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The Analysis of Biotechnology Foresight Application in Iranian Organizations

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ABSTRACT: Technology Foresight is a methodology for making the complexity and advanced nature of new technologies of future more comprehensible and transparent. The objective of this survey is to analyze and interpret weakness and strength of the current situation of Iran organizations regarding utilization of foresight activities of developing new technologies and its influence over the country by using qualitative Likert-scale questionnaire. The participants who took part in this survey were from different organizations in Iran, and they also participated in a workshop for practicing the related methods of Technology Foresight (TF). Statistical methods implemented for analyzing the results of the questionnaires are histogram chart, Kruskal-Wallis test and Mann-Whitney test for multi-comparison between organizations. The highlighted points of the analysis are lack of specialist, moderate attention on TF programmes and inconsistency between organization goals and government perspective. However, they have prepared plans and policies regarding foresight activities for shaping their organizations to meet future needs of technology competitiveness and development. Extensive explanations of responses are prepared in the statistical analysis of the paper.

Key words: Foresight Methodology, Qualitative Likert-Scale Survey, Biotechnology, STEEP Method

INTRODUCTION

It goes without saying that the development speed of new technologies in the world has an undeniable impact on the society. Although, several challenges and opportunities will be arising in the future of the society, there will be still numerous numbers of uncertainties. Recently, several strategies and methodologies have been created to control and manage these uncertainties for a long-term future in science. For example, Godet and Day et al. established a strategy in the area of managing new upcoming technologies in the firm for developing a future environmental strategy (Godet, 1987 and Day *et al.*, 2000). Future research, which is defined as a science oriented system over the planning a horizon of more than 10 years, is a well-known solution approach over uncertainties. The one who seriously involves in future activities is named as 'futurist' (Robert, 2010). For instance, one futurist named Richard Slaughter (Yoda, 2010) explained TF as "the ability to create and maintain a high-quality, coherent, and functional forward view, for example, to detect adverse conditions, guides policy, and shaping strategies to explore new markets for the products and services."

Technology Foresight is a subcategory of future research (Uotila *et al.*, 2007). It is the process of anticipating and managing changes in the future, which should be shaped through policy making and new product development rather than randomly occurrence of events. Furthermore, it is expected that changes would be inevitable through technology or social factors. So, it should be managed by a methodology that involves various processes. Therefore, TF is considered as a systematic process for developing methodologies regarding future developments. One special and effective tool in this process is gathering cross-section of people who look at future differently. For serving a comprehensive technology-related political decision making and strategic process, the TF process should be considered at national and regional levels in order to include more actors and organizations. (Uotila *et al.*, 2007) In other words, in this method, people from different fields such as industries, policy makers, or universities, etc participate to generate different ideas on foresight. Typical participants or stakeholders are governments and industries which develop products and applications along with the research institutions

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and universities that are also important stakeholders. Other actors such as Non-Government Organizations (NGOs), financial institutions, media, general public, and so forth can be the participants of TF application. Finally, TF helps us develop strategies and plans for longer term such as 10 or 15 years in recognition of uncertainties.

Further, TF is needed because of four major global driving forces and challenges that have impact on technology policies. Firstly, there is an increasing trend of competition among countries in the world. And all countries have rigorous competition especially developing countries which try to become the middle income countries, or the middle income countries intend to become developed nations. Secondly, there are many constrains that substantially affect nations and technologies such as water crisis, pollution, energy sufficiency, energy security, and so forth. The third is the increase of complexity in the population, migration, etc. For instance, when more people move into the cities, population growth becomes a serious problem. To act accordingly, biotechnology may become a great help in the food security of the population. And the last one is the main factor which is related to increasing strategic importance of science and technological competencies.

To take a look on TF methods, a brief description of most commonly used method is presented as follows. Brainstorming is a simple method to identify drivers that influence the future of a particular technology in some ways by using triggering questions for eligible participants (Borch *et al.,* 2007) Delphi is a very important method that a lot of people are to be involved to make decision, although it is very expensive. For example, in this methodology, there is a need for expert group gathering in order to identify trends and drivers. Afterward, the results are sent as a form of questionnaires to a bigger group of people to get response to know whether or not they agree with the experts' ideas. Environmental Scanning is a method that scans the trends and factors that affect the area of the related focus such as biotechnology industry, nanotechnology industry and ICT industry to name only a few. Technology Road mapping is another method that is quite simple and practical in the places which TF is being conducted for the first time to develop Road mapping in a certain area. Scenario Building and SWOT Analysis are also other practical methods in TF activates.

An exclusive three day workshop on Technology Foresight was held on 27-29 September 2010 in Tehran (Islamic Republic of Iran). It was supported by IOR-ARC Regional Centre for Science and Technology (RCSTT), Iranian Research Organization for Science and Technology (IROST), Ministry of Science Research and Technology, Deputy of Research with supporting international organizations such as The World Association of Industrial and Technological Research Organizations (WAITRO) and Islamic Educational, Scientific and Cultural Organization (ISESCO). The objectives of the workshop were to practice a methodology in the area of TF in Iran with the participation of specialists, experts, official organizations, researchers such as subordinates of Ministry of Science Research and Technology, Ministry of Industries and Mines, Ministry of Agriculture, and so on. In the workshop, special questionnaire regarding the impact and influence of TF over their organizations in the form of qualitative Likert-scale questions was distributed. The total number of participants or the sample size in this survey was 50 participants from different organizations and companies that is enough to guarantee reliable input and results. The analysis of this questionnaire was illustrated in this paper with the aim of interpreting and illustrating weakness and strength of the current situation of Iranian organizations and comparing them concerning the use of Technology Foresight applications.

The rest of the paper is organized as follows. A brief literature review for TF applications is brought in section (2). The groups of organizations are identified in section (3). Section (4) illustrates and analyses the results of questionnaires which are distributed among the participants and organizations in the workshop. The analysis of this section includes two parts: analyzing all organizations together and comparing grouped organizations. Finally, the conclusion is given in section (5).

In the literature there are numerous articles concerning TF applications and related concepts in industries, especially within recent decades. Zolingen, Semone and Klaassen conducted a report about selection processes and assessments into key qualification in Senior Secondary Vocational Education in the Netherlands using Delphi methodology. Also, they gave a brief history about Delphi method and analyzed its different types (Zolingen, *et al.,* 2003). A TF study was proposed by Andersen P.D et al. [16]aiming at enhancing a strategic outlook on sensor technology by utilizing international participants and Internet-based Delphi survey, with 24 countries respondent (Andersen P.D *et al.,* 2004). Another study conducted in Turkey with the name of Vision 2023 was a national TF program with the purpose of discussing and analyzing the vision of 2023 by utilizing contextualize perspective (Sheldon, 2010). It is indicated that if they offer any changes in the activities, it should be designed

by considering the relationship between context, content, and the process of that change (Sheldon, 2010). Delphi method was applied in another study about foresight application for developing scenarios of technology development in the energy and fuel sector in Portland and formulating the corresponding Roadmaps for their implementation for the first time in that country (Czaplicka-Kolarz *et al.,* 2009).

