and the process gains and losses are indicated.

Six of the firms carry out performance measurement with a documented procedure. Thirteen of them do it without a documented procedure and three of them do not apply performance measurement. Performance measurement is carried out in the areas shown in Table 3.3. It is practiced mostly for employees, engineering and design activities, suppliers and subcontractors. For business development, marketing and sales it is rarely performed. This result is probably because the marketing and sales departments do not exist in most of the companies.

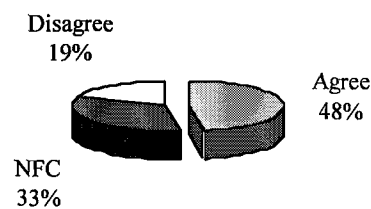
TABLE 3.3. Performance measurement areas.

Areas	Number of Firms
Employees	18
Engineering and Design	15
Suppliers	15
Subcontractors	14
Customer Relations	12
Production	12
Tendering	10
Marketing	9
Business Development	8
Sales	7

3.2. Strategic Planning

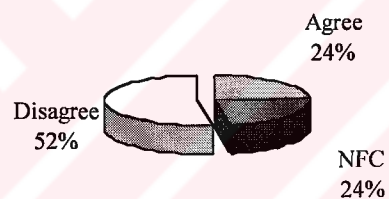
The survey questions 1, 2, 3, and 4 of the strategic planning section and their responses are represented below:

- (1) There is a declared company mission that is supported by all employees.

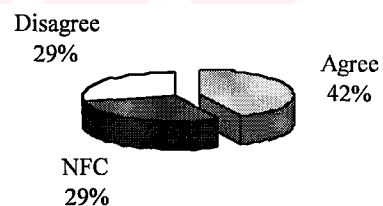


NFC: No firm conclusion

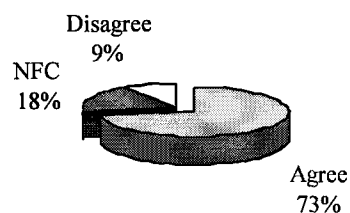
- (2) The company has a declared and documented strategic plan that is approved by top management.



- (3) The strategic plans are regularly evaluated and updated.



- (4) Customers' demands, supplies' means and other stakeholders including society are taken into account while plans, policies, and objectives are being developed.



Organizations are aware of the strategic planning concept but the implementation of the theory is inadequate. Almost all of them have a mission statement, strategic plans, and statement of objectives but just some of them evaluate and update these plans. There is a conflict in the given answers to questions two and three, as forty-two per cent of the firms indicated that they evaluate and update their strategic plans whereas only twenty-four per cent the firms stated that they have a declared and documented strategic plan. The continuous improvement concept is poorly understood.

Long-term Strategies

The most important performance objectives of the firms are securing the survival of the company, increasing profitability, and increasing conformance quality and the least important ones are increasing assets, service to environment, and service to community. The arrangement of the most important performance objectives is very meaningful as securing the survival of the company takes the first place in the sequence. The other objectives can not be realized unless this one is provided. The indication of increasing conformance quality as one of the most important performance objectives shows that the quality values are respected in the sector. Another important point is the relation between increasing profitability and increasing assets, as the former being one of the most important objectives and the latter being the least important. This is probably because of the competition in the sector. Companies tend to increase their profit without increasing their assets and market share with a minimum cost and high quality production.

TABLE 3.4. The companies' five most important performance objectives.

Performance Objectives	1 = most important					
	1	2	3	4	5	
Securing the survival of the company	5	3	5	5	1	63
Increasing profitability	9	2	1			56
Increasing conformance quality	3	4	3	2	3	47
Technological leadership	2	5	2	3		42
Increasing turnover	2	3	2	3	1	35
Welfare of the employees		2	1	2	8	23
Increasing market share	1	1	3	1	1	21
Service to community	1	1	1	1	1	15
Service to environment			2	1	1	9
Increasing assets		1	1			7

Short-term Plans

The most important action plans which are expected to be applied for the next two years period are reorganization, total quality management, employee training, establishment of project planning and control methods, acquiring quality or environmental certificates, and increasing employee efficiency. Revision of organizational structure and implementing new management techniques are the most common action plans of the companies. Advanced management techniques and competition in the construction market forces the organizations to review and modify their management system. The unskilled labor problem motivates the training program applications. Most of the companies are planning to implement QM programs within the next to years. Table 3.5 shows action plans for the next two years.

TABLE 3.5. The companies' five most important action plans for the next two years period.

Action Plans	1 = most important					
	1	2	3	4	5	
Reorganization	4		3		3	32
Total quality management	2	2		1	3	23
Establishment of project planning and control methods		2	3	2	1	22
Employee training		1	3	4	1	22
Acquiring quality/environmental specifications	3		1	1		20
Increasing employee efficiency	1	2	1	1	1	19
Just-in-time production		2	1	1	2	15
Manager training		2		1		10
Information systems	1		1	1		10
Quality circles or other team work applications	1	1				9
Development of suppliers relations	1					5
Development of new production technologies	1					5
Establishment of human resources/career planning procedures				1	2	4
Establishment of material management system		1				4
Development of subcontractor relations			1			3
Conformance to environmental specifications				1		2
Statistical process control						0

The most important action plans which were applied for the last two years are reorganization, just in time production, increasing employee efficiency, establishment of project planning and control methods, development of subcontractors relations. Reorganization, increasing employee efficiency, establishment of project planning and control methods are common action plans both for the past and future. Among these action plans the reorganization is the most popular one. It is stated as being the most important

by most of the companies in the past and for the future. This indicates a general trend in the sector towards development and innovation. Recognition of the importance of TQM and quality certification is increasing day by day. Although the importance given to the information systems is increasing, it is not satisfactory both in the past and for the future. The action plans, which were foreseen for the last two years, are shown in Table 3.6.

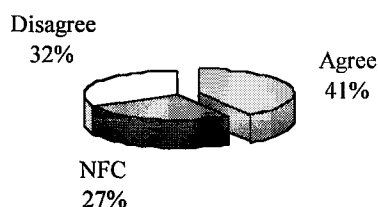
TABLE 3.6. The companies' five most important action plans for the last two years period.

Action Plans	1 = most important					
	1	2	3	4	5	
Reorganization	3	2	1	1	2	30
Just-in-time production	4		1		1	24
Increasing employee efficiency	1	2	2		2	21
Manager training		2	2	1		16
Quality circles or other team work applications	1	1	1	2		16
Development of subcontractor relations		2	2	1		16
Establishment of project planning and control methods	1	1	1	2	1	15
Total quality management		1	1	1	3	12
Acquiring quality/environmental specifications	2			1		12
Employee training		1	1	1		9
Development of new production technologies	1		1			8
Development of suppliers relations		1			1	5
Information systems				1	2	4
Establishment of human resources/career planning procedures				1		2
Establishment of material management system				1		2
Statistical process control					1	1
Conformance to environmental specifications						0

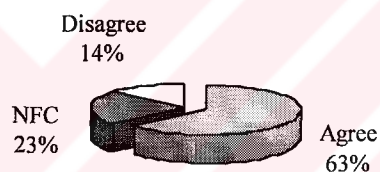
3.3. Leadership

Questions 1, 2, 3, 4, 5, and 6 of the leadership section and the related responses are indicated below:

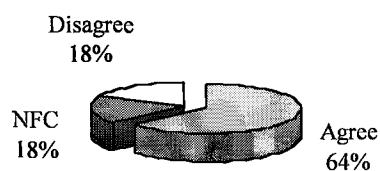
- (1) The top management communicates its policy and strategy to the employees.



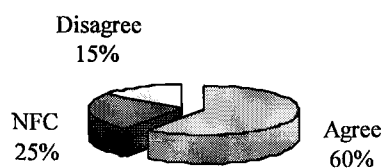
- (2) The employees communicate their ideas and views to the top management.



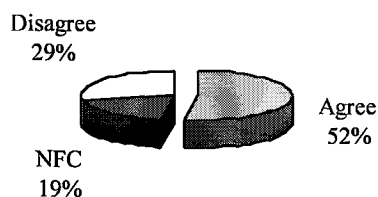
- (3) Top management influences individuals positively to carry out tasks and responsibilities.



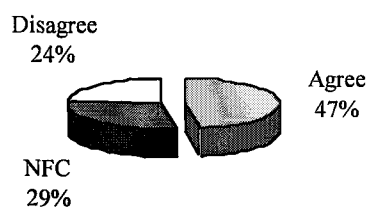
- (4) Top management involves in communication and role modelling of the quality values in our company.



(5) The senior executives are personally involved in reward and recognition activities.



(6) In crisis, a continuous improvement with interaction is preferred rather than fire fighting actions.



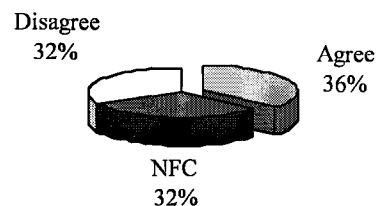
Quality starts at the top. Without upper management involvement, commitment, and leadership, a quality management program can not succeed [10].

The level of top management's policy and strategy communication is inadequate. Although, the employees easily communicate their ideas and views to the top level, they are not sufficiently informed about the organizations' policy and strategy. Even in some small-scale companies the employees do not know the policy and strategy of the organization. In more than half of the firms upper management does not forget the needs of employees for rewards and recognition. In most of the companies the top-level management assists in the development of quality values. "Continuous improvement" concept is not utilized in some of the companies. This feature distinguishes quality management from short-term management fixes.

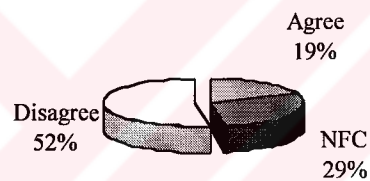
3.4. Human Resources

Questions 1, 2, 3, 4, 5, 6, 7, 8, and 9 of the human resources and their answers are represented below:

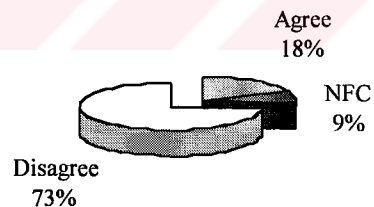
- (1) Hiring of new personnel is performed by long-range plans.



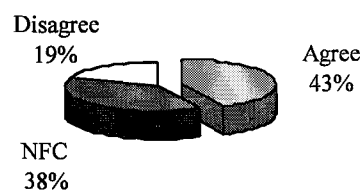
- (2) There is a training and improvement process for all employees including career planning.



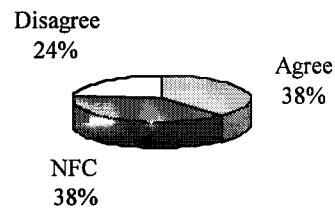
- (3) The employees participate in long-range planning of the company.



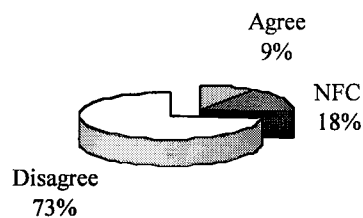
- (4) There is an efficient “top to bottom” and “bottom to top” communication.



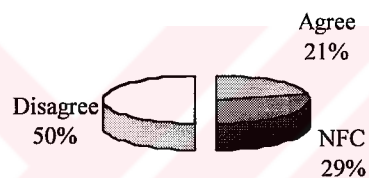
(5) The employees are involved in process improvement.



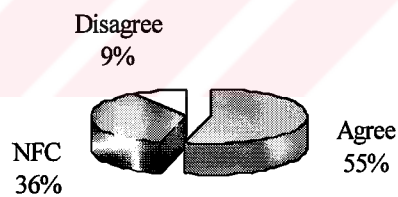
(6) The employee satisfaction surveys are regularly applied.



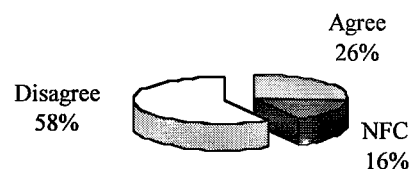
(7) The performance of the staff is regularly measured by a formal method.



(8) In our company, the health and safety conditions are satisfactory.



(9) There is a personal assistance program for the employees.



In the sector, the number of companies which perform new labor hiring by long-range plans and which do not are almost equal, whereas most of the firms do not carry out career plans for employees.

The employees are involved in process improvement moderately, whereas the participation of them in the long-range planning of the company is not at a satisfactory level. Nearly half of the companies indicated that they have an efficient communication level. In order for innovative ideas to be implemented effectively there must be a formal communication and feedback system to convey the ideas.

The employee satisfaction is poorly appreciated. In most of the companies performance measurement of the employees are not sufficient.

The responses to the eighth and ninth questions indicate that the health and safety conditions of the staff are quite satisfactory, whereas most of the companies do not pay attention to the personal assistance programs for the employees.

Employment Duration

In forty-three per cent of the companies managers work for five to ten years. In thirty-three of them managers work for ten to fifteen years. The managers work approximately 12.9 years. Figure 3.8 shows the managers employment duration.

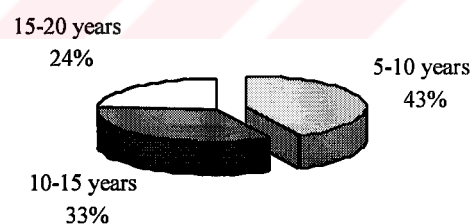


FIGURE 3.8. Managers' employment duration.

The sixty-two per cent of the companies employs its staff about five to ten years except for managers. Nineteen per cent is employed up to five years. Nineteen per cent is employed about ten to fifteen years. The employees work approximately 8.1 years and this indicates that managers are more stable than the other staff. The employees' employment duration is shown on Figure 3.9.

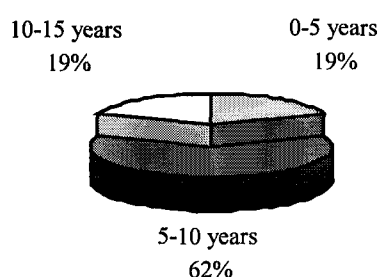


FIGURE 3.9. Employment duration of employees.

Quitting and Discharge Reasons

Most of the employees quit because of unsatisfactory wages or they are discharged because of their insufficient capacity. The number of experienced people does not meet the sector's demand. Completion of the projects is another reason for discharging employees. In Table 3.7 percentages of the quitting reasons of employees are indicated.

TABLE 3.7. Percentages of the quitting and discharge reasons of employees.

Reasons	Percentage				
	0-20	20-40	40-60	60-80	80-100
Unsatisfactory wages	2	4	3		
Adaptation problems with colleagues	4	2			
Not being able to promote	5	4			
Insufficient capacity of person	6	4		1	1
Excessive work hours	4	1	1		
Personal reasons	6	6			
Completion of project			1	1	1

Allocation of New Staff

Most of the firms prefer to employ experienced people rather than new graduates. Figure 3.10 indicates the allocation of new staff hiring among experienced people and new graduates.

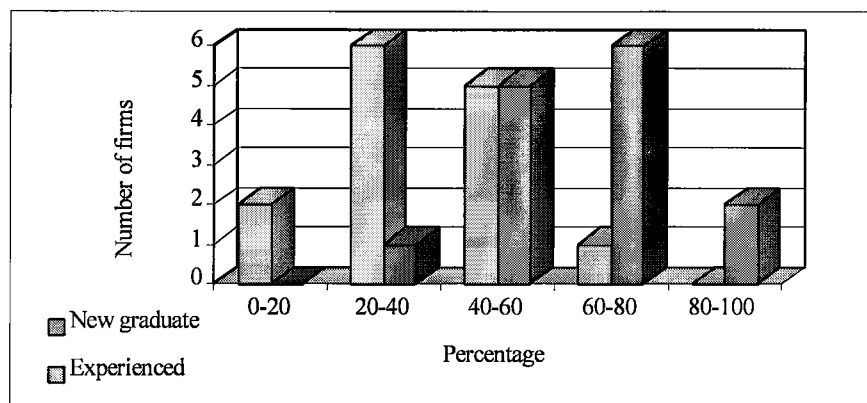


FIGURE 3.10. The allocation of new staff.

Thirty-nine per cent of the companies prefer to appoint managers both by promoting their own personnel and by transferring from other companies. Fifty-seven per cent of the firms appoint only by promoting their own personnel. Transferring from other firms only is not preferred (Figure 3.11).

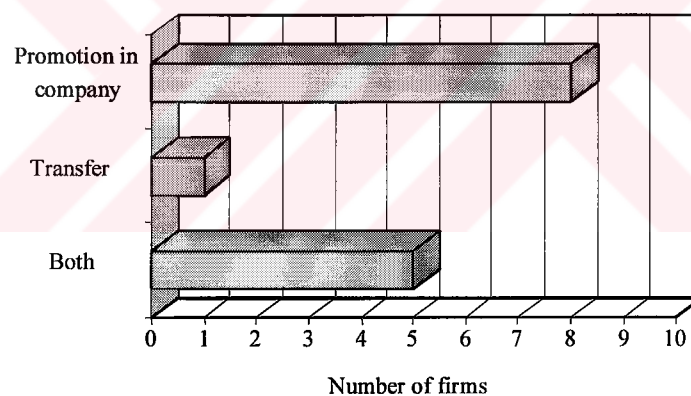


FIGURE 3.11. Manager appointment.

The employees' performance in their present position and duration of service in that position are both the promotion criteria for most of the companies. Some of the companies take into consideration only the performance of the employees. None of the firms consider the duration of service the only criterion (Figure 3.12).

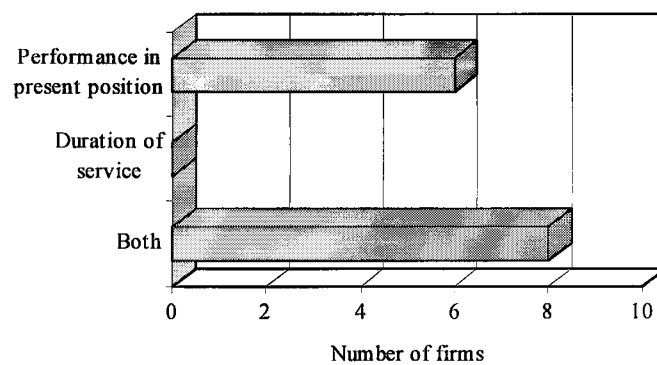


FIGURE 3.12. Criteria for promotion of employees.

Seventy-three per cent of the firms compare the working conditions and wages with their competitors. This, in turn, prevents alteration of wages and working conditions throughout the sector.

Training

Training is an important part of the quality management procedure. Half of the companies do not have a function or expert for their training program. In most of the firms training activities are applied by specialized training companies. In-house training seminars are applied by half of the companies and abroad training seminars are rarely applied.

Most of the companies did not indicate the rate of their training program cost in gross payment and wages, and the stated percentages are very low. Consequently, most of them did not indicate the rate of quality training program cost in total training budget. And also the stated percentages are again very low. This shows that they do not care about the training. Training programs can not be practiced without determining an applicable and satisfactory budget.

Performance Payment Plans

Performance payment plans directly affect the employees' motivation and efficacy. Bonus according to one's productivity is the most favorite performance payment that is practiced by the companies. Payment for skill and expertise, and payment for amount of

work done are also practiced by half of the companies. Figure 3.13 represents the performance payment plans.

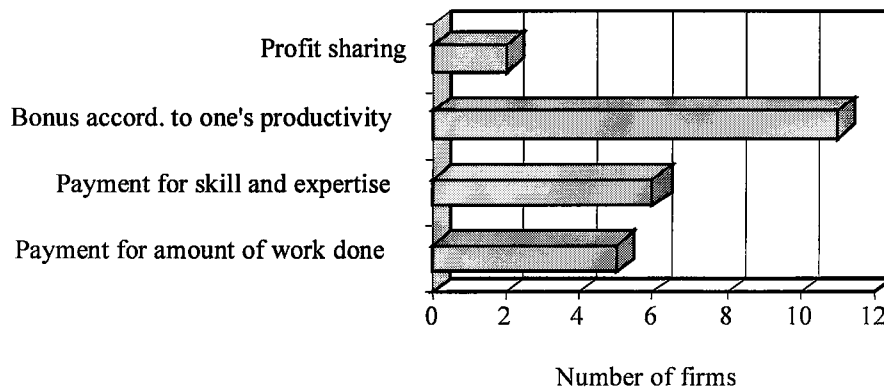


FIGURE 3.13. Performed performance payment plans.

Performance Measurement

In most of the companies the performance measurement about firm's relations with employees is performed but without a documented procedure. Eighteen per cent of the companies does not perform and eighteen per cent of them performs with a documented procedure. The most common performance measures are absenteeism, responsiveness to employee needs, and education and training offered. Figure 3.14 shows the utilized criteria. The average number of performance measurement criteria per company is 3.

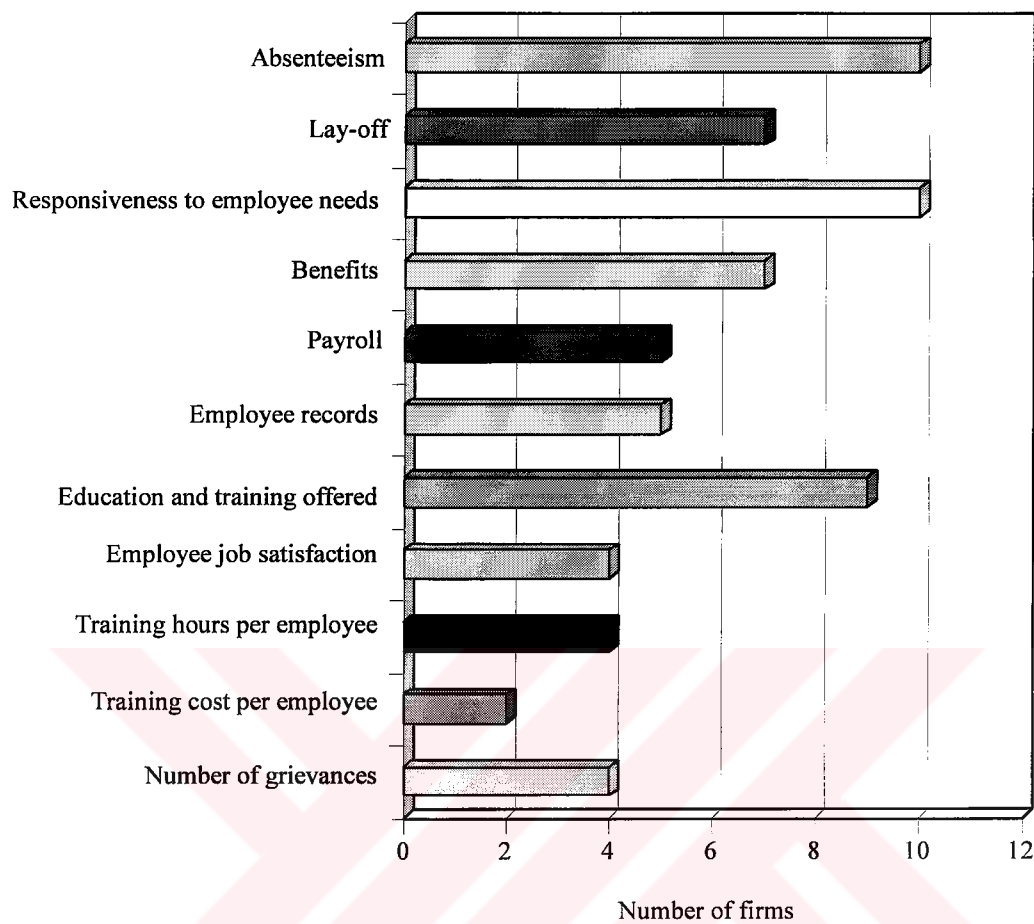


FIGURE 3.14. Performance measurement criteria for relation with employees.

3.5. Current Status of Quality Management Program

TQM is a company-wide action that involves everyone in an organization in an effort to increase customer satisfaction by continuously improving performance. In the survey the companies are asked for the definition of quality in two basic categories: conformance to specifications and customer satisfaction. The two definitions are interdependent and are related to the quality management approach employed by the company. Thirty-two percent of the companies defines the quality as conformance to specifications, forty per cent of them defines as customer satisfaction and twenty-eight of them defines as both conformance to specifications and customer satisfaction.

