Organizational change and applicability of Six Sigma Management Model in the Turkish National Soccer Team

Authors' Contribution:
A Study Design
B Data Collection
C Statistical Analysis
D Data Interpretation
E Manuscript Preparation
F Literature Search
G Funds Collection

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abstract

Background: In recent years, the Six Sigma Methodology has been primarily applied to the enhancement of performance. The purpose of this study was to implement Six Sigma Management Models in the Turkish National Soccer Team.

Material and methods: 24 matches of the Turkish National Soccer Team constituted the sample of research. The DMAIC method was used in this study. For statistical analysis of research data, IBM SPSS 18.0 for Windows and Minitab 17 statistical software program were used. As statistical techniques, brainstorm, fishbone, chi-square correlation analysis, Spearman correlation test, process capability analysis and control charts were used, which were the six sigma tools. The numerical values obtained were tested at $P < 0.01$ and $P < 0.05$ significance levels.

Results: As a result of the research, a statistically significant correlation was found among the match outcomes of the Turkish National Soccer Team and the game formation ($P = 0.04$), the positive shoot rate ($P = 0.03$), the positive defence rate on the first zone ($P = 0.00$) and the positive defence rate on the second zone ($P = 0.00$). As a result of the improvement, the z bench value for the positive defence rate on the first zone was increased from 0.47 to 0.59.

Conclusions: It can be said that the Six Sigma Management Model is applicable for coaching or training in soccer.

Key words: Six Sigma, soccer, DMAIC, correlation.

INTRODUCTION

Global competition, the rapidity of technological development, rapid changes occurring in customers' quality expectations and the expectations of society force organizations to change. The development and growth and the realization of the aims to maintain and to protect the presence of the organization require an organizational change which has a plan [1]. Sports organizations are also affected by such changes. In the changing and evolving world order, sports organizations which have to maintain and protect their presence must be open to all kinds of innovation and development and able to adapt to these changes [2].

Today, soccer has become the most popular sport with a number of athletes and sports fans. Beside this efficacy, soccer has already become an industry. Money spent on soccer and sponsorships races have increased interest in this sector and made soccer an ever growing industry. It has been a foregone conclusion in such a situation to benefit from the opportunities of technology in the soccer industry [3]. By reaching a significant potential both on the national and international arena, scientific studies conducted in the soccer science have moved soccer to a further advanced level. Subjective observations are generally used for the assessment of soccer games. By observations, good or bad aspects of teams are revealed and in the light of these obtained views, trainers direct their training. Due to monitoring conditions, human limits, prejudices, personal thoughts and the impact of emotions, subjective observations can give a misleading idea [4].

Match analysis and evaluation of the players are very important for soccer coaches. By using new technology tools and equipment while raising the future athletes in sports laboratories, training scientists are trying to develop new sports systems by using match analysis with a computer. In both assessments and the minimization of mistakes in the tactical work, a need for match analysis, for the monitoring players and the team performance, is of paramount importance. Statistics is the science of learning from data, and of measuring, controlling, and communicating uncertainty, and thereby it provides the navigation essential for controlling the course of scientific and societal advances [5]. In other words, statistics is the methodology which scientists and mathematicians have developed for interpreting and drawing conclusions from the collected data [6]. Statistical analysis abstractly and numerically allows us to understand key factors and trends behind the success of soccer [3].

In recent years, the Six Sigma Methodology has primarily been applied to the enhancement of performance and improvement of service quality [7]. More than a quarter of a century after its inception, Six Sigma can be considered a mature framework for performance improvement – as for maturity assessment at the organizational level [8]. Six sigma, as applied by large corporations like General Electric, Motorola, Honeywell and others, tries to create a closedloop approach to minimization or elimination of all manufacturing defects generated by the existing industrial processes [9]. Six Sigma is a proven set of methods to help you run your business or organization more efficiently and profitably. It is a way to reduce waste, stop delivering defective products and services from inefficient processes, and make your customers more than satisfied [10]. Six Sigma is a comprehensive and flexible system for achieving, sustaining and maximizing business success. Six Sigma is uniquely driven by close understanding of customer needs, disciplined use

of facts, data, and statistical analysis, and diligent attention to managing, improving, and reinventing business processes [11]. The Six Sigma Method, whose ultimate goal is to create a perfect process, consists of five stages. These stages; define, measure, analyze, improve and control.