A review of Technology Foresight was conducted in Iran with the aim of investigating and evaluating the current situation of e-government in Iran and other countries and they also proposed a customized model for e-government foresight in the country (Saghafi *et al.,* 2010). Overall, to examine the practice of foresight in general, Yoda (2010) used the perceptions of domain experts who participated in foresight activities in Japan. He wanted to analyze the impact of foresight applications on policy making, which he found that it is not high, and the perception largely depends on ages, organizations, and other characteristics of participants (Yoda *et al.,* 2010). Also, for further study on the impact of TF on three main era of society: industrial, information, one can refer to Linstone (2010) and for more review Yuan et al. (2010) and Miles (2010).

The complexity of the essence of an activity can be better understood through different strategies and methods of Technology Foresight applications. The main concern of this paper is identifying weakness, strength and different facets of Iran's TF activities. Moreover, in this paper it is attempted to answer the following questions:

- The effects and influence of foresight activities on organizations
- Amount of attentions given to the plans and strategies of future of organization
- Amount of attentions and investment given to the technologies and inventions
- How much is the influence of Technology Foresight planning on competition
- The effect of other factors on Technology Foresight applications of organization
- The coordination and harmony between organizations' future plans and government strategies and vision
- The education level of staffs conducting TF activities
- Major factors in the development of TF activities

Likert-scale survey and data analysis

Questions that are used in this survey are 14 questions that form 9 question groups totally and analyzed separately for both all organizations and between the organizations. Moreover, the analysis of questionnaire consist of two sections, firstly the understanding of organizations are analyzed and interpreted all together, and in the second section, the statistical results of different group of organizations are presented.

Analyzing the answers that was provided by all organizations

The answers of participants are presented by the graphical representation of the responds in the form bar graphs and the frequencies of each level are presented in tables. Bar graph is a well-known statistical tool for presenting non-continuous data. It is a suitable tool for displaying the actual distribution of data in answers. Moreover, it shows a clear orientation of data over the level of answers. The basic idea of bar graph is to find out how the data are distributed. In distributions like normal distribution for example, answers are distributed around the center level symmetrically. The indices that show the behavior of histogram chart are mean, median and mode of the answers. Furthermore, by drawing a bar graph, it will be clear if there are any "skewed" distributions. In addition, another crucial parameter that is used to measure the answers is skewness. Moreover, the value of skewness shows how the intense of data are distributed. The zero skewness values are evenly distributed on both sides of the mean. Also, in right-skewed or positively skewed shape answers are biased on the left side, and in the negative value of skew the bulk of the answers lie to the right section of the mean (Bajpai, 2009).

Karl Pearson proposed several equations to calculate the value of skewness. But the most commonly used equation in the applications is the use of third moment about the mean illustrated in Eq. (1).

In this section Eq. (1) is used to calculate the skewness of the responses (Spiegel *et al.,* 2008).

$$Moment\ coefficient\ of\ skewness = a_3 = \frac{m_3}{s^3} = \frac{m_3}{(\sqrt{m_2})^3} \quad (1)$$

Participants of the survey of Technology Foresight activities were from different organizations that made the survey more reliable and profound. The survey in Iran's organizations were conducted by using Likert-scale questionnaires responded by experts, researchers and official of different organizations. The answer of questions are leveled with five qualitative levels as follows: 1-"poor" ,2- "Not Good", 3- "Fair", 4- "Good", 5-"Great". For the convenience of interpreting the results, the numbers of each level are used for analyzing by SPSS and STATA softwares.

The first two questions asked were about the amount of importance and acquaintance of TF in organizations. Moreover, it is asked to analyze how much each organization is familiar with the TF programme. Table 1 and fig. 1(a) illustrate the frequency and bar graph of all organizations' responses. The results show that the mode of answers is "Fair". It means that the "fair" level is selected with 30 percent that is the highest response level. Almost zero skewness in Table 9 illustrates some descriptive indices of groups of questions. However, the missing data is ignored in all questions.

Table 9 shows that there is no significant bias over the left or right section. Therefore, it can be inferred that all organizations have a preliminary acquaintance with TF programme, but it is also suggested to pay more attention to training and getting acquaintance with standard TF activities.

Answers of Yes/No responses in group two are gathered and illustrated in Table 2, for analyzing. Question number three asked, if the organization of participants have developed outlook for the future. The result of the question given in Table 2 shows that 92% of answers were "Yes" and it demonstrates that nearly all organisations have good prospective outlook. However, the results of question number four asked about, whether they have used any foresight methods is 38% "yes" which reveals that a few organizations used standard method of foresight for developing their outlook. Also, the results of question number five which asks if they have engaged experts to use TF programme is 23% "Yes" and it shows that the use of specialists is considerably low. Therefore, it can be concluded that the organizations should be encouraged to use experts in developing TF program in their organizations. This would ensure to develop an efficient and effective program to be used for the future of organization.

The group three (questions number six and seven) is related to the amount of attention given to the future plans, policies and important decisions in the organizations. The respondents and mode of results in Table 3 and fig. 1(b) are almost on "Good" and "Fair" qualitative level with 38% and 39.2% frequency. The negative skewness presented in Table 9 illustrates some descriptive indices of groups of questions. However, the missing data is ignored in all questions.

Table 9 indicates that the normal distribution in fig. 1(b) is left-skewed. It means that the bulk of answers is toward the "Good" and "Great" levels. Therefore, it can be concluded that they have enough awareness to consider the future programs in their plans and policies of their organization.