The general perception of the ranking of cost, schedule, quality, and reliability, in terms of what drives a project, was very difficult; they were viewed as all being equally important and interdependent. Quality is mostly rated as first, reliability as second, and schedule and cost alternate between third and fourth ranks (Table 3.8).

TABLE 3.8. Ranking of cost, schedule, quality, and reliability.

Drivers of a project	1 = most important				
	1	2	3	4	
Quality	13	5	3	1	74
Reliability	3	11	3	4	55
Schedule	5	1	7	8	45
Cost	1	5	9	7	44

Problem Areas

Companies encounter problems in almost all the areas indicated in the survey. There are four areas of primary concern. Customer relations is first, communication is second, coordination and subcontractor relations are third and fourth (Table 3.9). Coordination and communication problems indicate the poor management involvement and lack of teamwork. Although firms have problems about the subcontractor relations, supplier relations are not stated as a problem area.

TABLE 3.9. Problem areas.

Areas	1 = most important					
	1	2	3	4	5	
Customer relations	5	2	2	4	2	49
Communication	4	2	5	1	2	47
Coordination	4	0	5	4	2	45
Subcontractor relations	4	5	1	1	0	45
Material management	4	5	0	0	3	43
Engineering	5	1	2	3	2	43
Management	1	1	4	3	3	30
Supplier relations	1	3	1	1	3	25

Barriers Preventing Companies From Reaching Higher Quality Levels

The most important barriers preventing companies from reaching higher quality levels are indicated to be lack of skilled craftsmen, misunderstanding quality, and time constraints (Table 3.10). These are all interdependent problems. Because of limited time the inexperienced staff are not trained efficiently and quality concept is not communicated effectively. In construction industry the unskilled labor is a major problem.

TABLE 3.10. Barriers for reaching higher quality levels.

Areas of problems	1 = most important					
	1	2	3	4	5	
Lack of skilled craftsmen	3	6	2	5	1	56
Misunderstanding quality	6	2	3	2	1	52
Time constraints	2	5	3	2	6	49
Heavy work load	5		1	1	4	34
Lack of subcontractor relations	2	2	6		1	37
Lack of finance	3	2	2	2		33
Lack of supplier relations		2	3	4		25
Lack of experience		2	1	1		13

TQM Implementation

Four of the companies employ an overall formal TQM program. Five of them are planning to implement TQM in the next year. Thirteen of the firms are not planning to implement for the time being because eight of these are satisfied with their quality performance and five of them do not have sufficient information about TQM systems. These companies must be informed about the QM systems. In USA some of the large contractors began to formally implement TQM in the early 1990s [3]. Although it is a new concept in Turkish construction industry, majority of the companies is knowledgeable about and interested in quality improvement.

The companies implementing TQM began implementation within the last two years and all of these firms are contractors. They are completely satisfied with quality management implementation. The firms, which are in the process of implementing or will begin implementing TQM, have stated, as the most important reason is improvement of the internal organization of the firm, especially with respect to productivity. TQM will improve the firm's internal organization and its productivity by forcing it to describe work procedures and clearly define all organizational responsibilities. The second important reason is to consolidate and expand market share, since TQM implementation helps to

companies to gain the confidence of new and existing customers. Table 3.11 shows the reasons or motives for implementing quality management systems.

TABLE 3.11. Motivation for implementing TQM.

Reasons	Number of firms
To improve the organization's efficiency	7
To consolidate and expand market share	6
To increase the quality image of the company in the market	5
To improve product and service quality	3
Diminish product liability risk	3
To provide harmony in employee-employer relations	1

The level of employees' participation in quality management efforts decreases from top to bottom. In all of the companies the top managers are completely participated. More than half of the middle management is also participated. Participation of the first-line supervision is varies, in some of the companies all of them are participated and in some none of them is participated. In majority of the companies more than half of the rank and file employees are not participated.

ISO 9000 Certification

Increasingly more European and US companies are being asked by business partners to implement formal quality assurance systems. As a result, a large number of industrial and service companies and government and health care institutions worldwide are implementing quality assurance systems that conform to the ISO 9000 series of standards [9].

According to the survey results conducted with ISO 9000 certified organizations in Belgium, ISO 9000 implementation is a popular activity in many different economic sectors. Table 3.12 lists the business sectors represented by the responding companies and the percentage of the respondents in each category. In Belgium 3.55 per cent of the certified organizations is construction companies [9].

TABLE 3.12. Percentage of industry sectors with ISO 9000 certificates in Belgium.

Sector	Percentage of organizations with certificates
Chemical	24.82
Ferro	13.12
Services	7.8
Textiles	7.09
Food	5.67
Transport	4.96
Automotive	3.9
Construction	3.55
Petrochemical	3.55
Telecommunications	3.19
Industrial installations	3.19
Machine construction	2.48
Information technology	2.13
Packaging	1.77
Paper and cardboard	1.42
Glass	1.06
Distribution	0.71
Hotel and restaurant	0.35
Pharmaceutical	0.35
Other diverse sectors	8.87

However, in the Turkish construction sector none of the participating organizations has ISO 9000 certificates. Only two of them applied for ISO 9000 certification. Nine of them are planning to apply within the next year. Most of the companies, which are not planning to have a certificate, are satisfied with their current quality management system.

The ISO 9000 standards are being applied and adapted increasingly by more companies. It is a good start for TQM implementation.

QM Organization

In most of the companies there is a quality policy, only eighteen per cent of the companies does not have it. In almost all of the companies there are strategic objectives. In more than half of the companies' quality objective evaluation is based on previous performance data.

Table 3.13 shows the existing organizational entities in the companies which are directly associated with quality. Nine of the firms have quality department. Quality control laboratories are the most common unit in the construction companies. Quality circles, quality steering groups, and quality improvement support groups are not established in most of the organizations.

TABLE 3.13. Existing organizational entities.

Organizational Entities	Number of firms
Quality Control Laboratories	12
Quality Department (Manager - Chief)	9
Quality Circles	3
Quality Steering Groups	3
Quality Improvement Support Groups	3

QM Tools

The companies utilize various quality management tools. The most commonly used methods are flowcharting, cause and effect analysis, brainstorming, and statistical methods. Table 3.14 shows utilized quality management tools. Five companies do not use any tool and most of the companies utilize only one or two methods. The utilization of quality management tools is not sufficient.

TABLE 3.14. Quality management tools.

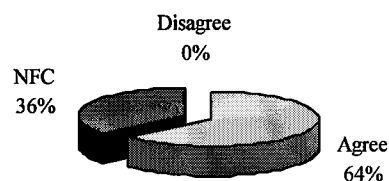
Tools	Number of firms
Flow charting	8
Cause and effect analysis	7
Brainstorming	6
Statistical methods	6
QFD -Quality Function Deployment	3
Pareto analysis	0

Process Improvement

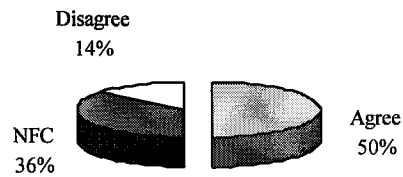
Problem identification and solution focus on the processes involved. A process might be the vibration of fresh concrete, the fabrication of structural steel, the preparation of review of a shop drawing, or the way in which a project manager deals with a client and with other members of the team. Quality comes not from inspection, but from improvement of the process. Primary function of inspection is to provide information that can be used to identify problem areas that must be studied so that a particular process can be improved [10]. The concept of continually improving work processes is one of the fundamental principles of quality management. The ability to produce a quality product largely depends on the relations among parties involved in the process. The quality of any stage in a process is contingent upon the quality of the previous stages.

In most of the companies the processes are continuously examined and improved by innovations and creativity. Progress is the result of creative ideas and innovative activities.

(17) Processes are continuously examined and objectives are defined for improvement.



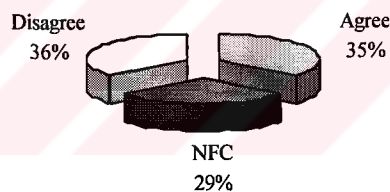
(18) Processes are continuously improved by innovations and creativity.



Person or a (sub) process in the company that receives a product or a service from another is an internal customer. Satisfaction of the internal customer is strongly emphasized in QM because it promotes better communication and improves working relationships.

In some of the companies the internal customer concept is not understood and is not in practice. To promote better communication and to improve working relationships internal customer has to be satisfied.

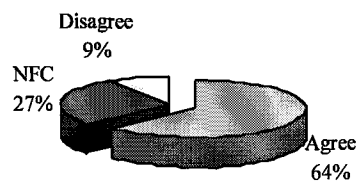
(19) Internal customer concept is well understood and it is in practice in the company.



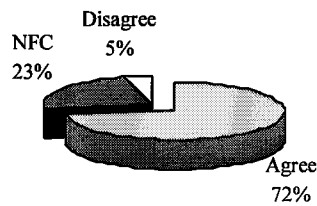
3.6. Organization and Communication

Questions 1, 2, 3, 4, 5, and 6 of this section and their responses are stated below:

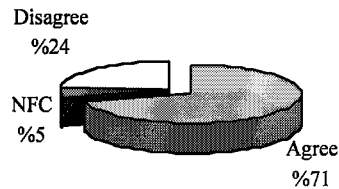
(1) Authority and responsibility of all officers in the company are well defined.



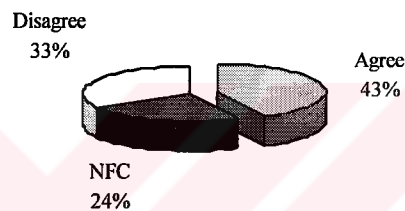
(2) The defined authorities and responsibilities are practiced in the whole company.



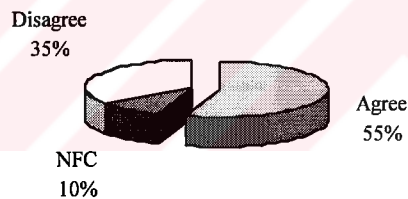
(3) There is formal procedure for the planning and execution of the activities.



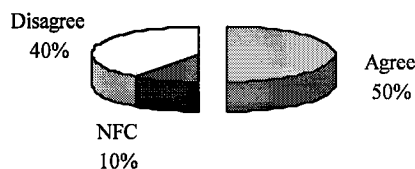
(4) Implemented procedures are periodically reviewed and updated.



(5) Construction site planning works are performed by central management.



(6) Construction site plans are performed by a documented procedure.



Authority and responsibility of all officers are well defined and practiced even better in most of the companies. The majority of firms have formal procedures for the planning and execution of the activities, however, the degree of updating and reviewing these procedures is not very high resulting in inadequate continuous improvement.

In most of the firms central management performs the construction site planning works but half of them perform site plans by a documented procedure.

Forty-five per cent of the companies perform information flow between construction site and head office regularly according to a defined procedure, thirty per cent perform regularly without a defined procedure, and the rest of them perform irregularly without a defined procedure. In most of the companies the information flow procedure is defined. Eighty per cent the companies have special unit in head office about the construction site(s).

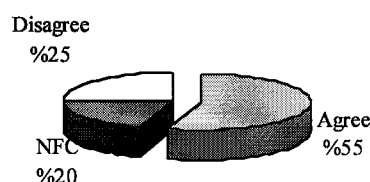
In forty-seven per cent of the companies the project team is arranged by project manager, in thirty-two per cent of them project team is determined by central management, and in the rest of them project manager and central management jointly determine the project team.

In most of the companies more than fifty percent of the expenditure orders are given by the project manager without conferring with the head office. In most of the companies ninety percent of discipline authority orders is given by project manager without conferring with the head office. The limits of the discipline authority of project manager are broader than those limiting his expenditure authority . In most of the firms project managers' authority limits are very broad.

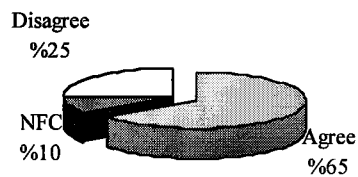
3.7. Customer Relations

Questions 1, and 2 of the customer relations section is indicated below:

(1) There is a mechanism for listening to and communicating with the customer.



(2) Customer complaints are utilized as a source for improving processes.



In more than half of the companies the customer relations are maintained by a communication mechanism. Moreover, in most of the companies, customer complaints are utilized as a source for improving processes.

Application of client-feedback surveys measures the level of customer satisfaction. The surveys seek out areas of dissatisfaction and feed the information back to the company so that action can be taken to eliminate the source of any dissatisfaction. Only two of the firms apply client-feedback surveys every year regularly and six of them apply such surveys at the end of projects. Most of them do not use customer surveys.

Performance Measurement

The performance measurement about customer relations is performed but without a documented procedure. Thirty-eight per cent of the companies do not perform and only fourteen per cent of them perform with a documented procedure. The most common performance measures are repeat business, budget conformance, schedule conformance, and accuracy of execution. Figure 3.15 shows the utilized criteria. The average number of performance measurement criteria per company is about 3 (or 5).

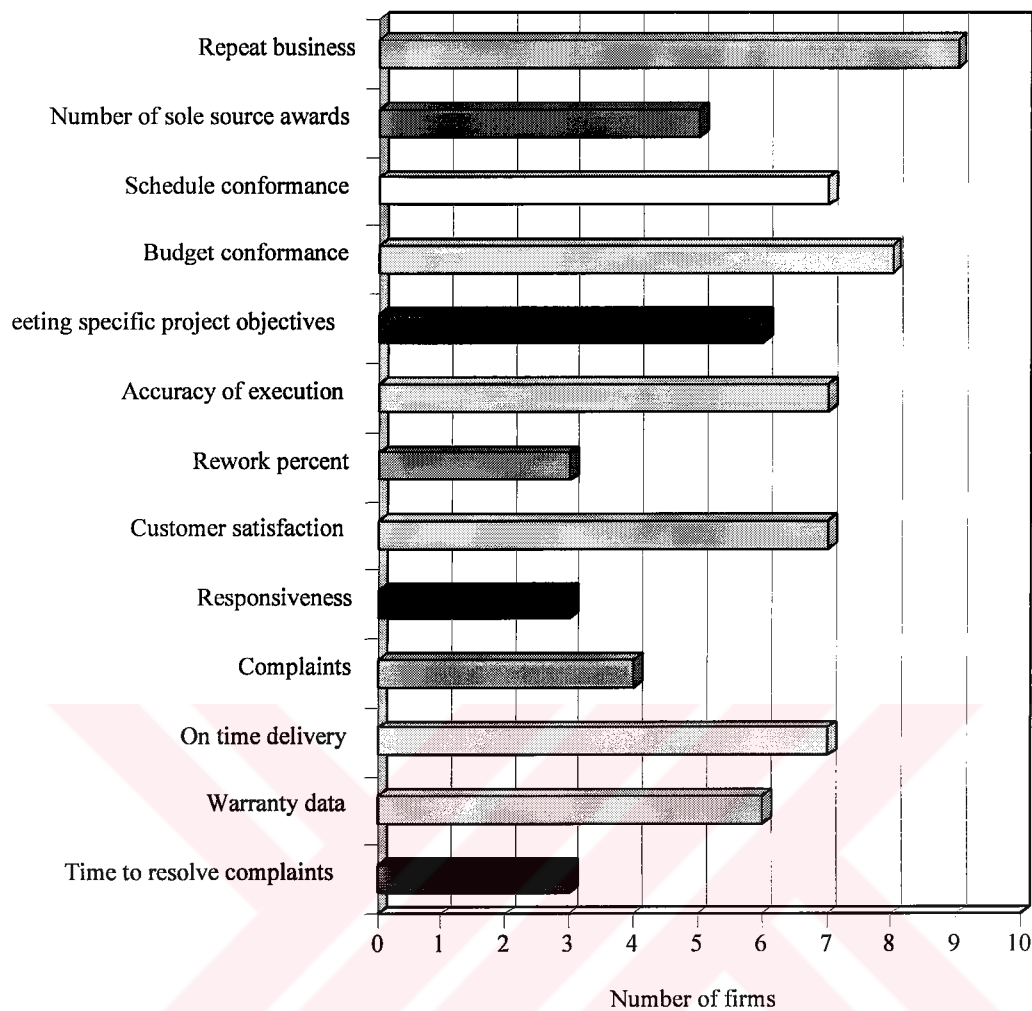


FIGURE 3.15. Performance measurement criteria for customer relations.

About marketing, sales, finance and administration, business development, and tendering the performance measurement is carried out mostly without a documented procedure. Figure 3.16 represents the performance measurement status of companies about above-mentioned areas. Figures 3.17, 3.18, 3.19, 3.20, and 3.21 respectively show the performance criteria for the above areas. In marketing, the most common performance measure criterion is the number of gained or lost accounts. For sales only two criteria are utilized and these are the rate of new customers in existing customers, and sales expense to revenue. In finance and administration, the most common criteria are order entry/billing accuracy, and revenue per employee. For the business development, the profit/loss statement is the most commonly applied criterion. Number and diversity of clients, market share, and current backlog are also important criteria. As for the tendering, the rate of

tenders won to all tenders prepared within the year is a common criterion, as well as the ratio of value of tender won to that of the nearest competitor.

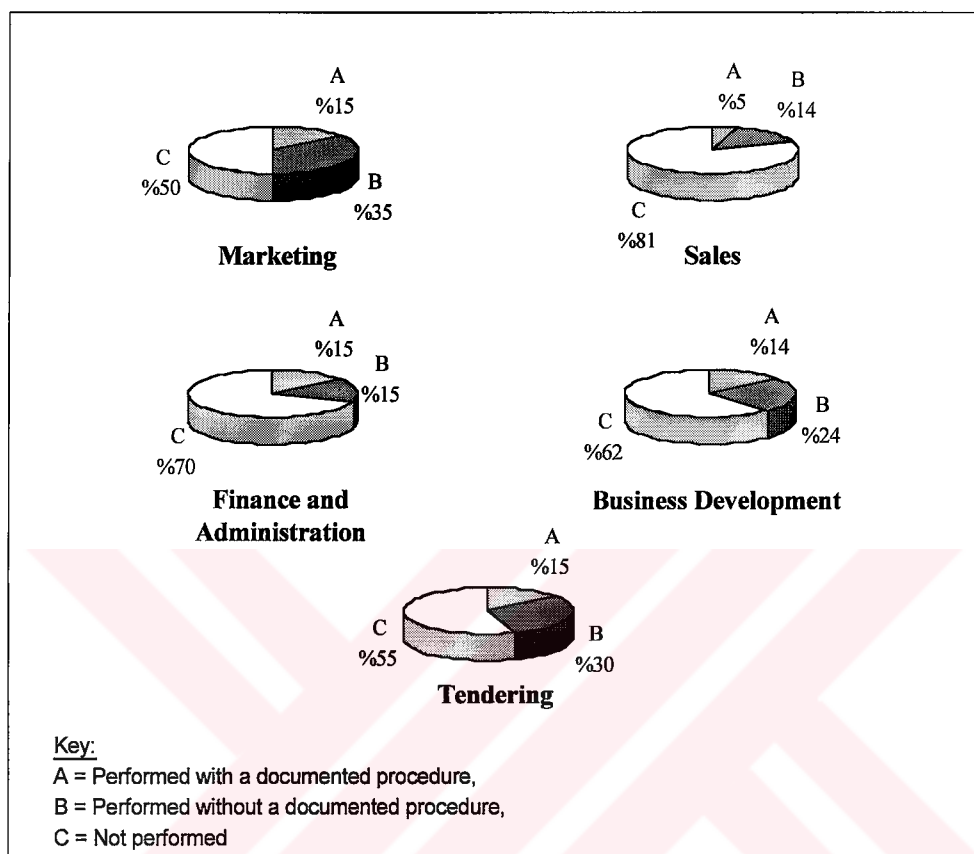


FIGURE 3.16. Performance measurement areas.

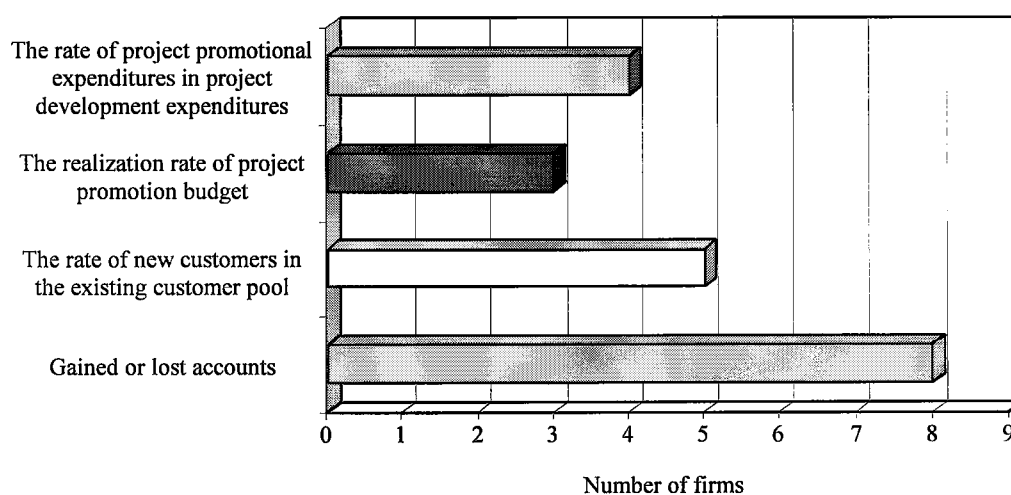


FIGURE 3.17. Performance measurement criteria for marketing.

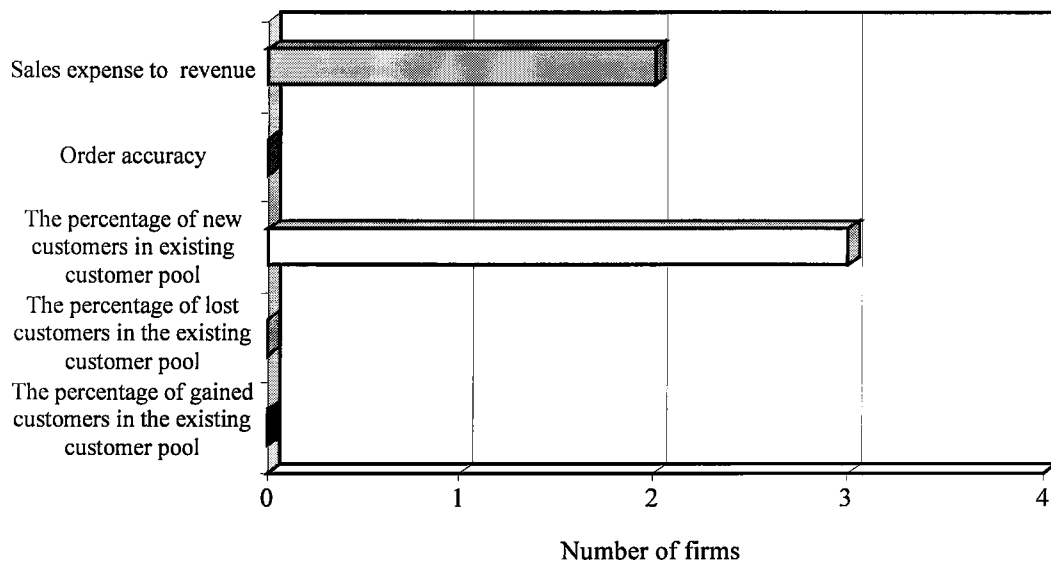


FIGURE 3.18. Performance measurement criteria for sales.