Although there are match analysis studies in the soccer literature, there is no work related to the application of Six Sigma in soccer. The main purpose of the research is to implement Six Sigma Management Models and Tools in the Turkish National Soccer Team by utilizing data obtained with match analysis.

MATERIAL AND METHODS

This research was conducted in the correlational scan model. The correlational scan model is a research model that aims to determine the presence of exchanges and the extent of the exchanges between two or more variables [12]. The material for the research constituted the matches which were played by Turkish National Soccer Team. It had the same characteristics in terms of team rosters; 24 matches were selected that had been played during 2012 and 2013 season as the sample of the Turkish National Soccer Team. In the research, the DMAIC (Define-Measure-Analyze-Improve-Control) steps called the Six Sigma Improvement Plan or the Six Sigma Roadmap were implemented. The Six Sigma Roadmap is an application method that is an approach consisting of five stages which respectively follow each other. The Six Sigma application methodology is a Six Sigma road map that systematically examines how to define, measure, analyze, improve and control the process to identify and eliminate the main causes of non-conformities.

Six Sigma Application Methodology

Define Phase: At this stage of the Six Sigma Application Methodology, the first thing to do is to determine the factors affecting the match outcomes and so to create a database. Brainstorming and a cause-effect diagram were used in the research to create the database.

Brainstorming is a variant of discussion groups aiming to generate ideas or solutions and individualized approach in that the mediator has a minimal involvement. This recommendation focuses on participants to make suggestions without comment on other participants' ideas [13].

The factors thought to influence the outcome of the Turkish National Soccer Team matches were determined via brainstorming. This process was conducted with the Turkish National Soccer Team's coaches and analysts and with experts who were UEFA Pro, UEFA A and UEFA B coaches.

A cause and effect diagram often called a "fishbone" diagram can help in brainstorming to identify possible causes of the problem and in sorting ideas into useful categories. The fishbone diagram is a tool for analyzing the business process and its effectiveness. It is also commonly referred as "Ishikawa Diagram" because it was invented and incorporated by Mr. Kaoru Ishikawa, a Japanese quality control statistician. It is defined as a fishbone because of its structural outlook and appearance. In normal stature it looks like a skeleton of a fish. The fishbone diagram and analysis typically evaluates the causes and sub-causes of one particular problem and, therefore, assists to uncover all the symptoms of any business problem [14]. A fishbone diagram is a visual way to look at cause and effect. It is a more structured approach than some other

tools available for brainstorming causes of a problem. The problem or effect is displayed at the head or mouth of the fish (y = dependent variables = match outcomes). Possible contributing causes are listed on the smaller "bones" (x = independent variables = the factors believed to influence the outcome of the Turkish National Soccer Team's matches) under various cause categories. A fishbone diagram, created as a result of brainstorming, was given in **Appendix 1** for the Turkish National Soccer Team.

Measure Phase: At this stage, dependent and independent variables were measured according to the databases created as a result of brainstorming and the fishbone diagram.

DATA COLLECTION TOOLS

For the purpose of collecting research data, to create the basis of research, a field survey was conducted by examining the articles, theses and several books on issues related to football and match analysis. In addition, the theoretical aspects of the research were established by information exchange with experts of the management science and the statistics science, soccer analysts and coaches.

Outcomes of the matches, goals, goals allowed, match type, match location (home or away match), trainer, the mean age of teams, offside and yellow cards data were obtained from the Turkish Football Federation official website; stadium's altitude data was obtained from stadiums' websites; temperature, pressure and humidity data were obtained from the related websites; 1st half, 2nd half and overall ball possession rate, play the ball rate on the 1st, the 2nd, the 3rd and the opponent zone, positive short pass rate, positive long pass rate, average pass time, average pass, play with pass rate, positive headshoot rate, positive shoot rate, corner, free kick in the 3rd zone, winning ball rate on the 1st, the 2nd and the 3rd zone and losing ball rate on the 1st, the 2nd and the 3rd zone data were obtained from the E-Analyze Digital Soccer Match Analysis Software Programme; game formation, positive right wing attack rate, positive left wing attack rate, positive central attack rate, sprints which were made to penalty area by players, positive ball rate returning from the opponent after shooting, the positive defence rate on the 1st zone and the positive defence rate in the 2nd zone were obtained by watching videos of the matches and taking notes.