Table 4 and the bar graph in fig. 1(c) illustrate the results of questions number eight and nine in group four. The questions are about the position of new technologies in the future plans of individual organization and the allocated budget that is spent on

Table 1. The respond frequency of group one

	1-Poor	2- Not good	3-Fair	4-Good	5-Great	Total
Frequency	5	19	**25**	21	13	83
Percent	6	22.9	**30.1**	25.3	15.7	100

Table 2. The answers of group two

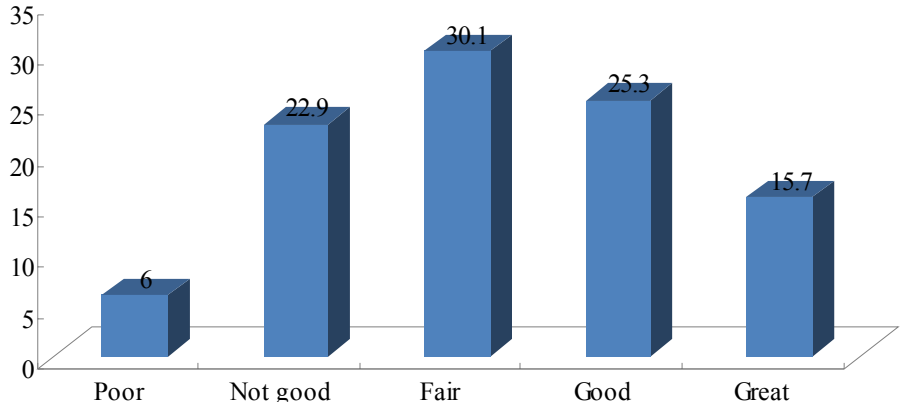
Answer	Question #3		Question #4		Question #5	
Yes	**36**	92%	**13**	38%	**8**	23%
No	**3**	8%	**21**	62%	**27**	77%

Table 3. The respond frequency of group three

	1-Poor	2- Not good	3-Fair	4-Good	5-Great	Total
Frequency	3	6	**31**	30	9	79
Percent	3.8	7.6	**39.2**	38	11.4	100

Table 4. The respond frequency of group four

	1-Poor	2- Not good	3-Fair	4-Good	5-Great	Total
Frequency	7	12	21	**25**	10	75
Percent	9.3	16	28	**33.3**	13.4	100



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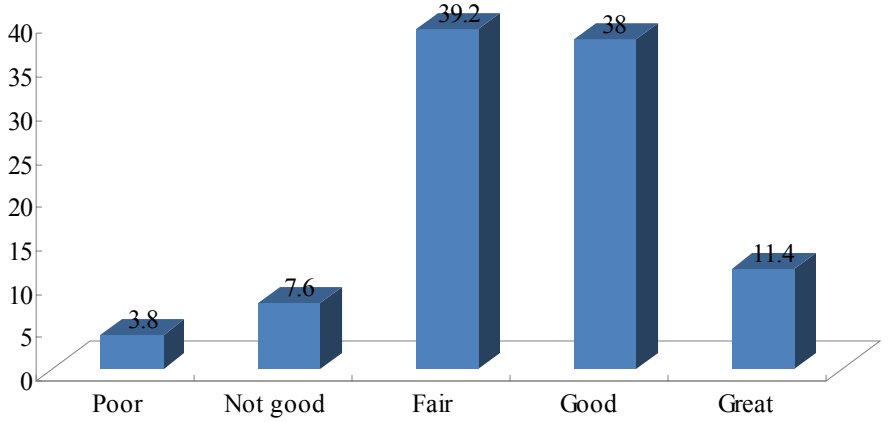

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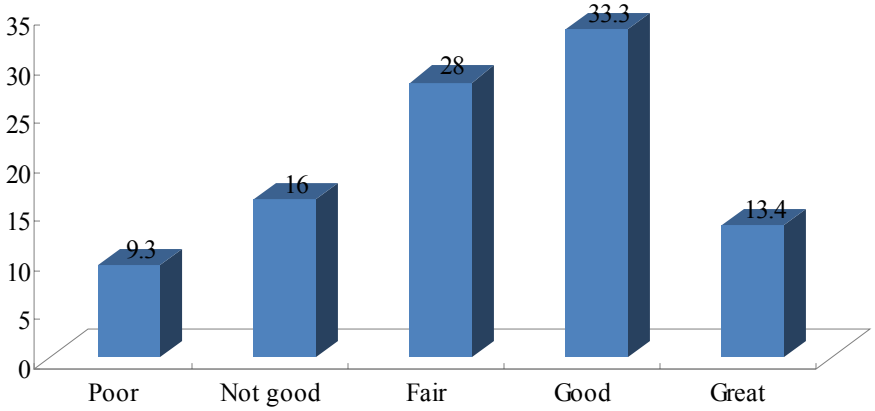
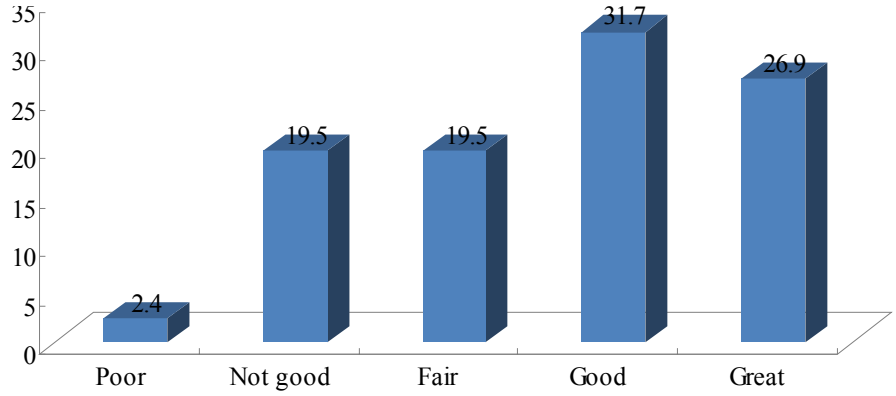


(c)



(d)

Fig. 1. Bar graphs of questions of group one=(a), three=(b), four=(c), five=(d)

the plan. The mode of answers is on "Good" quality with 33 percent frequency which means that comparing with the other four qualitative levels; it has the highest amount of frequency. Moreover, obtaining negative value of skewness in Table 9 illustrates some descriptive indices of groups of questions. However, the missing data is ignored in all questions.
Table 9 illustrates that the answers bias toward "Great" level shows the high attention given by organizations in the country for future activities and new upcoming technologies.

In group five of questions the opinions of participants were sought concerning whether or not TF activities are considered as a key issue in developing competitive environment in the institutions. Answers brought in Table 5 and bar graph in fig. 1(d) show a bulk of answers on "Good" and "Great" qualitative level with 31.7% and 26.8% frequency. Therefore, it can be inferred that all organizations agree with the importance of TF applications' impact on competitiveness development.

Table 6 and fig. 2(a) represent the answers of question number eleven of group six. The question is about the environmental factors impact of the organization on foresight activities. The answers show that the highest frequency of answers is on the "Good" level with 66.7%. This shows that the impact degree of factors is more than moderate. Also, the negative skewness in Table 9 illustrates some descriptive indices of groups of questions. However, the missing data is ignored in all questions.