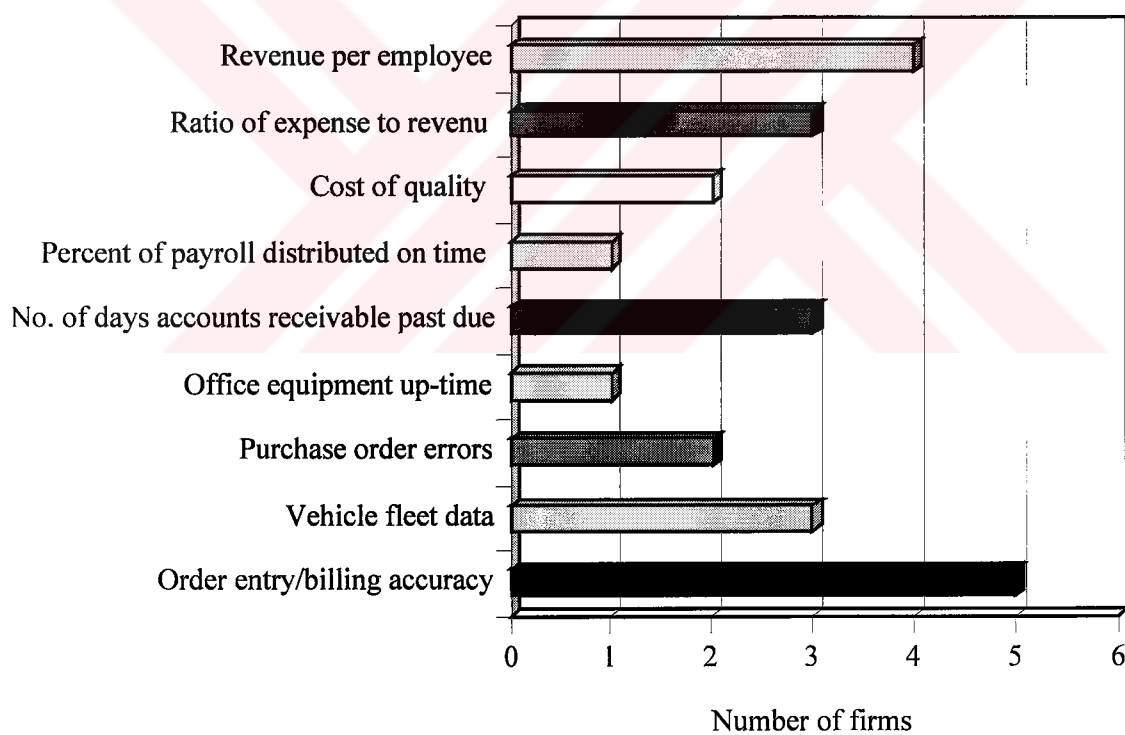


FIGURE 3.19. Performance measurement criteria for finance and administration.

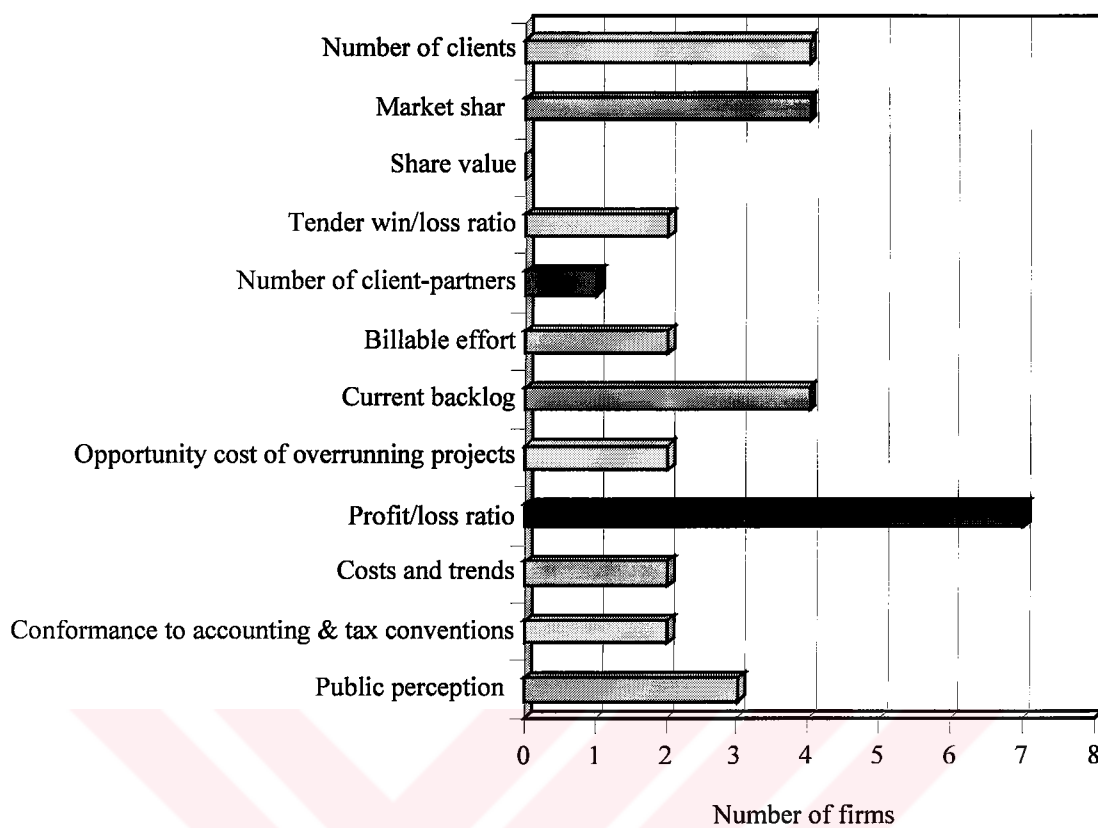


FIGURE 3.20. Performance measurement criteria for business development.

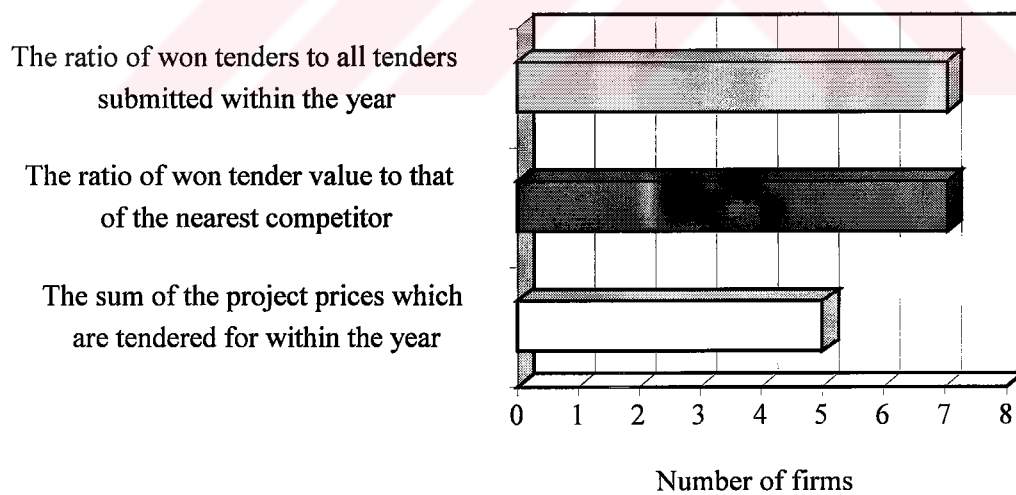


FIGURE 3.21. Performance measurement criteria for tendering.

3.8. Supplier Relations

The quality of the project built by the constructor is directly related to the quality of the materials and equipment supplied by the vendors. Close and long-term relationship with these suppliers is required if the constructor is to achieve the best economy and quality.

Purchasing in most of the firms is carried out by both central management and site management and the ratio depends on the project size. In small-scale firms purchasing is performed by central management.

The number of suppliers that firms work with varies between 10 and 100 depending on the project and its magnitude. In most of the projects more than eighty per cent of the materials is provided by suppliers. The companies work repeatedly with more than seven per cent of the suppliers. Firms generally prefer to establish long-term relationships with the suppliers.

Selection Criteria

Suppliers are selected according to their capacity, quotation price of material, quality perception, just in time delivery, and conformance to company policies. As shown on Table 3.15, the most important selection criterion is quotation price of material. Their quality perception and capacity are equally weighed and come out in the second place. Low margins in the construction market seem to force the companies to select the suppliers according to their quotation price.

TABLE 3.15. Selection criteria of suppliers.

Characteristic	1 = most important					
	1	2	3	4	5	
Quotation price of material	9	6	1		1	73
Capacity	8	2	1	2	1	56
Quality perception	8		4	1	1	55
Just in time delivery	7	1	2	5		55
Conformance to company policies	1	2	1	1	5	23

Performance Measurement

Construction equipment are purchased, rented, or leased depending on the project's location, duration, and magnitude. But mostly they prefer the first two options cited above. Equipment suppliers are chosen according to the characteristics given in Table 3.16. Equipment performance is the most effective selection criterion. Reliability of the firm takes the second place.

TABLE 3.16. Selection criteria of equipment suppliers.

Characteristic	1 = most important			
	1	2	3	
Equipment performance	12	4	1	45
Reliability of the firm	12	1	5	43
Service possibilities	8	5	4	38

The firms generally carry out performance measurement about suppliers without a documented procedure. Seventeen per cent of the companies carry out performance measurement based on a documented procedure. The most common performance measures are quality performance, on-time delivery, and cost (price). In Figure 3.22 the most utilized performance measures are given.

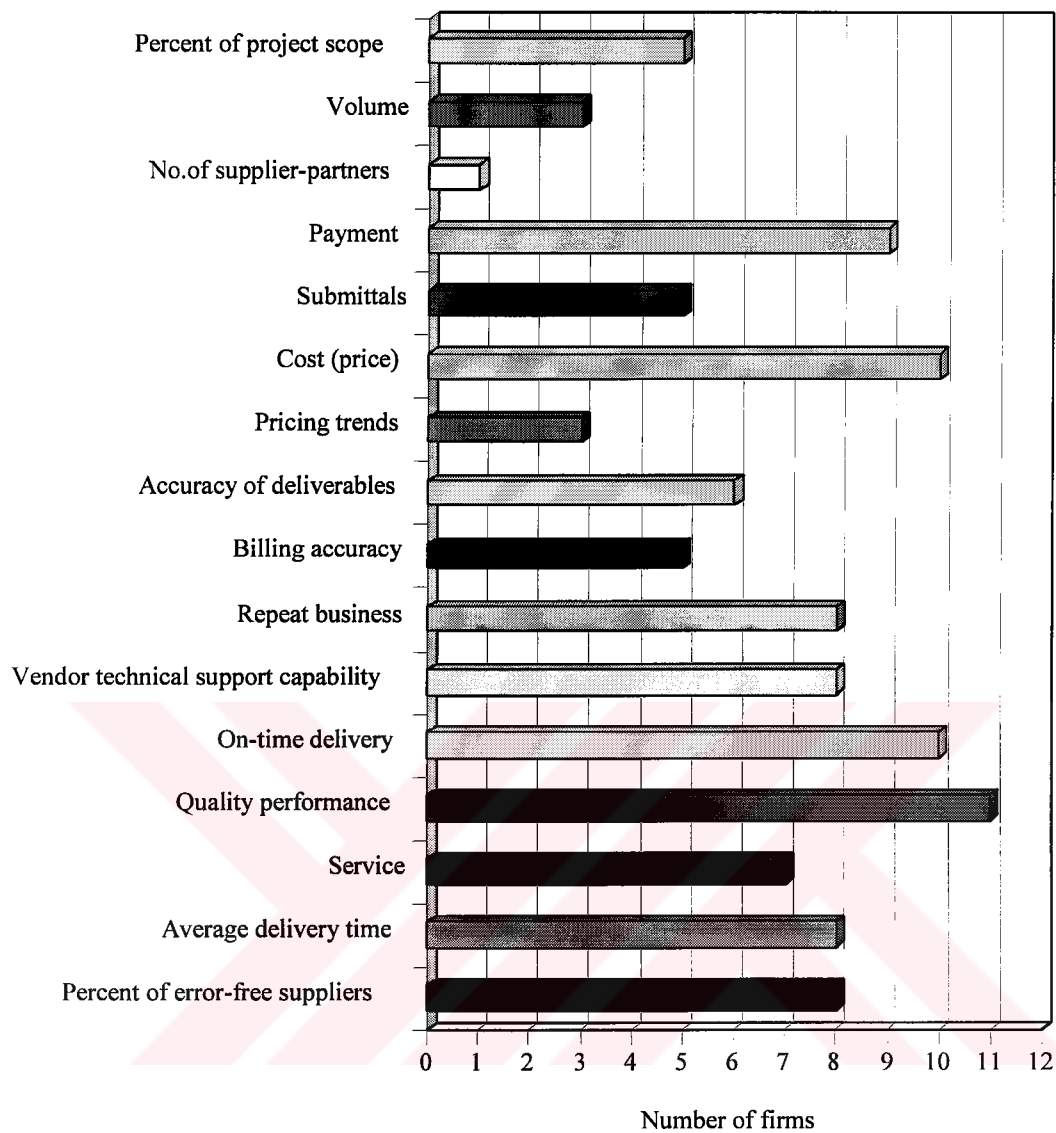


FIGURE 3.22. Performance measurement criteria for suppliers.

3.9. Subcontractor Relations

The quality of the work performed by the subcontractors is also directly related to the quality of the project built by general contractor. The working relationships between subcontractors and general contractors begin during the estimating and bidding process.

Almost all the companies prefer to work continuously with specific subcontractors. The firms work with 10 to 20 subcontractors for each project. More than fifty per cent of the work is performed by subcontractors, on some projects it is about eighty to ninety per cent of the work. The composition of the subcontractors selected for a project will invariably be altered from previous projects. This is a result of the fact that the relationship of a subcontractor with a general contractor is project specific.

Selection Criteria

Subcontractors are selected according to the characteristics such as capacity, quotation price of the work, quality perception, and on-time production. Table 3.17 shows the priority of the selection criteria. The most important criteria are their capacity and quality perception.

TABLE 3.17. Selection criteria of subcontractors.

Characteristic	1 = most important				
	1	2	3	4	
Capacity	7	5	6		55
Quality perception	7	3	4	5	50
Quotation price of work	5	7	2	3	48
Just in time delivery	3	3	5	7	38

Almost all of the companies are involved in completely directing and planning the subcontractors' work. They also provide sufficient time for the subcontractor to properly prepare a bid.

Performance Measurement

Forty per cent of the firms carry out performance measurement about subcontractors without a documented procedure and thirty per cent of them carries out performance measurement based on a documented procedure. The most common

performance measures are quality performance, and cost (price). Figure 3.23 shows the most utilized performance measurement criteria.

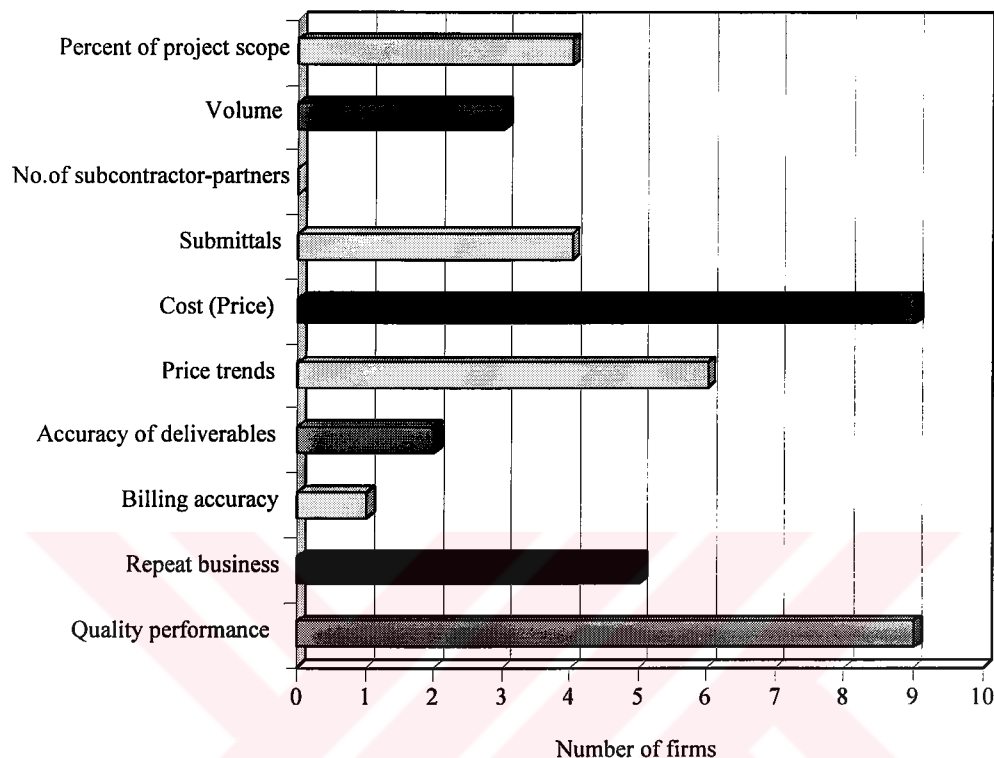


FIGURE 3.23. Performance measurement criteria for subcontractors.

3.10. Engineering and Design

The project organization in engineering and design is generally executed without a documented procedure. Half of the firms apply quality plan for each project.

Nearly all the firms perform a detailed budget and expenditure control by a defined procedure for each project. Half of them perform control according to a documented procedure and half without a documented procedure.

A detailed work schedule according to work quantity is generally performed without a documented procedure.

Half of the firms carry out performance measurement about engineering service without a documented procedure and twenty-three per cent of them carry out with a documented procedure. The most common performance measures are changed orders and average time to process proposals. In Figure 3.24 the most utilized performance measurement criteria are shown.

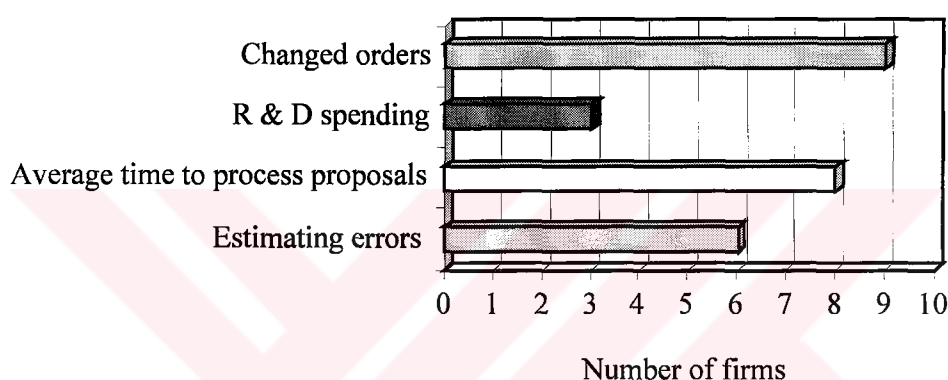


FIGURE 3.24. Performance measurement criteria for engineering service.

The companies' documentation level in engineering and design works is not satisfactory. Quality values in terms of quality management in most of the firms are not recognized.

3.11. Production

Some of the companies produce materials. Economic reasons, strategic reasons, or contract obligations motivate the construction companies' material production activity. Contract obligation is the most important reason that leads to production. It is followed by economic reasons. Companies generally consume all of the produced material by themselves.

Companies mostly carry out performance measurement about production without a documented procedure. The most common performance measurement criteria are actual performance to planned performance; and cost per unit. In Figure 3.25 the most utilized performance measurement criteria are shown.

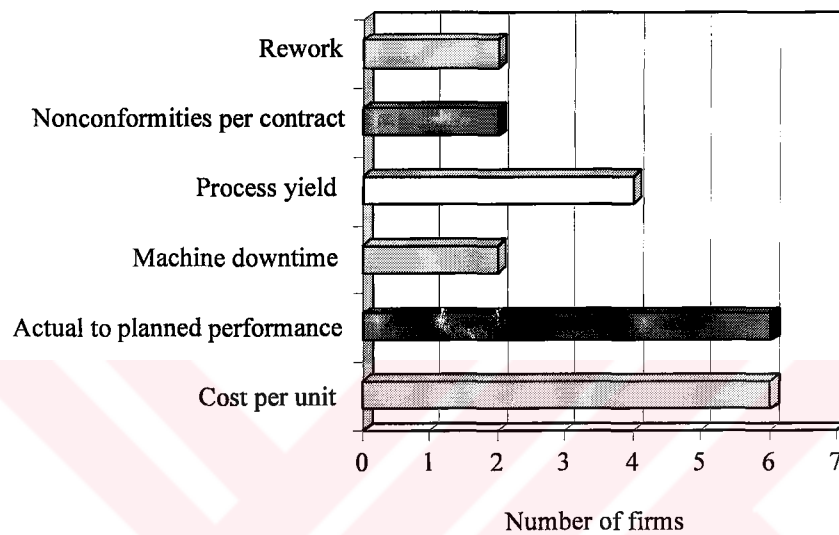


FIGURE 3.25. Performance measurement criteria for production.

3.12. Benchmarking

Benchmarking is a process that targets key improvement areas, and identifies and studies best practices for continuous improvement and increase competitive advantage.

Nine companies practice benchmarking, but most of them do not follow the competitors systematically. Among these nine companies only two claim to have special teams to apply benchmarking.

In the construction sector, companies do not make comparisons with their competitors. This, in turn, results in a set-back to the efforts for continuous improvement.

3.13. Post-Project Analysis

Almost all of the companies make post-project analysis in order to determine the best applications. More than fifty per cent of the completed projects are analyzed.

Success level of the project is the most utilized selection criterion in the selection of projects for post-project analysis. Criteria based on revenue and customer are also common (Table 3.18).

TABLE 3.18. Selection criteria of projects.

Criterion	Number of firms
Success level	15
Revenue	12
Customer	12
Region/country	12
Technology	10

In all of the companies, project analysis is performed by either a specialized person/team or employees who worked in that project.

Conformance to schedule and conformance to total cost objectives are the most utilized criteria for analysis (Table 3.19).

TABLE 3.19. Analysis criteria of projects.

Areas	Number of firms
Conformance to schedule	11
Conformance to total cost objectives	10
Conformance to quality objectives	7
Conformance to unit cost objectives	6
Conformance to safety objectives	3
Conformance to environmental objectives	2

The analysis results are used both in process improvement and in management decisions.

4. SUMMARY AND CONCLUSIONS

4.1. Implementation and Related Issues

Twenty-two of the selected twenty-five companies have participated in the survey. Some of the firms that are chosen to participate in the survey were not willing to give information about the company's status.

According to the survey results, the companies' initial approach to the survey is parallel to their understanding of TQM; in other words, the firms that have a formal TQM program were more eager to respond the questionnaire.

The participant companies can be divided in three categories; (1) the firms which have a formal TQM program, (2) the firms which are knowledgeable about TQM but do not employ any TQM program, (3) the firms which do not have any information about TQM.

4.2. Major Findings

The following important points are derived from the evaluation of responses given by participant companies:

- All of the companies appear to have a formal procedure for the planning and execution of the activities but evaluation and updating of these procedures are not sufficient.
- The companies' long-term strategies are mainly based on securing the survival of the company.
- Short-term planning for reorganization and TQM implementation are considered to be the most important action plans.

- The employees can easily convey their ideas and views to the top management, however, they are not informed adequately by the top management about the policy and strategy. In other words, the lack of strategy deployment is observed.
- Continuous improvement concept is not utilized in some of the companies.
- Human resources management is not practiced effectively; career planning of employees is not performed, employee satisfaction is not evaluated systematically, and the employees are not involved in long-range planning.
- The companies do not give importance to training. In most of them the training program budget is not defined.
- The turnover of the managers, and technical and administrative personnel is low.
- The problem areas for most of the companies are customer relations, communication, coordination, and subcontractor relations.
- Time constraint is stated by most of the companies as a barrier for reaching higher quality levels.
- Four of the companies have formal TQM program, five of them are planning to employ a formal TQM program, eight of them do not employ TQM as they are satisfied with their current quality level, and the remaining five companies do not have any information about TQM.
- The most important reasons to employ TQM programs are to improve internal organization and to expand market share.
- Two of the companies have applied for an ISO 9000 series of quality assurance certificate, and nine of them are planning to apply within the next year.
- There is a mechanism for listening to and communicating with customers. However, the customer satisfaction level is not measured systematically.
- The quotation price is the most important supplier selection criterion.
- The information flow between the general contractor, and suppliers and subcontractors is not functioning properly.
- Benchmarking is not practiced in most of the companies.
- Companies usually perform post-project analysis.
- Performance measurement is generally carried out without a documented procedure in most of the areas.
- Documentation of procedures is not well established.

4.3. Suggestions

Companies must institute TQM to be competitive in the national and international construction market. TQM is both an operational philosophy and a methodology in which there is a strong commitment to customers, employees, and improvement. It goes well beyond the traditional limits of quality assurance and quality control.

Almost all of the companies are aware of the quality values and interested in quality improvement. For the construction sector in Turkey TQM is a new concept. The companies are not experienced enough to implement TQM properly and they have problems in some areas.