THE RELIABILITY AND VALIDITY OF THE DATA COLLECTION TOOLS

In order to ensure the reliability of the data, all matches were also analyzed by an analyst expert except researcher. Kappa statistics was performed to determine interobserver reliability (Table 1). Kappa statistics is a statistical method for measuring the comparative reliability of numbness between two or more independent observers. For Kappa 1 and 0 values are reviewed that 1 is perfect agreement, 0 is exactly what would be expected by chance. 0.81–1.00 shows perfect numbness [15].

Examining Table 1, it was observed that kappa values were between 0.857 and 1.000. In that context, it was said that analysts' numbness was great and measurements were reliable.

Because we made use of UEFA Pro, UEFA A, UEFA B coaches and analysts' knowledge and determined the measured value by examining studies which were made before the match analysis in Turkey and in the world, in the research it can be said that the measurement tool is reliable.

Table 1. Kappa test results of interobserver

Measured parameters	Interobserver Kappa statistical values
Overall ball possession	1.000
1st half ball possession	1.000
2nd half ball possession	1.000
Play the ball rate on the 1st zone	0.909
Play the ball rate on the 2nd zone	0.857
Play the ball rate on the 3rd zone	0.906
Play the ball rate on opponent zone	1.000
Positive short pass rate	1.000
Positive long pass rate	1.000
Average pass time	1.000
Average pass	1.000
Play with pass rate	1.000
Positive right wing attack rate	1.000
Positive left wing attack rate	1.000
Positive central attack rate	1.000
Sprints which were made to penalty area by players	1.000
Positive headshoot rate	1.000
Positive shoot rate	1.000
Positive ball rate returning from the opponent after shooting	1.000
Corner	1.000
Free kick in the 3rd zone	1.000
Positive defence rate on the 1st zone	0.955
Positive defence rate in the 2nd zone	0.912
Winning ball rate on the 1st zone	1.000
Winning ball rate in the 2nd zone	1.000
Winning ball rate in the 3rd zone	1.000
Losing ball rate on the 1st zone	1.000
Losing ball rate in the 2nd zone	1.000
Losing ball rate in the 3rd zone	1.000

ANALYZE PHASE

IBM SPSS 18.0 for Windows and Minitab 17 statistical software program were used for statistical analysis of the research data. Chi-Square correlation analysis was used to reveal the relations among match outcomes and the game formation, the match type, the match location (home or away match), and the trainer. Spearman correlation analysis was used to reveal the relations among match outcomes and the players' mean age, the 1st half, the 2nd half and overall ball possession, play the ball rate on the 1st, the 2nd, the 3rd and the opponent zone, positive short pass rate, positive long pass rate, average pass time, average pass, play with pass rate, positive headshoot rate, positive shoot rate, corner, free kick in the 3rd zone, positive right wing attack rate, positive left wing attack rate, positive central attack rate, sprints which were made to the penalty area by players, positive ball rate returning from the opponent after shooting, positive defence rate on the 1st zone, positive defence rate in the 2nd zone, missing ball rate on the 1st, the 2nd, and the 3rd zone, winning ball rate on the 1st, the 2nd and the 3rd zone, offside, yellow cards, temperature, pressure and humidity. The obtained numerical values were tested at $P < 0.01$ and $P < 0.05$ significance level.

To measure the process capability of the Turkish National Soccer Team (to determine the sigma level of the current situation) Process Capability Analysis was made via Minitab 17 statistical program. Control Charts were used to determine whether or not the process is in control.