Table 9 intensifies this hypothesis too. Moreover, environmental factors as the drivers or barriers exist out of organizations' control, such as government policies, wars and conflicts, advertisements, interest and exchange rates.

In group seven, the participants were asked how much his or her organization goes along with the country prospective vision. The answers illustrated in Table 7 and fig. 2 (b) reveals that, there is not significant coordination between organizations and government prospective vision. Moreover, there are two higher levels with 37.8 percent frequency and almost zero skewness showing that the answers are on "Good" and "Fair" qualitative levels. Therefore, it can be concluded that one big drawback of the foresight plans of the organizations is not being developed with harmony and coordination with the country future plans. This may lead to unwanted problems and barriers toward future plans of organizations and the country. This may indicate that there is no proper and standard TF application use in various organizations in the country.

The education level of staff in all organizations was asked in the group eight of questions. The results in Table 8 and fig. 2 (c) show that, the frequency of the mode of the answers is on "good" level with 54.1%. Therefore, it can be inferred that the education levels of staff to use TF techniques are sufficient to accomplish the future plans and policies.

Table 5. The respond frequency of group five

	1-Poor	2- Not good	3-Fair	4-Good	5-Great	Total
Frequency	1	8	8	**13**	11	41
Percent	2.4	19.5	19.5	**31.7**	26.9	100

Table 6. The respond frequency of group six

	1-Poor	2- Not good	3-Fair	4-Good	5-Great	Total
Frequency	0	1	4	**24**	7	36
Percent	0	2.8	11.1	**66.7**	19.4	100

Table 7. The respond frequency of group seven

	1-Poor	2- Not good	3-Fair	4-Good	5-Great	Total
Frequency	0	6	**14**	**14**	3	37
Percent	0	16.3	**37.8**	**37.8**	8.1	100

Table 8.The respond frequency of group eight

	1-Poor	2- Not good	3-Fair	4-Good	5-Great	Total
Frequency	0	4	9	**20**	4	37
Percent	0	10.8	24.3	**54.1**	10.8	100

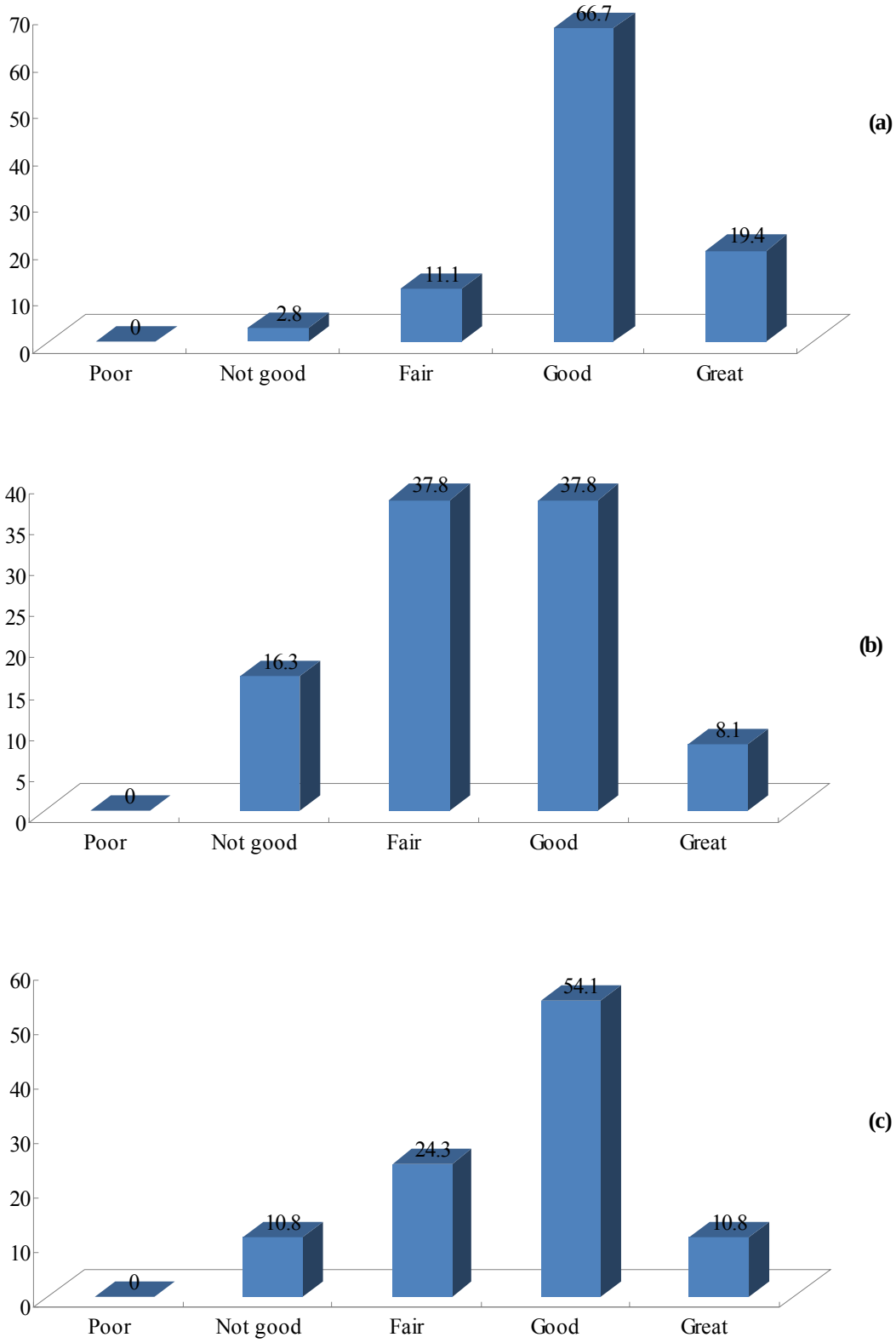


Fig. 2. Bar graphs of questions group six=(a), seven=(b), eight=(c)

Table 9 illustrates some descriptive indices of groups of questions. However, the missing data is ignored in all questions.

The five most important and effective factors of foresight techniques are social factors, Technology, economic, environment, politics (STEEP) which have great impact over the result of TF activities. The nature and kind of each factor highly depends on the subject of TF programme. Examples of trends in these factors are as follows:

- In social factor, lifestyle trends, demographic, consumer buying patterns, ethical issues ... are trends that might be important in social factors of the subject.
- For the technology factor, there are examples such as technology legislation, potential innovation, technology access, licensing and patents that may have impact over the subject of study.
- Examples for economic factors are market and trade cycle, interest and exchange rates, international trades and monetary issues, general taxation issues and so forth.
- The trends and questions that may rise for environmental factors may relate to ecological, weather, climate change, pollution, environmental legislation and so forth.
- Trends that might be important in political factors are government policies, future legislation, trading policies, regulatory bodies and processes, …

STEEP factors that have significant impact over foresight programmes were numbered according to importance given by participants in the last question. Moreover, each person at most has three choices for numbering the factors.