Main problem areas according to the survey results are documentation, communication, training, and process improvement. In most of the companies almost all the work is carried out with a defined but not documented procedure. An implementation project, just as a construction project, requires extensive documentation. The implementation efforts, the successes, and the failures all need to be documented, because this information can be used to aid in the future implementation efforts. For continuous improvement, an effective communication should be established with both internal and external customers, i.e. customers, employees, suppliers, and subcontractors. Training is necessary because TQM uses a participative, disciplined, and organized approach to problem identification and problem solution. Training topics typically include quality awareness, teamwork, leadership, interpersonal communication, problem solving techniques, and job-related technical skills. The training programs should be practiced regularly. Top management and all other employees should also be trained about quality values.

In Turkish construction market ISO 9000 quality assurance systems do not have a widespread application. Applying for ISO 9000 will be a crucial initiation point for the companies, which plan TQM implementation. ISO 9000 implementation provides a good foundation for TQM.

Foundations such as Kalder (Quality Association), Union of Turkish Contractors, and Turkish Chamber of Civil Engineers can play a vital role in the introduction of TQM systems and TQM implementation in the Turkish construction sector by organizing seminars and issuing publications.

Implementation of TQM takes time and resources. According to a research result, the implementation process requires about three years of dedicated effort before substantial benefits are realized throughout the company [3]. Implementation and improvements are an investment to the future and can create a long-term gain in efficiency and profitability.

With some minor modifications the survey should be conducted several years later once again to see the changes in the sector. For the training of craft workers a study can be done to determine how best to train craft workers in TQM concepts.

For the construction job sites a special questionnaire can be prepared and applied. Since the public companies represent an important part of the construction sector another questionnaire can be applied to the public institutions.

Further study on contracting methods applied in Turkey can also be carried out because it has a direct effect on the projects, and it affects the working atmosphere of owners and contractors.

APPENDIX A

The English version of the original questionnaire is provided here. It is composed of thirteen parts and consists of thirty-three pages:

Sections	Number of questions in the sections
(1) Business Profile.....	11
(2) Strategic Planning	7
(3) Leadership	6
(4) Human Resources.....	25
(5) The Current Status of the Quality Management Program.....	19
(6) Organization and Communication	11
(7) Customer Relations	15
(8) Supplier Subcontractor Relations.....	9
(9) Subcontractor Relations	8
(10) Engineering and Design	6
(11) Production	4
(12) Benchmarking	3
(13) Post-Project Analysis	5
Total Number of Questions.....	129

OBJECTIVE

The objective of this survey is to determine the present assessment of quality management system of construction industry and to define strategic policies for the future.

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I. BUSINESS PROFILE

1. Please state the rate of your company's activities in the following fields in its total yearly turnover.

- . Design%
- . Consultant%
- . Contractor%
- . Subcontractor%

2. Please state the characteristic of the business.

- . Independent firm.....☐
- . Branch of a big company.....☐
- . Sub company of a holding.....☐

3. How long have your company been in service in this sector?

.....Year(s)

4. Please state the average number of full time equivalent people within the organization being assessed in 1997.

- . Technical staff
- . Administrative staff
- . Logistic staff
- . Unskilled labor
- . Skilled labor
- . Foreman

5. State the average distribution of full time equivalent people being assessed according to the place of employment in 1997.

- . Construction site%
- . Head Office %

6. State the construction fields in which your company is acting.

- . Residential..... ☐
- . Building..... ☐
- . Roads, Highways..... ☐
- . Railways..... ☐
- . Infrastructure works..... ☐
- . Dams..... ☐
- . Airports..... ☐
- . Harbors..... ☐
- . Industrial Buildings..... ☐
- . Other (Please state)..... ☐

.....

.....

.....

7. Please state the geographical location of your company's activities.

- . In a certain region..... ☐
- . In the whole country..... ☐
- . Abroad..... ☐

8. What is the percentage of your company's field of activities in its yearly turnover in 1997.

- . Local _____ %
- . Abroad _____ %

9. What are the shares of client groups of your company in its yearly turnover in 1997.

- . Private companies _____ %
- . Public foundations _____ %

10. Performance measurement in your company is

- . performed with a documented procedure.....☐
- . performed without a documented procedure.....☐
- . not performed.....☐

11. State the areas in which the performance measurement is executed in your company.

- . Employees.....☐
- . Customer relations.....☐
- . Production.....☐
- . Engineering services.....☐
- . Suppliers.....☐
- . Subcontractors.....☐
- . Marketing.....☐
- . Sales.....☐
- . Business development.....☐
- . Tendering.....☐
- . Other (Please state).....☐

-
-
-

II. STRATEGIC PLANNING

Please circle the number that clearly defines your opinion about the PRESENT condition of your company.

- | | <u>I agree</u> | | <u>I disagree</u> | |
|--|----------------|---|-------------------|-----|
| 1. There is a declared company mission that is supported by all employees. _____ | 1 | 2 | 3 | 4 5 |
| 2. The company has a declared and documented strategic plan that is approved by top management. _____ | 1 | 2 | 3 | 4 5 |
| 3. The strategic plans are regularly evaluated and updated. _____ | 1 | 2 | 3 | 4 5 |
| 4. Customers' demands, supplies' means and other stake holders including society are taken into account while plans, policies, and objectives are being developed. _____ | 1 | 2 | 3 | 4 5 |
| 5. Please arrange in order your company's five most important performance objectives. (1 = most important) | | | | |
| . ____ Increasing profitability | | | | |
| . ____ Increasing conformance quality | | | | |
| . ____ Increasing assets | | | | |
| . ____ Increasing market share | | | | |
| . ____ Increasing turnover | | | | |
| . ____ Survival of company | | | | |
| . ____ Technological leadership | | | | |
| . ____ Service to community | | | | |
| . ____ Service to environment | | | | |
| . ____ Welfare of the employees | | | | |
| . Other (Please state) | | | | |
| | | | | |
| | | | | |
| | | | | |

6. Please arrange in order five of the most important ACTION PLANS that your company foresees to be applied for the next two years period. (1 = most important)

- . ____ Just-in-time production
- . ____ Reorganization
- . ____ Manager training
- . ____ Statistical process control
- . ____ Quality circles or other team work applications
- . ____ Establishment of material management system
- . ____ Conformance to environmental specifications
- . ____ Employee training
- . ____ Development of suppliers relations
- . ____ Development of subcontractors relations
- . ____ Acquiring quality/environmental certificates
- . ____ Total quality management
- . ____ Information systems
- . ____ Development of new production technologies
- . ____ Increasing employee efficiency
- . ____ Establishment of project planning and control methods
- . ____ Establishment of human resources/career planning procedures
- . ____ Other (Please state)
- . ____
- . ____
- . ____

7. Please arrange in order five of the most important ACTION PLANS that your company foresaw to be applied for the last two years period. (1 = most important)

- . ____ Just-in-time production
- . ____ Reorganization
- . ____ Manager training
- . ____ Statistical process control
- . ____ Quality circles or other team work applications
- . ____ Establishment of material management system
- . ____ Conformance to environmental specifications
- . ____ Employee training
- . ____ Development of suppliers relations
- . ____ Development of subcontractors relations
- . ____ Acquiring quality/environmental certificates
- . ____ Total quality management
- . ____ Information systems
- . ____ Development of new production technologies
- . ____ Increasing employee efficiency
- . ____ Establishment of project planning and control methods
- . ____ Establishment of human resources/career planning procedures
- . ____ Other (Please state)
- . ____
- . ____
- . ____

III. LEADERSHIP

Please circle the number that clearly defines your opinion about the PRESENT condition of your company.

- | | <u>I agree</u> | <u>I disagree</u> |
|---|-------------------|-------------------|
| 1. The top management communicates its policy and strategy to the employees. _____ | 1 2 3 4 5 | |
| 2. The employees communicate their ideas and views to the top management. _____ | 1 2 3 4 5 | |
| 3. Top management influences individuals positively to carry out tasks and responsibilities. _____ | 1 2 3 4 5 | |
| 4. Top management involves in communication and role modelling of the quality values in our company. _____ | 1 2 3 4 5 | |
| 5. The senior executives are personally involved in reward and recognition activities. _____ | 1 2 3 4 5 | |
| 6. In crisis, a continuous improvement with interaction is preferred rather than fire fighting actions. _____ | 1 2 3 4 5 | |

IV. HUMAN RESOURCES

Please circle the number that clearly defines your opinion about the PRESENT condition of your company.

- | | <u>I agree</u> | | <u>I disagree</u> | |
|--|----------------|---|-------------------|-----|
| 1. Hiring of new personnel is performed by long-range plans._____ | 1 | 2 | 3 | 4 5 |
| 2. There is a training and improvement process for all employees including career planning._____ | 1 | 2 | 3 | 4 5 |
| 3. The employees participate in long-range planning of the company._____ | 1 | 2 | 3 | 4 5 |
| 4. There is an efficient "top to bottom" and "bottom to top" communication._____ | 1 | 2 | 3 | 4 5 |
| 5. The employees are involved in process improvement.____ | 1 | 2 | 3 | 4 5 |
| 6. The employee satisfaction surveys are regularly applied._____ | 1 | 2 | 3 | 4 5 |
| 7. The performance of the staff is regularly measured by a formal method._____ | 1 | 2 | 3 | 4 5 |
| 8. In our company, the health and safety conditions are satisfactory._____ | 1 | 2 | 3 | 4 5 |
| 9. There is a personal assistance program for the employees._____ | 1 | 2 | 3 | 4 5 |

10. The average turnover of the managers is years.

11. The average turnover of the employees is years.

12. What are the reasons for quit of employees, please indicate percentage?

- . _____% Unsatisfactory wages
- . _____% Adaptation problems with colleagues
- . _____% Not being able to promote
- . _____% Insufficient capacity of person

- . _____% Excessive work hours
- . _____% Personal reasons
- . _____% Other (Please state)
-
-
-

13. State the allocation of new staff employed during last three years according to the following criteria.

- . _____% New graduate
- . _____% Experienced

14. How are the managers appointed?

- . Promotion in company is preferred..... ☐
- . Transfers from other companies is preferred..... ☐
- . Both of them..... ☐

15. What are the criteria for promotion of employees?

- . Performance in present position..... ☐
- . Duration of service in present position..... ☐
- . Both of them..... ☐
- . Other (Please state)..... ☐
-
-
-

16. Do you compare working conditions with competitors?

- ☐ Yes ☐ No

17. Do you compare wages with competitors?

- ☐ Yes ☐ No

18. Is there a function (or expert) for training in your company?

- ☐ Yes ☐ No

19. Indicate the rate of training program cost in gross payment and wages in 1997.
.....%

20. Indicate the rate of quality training program cost in total training budget in 1997.%

21. How are the training programs are applied? (You may mark more than one choice)

- . Training seminars are given by specialists in company..... ☐
- . Training seminars are given by specialized companies..... ☐
- . Training seminars are given abroad..... ☐

22. How frequently the employees are trained in the following subjects?

<u>Training Subject</u>	<u>Never</u>	<u>every 24 months</u>	<u>every 12 months</u>	<u>every 6 months</u>	<u>more frequently</u>
Project management	1	2	3	4	5
Problem solving techniques	1	2	3	4	5
Quality techniques	1	2	3	4	5
Human relations	1	2	3	4	5
Team work	1	2	3	4	5
Leadership	1	2	3	4	5
Motivation	1	2	3	4	5

23. Which of the following performance payment plans are practiced in your company? (You can mark more than one choice.)

- . Profit sharing..... ☐
- . Bonus according to one's productivity..... ☐
- . Payment for skill and expertise..... ☐
- . Payment for amount of work done..... ☐
- . None of the above..... ☐
- . Other (Please state)..... ☐

.

.

24. Performance measurement about relations with employees is

- . performed with a documented procedure..... ☐
- . performed without a documented procedure..... ☐
- . not performed..... ☐

25. If you are doing performance measurement about your relations with employees, which of the following performance criteria do you use? Please indicate.

- . Absenteeism ☐
- . Lay-off..... ☐
- . Responsiveness to employee needs,
inputs, suggestion ☐
- . Benefits ☐
- . Payroll ☐
- . Employee records ☐
- . Education and training offered ☐
- . Employee job satisfaction ☐
- . Training hours per employee ☐
- . Training cost per employee..... ☐
- . Number of grievances ☐
- . Other (Please state) ☐

-
-
-

V. THE CURRENT STATUS OF THE QUALITY MANAGEMENT PROGRAM

1. Which one of the following quality definitions is more likely to explain your quality perspective.
 - A. Conformance to specifications.....☐
 - B. Customer satisfaction.....☐

2. Arrange the following in order of importance. (1 = most important)
 - . ____ Cost
 - . ____ Schedule
 - . ____ Quality
 - . ____ Reliability

3. Arrange in order the areas in which you encounter problems more frequently. (1 = most important)
 - . ____ Engineering
 - . ____ Management
 - . ____ Coordination
 - . ____ Communication
 - . ____ Materials management
 - . ____ Subcontractor relations
 - . ____ Supplier relations
 - . ____ Customer relations
 - . ____ Other (Please state)
 - . ____
 - . ____
 - . ____

4. Arrange in order the barriers for reaching higher quality levels. (1 = most important)
 - . ____ Misunderstanding quality
 - . ____ Lack of subcontractor relations
 - . ____ Lack of supplier relations
 - . ____ Heavy work load

. ___Lack of skilled craftsmen

. ___Time constraints

. ___Lack of experience

. ___Lack of finance

. ___Other (Please state)

.....

.....

.....

5. Does your company employ an overall total quality management (TQM) system?

. Yes, we have been employing a program for years.

. We are planning to employ in 1998.....☐

. We are not planning to employ for the time being☐

6. If there is no overall TQM system application plan, why do you not want to employ?

. We do not have sufficient information about QM systems.....☐

. Quality performance in our company is satisfactory.☐

7. What are the aims for implementing TQM system? (You may mark more than one choice.)

. To increase the quality image of the company in the market.....☐

. To improve the organization's efficiency☐

. To improve product and service quality☐

. To consolidate and expand market share☐

. Diminish product liability risk☐

. To provide harmony in employee-employer relations☐

. Other (Please state)☐

.....

.....

.....

8. If your answer for 5th question is not yes, pass to 9th question. Is your organization satisfied with quality management implementation?

Very satisfied 1 2 3 4 5 Highly dissatisfied

9. Please rate the level of participation of the following groups in quality management efforts.

1 = All of them, 2 = More than half, 3 = Half of them,
4 = Less than half, 5 = None of them

- . Top management _____ 1 2 3 4 5
 . Middle management _____ 1 2 3 4 5
 . First-line supervision _____ 1 2 3 4 5
 . Rank and file employees _____ 1 2 3 4 5

10. Does your company have ISO 9000 certificate?

- . Yes, We got ISO 9000 certificate in _____.
 . No, We applied to get a certificate..... ☐
 . No, We are going to get in 1998..... ☐
 . We are not planning to get a certificate..... ☐

11. If you do not plan to get ISO 9000 certificate, why?

- . We do not have enough information about ISO 9000..... ☐
 . The performance of our firm is satisfactory ☐
 . Present quality management system is satisfactory..... ☐

Please circle the number that clearly defines your opinion about the PRESENT condition of your company.(Questions 12. - 16.)

- | | <u>I agree</u> | | | | <u>I disagree</u> |
|---|----------------|---|---|---|-------------------|
| 12. There is a quality policy. _____ | 1 | 2 | 3 | 4 | 5 |
| 13. There are strategic quality objectives _____ | 1 | 2 | 3 | 4 | 5 |
| 14. Quality objective evaluation in our company
is based on previous performance data. _____ | 1 | 2 | 3 | 4 | 5 |

15. Indicate the existing organizational units in your firm.

- . Quality department (Manager - Chief)..... ☐
- . Quality Control Laboratories..... ☐
- . Quality circles..... ☐
- . Quality Steering Groups..... ☐
- . Quality improvement support groups..... ☐

16. Which of the following quality management tools are utilized to develop client's requirements? (You may mark more than one choice.)

- . Flow Charting..... ☐
- . Brainstorming..... ☐
- . Cause and effect analysis..... ☐
- . Pareto analysis..... ☐
- . Statistical methods..... ☐
- . QFD - Quality Function Deployment..... ☐
- . Other methods (Please state)..... ☐
- ☐
- ☐

Please circle the number that clearly defines your opinion about the PRESENT condition of your company. (Questions 17.-22.)

17. Processes are continuously examined and objectives are defined for improvement.

I agree 1 2 3 4 5 I disagree

18. Processes are continuously improved by innovations and creativity.

I agree 1 2 3 4 5 I disagree

19. In this company, "Internal customer"(*) concept is well understood and it is in practice in the company.

I agree 1 2 3 4 5 I disagree

(*) Internal customer: Person or a (sub) process in the company that receives a product or a service from another. (All the staff is internal customer.)

VI. ORGANIZATION AND COMMUNICATION

Please circle the number that clearly defines your opinion about the PRESENT condition of your company. (Questions 1-6.)

1. Authority and responsibility of all officers in the company are well defined.

I agree 1 2 3 4 5 I disagree

2. The defined authorities and responsibilities are practiced in the whole company.

I agree 1 2 3 4 5 I disagree

3. There is formal procedure for the planning and execution of the activities.

I agree 1 2 3 4 5 I disagree

4. Implemented procedures are periodically reviewed and updated.

I agree 1 2 3 4 5 I disagree

5. Construction site planning works are performed by central management.

I agree 1 2 3 4 5 I disagree

6. Construction site plans are performed by a documented procedure.

I agree 1 2 3 4 5 I disagree

7. Information flow between construction site and head office

- . is performed regularly according to a defined procedure. ☐
- . is performed regularly without a defined procedure. ☐
- . is performed irregularly without a defined procedure. ☐

8. There is a special unit in head office involving construction site.

☐ Yes ☐ No

9. How is site project team arranged?

- . Project manager determines his own team. ☐
- . Project team is determined by central management. ☐

10. What is the expenditure limits of project manager?

- . 90 percent of the expenditure orders are given by the project manager without conferring with head office..... ☐
- . 50 percent of the expenditure orders are given by the project manager without conferring with head office..... ☐
- . 10 percent of the expenditure orders are given by the project manager without conferring with head office..... ☐

11. Indicate the limits of the discipline authority of project manager.

- . 90 percent of the orders are given by the project manager without conferring with head office..... ☐
- . 50 percent of the orders are given by the project manager without conferring with head office..... ☐
- . 10 percent of the orders are given by the project manager without conferring with head office..... ☐

VII. CUSTOMER RELATIONS

Please circle the number that clearly defines your opinion about the PRESENT condition of your company.

- | | <u>I agree</u> | | <u>I disagree</u> | |
|--|--------------------------|---|-------------------|-----|
| 1. There is a mechanism for listening to and communicating with customer. _____ | 1 | 2 | 3 | 4 5 |
| 2. Customers complaints are utilized as a source for improving processes. _____ | 1 | 2 | 3 | 4 5 |
| 3. Does your company apply client-feedback surveys? | | | | |
| . No..... | ☐ | | | |
| . Applied every year regularly..... | ☐ | | | |
| . Applied at the end of a project..... | ☐ | | | |
| 4. Performance measurement about customer relations is | | | | |
| . performed with a documented procedure..... | ☐ | | | |
| . performed without a documented procedure..... | ☐ | | | |
| . not performed | ☐ | | | |
| 5. If you are doing performance measurement about customer relations, which of the following performance criteria do you use? Please indicate. | | | | |
| . Repeat business..... | ☐ | | | |
| . Number of sole source awards..... | ☐ | | | |
| . Schedule conformance..... | ☐ | | | |
| . Budget conformance..... | ☐ | | | |
| . Meeting specific project objectives..... | ☐ | | | |
| . Accuracy of execution..... | ☐ | | | |
| . Rework percent..... | ☐ | | | |
| . Customer satisfaction..... | ☐ | | | |
| . Responsiveness..... | ☐ | | | |
| . Complaints..... | ☐ | | | |
| . On time delivery..... | ☐ | | | |
| . Warranty data..... | ☐ | | | |

- . Time to resolve complaints..... ☐
- . Other (Please state)..... ☐
-
-
-

Answer among the following questions about departments that exist in your organization.

6. Performance measurement about marketing is
- . performed with a documented procedure..... ☐
 - . performed without a documented procedure..... ☐
 - . not performed..... ☐
7. If you are doing performance measurement about marketing, which of the following performance criteria do you use? Please indicate.
- . The rate of project promotional expenditures in project development expenditures ☐
 - . The realization rate of project promotion budget ☐
 - . The rate of new customers in the existing customer pool ☐
 - . Gained or lost accounts ☐
 - . Other (Please state)..... ☐
 -
 -
 -
8. Performance measurement about sales is
- . performed with a documented procedure..... ☐
 - . performed without a documented procedure..... ☐
 - . not performed..... ☐

9. If you are doing performance measurement about sales, which of the following performance criteria do you use? Please indicate.

- . Sales expense to revenue ☐
- . Order accuracy ☐
- . The percentage of new customers in the existing customer pool ☐
- . The percentage of lost customers in the existing customer pool ☐
- . The percentage of gained customers in the existing customer pool ☐
- . Other (Please state)..... ☐
-
-
-

10. Performance measurement about finance and administration is

- . performed with a documented procedure..... ☐
- . performed without a documented procedure..... ☐
- . not performed..... ☐

11. If you are doing performance measurement about finance and administration, which of the following performance criteria do you use? Please indicate.

- . Revenue per employee..... ☐
- . Expense to revenue..... ☐
- . Cost of quality..... ☐
- . Percent of payroll distributed on time..... ☐
- . Number of days accounts receivable past due..... ☐
- . Office equipment up-time..... ☐
- . Purchase order errors..... ☐
- . Vehicle fleet data..... ☐
- . Order entry/billing accuracy..... ☐
- . Other (Please state)..... ☐
-
-
-

12. Performance measurement about business development is

- . performed with a documented procedure..... ☐
- . performed without a documented procedure..... ☐
- . not performed..... ☐

13. If you are doing performance measurement about business development, which of the following performance criteria do you use? Please indicate.

- . Number of clients ☐
- . Market share ☐
- . Share value..... ☐
- . Control win/loss ratio..... ☐
- . Number of client-partners ☐
- . Billable effort ☐
- . Current backlog..... ☐
- . Opportunity cost of overrunning projects ☐
- . Profit/loss ☐
- . Costs and trends..... ☐
- . Conformance to accounting and tax conventions ☐
- . Public perceptions..... ☐
- . Other (Please state ☐

.

.

.

14. Performance measurement about tendering is

- . performed with a documented procedure..... ☐
- . performed without a documented procedure..... ☐
- . not performed..... ☐

15. If you are doing performance measurement about tendering, which of the following performance criteria do you use? Please indicate.

- . The rate of won tenders to all within the year..... ☐
- . The ratio of won tender value to that of the nearest competitor..... ☐
- . The sum of the project prices which are tendered for within the year..... ☐
- . Other (Please state)..... ☐
-
-
-

VIII.SUPPLIER RELATIONS

1. Purchasing in our firm

- . is carried out by central management..... ☐
- . is managed in construction sites..... ☐
- . is carried out by both central management and site management..... ☐

2. Give following information about suppliers that your company works with

- . The number of suppliers your company worked with last year.
- . The number of suppliers you work with for each project.
- The percentage of materials provided by suppliers.%
- The percentage of suppliers you work with over again.%

3. Suppliers are selected according to following characteristics. Arrange in order of priority (1 = most important).

- . Their capacity..... ☐
- . Quotation price of material..... ☐
- . Quality perception..... ☐
- . Just-in-time delivery..... ☐
- . Conformance to company policies..... ☐
- . Other (Please state)..... ☐
-
-
-

4. In our company construction equipment are (Please indicate percentages.)

- . purchased
 - . original..... ☐ _____ %
 - . second-hand..... ☐ _____ %
- . rented..... ☐ _____ %
- . purchased by leasing..... ☐ _____ %

5. What do you take into account while choosing firms which sells or rents equipment? Arrange in order of priority. (1 = most important)

- . Equipment performance..... ☐
- . Reliability of the firm..... ☐
- . Service possibilities..... ☐
- . Other (Please state)..... ☐
-
-
-

6. The company has some special equipment.

☐ Yes ☐ No

7. Performance measurement about suppliers is

- . performed with a documented procedure..... ☐
- . performed without a documented procedure..... ☐
- . not performed..... ☐

8. If you are not doing performance measurement, why?

- . We have detailed information about supplier..... ☐
- . Supplier complies with dead-lines..... ☐
- . Supplier's way of working complies with our company..... ☐

9. If you are doing performance measurement about suppliers, which of the following performance criteria do you use? Please indicate.