RESULTS

Table 2. Chi-Square test results between matches' outcome and game formation Chi-Square test

	Value	df	Sig. (2-tailed)
Pearson chi-square	6.147[a]	2	.046*
Likelihood Ratio	6.557	2	.038
Linear-by-Linear Association	5.682	1	.017
N	24		

*Note: *.Chi-Square is significant at the 0.05 level (2-tailed).*

Table 3. Spearman correlation test results (Spearman's rho)

		Match outcomes	Positive shoot rate
Match outcomes	Correlation coefficient	1.000	.444
	Sig. (2-tailed)		.030*
	N	24	24
Positive shoot rate	Correlation coefficient	.444	1.000
	Sig. (2-tailed)	.030*	
	N	24	24

*Note: *. Correlation is significant at the 0.05 level (2-tailed).*

Table 4. Spearman correlation test results (Spearman's rho)

		Match outcomes	Positive defence rate on the 1st zone	Positive defence rate in the 2nd zone
Match outcomes	Correlation coefficient	1.000	.574	.533
	Sig. (2-tailed)		.003**	.007**
	N	24	24	24
Positive defence rate on the 1st zone	Correlation coefficient	.574	1.000	.351
	Sig. (2-tailed)	.003**		.092
	N	24	24	24
Positive defence rate in the 2nd zone	Correlation coefficient	.533	.351	1.000
	Sig. (2-tailed)	.007**	.092	
	N	24	24	24

*Note: **.Chi-Square is significant at the 0.05 level (2-tailed).*

Examining Table 2, it was observed that Pearson chi-square value (*P*) was 0.046. So at the 0.05 significance level, a statistically significant correlation was found between match outcomes and the game formation of the Turkish National Soccer Team.

Examining Table 3, it was observed that Spearman correlation coefficient value was 0.444 and Sig. (2-tailed) value (*P*) was 0.030. So at the 0.05 significance level, a statistically significant correlation at the middle level on positive direction was found between match outcomes and the positive shoot rate of the Turkish National Soccer Team.

Examining Table 4, it was observed that Spearman correlation coefficient value was 0.574 and Sig. (2-tailed) value (P) was 0.003 for the positive defence rate on the 1st zone and Spearman correlation coefficient value was 0.533 and Sig. (2-tailed) value (P) was 0.007 for the positive defence rate in the 2nd zone. So at the 0.01 significance level, a statistically significant correlation at the middle level on positive direction was found between match outcomes and the positive defence rate on the 1st zone and the positive defence rate in the 2nd zone of the Turkish National Soccer Team.

IMPROVE

This phase consists of works which are proposed and should be applied to provide success in defence in the 1st zone. These works are:
- 1 v 1 defending drills (pressure),
- 2 v 2 defending drills (pressure-support),
- 3 v 3 defending drills (pressure-support-balance),
- Defending responsibilities of the 2nd zone players in the 1st zone,
- Binary compression,
- Depth drills on defending,
- Defending drills for cross ball,
- Defending drills for wing attacks.

CONTROL

In this phase, by analyzing the database of matches of the Turkish National Soccer Team in the 2012 and 2013 seasons, process capability analysis was made for the positive defence rate in the 1st zone variables which had the most effect on match outcomes (Spearman Correlation Coefficient = 0.574).
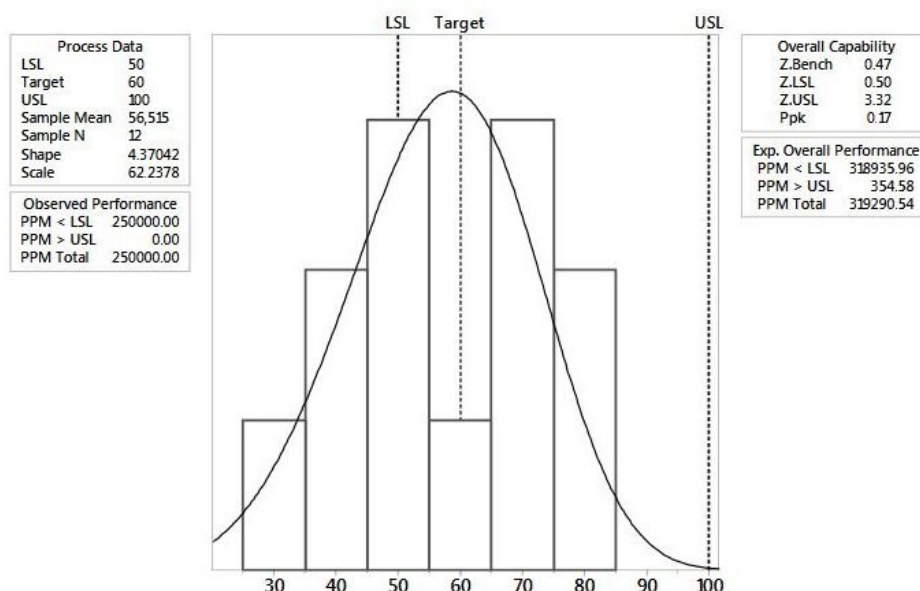