The results shown in Table 10 illustrate that social and political factors are more popular than other factors among organizations. These results may raise additional questions like why technology and environmental factors which are very crucial in foresight activities have fewer votes comparing with other ones. These results might show a discrepancy or a drawback in the system of Iran's organizations concerning lack of TF application and understanding of the factors.

Inferential analysis on the differences among the organizations

In this section, organizational groups are compared to analyze their status and Technology Foresight activities to develop future plans. With these analyses some possible weakness and strength of organizations in the country may be found. Two tests are used in the analyses for comparison among organizations. The first one is Kruskal-Wallis (KW) Test to see if there is a significant difference among all groups of organizations or not, and if there is, the Mann-Whitney test have been implemented to compare all pairs of groups separately. More details about these two tests are as follows:

$$KW = \frac{12}{N(N+1)}\left(\sum \frac{R_i^2}{n_i}\right) - 3(N+1) \qquad (2)$$

Table 9. Statistic result of all groups of questions

	Question G1	Question G3	Question G4	QuestionG 5	Question G6	Question G7	Question G8
N	83	79	75	41	36	37	37
Mean	3.22	3.46	3.25	3.61	4.03	3.38	3.65
Mode	3	3	4	4	4	3[a]	4
Std. Deviation	1.15	.93	1.16	1.16	.65	.86	.82
Variance	1.318	.867	1.354	1.344	.428	.742	.679
Skewness	-.043	-.455	-.356	-.382	-.676	-.015	-.506

a. Multiple modes exist. The smallest value is shown

Table 10. STEEP factors chosen by organizations in group nine of questions

Factors	Social	Technology	Environmental	Economic	Political
Sum of Votes	29	16	8	15	25

Where N is the total sample size, R_i and n_i are the sum of ranks and the number of subjects in group i, respectively. If the sample size within each of *k groups (groups to be compared) is bigger than five then* the Kruskal-Wallis can be compared with a χ^2 distribution with *k-1* degrees of freedom. Critical values of χ^2 distribution for different levels of significance are brought in statistical books such as Howard [2]. The null hypothesis of this test will be accepted if all k groups have an identical distribution. Therefore, the KW distribution approaches considered to the χ^2 distribution with *k-1*degrees of freedom. Otherwise, it will be rejected if KW test value is greater than the critical value found for χ^2 distribution at specified level of significance[2] .

In the case of rejecting null hypothesis, it can be said that, there is at least one significant difference among all groups. However, it can not be understood which groups have what kind of difference by this test. Then for solving this problem, the Mann-Whitney test has been implemented for pair wise comparison between groups. Mann-Whitney test are computed by the following equation:

$$Z = \frac{U - mn/2}{\sqrt{mn(N+1)/12}} \qquad (3)$$

In this formula, N, m, and n are the total observation, and the ranks of observations in each of two groups respectively. If the Mann-Whitney test statistic is greater than normal critical value with $(1-\alpha)$ confidence level, the null hypothesis will be rejected. After being familiarized with equations of tests and their utilizations, the statistical results of questionnaire are brought in the following section (Comrey *et al.*, 2009).

Participants Organizations

The Participants of the survey were from different organizations, so it is made the survey more reliable and profound. The participants are classified in 6 groups for analyzing and interpreting the comparison among organizations. The members of each class have similarities or are from the same organization. The first group is Science and Technology Park institutions (Technology Parks) which participated from different parts of the country. The second group is Iranian Research Organization for Science and Technology (IROST) together with IOR- ARC Regional Centre for Science and Technology (RCSTT) that were the host of workshop, and the rest of the groups are as follows: Group three is Universities. National Institute for Genetic Engineering and Biotechnology (NIGEB) is the fourth group. Agricultural Biotechnology Research Institute of Iran (ABRII) is group five, and the last group is other actors and organizations that participated in this three day workshop.

The first group of questions which is about the amount of importance and acquaintance with TF activities in organizations is analyzed among participants and the results are indicated in Tables 11 and 12, and fig. 4 (a). Kruskal-Wallis Test was taken to identify, if all organizations have same acquaintance with TF activities (Table 11). P-value of the test (0.052) indicates that there is no significant difference among the group when the level of significance is set on less than 0.052. Moreover, this test illustrates that the answers of the six groups of organizations with 94% confidence are fairly different. It means with 94% of confidence, we can say there is a difference, but with 95% it cannot be said. The second group of questions is about the amount of attention which is given to the future plans of policies and decisions in the organizations.

Fig. 4(a) illustrates that the Technology Parks and IROST comparing with the other institutions differ over the answers of the first group questions, but the kruskal-wallis test has shown that this difference is not significant at the level of 95%. So there is no need for pair wise comparison.

Table 11.The results of Kruskal-Wallis test of question groups

	Chi-Square	Df	P-Value
Group 1	10.968	5	0.052
Group 3	24.817	5	0.000[a]
Group 4	3.941	5	0.558
Group 5	3.645	5	0.602
Group 6	1.852	5	0.869
Group 7	4.957	5	0.421
Group 8	2.72	5	0.743

[a]There is significant difference at the 0.05 level

The kruskal-wallis test for the third group is significant at the 95% confidence level. The questions six and seven in the third group are about the amount of Therefore, Mann-Whitney's test was taken between each of the two groups and the results for the third group were shown in Table 12. The gray records highlight the pair of organizations in the first column and second column is significantly different.

It can be seen that the IROST has the most difference with three groups. They pay less attention to considering future plans into their policies and decisions. The box plot drawn in Fig. 4 (b) agrees with the result of the comparison. Therefore, it should be noted that IROST has a considerable weakness in considering future programmes in their daily policies and plans.

The answers of yes/no questions in group two for organizational comparison are shown in Fig.3. In question three, the agreement among organizations exists and it indicates that they have a specified outlook for their future programme. However, the results of question four show that they have rarely used any method for foresight programme. Moreover, the result of this question shows that the technology Parks, IROST and ABRII organizations have not used any methods on their foresight activities. This might indicate a weakness in these organizations. Fig. 3 for question five illustrates that the same organizations that mentioned for question four have not usually employed experts in using TF techniques. This shows another weakness for their future programme development that should be also considered in developing policies.