- . Percent in project scope..... ☐
- . Volume..... ☐
- . Number of supplier-partners..... ☐
- . Payment..... ☐
- . Submittals..... ☐
- . Cost (price)..... ☐
- . Pricing trends..... ☐
- . Accuracy of deliverables..... ☐

- . Billing accuracy.....☐
- . Repeat business.....☐
- . Vendor technical support capability.....☐
- . On-time delivery.....☐
- . Quality performance.....☐
- . Service.....☐
- . Average delivery time.....☐
- . Percent of suppliers without error.....☐
- . Other (Please state).....☐

-
-
-



IX. SUBCONTRACTOR RELATIONS

1. Give following information about your company's relation with subcontractors.

- . The number of subcontractors you worked with last year.
- . The number of subcontractors you work with for each project.
- The percentage of work executed by subcontractors.%
- The percentage of subcontractors you work with over again.%

2. State your company's relations with subcontractors.

- . We work with a new subcontractor for each project. ☐
- . There are specific subcontractors we work continuously.....☐
- . We do no work with subcontractors.....☐

3. Subcontractors are selected according to following characteristics. Arrange in order of priority (1 = most important).

- . ____ Their capacity
- . ____ Quotation price of the work
- . ____ Quality perception
- . ____ Just-in-time production
- . ____ Other (Please state)
-
-
-

4. To what extent is your company involved in directing and planning the subcontractor's work?

We involve in whole job 1 2 3 4 5 We do not involve in at all

5. Our company provides sufficient time for the subcontractor to properly prepare a bid.

I agree 1 2 3 4 5 I disagree

6. Performance measurement about relations with subcontractors is
- . performed with a documented procedure..... ☐
 - . performed without a documented procedure..... ☐
 - . not performed..... ☐
7. If you are not doing performance measurement, why?
- . We have detailed information about subcontractor..... ☐
 - . Subcontractor complies with dead-lines..... ☐
 - . Subcontractor's way of working complies with our company ☐
8. If you are doing performance measurement about subcontractors, which of the following performance criteria do you use? Please indicate.
- . Percent of project scope..... ☐
 - . Volume..... ☐
 - . Number of supplier-partners..... ☐
 - . Submittals..... ☐
 - . Cost (price)..... ☐
 - . Price trends..... ☐
 - . Accuracy of deliverables..... ☐
 - . Billing accuracy..... ☐
 - . Repeat business..... ☐
 - . Quality performance..... ☐
 - . Other (Please state)..... ☐
 -
 -

X. ENGINEERING AND DESIGN

1. Project organization

- . is executed with a documented procedure..... ☐
- . is executed without a documented procedure..... ☐

2. Is there a quality plan for each project?

- ☐ Yes ☐ No

3. A detailed budget and expenditure control is performed by a defined procedure for each project.

- . According to a documented procedure..... ☐
- . Without a documented procedure..... ☐
- . We do not perform ☐

4. A detailed work schedule according to the work quantity for each project is performed by a defined procedure.

- . According to a documented procedure..... ☐
- . Without a documented procedure..... ☐
- . We do not perform ☐

5. Performance measurement about engineering service is

- . performed with a documented procedure..... ☐
- . performed without a documented procedure..... ☐
- . not performed..... ☐

6. If you are doing performance measurement about engineering service, which of the following performance criteria do you use? Please indicate.

- . Change orders..... ☐
- . R & D spending..... ☐
- . Average time to process proposals..... ☐
- . Estimating errors..... ☐
- . Other (Please state)..... ☐

.....

.....

XI. PRODUCTION SYSTEM

1. Production is motivated by

- . Economic reasons _____ %
- . Strategic reasons _____ %
- . Contract obligations/regional compulsions _____ %

2. Is the produced materials completely utilized by your company?

☐ Yes ☐ No

3. Performance measurement about production is

- . performed with a documented procedure..... ☐
- . performed without a documented procedure..... ☐
- . not performed..... ☐

4. If you are doing performance measurement about production, which of the following performance criteria do you use? Please indicate.

- . Rework..... ☐
- . Nonconformities per contract..... ☐
- . Process yield..... ☐
- . Machine downtime..... ☐
- . Actual performance to goal..... ☐
- . Cost per unit..... ☐
- . Other (Please state)..... ☐

.....

.....

.....

XII. BENCHMARKING

Benchmarking is a continuous and systematic method of searching the best national or international practice and adapting that to your organization. This search could be towards the products, services or business applications of organizations competitors that are known as leaders in the industry or specific business processes.

1. Do you practice benchmarking according to the above definitions?

☐ Yes ☐ No

2. Are the competitors followed systematically?

☐ Yes ☐ No

3. Is there a benchmarking team?

☐ Yes ☐ No



XIII.POST-PROJECT ANALYSIS

1. Is there an analysis after each project to determine best applications and to light the way of future projects?

☐ Yes ☐ No

2. The percentage of projects that are analyzed. _____%

3. What are the selection criteria for projects to be analyzed?

. Revenue.....☐

. Technology.....☐

. Customer.....☐

. Region/country.....☐

. Success level.....☐

. Other (Please state).....☐

.

.

.

4. Who are participating in post-project analysis?

. Analysis is performed by employees who worked in that project.☐

. There is a specialized person/team for this purpose in company.....☐

. Analysis is performed by specialists outside the company.☐

5. Which criteria do you utilize for analysis? Please mark.

. Conformance to total cost objectives.....☐

. Conformance to schedule.....☐

. Conformance to quality objectives.....☐

. Conformance to unit cost objectives.....☐

. Conformance to safety objectives.....☐

. Conformance to environmental objectives.....☐

. Other (Please state).....☐

.

.

6. How do you utilize analysis results?

. They are used in new training programs.....☐

. They are used in process improvement.....☐

. They are used in management decisions.....☐

. Other (Please state).....☐

•

•

•



APPENDIX B

This part contains answers to the survey questions given by participating firms. Twenty-two firms have participated in the survey. To preserve confidentiality company names are not mentioned.



1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
---	---	---	---	---	---	---	---	---	----	----	----	----	----	----	----	----	----	----	----	----	----

1. BUSINESS PROFILE

1.1	1		25	25			25	50	80	10		3	35					60			
	2		25	25	100		25	50	20			7	65					40			
	3	100	25	25		100	25			90	100	90		100	100	100	100	95		100	98
	4		25	25			25											5			2

1.2	1		X	X			X		x	X	X	X	X		X		X		X	X		X	X
	2	X			X	X		X															
	3												X		X		X				X		

1.3		17	12	1	22	8	20	11	6	27	33	11	25	22	50	22	26	8	30	40	42	48
-----	--	----	----	---	----	---	----	----	---	----	----	----	----	----	----	----	----	---	----	----	----	----

1.4	1	300	18	70	9	30	6		27	25		300	85	100	70	121	342	209	50	15	90	160	99
	2	100	7		4	2	2		5	50		100	8	150	50	273	188	325	50	3	138	30	90
	3									60		50	12	250	20	100	766	250	35	1	143	20	35
	4									100		900		250	3000	700	759	2700	40				100
	5									100		400		500	500	600	1144	850	25				200
	6									20		250		10	100	100	93	166	15				52
		400	25	70	13	32	8	0	32	355	0	2000	105	1260	3740	1894	3292	4500	215	19	371	210	576

1.5	1								0	85	78	80	65	80	97	95	98	90	70	0	61		75
	2								100	15	22	20	35	20	3	5	2	10	30	100	29		25

1.6	1	X	X			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
	2	X				X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	3	X						X				X	X		X	X		X			X	X	
	4	X						X				X			X	X		X			X	X	
	5	X	X				X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	
	6	X						X				X			X	X		X			X	X	
	7	X						X				X			X	X		X			X	X	
	8	X						X		X					X			X				X	
	9	X	X				X	X	X		X	X		X	X	X	X	X		X	X	X	X
	10									X			X										
	11	X										X				X			X				X
	12	X	X	X			X		X				X	X		X		X		X			
	13	X						X						X			X		X				X

1.7	1				X																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																															
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1.8	1	10	70			50	100	90	40	10		90	100	15	100	90	60	80	95	65		80	100
	2	90	30			50	0	10	60	90		10	0	85	0	10	40	20	5	35		20	0

1.9	1	40	90	99		50	90	10	100	10		20	15	90	5	60	90	42	90	100		100	0
	2	60	10	1		50	10	90	0	90		80	85	10	95	40	10	58	10	0		0	100

1.10	1	X			X	X						X			X		X						
	2		X	X			X		X	X		X	X		X		X		X	X	X	X	X
	3							X			X						X						

1.11	1		X	X	X	X	X		X	X		X	X	X	X	X	X		X	X	X	X	X
	2		X			X	X		X	X		X		X	X	X	X		X		X	X	X
	3			X			X		X	X		X		X	X	X	X			X	X	X	X
	4	X	X	X	X	X	X					X	X	X	X	X	X		X		X		
	5	X	X		X	X	X		X	X		X	X	X	X	X	X			X	X		
	6	X	X		X	X	X			X		X		X	X	X	X				X	X	
	7	X	X			X	X					X		X		X	X					X	
	8	X	X			X						X		X		X						X	
	9								X	X		X		X	X	X		X		X			
	10				X				X			X		X	X	X	X		X	X			

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
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4. HUMAN RESOURCES

4.1	1				X			X		X			X									
	2			X		X	X													X		
	3	X	X					X						X		X			X		X	
	4											X			X		X					
	5			X					X		X							X				

4.2	1												X									
	2		X								X											X
	3				X	X									X		X	X	X	X		
	4							X						X		X						
	5	X		X			X	X		X	X		X			X						

4.3	1				X								X				X					
	2																				X	
	3					X								X								
	4			X	X			X	X		X				X	X	X		X	X		
	5	X	X						X	X		X	X									

4.4	1				X				X			X		X		X		X				
	2					X			X						X							
	3			X			X					X		X			X		X	X	X	
	4		X																			
	5	X					X			X												

4.5	1								X				X					X	X			X
	2				X	X					X							X	X			
	3		X	X			X			X		X		X			X			X		
	4	X						X	X						X	X						
	5																					

4.6	1												X									
	2																				X	
	3									X		X					X		X			
	4				X	X	X														X	
	5	X	X	X				X	X	X	X		X		X	X	X		X			

4.7	1												X									
	2								X						X							
	3							X			X								X	X		
	4																					
	5								X			X		X		X	X	X				X

4.8	1		X		X		X				X		X	X		X			X			
	2	X								X		X										
	3			X		X		X							X		X	X		X		
	4								X													X
	5																					

4.9	1					X						X		X								
	2				X								X									
	3		X			X								X								
	4	X						X								X	X					
	5			X				X	X	X	X				X		X		X			

4.10	Year	20	9		10	10	6	20	10	6	15	15	11	8	20	15	15	10	5	15	20	15	17
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4.11	Year	10	7		5	2	4	15	7	5	10	8	8	5	15	10	5	2	4	15	10	10	13
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4.12	1								30			15	10	60			40	45	50		40		25
	2								30		10	15					10	5			20		
	3											20		5	10	5	20	10	10		40		37.5
	4								20	25	80	5		10	20	10	10	10	20	90			12.5
	5								20			5			50		10	10	10				
	6									25	10	40	5	25	20	10	10	20	10	10			25
	7								50				85			75							

4.13	1								30	30	50	30	10	0	50	50	60	30	30	50	30		80
	2								70	70	50	70	90	100	50	50	40	70	70	50	70		20

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
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4.24

1				X	X						X				X							
2			X	X			X		X	X			X	X		X	X	X		X	X	X
3	X							X			X							X				

4.25

1					X	X			X	X			X			X			X		X	X
2						X			X			X			X			X			X	X
3			X		X	X				X			X		X		X	X		X		X
4			X				X						X	X	X	X				X		
5						X						X	X			X					X	
6				X		X						X				X						X
7			X	X	X	X	X					X				X			X			X
8									X	X		X							X			
9			X				X	X			X											
10					X		X															
11			X	X					X													X



1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
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5. THE CURRENT STATUS OF THE QUALITY MANAGEMENT PROGRAM

5.1

A	X	X			X	X	X	X	X			X		X	X	X			X			X
B		X	X	X	X	X				X	X		X	X	X	X	X		X		X	X

5.2

1	4	4	2	2	3	3	3	4	3	2	1	3	3	3	2	4	4	2	4	3	4	3
2	1	3	4	3	4	4		3	1	4	3	4	2	4	1	3	3	3	1	4	1	4
3	3	1	1	1	1	2	1	1	2	3	4	1	1	1	3	2	1	1	2	1	2	1
4	2	2	3		2	1	2	2	4	1	2	2	4	2	4	1	2	4	3	2	3	2

5.3

1	1	6	6	1		4	1		8	1	3		5	1	2	3	6	6	4	5	4	
2	3	5	5	4	5	6	2		3	1	4		4	7	7		8	3	3	7	6	
3	4	3	1	3	4	5	4		4	1	6		3	8	3		7	1	1	3	5	
4		2	3		1	3	3		5	1	8	3	1	6	6		4	2	5	1	3	
5		1	2	2	2	1	5		7	1	7			5	1		5	8		2	2	
6									2	1	1	2	2	2	4	2	1	7		6	1	3
7	5								6	1	2			3	5		2	5		4		2
8	2	4	4	5	3	6			1	1	5	1		4	8	1	3	4	2	8		1

5.4

1	8	1			8	3	4			4	5		1	2	1	3	1	3		1	2	1
2	7	2			7	1			3	3	3			3	3	1	5	7		3		2
3	6	3			6	2			4		4			4	4		6	6		2	3	3
4	5	6	1	3	5	5		1			1	1		6	6		4	8		6	1	5
5	4	5	2	1	1	4	3			2	6	2	2	7	2		3	2	1	4	4	4
6	1	4	3	2	4	7	5	2	1		2	3	3	5	5	2	2	5		5	5	6
7	3	8	4		2	8	2				8			8	8		8	6		8		8
8	2	7			3	6	1	3	2	1	7		4	1	7		7	4		7		7

5.5

1					2				1						2					1		
2				X										X				X			X	X
3	X	X	X			X	X	X	X		X	X	X		X		X		X			

5.6

1		X	X										X		X		X					
2	X					X	X	X	X		X	X							X			

5.7

1										X				X		X		X		X		
2				X	X									X		X		X		X		X
3				X												X		X		X		
4				X						X						X		X		X		X
5				X	X					X												
6				X																		

5.8

1					X																	
2										X							X					
3																						
4																						
5																						

5.9/1

1				X	X	X				X	X	X				X						X
2		X					X													X		
3																						
4																						
5																						

5.9/2

1				X	X						X					X						X
2						X					X									X		
3		X				X																
4										X												
5																						

5.9/3

1					X		X					X					X					X
2																						
3				X								X								X		
4		X				X																
5										X												

5.9/4

1					X																	
2																						
3																						
4											X					X				X		
5		X		X		X	X			X												X

5.10

1																						
2			X													X						
3						X			X		X		X		X	X	X	X	X	X		X
4				X		X		X	X			X		X						X		

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
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5.11

1													X									
2																						
3								X							X						X	

5.12

1				X		X			X			X	X	X	X		X			X		
2	X							X								X					X	X
3		X								X								X		X		
4																						
5			X		X		X										X					

5.13

1				X		X			X			X	X	X	X		X			X		
2	X	X						X	X									X		X		X
3			X							X						X					X	
4																						
5					X												X					

5.14

1						X				X				X			X			X		
2	X	X		X												X				X		
3			X					X				X					X				X	
4																X						X
5					X					X			X									

5.15

1			X			X	X			X				X			X	X			X	X
2		X			X	X			X			X		X	X	X	X	X	X			X
3		X			X				X													
4					X											X				X		
5					X	X														X		

5.16

1			X	X	X	X						X	X						X	X		
2					X							X							X	X		X
3		X				X						X							X	X	X	
4																						
5		X								X				X	X		X					X
6						X							X					X				
7																					X	

5.17

1											X	X			X					X		
2									X	X	X					X						X
3													X			X		X	X		X	
4																						
5																						

5.18

1														X						X		
2										X	X	X	X			X						
3									X	X						X			X		X	
4																		X				X
5																						

5.19

1														X						X		
2												X				X						X
3											X		X			X				X		
4									X										X			
5										X	X							X				

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
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6. ORGANIZATION AND COMMUNICATION

6.1	1	X			X	X				X		X	X		X	X	X			X			
	2		X				X													X	X		
	3						X	X		X			X					X				X	
	4																	X					
	5			X																			

6.2	1		X			X				X		X	X		X		X			X			
	2	X					X					X	X		X		X		X		X	X	X
	3				X			X	X		X							X					
	4																						
	5			X																			

6.3	1			X	X	X	X					X		X		X			X				
	2	X	X							X			X	X		X				X			
	3																					X	
	4																				X		
	5								X		X							X	X				

6.4	1				X	X								X		X			X				
	2	X								X			X	X									
	3		X				X			X					X								
	4																			X	X	X	
	5			X						X								X	X				

6.5	1			X		X						X			X								
	2		X				X	X		X								X	X			X	
	3	X												X									
	4												X			X					X		X
	5				X					X						X							

6.6	1				X	X						X	X		X		X						
	2	X								X						X							X
	3																		X		X		
	4		X				X							X								X	
	5			X				X			X							X					

6.7	1	X			X	X	X			X		X	X		X		X						
	2		X												X		X		X	X	X		
	3			X				X			X			X			X						

6.8	Y	X	X		X	X	X	X		X		X	X	X	X	X	X			X	X	X	
	N			X						X		X					X						

6.9	1	X				X				X	X	X	X	X	X	X	X	X	X		X		X
	2		X		X	X		X			X			X	X	X	X	X			X		

6.10	1	X								X	X	X	X	X							X		X
	2		X	X	X	X	X	X									X	X			X	X	
	3																X		X				

6.11	1	X		X	X	X	X			X	X	X	X	X			X				X		X
	2		X					X										X				X	
	3																X		X				

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
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7. CUSTOMER RELATIONS

7.1

1					X				X		X	X		X				X			
2								X		X						X				X	X
3				X											X			X		X	
4							X						X								
5	X	X															X				

7.2

1					X	X			X					X				X			
2		X	X					X			X	X	X			X				X	
3										X											X
4															X			X		X	
5	X																X				

7.3

1			X					X	X	X		X	X		X		X		X	X	
2		X				X															X
3	X					X					X			X		X		X			

7.4

1					X									X		X					
2		X				X		X	X		X	X	X		X			X		X	
3	X		X				X			X							X	X		X	X

7.5

1					X	X			X	X		X		X	X				X		X
2									X			X		X					X		X
3									X	X		X		X					X		X
4		X			X	X					X		X				X		X		X
5		X			X							X		X			X		X		X
6		X			X						X		X			X		X		X	
7												X		X		X		X		X	
8									X			X	X	X	X			X		X	
9									X									X		X	
10					X	X										X				X	
11		X			X	X							X	X				X		X	
12		X			X				X	X						X			X		
13									X		X							X			

7.6

1	X				X						X										
2		X				X						X			X	X				X	X
3			X				X		X	X		X		X		X	X	X			X

7.7

1	X				X	X														X	
2					X											X				X	
3		X			X	X									X					X	
4	X				X						X		X		X	X				X	X

7.8

1											X										
2		X											X		X						
3	X		X	X	X	X	X		X	X		X		X	X	X	X	X	X	X	X

7.9

1											X		X								
2																					
3		X									X				X						
4																					
5																					

7.10

1									X		X			X							
2															X		X		X		
3	X		X	X	X	X		X		X		X	X			X		X		X	X

7.11

1											X			X	X				X		
2														X			X				
3											X			X							
4																			X		
5									X								X		X		
6																			X		
7									X		X										
8											X			X			X				
9									X		X			X			X		X		

7.12

1											X		X	X							
2									X	X					X		X		X		
3	X	X	X	X	X	X			X		X				X	X	X		X	X	X

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
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7.13	1									X		X					X		X			
	2									X		X					X		X			
	3																					
	4										X		X									
	5																			X		
	6									X										X		
	7								X			X					X		X			
	8										X								X			
	9								X	X			X	X	X	X	X		X			
	10										X			X	X							
	11																X		X			
	12								X			X							X			

7.14	1									X		X			X							
	2											X			X	X	X		X	X		
	3	X	X	X	X	X	X			X		X						X			X	X

7.15	1									X		X		X			X	X		X	X	
	2										X		X	X			X	X		X	X	
	3											X		X	X	X	X		X			



1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
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8. SUPPLIER RELATIONS

8.1

1	X	X	X			X	X												X	X	
2				X																	
3					X				X	X	X		X	X	X	X	X				X

8.2

1	100	19				17			150				250	500	175	500	80	100			100
2	50	4			50	3			100				20	100	30	100	20	50			30

3	40	75			100	70			80		100		90	100	90	100	100	90			100
4	80	80				60			80		80		75	80	80	90	70	90			95

8.3

1		1		1	1	1					1		4	5	1	2	3	2		1	1	4
2	1	1	1	1	1	1			1		2		5	3	2	1	2	1		2	2	2
3	1			1	1				1		5		3	1	3	3	1	1		4	3	1
4		1		1	1	1			1		4		1	2	4	4	4	1		3	4	3
5										1	3		2	4	5	2	5			5	5	5

8.4

1	50	100	50	20	60		40		10		30		70	70	90	93	60	25		25	100	95
2									10		20		10					25		25		
3	50		50	80	40	100	60		70		30		10			5	40	25		25		5
4									10	100	20		10	10	2		25		25			

8.5

1	1		1	1	1	1	1			1	1		1	2	2	3	1	1		2	1	2
2	1	1	1	1	1	1	1		1		3		3	1	3	1	3	3		1	2	1
3	1	1	1	1	1	1	1			1	2		2	3	1	2	2	2		3	3	3

8.6

Y										X	X		X	X	X	X		X		X	X	X
N									X								X					

8.7

1					X											X				X		
2		X	X	X		X			X	X	X		X		X		X				X	
3	X						X											X				X

8.8

1																						
2																						
3																						X

8.9

1		X			X	X					X									X		
2				X	X													X				
3													X									
4				X	X				X		X			X	X	X	X			X		
5					X	X					X			X						X		
6		X		X	X						X		X	X	X	X	X			X		
7											X			X						X		
8		X		X					X		X		X	X								
9					X				X		X			X				X				
10		X			X	X			X				X	X			X			X		
11				X	X	X			X	X				X	X					X		
12		X		X	X				X	X			X	X		X	X			X		
13		X			X	X				X	X		X	X	X	X	X			X		
14				X	X				X				X	X	X		X					
15		X		X	X	X			X					X	X					X		
16		X		X	X				X					X	X	X	X					

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
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9. SUBCONTRACTOR RELATIONS

9.1	1		10			100	12	6		10		80		80	200	50	100	50	40			80	
	2	4	8			25	9			3		30	2	10	20	20	20	5	20			20	

3	20	60			60	65	20		30		50	30	50	50	60	60	60	95			100	50
4	80	90			10	85	70		70		70	90	50	90	70	90	80	90			90	70

9.2	1									X		X											
	2	X	X	X	X	X	X			X	X			X	X	X	X	X	X		X	X	X
	3																						

9.3	1	3	1		2	1	2	1			2	2	3	1	3	2	3	1	3		1	1	3
	2	4	3		3	4	4				1	1	2	1	2	1	1	2	2		2	2	2
	3	1	4		4	2	3	2		1	3	3	1	1	1	4	2	4	1		4	3	1
	4	2	2		1	3	1	3		2	4	4		1	4	3	4	3	4		3	4	4

9.4	1	X		X	X	X				X	X		X		X								
	2						X									X	X	X		X		X	
	3		X				X				X												
	4																				X		
	5														X								

9.5	1		X		X	X				X		X		X	X	X	X			X		X
	2					X	X			X		X						X			X	
	3	X		X																		
	4																					
	5																					

9.6	1	X			X	X								X		X				X		
	2		X	X			X			X		X		X		X				X		
	3						X			X		X				X	X					X

9.7	1						X					X					X	X				
	2											X										
	3																					X

9.8	1	X	X			X														X		
	2		X		X	X																
	3																					
	4				X	X	X													X		
	5		X			X	X			X		X	X		X					X		
	6		X		X					X		X	X	X						X		
	7									X			X									
	8												X									
	9				X		X				X			X						X		
	10		X			X				X		X	X	X	X	X				X		