Fig. 1. Process capability analysis of the positive defence rate in the 1st zone in 2012. Calculations based on the Weibull Distribution Model

When Figure 1 examined, it was observed that Z. Bench value (sigma value) was 0.47, and the ppm (parts per million) value was 319,935.54 for the positive defence rate in the 1st zone in 2012. When match outcomes were examined,

it was observed that the Turkish National Soccer Team had six losses, one draw and five wins of twelve matches in the 2012 season.
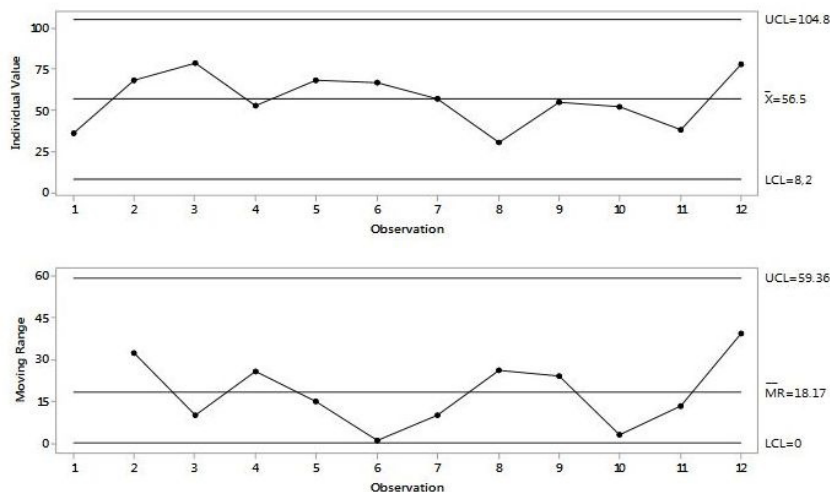

Fig. 2. I-MR control chart of the positive defence rate in the 1st zone in 2012

When Figure 2 was examined, it was observed that the positive defence rate in the 1st zone process was under control in the 2012 season.
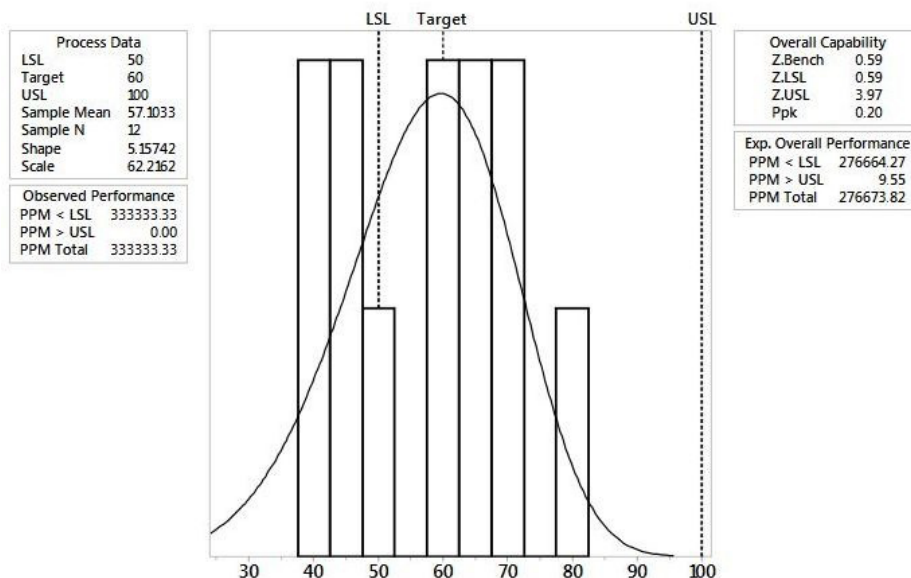