The fourth group of questions was about the position of new technologies in the future plans of individual organization and the amount of budget that is spent to develop technologies plan. The KW Test is carried out among organizations and the result of P-value (0.558) shown in table 11 indicates that there is no significant difference. Hence there is no need to compute Mann-Whitney test for multi comparison among organizations when there is not any difference between them. Also, the box plot of the answers of organizations is drawn in Fig. 5(a) for clarifying this comparison more. Therefore, the pervious result of this group stands here, as well. The conclusion indicates that the organizations in the country have given their highest attention to future activities and upcoming technologies.

Similarly, the result of KW Test for question ten in group five is given in table 11 and the box plot of the organizations are shown in Fig. 5(b). The results indicate that, there is no special difference between the institutions concerning the TF activities as the key

Table 12. Mann-Whitney test for comparing for question group three between organizations

(I) Institution	(J) Institution	Test statistic	P-value
Technology Parks	IROST	-2.355	0.019
	ABRII	-1.231	0.218
	Universities	-0.276	0.783
	NIGEB	-2.726	0.006
	Others	-1.899	0.058
IROST	ABRII	-3.253	0.001
	Universities	-2.002	0.045
	NIGEB	-3.682	0.000
	Others	-3.708	0.000
ABRII	Universities	-0.829	0.407
	NIGEB	-2.274	0.023
	Others	-0.544	0.587
Universities	NIGEB	-2.083	0.037
	Others	-1.045	0.296
NIGEB	Others	-1.618	0.106

Since the total significance is 0.05 and we have 15 comparisons here, the P-values less than 0.0033 will be significance here

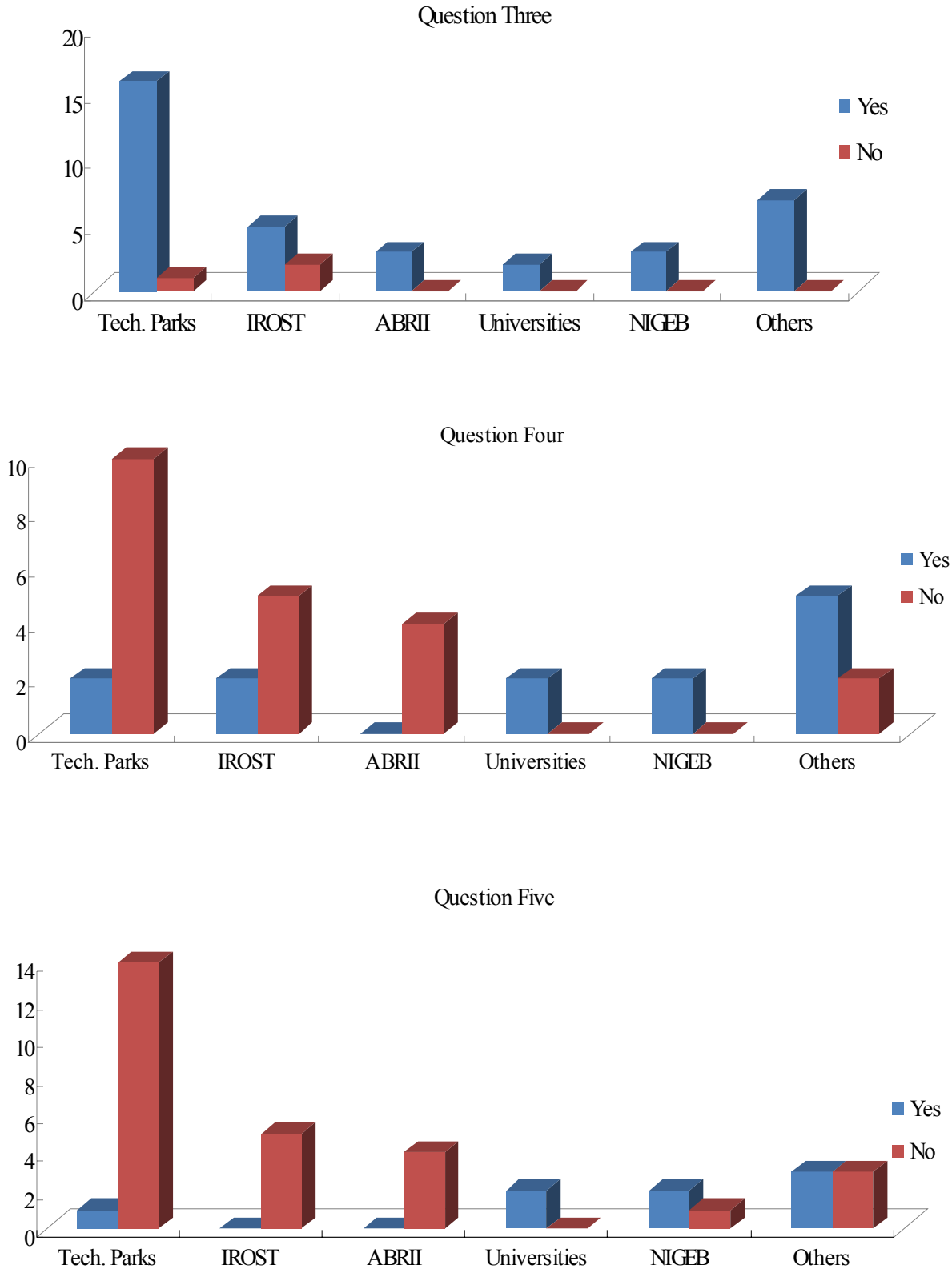
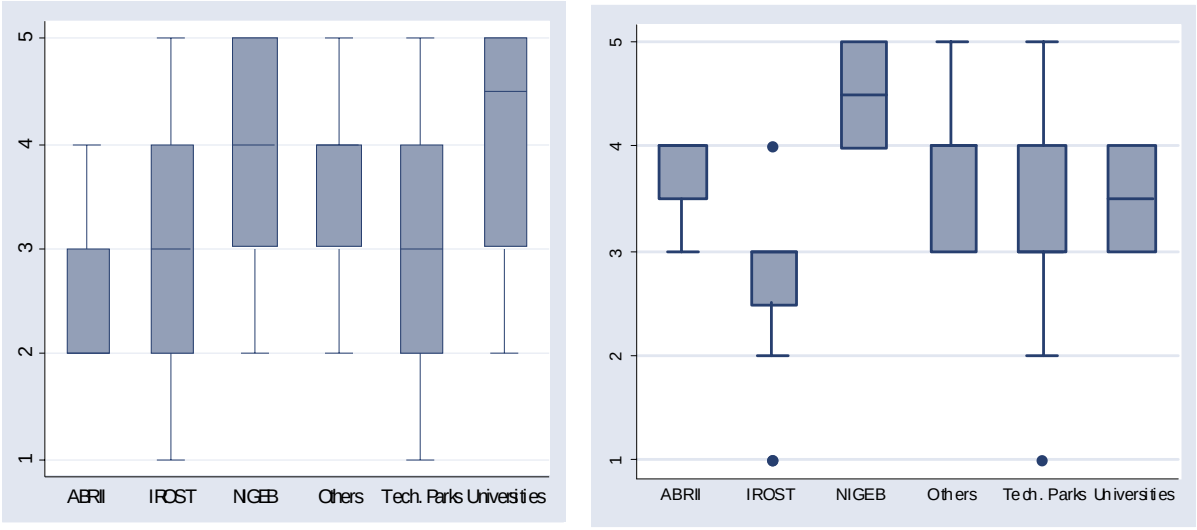
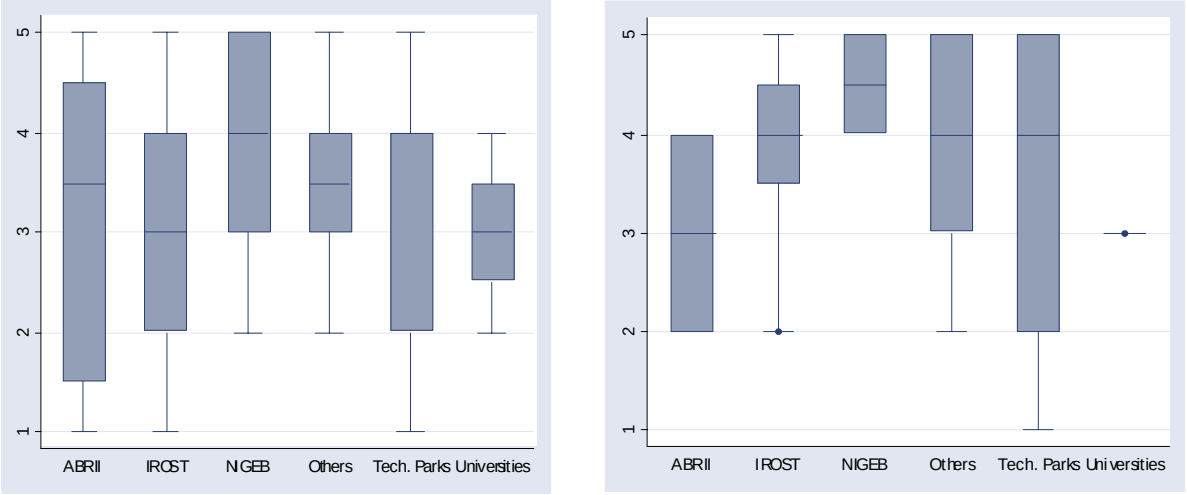