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
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10. ENGINEERING AND DESIGN

10.1	1				X	X			X	X		X		X	X		X			X			
	2	X	X	X			X	X			X		X		X		X	X		X	X	X	X

10.2	Y	X				X		X	X	X		X	X		X				X				X
	N		X	X			X				X		X		X		X	X		X	X		

10.3	1	X			X	X			X			X	X	X	X		X						X
	2		X	X			X	X			X					X		X	X		X	X	
	3									X										X			

10.4	1	X			X	X			X			X	X		X		X						
	2		X	X			X	X			X			X		X		X	X	X	X	X	X
	3									X													

10.5	1	X										X	X		X		X						
	2		X	X	X	X	X	X					X		X		X		X		X		
	3									X	X	X						X		X		X	X

10.6	1	X	X			X	X					X	X		X			X		X			
	2					X						X							X				
	3	X	X		X	X	X								X	X		X					
	4	X			X	X						X			X					X			
	5	X	X			X										X							



1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
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11. PRODUCTION SYSTEM

11.1	1								0		40			30	0	50	50	60				40
	2								0		40			0	0	50	30	30				40
	3								100		20			70	100	0	20	10				20
11.2	Y								X						X	X	X					X
	N										X			X				X				
11.3	1								X		X			X								
	2														X	X	X				X	X
	3																	X				
11.4	1													X		X						
	2								X		X											
	3								X		X				X	X						
	4													X			X					
	5										X				X	X	X				X	X
	6										X			X		X	X				X	X



1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
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12. BENCHMARKING

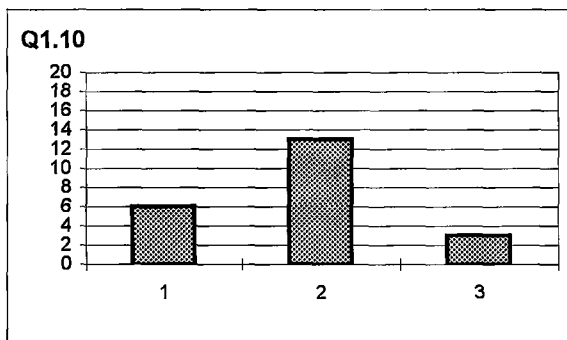
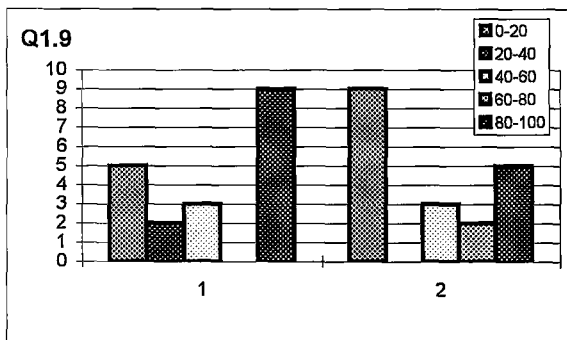
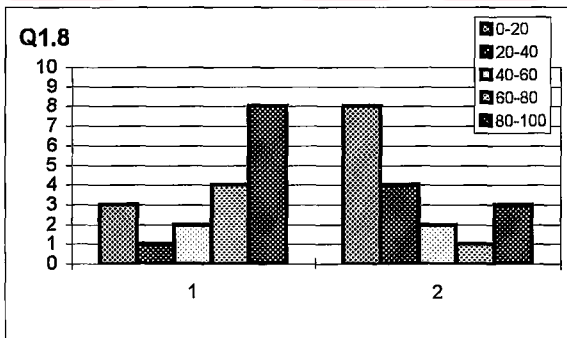
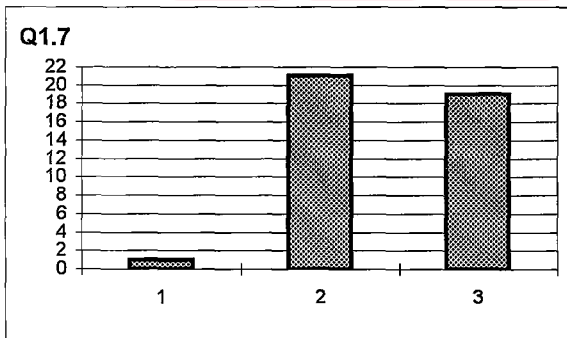
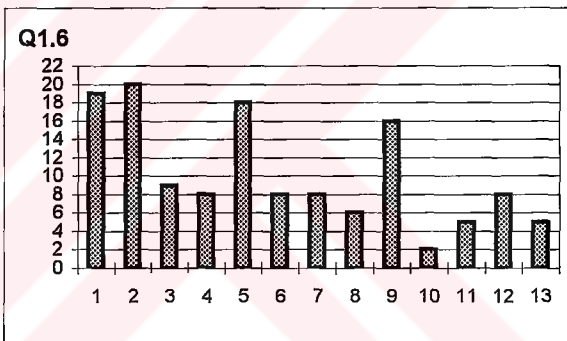
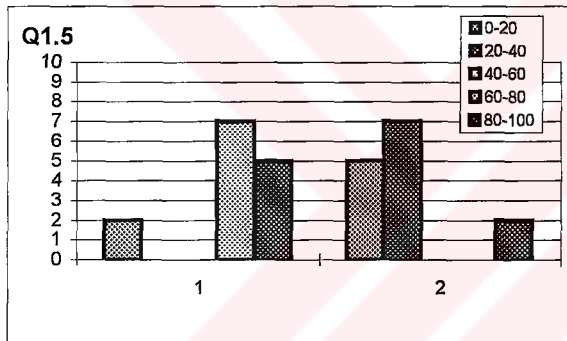
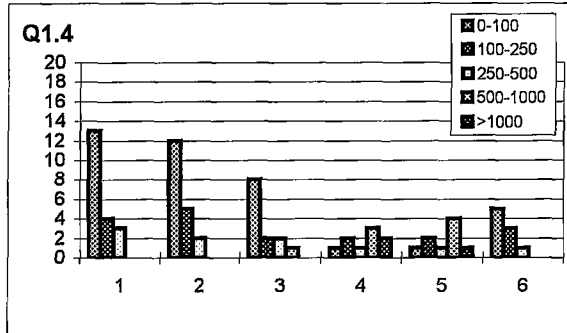
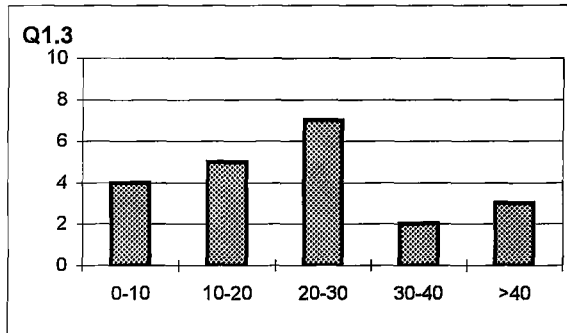
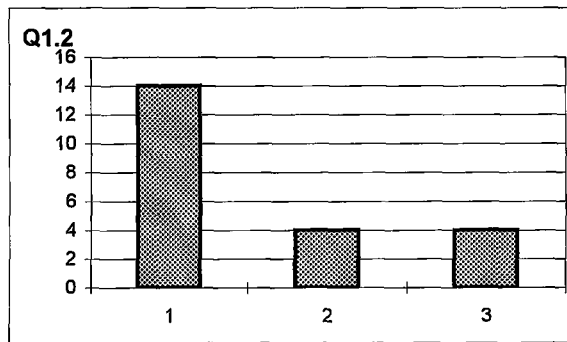
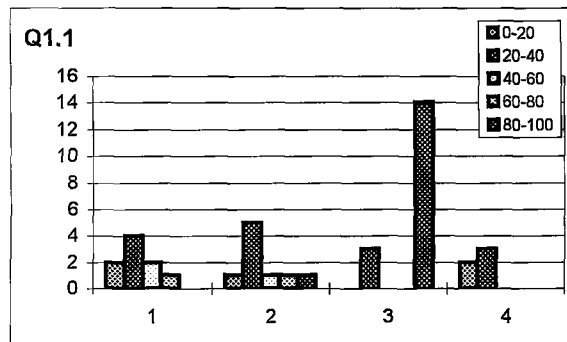
12.1	Y			X	X						X		X	X		X			X		X	X
	N	X	X			X	X			X	X		X		X		X	X		X		
12.2	Y										X			X								
	N			X	X								X			X			X		X	X
12.3	Y										X			X								
	N			X	X								X			X			X		X	X



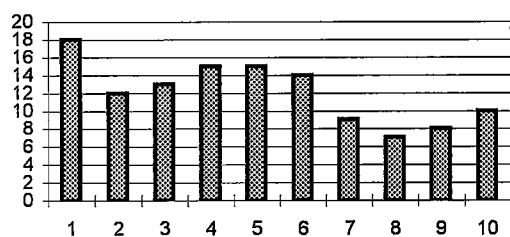
APPENDIX C

This part includes the graphical representation of the answers. QA.B refers to the graph of the question B for part A.

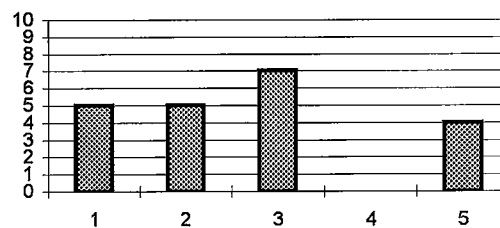




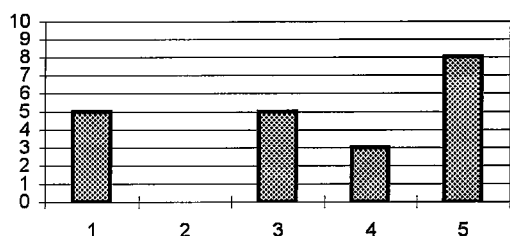
Q1.11



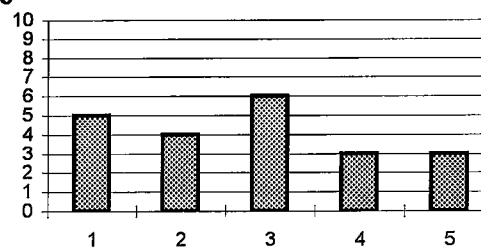
Q2.1



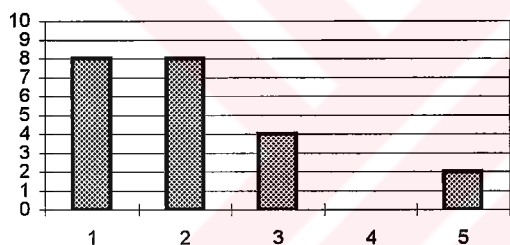
Q2.2



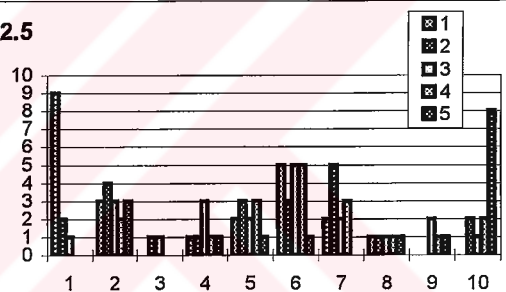
Q2.3



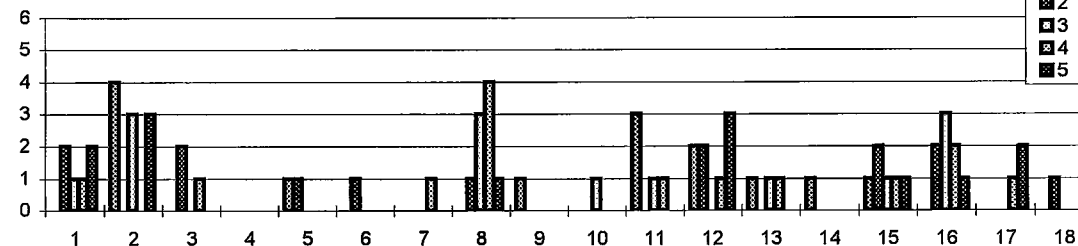
Q2.4



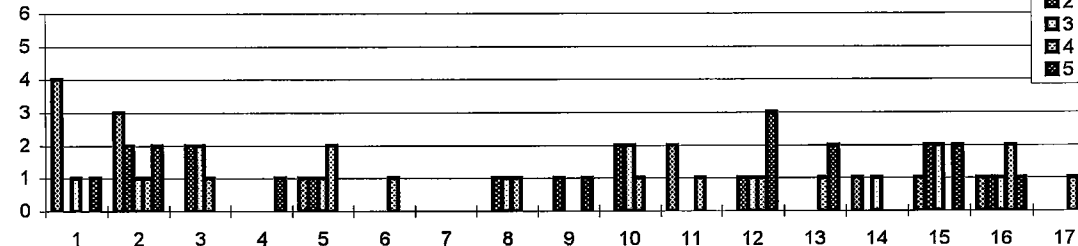
Q2.5



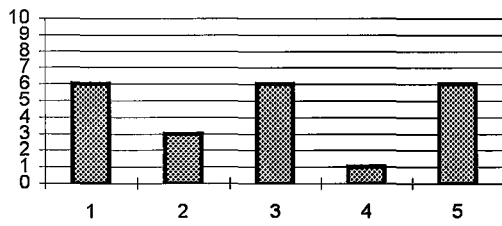
Q2.6



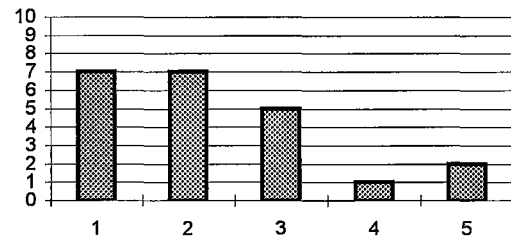
Q2.7



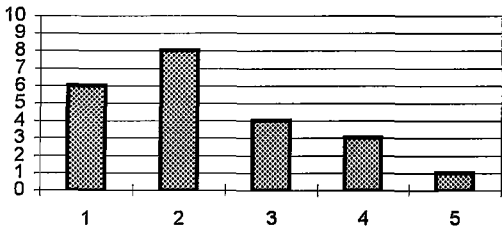
Q3.1



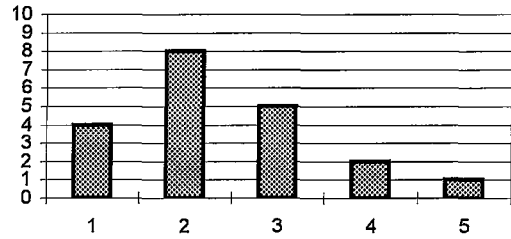
Q3.2



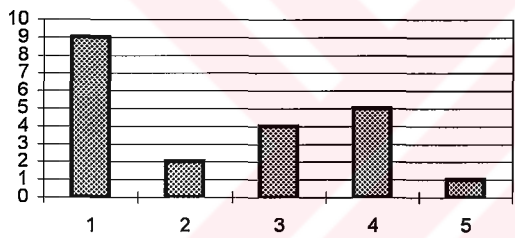
Q3.3



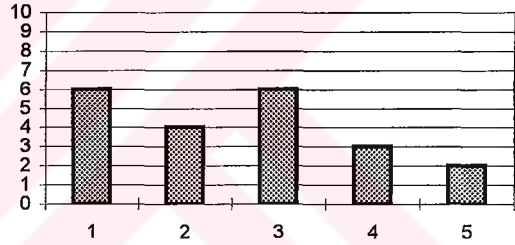
Q3.4



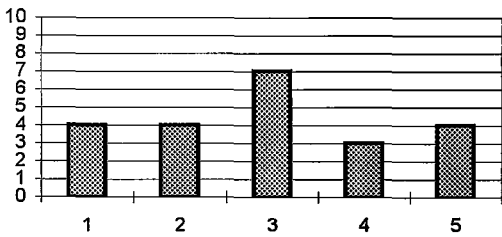
Q3.5



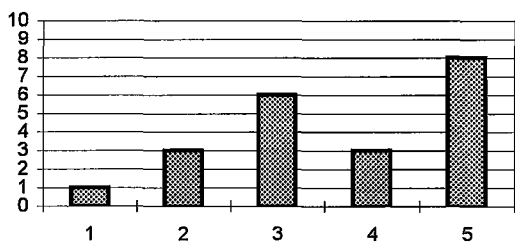
Q3.6



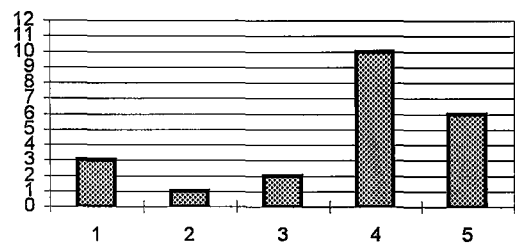
Q4.1



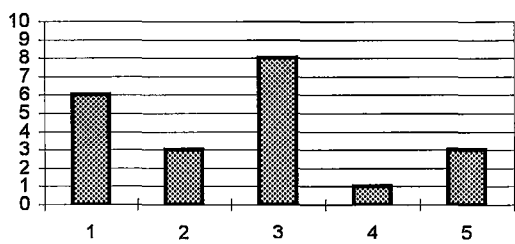
Q4.2



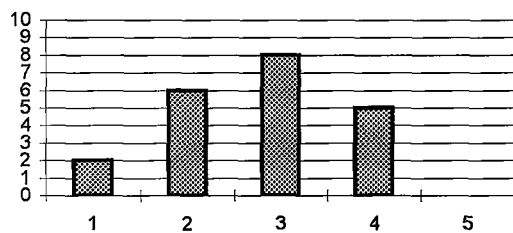
Q4.3



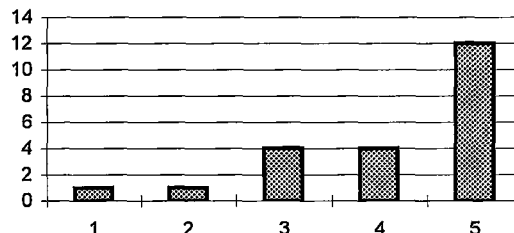
Q4.4



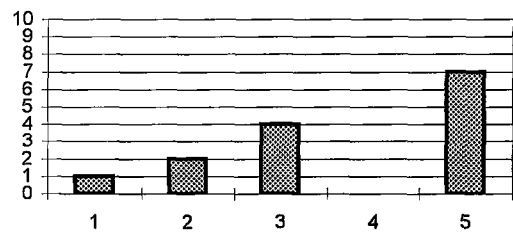
Q4.5



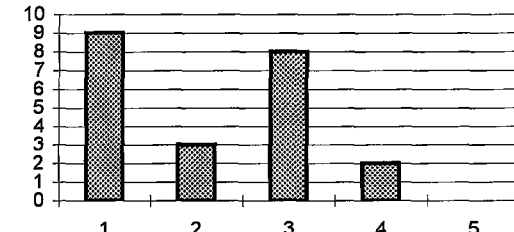
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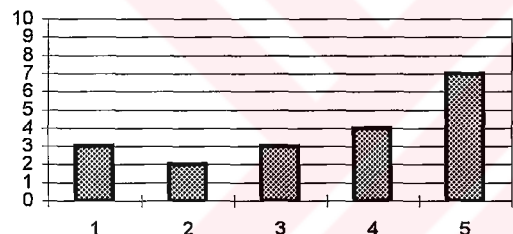
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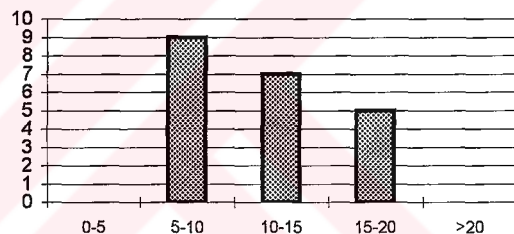
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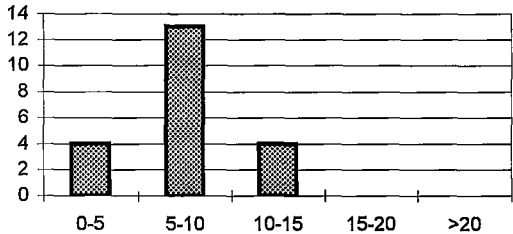
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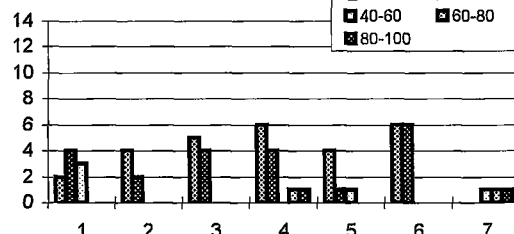
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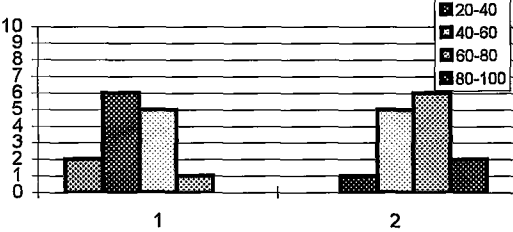
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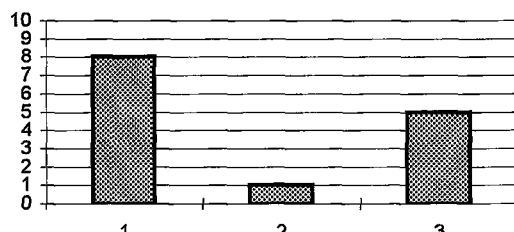
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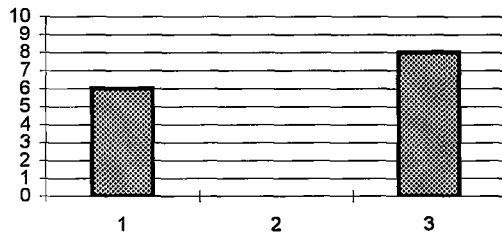
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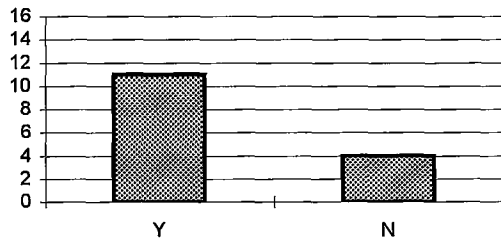
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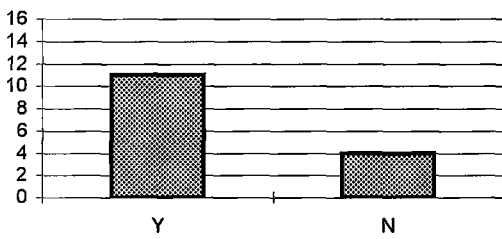
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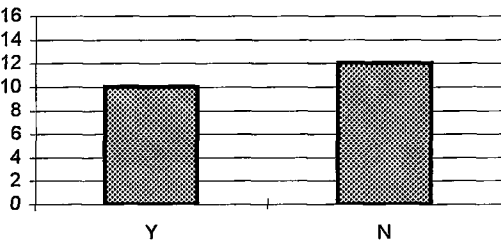
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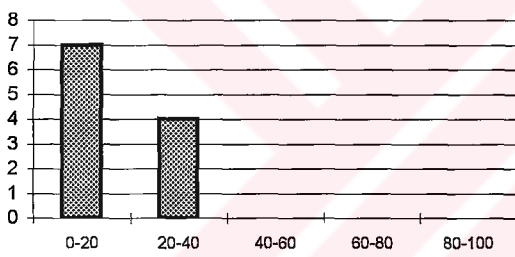
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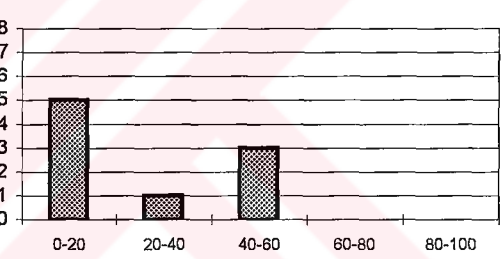
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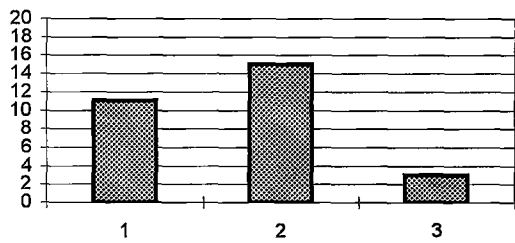
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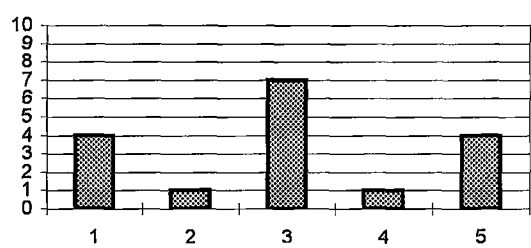
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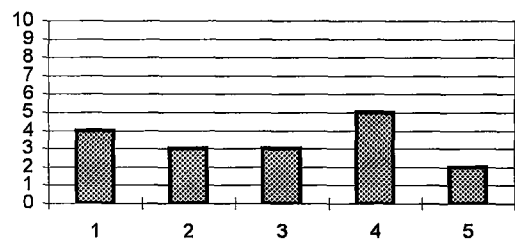
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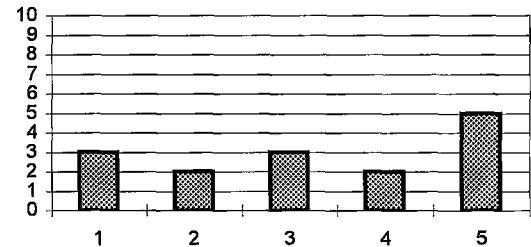
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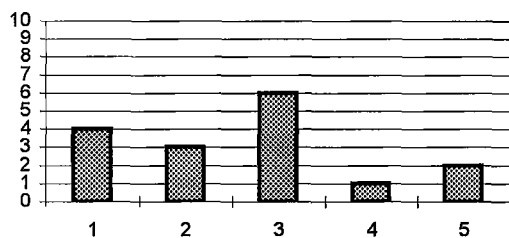
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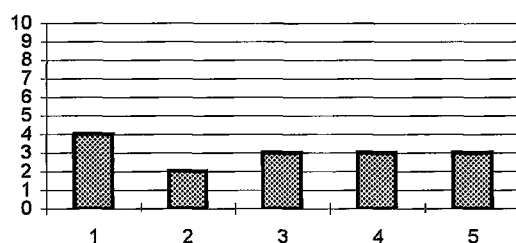
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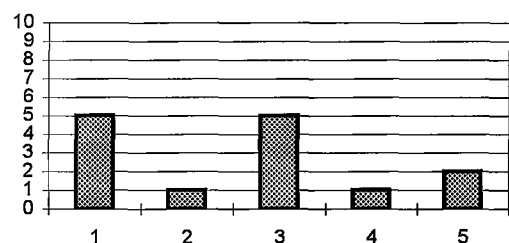
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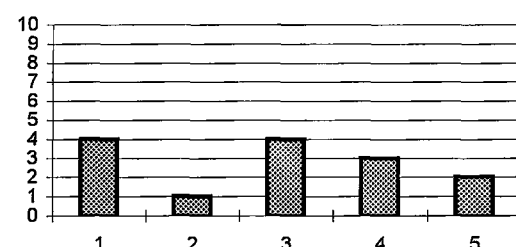
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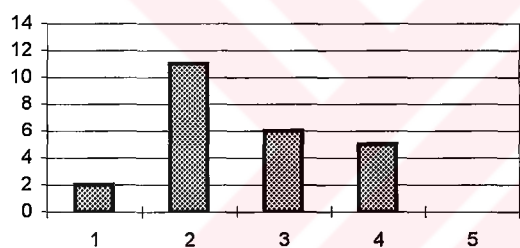
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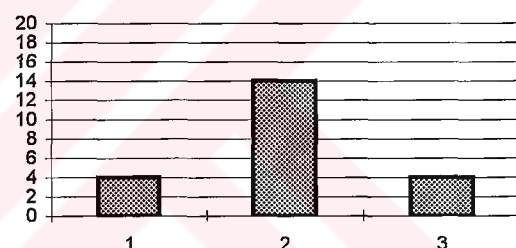
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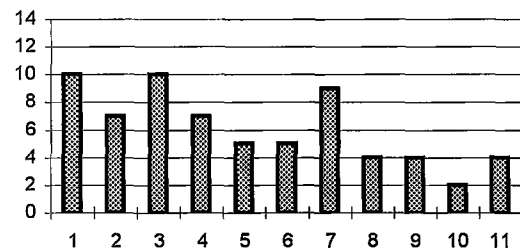
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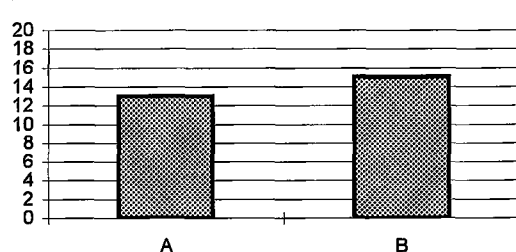
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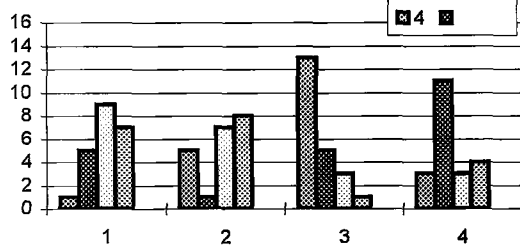
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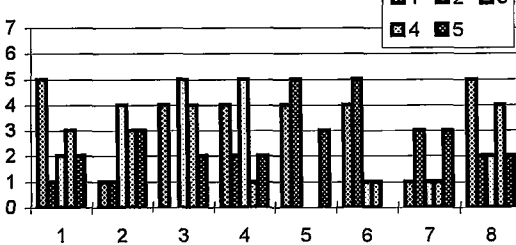
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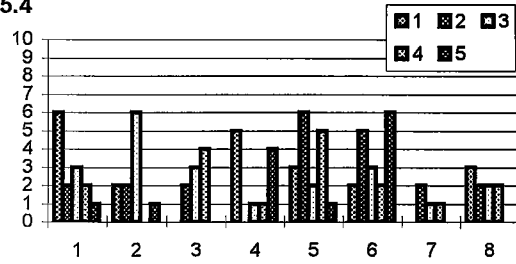
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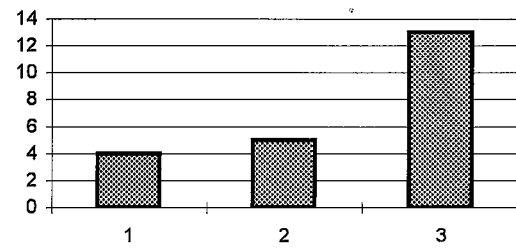
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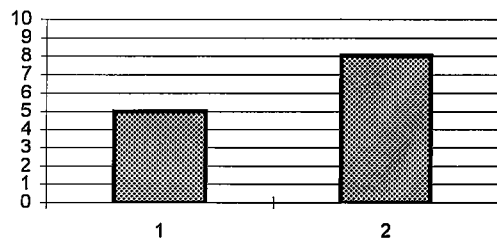
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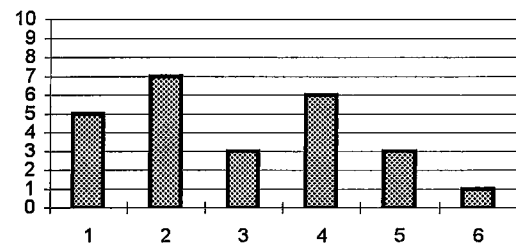
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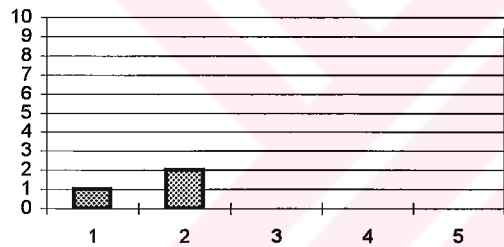
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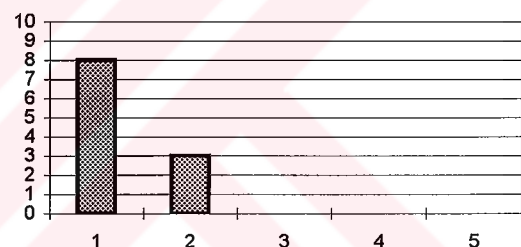
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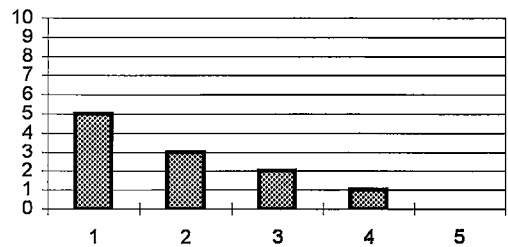
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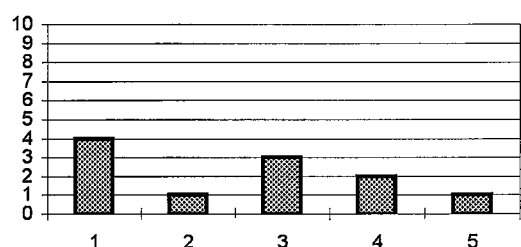
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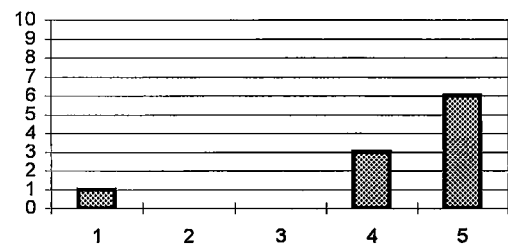
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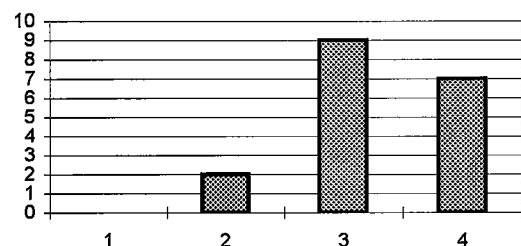
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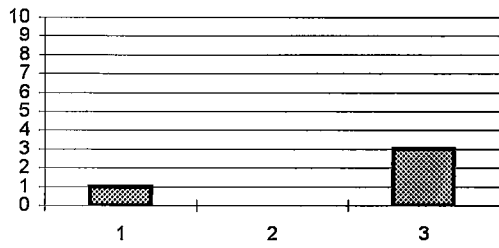
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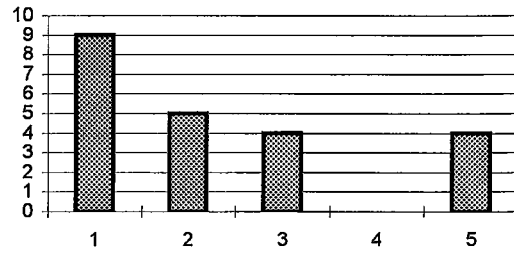
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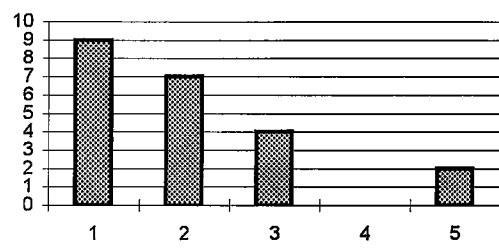
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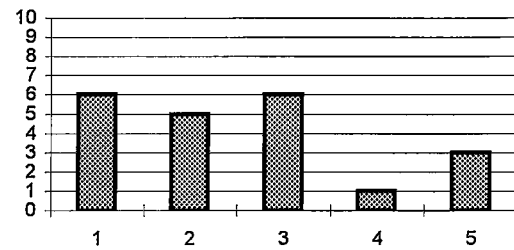
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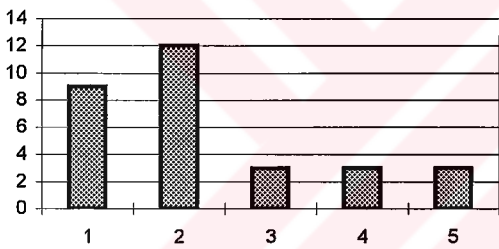
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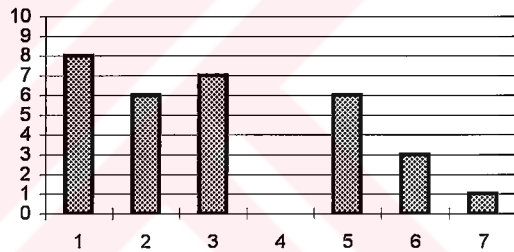
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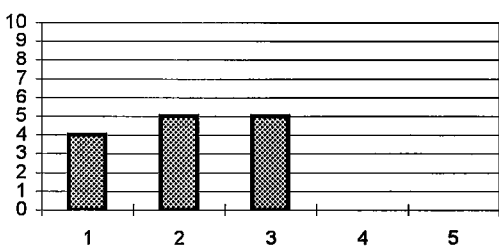
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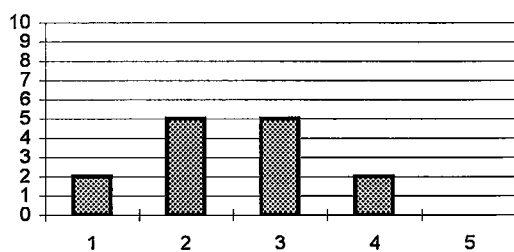
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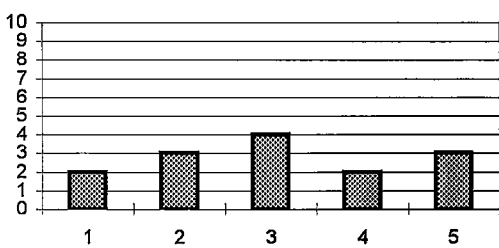
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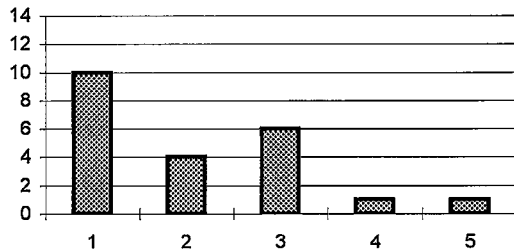
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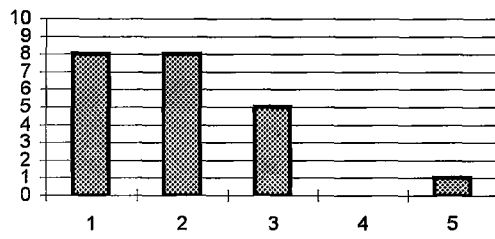
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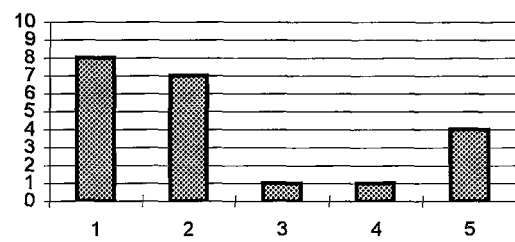
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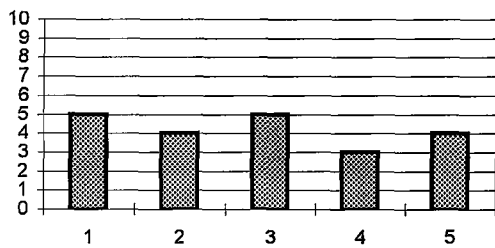
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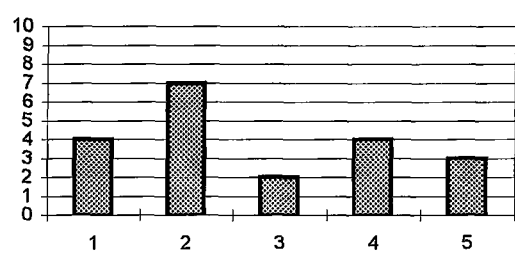
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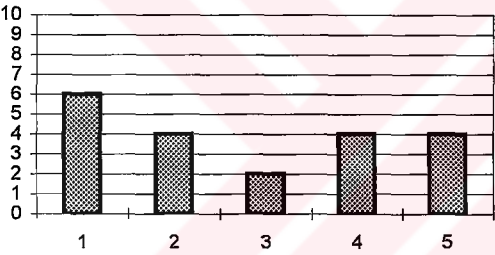
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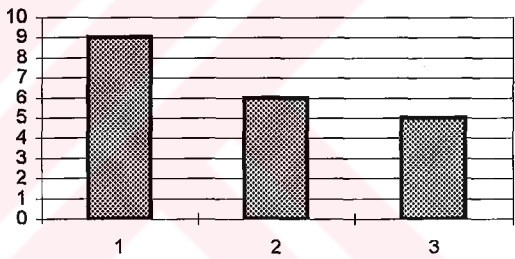
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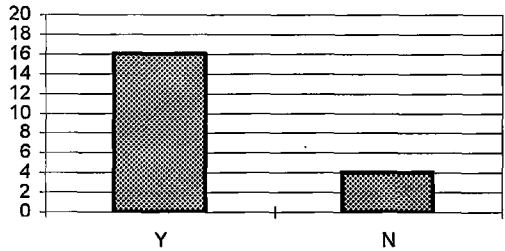
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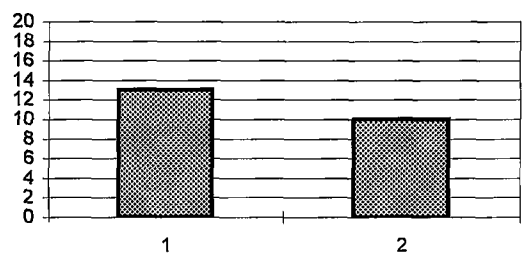
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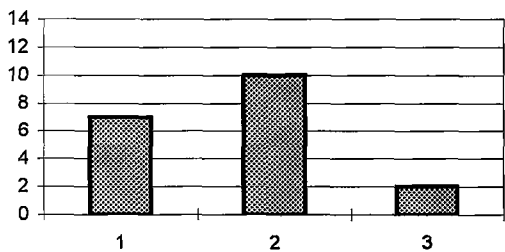
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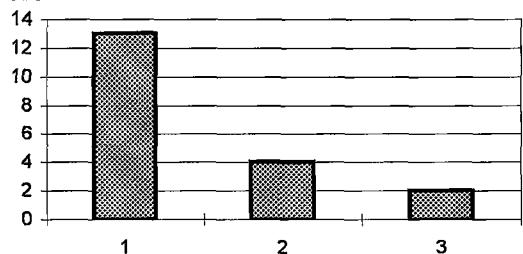
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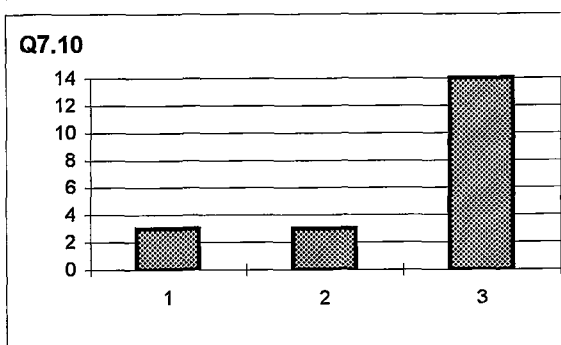
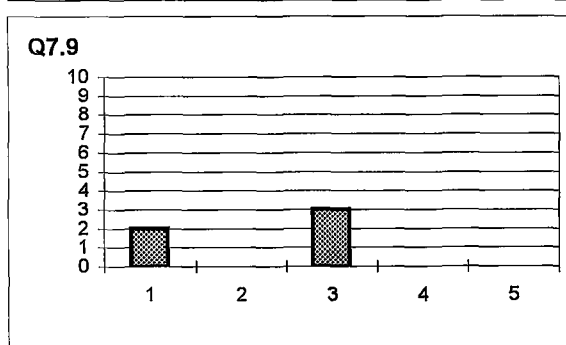
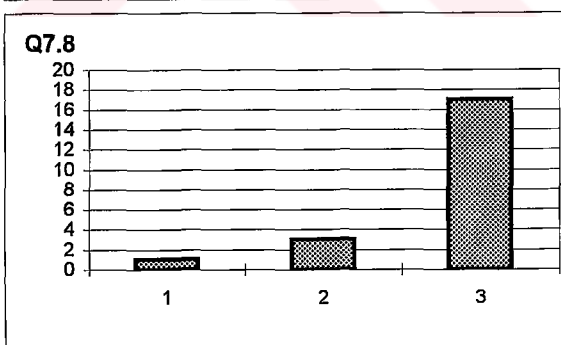
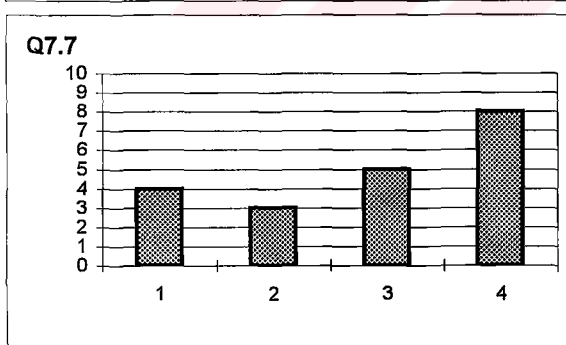
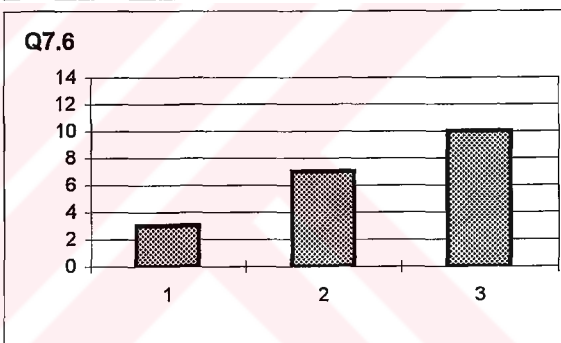
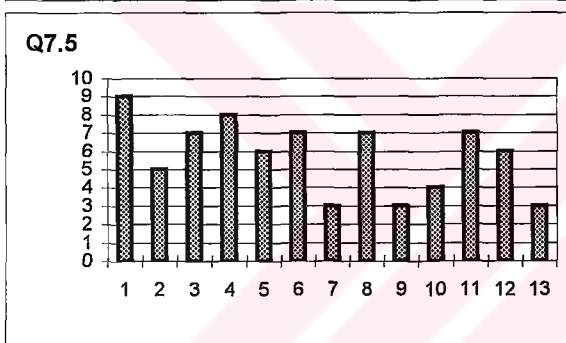
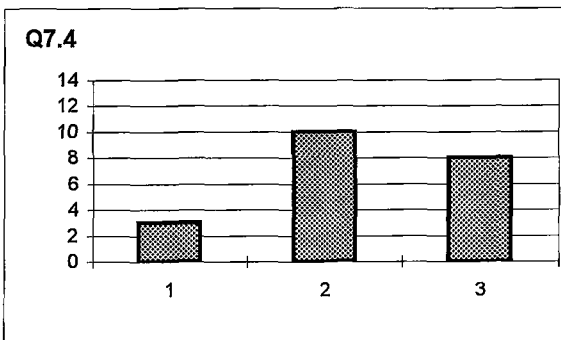
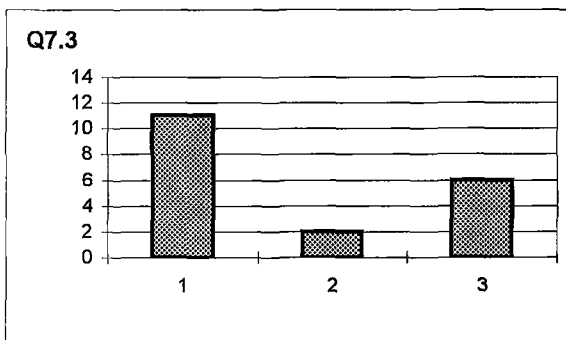
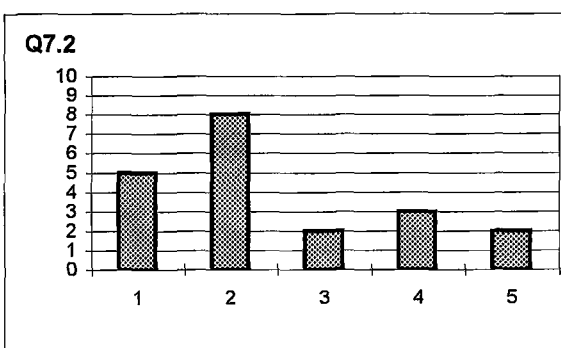
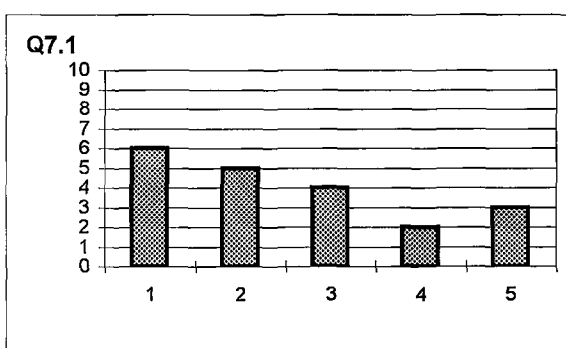