Fig. 3. Results of question group two



(a) (b)

Fig. 4. Box plot of institution for question group one=(a) and three=(b)



(a) (b)

Fig. 5. Box plot of institution for question group four=(a) and five=(b)

issue and its impact on the competitive environment of institutions. In this regard, almost all organizations have the same opinion about the role of foresight activities in creating competitive environment in the organizations.

Group six of questions concerns the severity of the environmental factors impact on the organizations' foresight activities and the results in Table 11 show that, there is not much difference between the responses of the institutions. Moreover, the results show a unanimous opinion about the influence of external factors over foresight activities of the organizations. In addition, the box plots of organizations drawn in Fig. 6(a) show that the mean of all organizations is on the "Good" level. Therefore, it is highly suggested that the external or environmental factors should be considered in future programmes of the organizations.

The result of KW Test of group seven indicates that all organizations' responses is on a unanimous level and the foresight activates are coordinated with the country's outlook and vision. Furthermore, the box plot of organizations in Fig. 6(b) shows that their answers are varies between good and fair section and there is no significant difference between them. Consequently, it is crucial for organizations to adjust their future goals and programmes with government policies and future perspectives, that not only improves the accomplishment of the organizations' plan, but also they will have the support of the government.

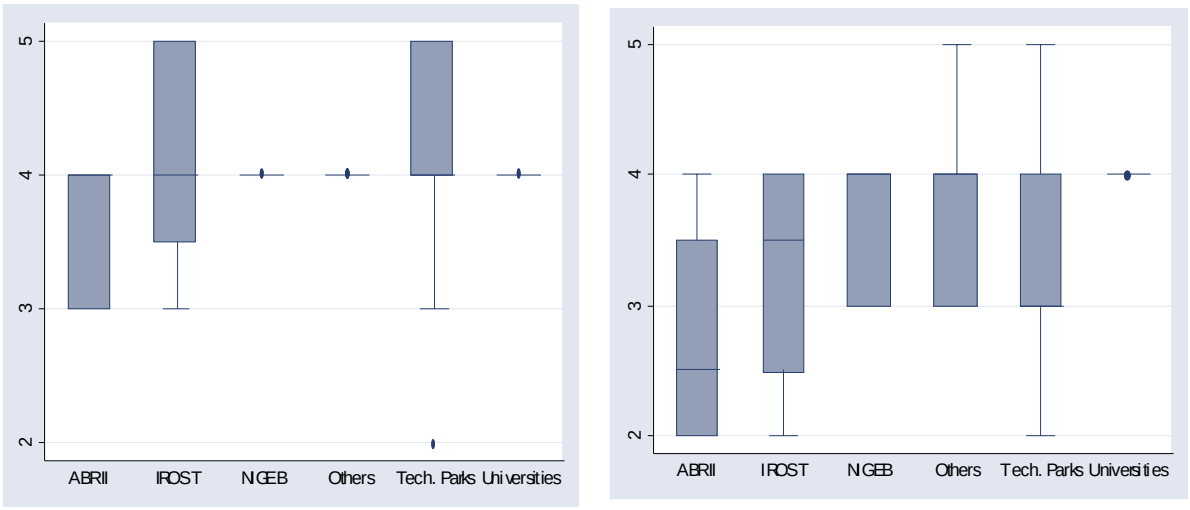


Fig. 6. Box plot of institution for question group six=(a) and seven=(b)

Group eight of questions is related to the education level of the organizations' staff which is highly required for the foresight activities. The result of KW Test in Table 11 shows that there is no significant difference between the answers of the organizations. However, the highest level of all answers of this question is on "good" level (Table 8). Therefore the organizations should attempt to improve their expertness in application of foresight activities.