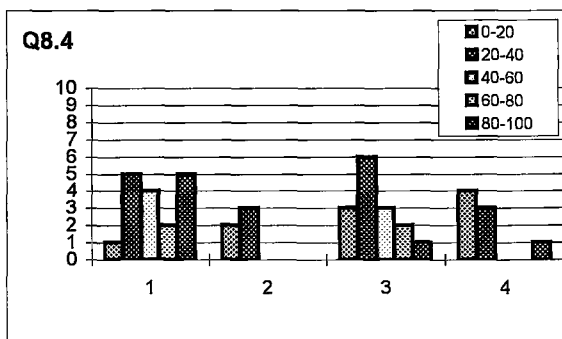
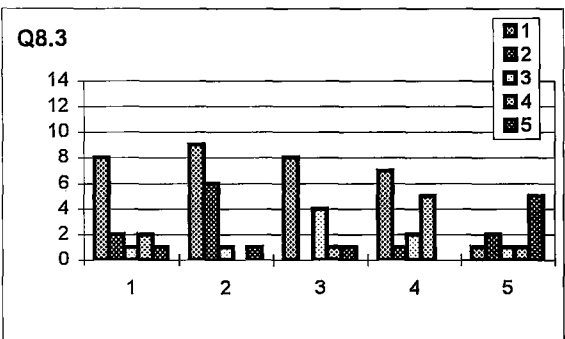
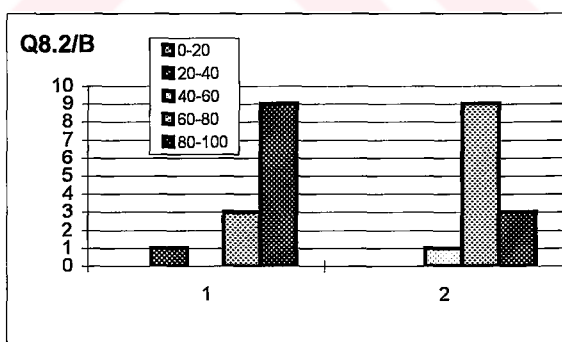
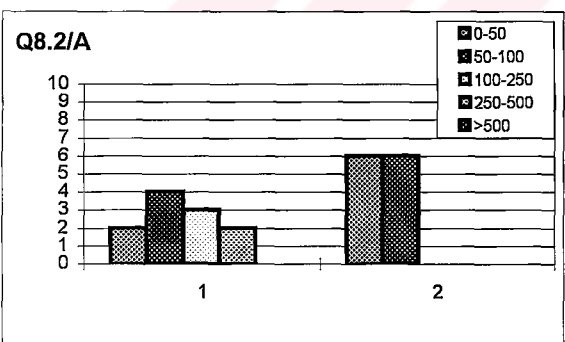
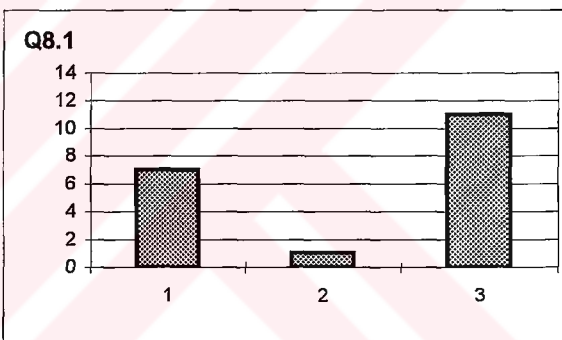
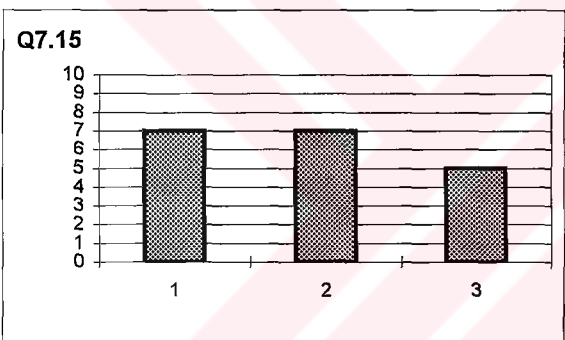
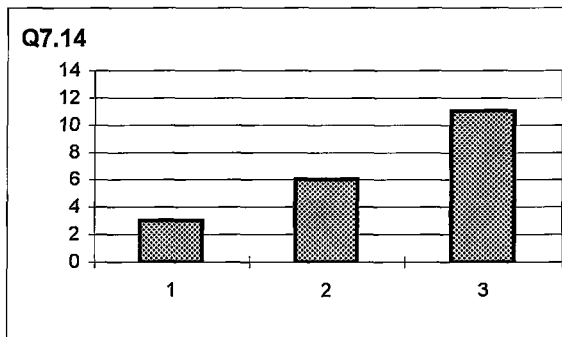
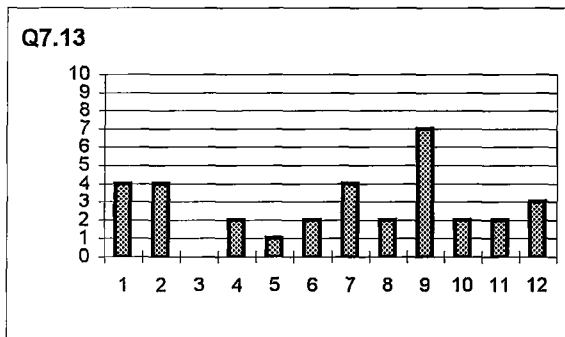
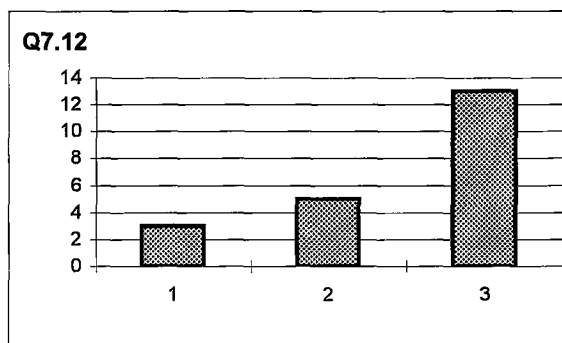
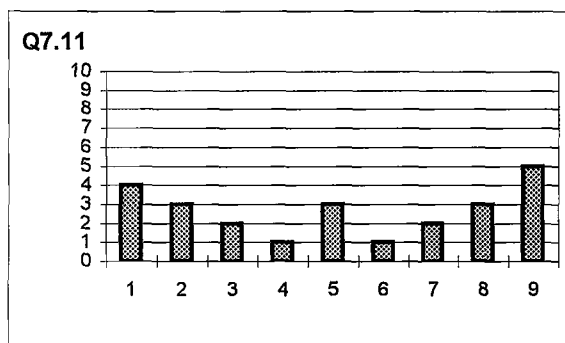
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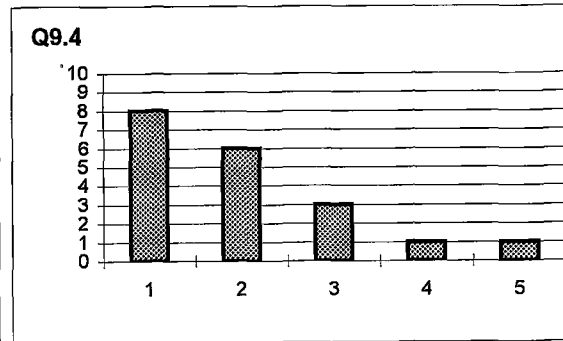
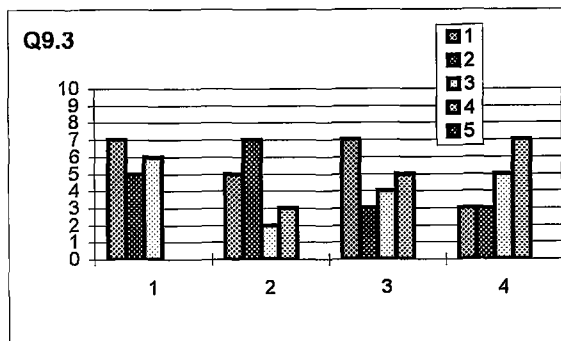
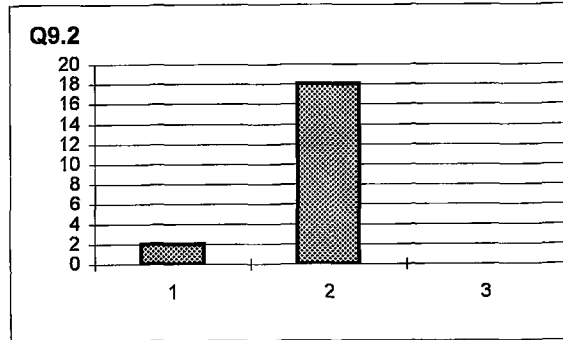
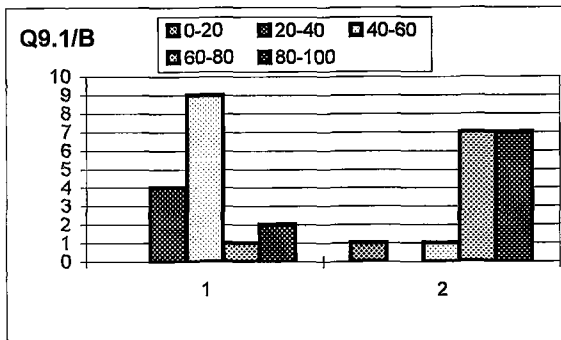
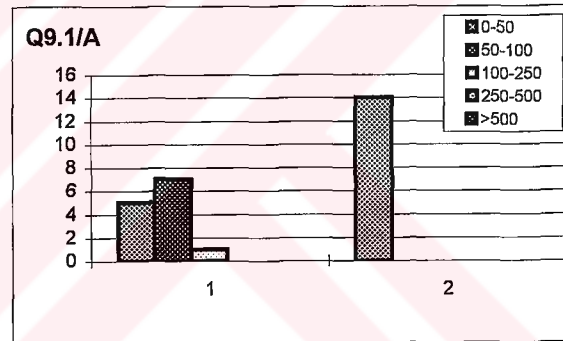
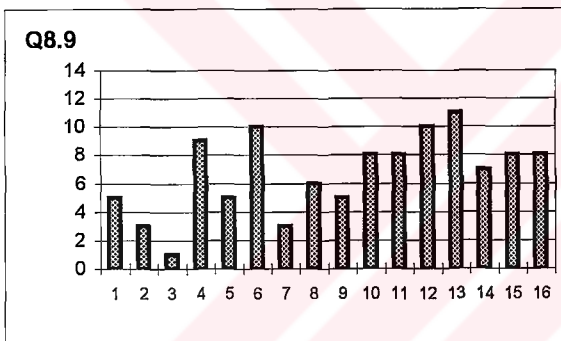
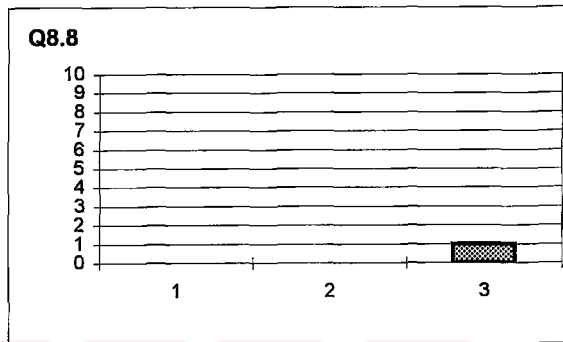
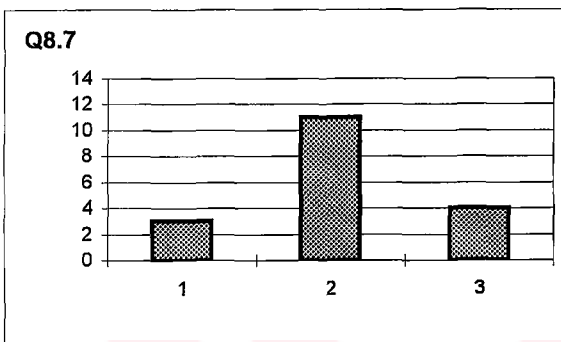
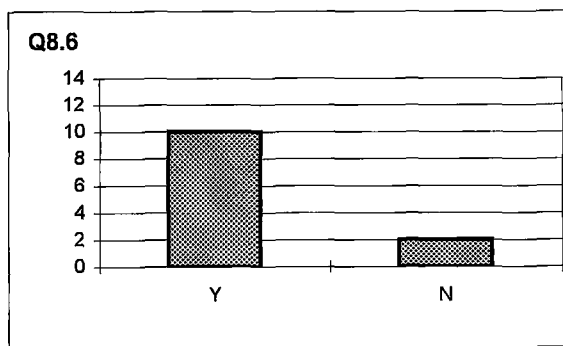
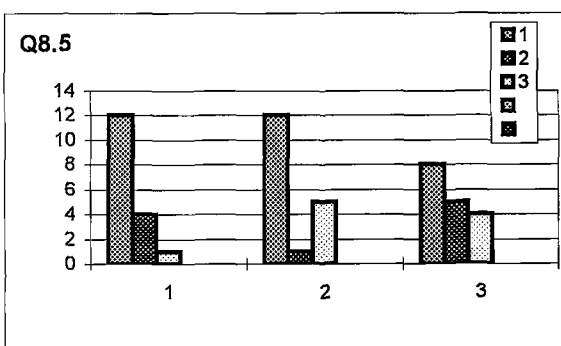


Q6.11

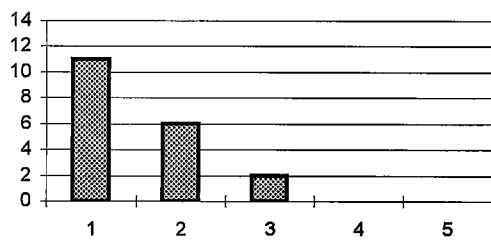




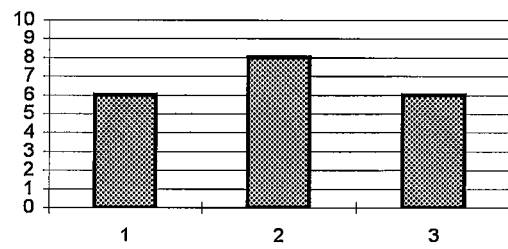




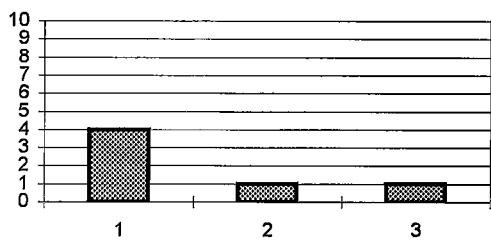
Q9.5



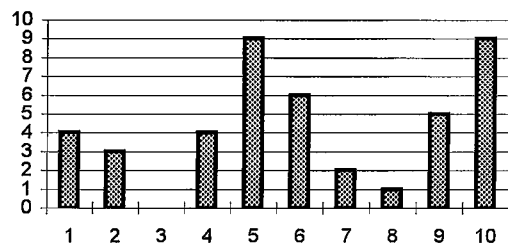
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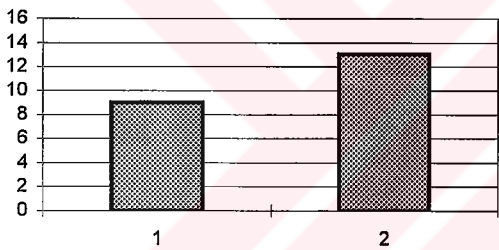
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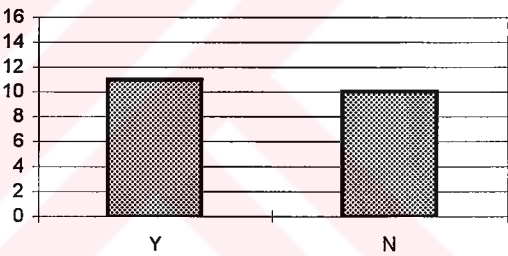
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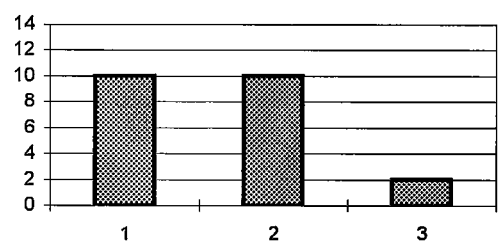
Q10.1



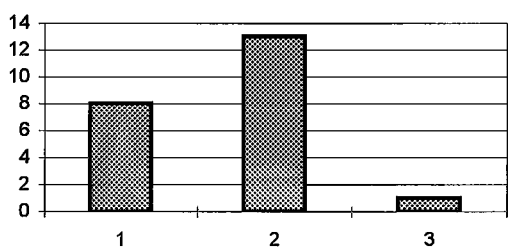
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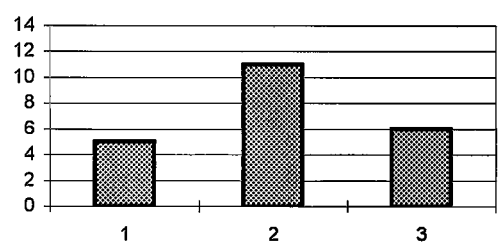
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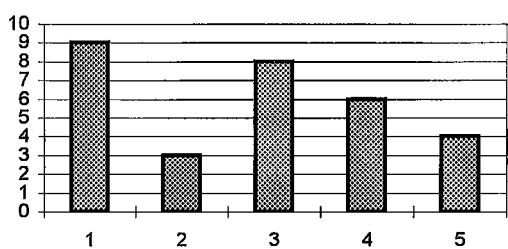
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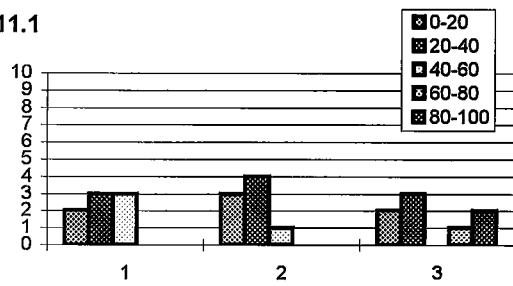
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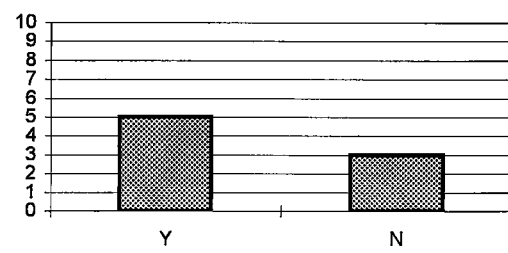
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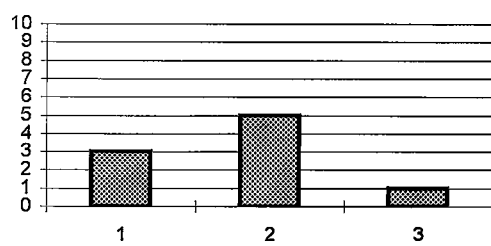
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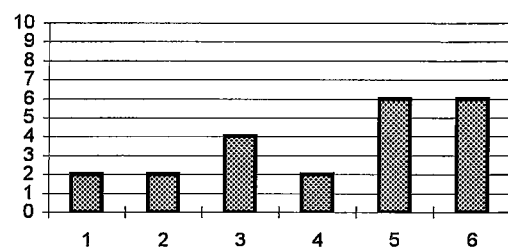
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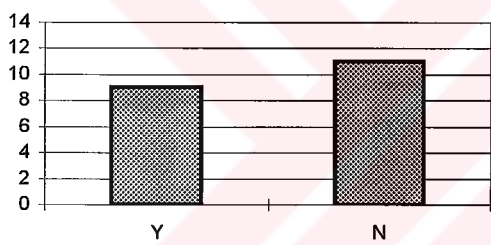
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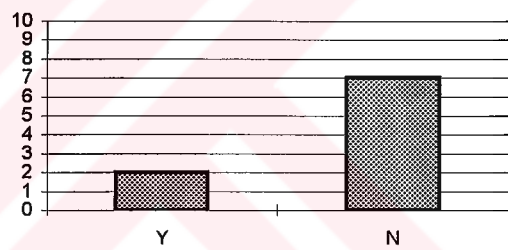
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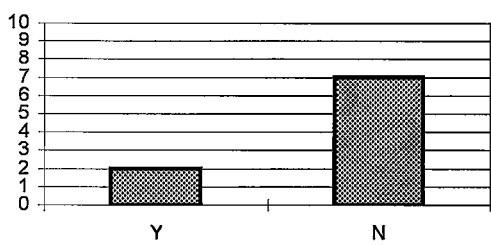
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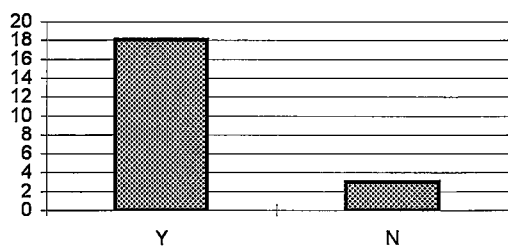
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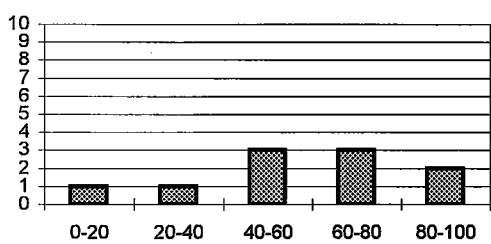
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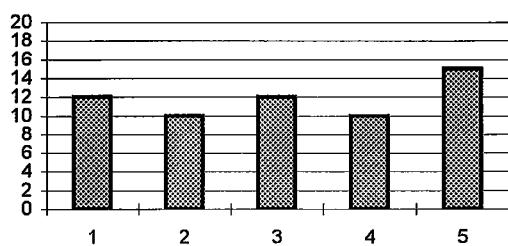
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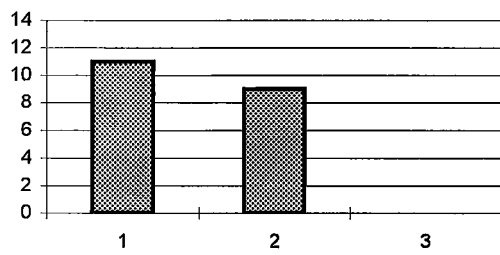
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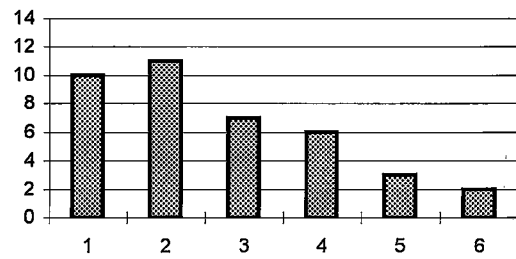
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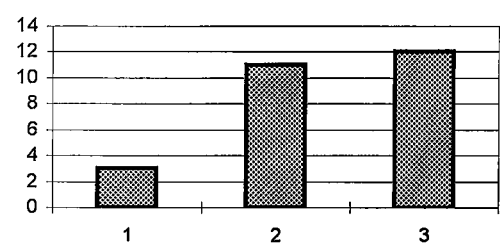
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Q13.5



Q13.6



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