In-group nine STEEP factors that are more important in developing TF activities are highlighted by the participants according to importance. These factors were described in more details in the previous section. The answers in each group of organizations are shown in Table 13, and for better comparison; normalized answers are drawn in Fig.7. It can be inferred from the figure that the political and social factors for IROST has the highest ranking and the economic and technology factors are ranked in a same level. In another view, we can say from Fig. 7 that the political factor in ABRII has the least ranking comparing to other organizations. However, this factor has the top ranking for the Technology Parks and universities. Table 10 shows the frequency of all answers in this question. Although, social and political factors are at the highest level, political factors are at the lower level than social factors of IROST's votes. This table indicates that the environmental factor has the lowest level and there are just two groups of organizations which vote high level on this factor with. Overall, this analysis indicates which organization pays a lower attention to each STEEP factor.

RESULTS & DISCUSSION

A workshop of Technology Foresight application was held by IOR- ARC Regional Centre for Science and Technology (RCSTT) and other organizations in Tehran. The objectives of the workshop were to practice a method in the area of TF with participating specialist, experts, official organizations, and researchers. A special questionnaire regarding the impact and influence of TF over their organizations in the form of qualitative Likert-scale questions was distributed. The results and analysis of this questionnaire is illustrated in this paper with the aim of interpreting and comparing different organizations concerning the use and advantages of TF applications upon the current situation of Iran. Questions are grouped in nine sections (see questionaries) for analyzing different aspects of TF. Organizations are divided to six groups for comparison. Statistical methods that are used in this paper for analysis of the answers are Kruskal-Wallis test, Mann-Whitney tests for multi comparison test and bar graphs and box plots.

The results of the analysis reveal weaknesses and strengths of Iran's organizations in different aspects. The results of first group show that all organizations have a preliminary acquaintance with TF programme. But it is suggested that the organizations should pay more attention to training and getting more acquaintance with TF activities and applications. Also, KW test for comparing organizations in this group indicates that with 95% percent confidence level, there is no significant difference between the answers of six groups of organizations. However, it is shown that more

Table 13. Ranking factors by institutions, the responds of group nine

Factor \ Institution	Technology Parks	IROST	ABRII	Universities	NIGEB	Others
Social	10	9	3	1	2	4
Economic	6	3	1	1	2	2
Political	12	7	0	2	2	2
Technology	5	3	2	1	3	2
Environmental	0	1	2	0	0	5

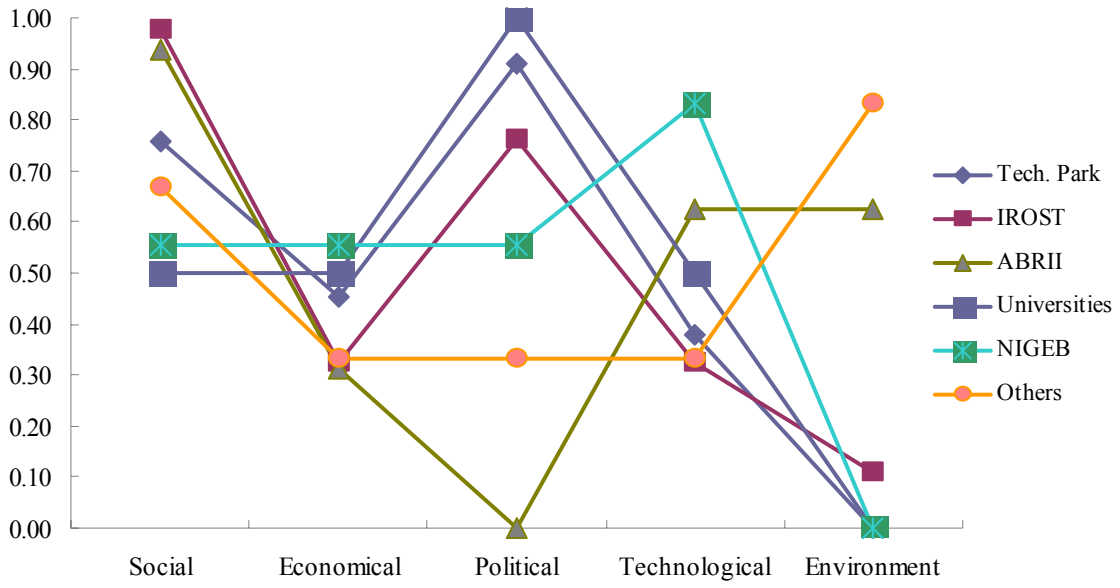


Fig. 7. Normalized answers of question group nine

training is needed in Technology Parks, IROST and ABRII organization to learn TF activities and to use the standard method of TF. Also, the results in group two illustrate that all organizations have a good prospective for their future but they should use foresight methods to develop their future plans. The experts should also be used to developing an efficient and effective programme for the future of organization. The group three of questions shows that they have paid enough attention to put the future programmes in their plans and policies of their organization. However, KW test reveals that there is a significant difference between the organizations. Moreover, Mann-Whitney tests for multi comparison between groups show that IROST and Technology Parks have a considerable weakness in developing TF base future programmes' policies and plans.

The result that we can see from the group four of questions reveals that all organizations have paid enough attention for future activities and new upcoming technologies in their organizations. In addition, the result of KW Test for this group indicates that there is no significant difference between the organizations. Respondents' answers in group five shows that there are strong believe in TF as an important factor which should be used as a competitiveness development in the national technology promotion. The effect of external factors over foresight activities in group six of questions were asked and the participants' belief about the impact degree of the factors is more than moderate. Also, the results in group seven reveal that the future plans of the organizations do not significantly coordinate with the governments' prospective vision. Therefore, it is

highly suggested that organizations should learn to revise and improve foresight plans and goals to have consistency with governmental policy and plan. The results of group eight of the questions related to the education level of the staff in all organizations illustrate that it is sufficient to accomplish their programmes. At group nine of the questions, the impact of STEEP factors over foresight program was asked. These factors were numbered according to importance by the participants in the last question. In this the question, the results may raise additional questions like why technology and environmental factors which are very crucial in foresight activities gain fewer votes from participants comparing to the other ones. In addition, it might show a discrepancy or drawbacks in the planning system of the organizations and lack of understanding of the foresight activities and applications. For a better comparison, normalized votes which are drawn in Fig.7 show which organizations pay lower attention to each STEEP factor.

CONCLUSION

In this study the application of Technology Foresight in developing future plans and policies in biotechnology institutions and industries is investigated. The obtained results showed that the organizations have an initial acquaintance with TF application. However, the standard application of TF in these organizations is still not in use as the standard format; therefore, the plans and policies currently developed in organizations is not much focused on successful future development programmes. The drawback could be seen by well not understanding of STEEP factors by the participants as being important in developing Technology Foresight plans and performances. It can also be seen through this study that the future plans of organizations are not significantly coordinated with government future visions and plans of action. This important highlighted issue should be further studied since it has serious impact on achieving national development goals.

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