Fig. 3. Process capability analysis for the positive defence rate in the 1st zone in 2013. Calculations based on the Weibull Distribution Model

When Figure 3 was examined, it was observed that Z. Bench value (sigma value) was 0.59, and ppm (parts per million) value was 276,664.82 for the positive defence rate in the 1st zone in 2013. When match outcomes were examined, it was observed that the Turkish National Soccer Team had six wins, three draws and three losses of twelve matches in the 2013 season. As it is seen from these data, when process quality increased, in other words faults made by soccer players decreased, success increased.
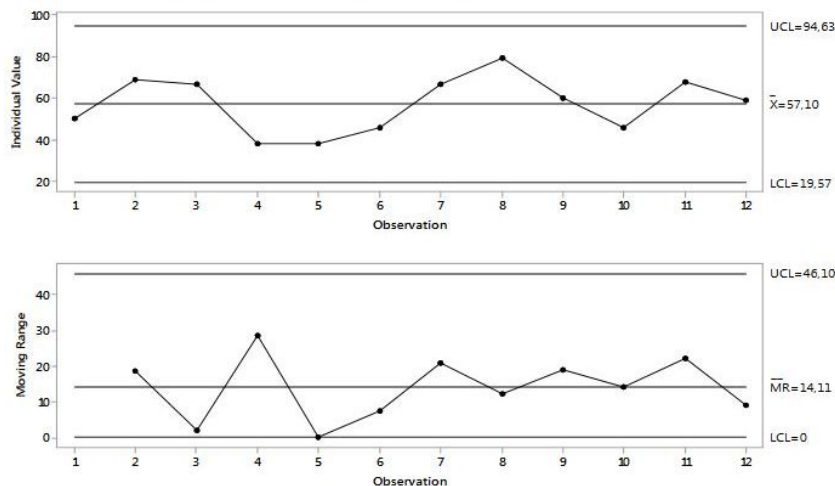
Fig. 4. I-MR control chart of the positive defence rate in the 1st zone in 2013

When Figure 4 was examined, it was observed that the positive defence rate in the 1st zone process was under control in the 2013 season.

DISCUSSION

As a result of the research, it was found that the match type, the match location (home or away matches), trainer, players' mean age, the 1st half, the 2nd half and the overall ball possession, play the ball rate in the 1st, the 2nd, the 3rd and the opponent zone, the positive short pass rate, the positive long pass rate, the average pass time, average pass, the play with pass rate, the positive headshoot rate, the positive right wing attack rate, the positive left wing attack rate, the positive central attack rate, sprints which were made to the penalty area by players, the positive ball rate returning from the opponent after shooting, corner, free kick in the 3rd zone, missing ball rate in the 1st, the 2nd, and the 3rd zone, the winning ball rate in the 1st, the 2nd and the 3rd zone, offside, yellow cards, temperature, pressure, humidity and altitude hadn't affected match outcomes of the Turkish National Soccer Team. On the contrary, it was found that game formation, the positive shoot rate, the positive defence rate in the 1st zone and the positive defence rate in the 2nd zone affected match outcomes of the Turkish National Soccer Team.

A statistically significant correlation was found between match outcomes and the game formation. The Turkish National Soccer Team used 4-2-3-1 and 4-4-2 formations in matches which were played in the 2012 and 2013 seasons, and it was more successful in the 4-4-2 formation. The 4-2-3-1 formation has shortcomings in terms of defense and offense, contrary to the 4-4-2 formation. It is also said that these shortcomings prevent winning the matches. In the 4-4-2 formation, four players in the midfield have both defensive and offensive tasks. The Turkish National Soccer Team with the contribution of four players in the midfield concluded the defensive principles positively in the 4-4-2 formation and with this formation it had fewer goals allowed in the played matches. In the 4-2-3-1 formation, it can be thought that especially wing players have attack tasks, and because of these tasks they cannot fulfill the defensive tasks in all defence zones.

A statistically significant correlation in the positive direction was found between match outcomes, the positive defence rate in the 1st zone and the positive defence rate in the 2nd zone. Pressure, support and balance are some of the defence

principles of soccer. Never applying or not applying on time these principles will create some free space in the defence zone in favor of the opponent team, so teams which make a mistake in the defence zone will have more goals allowed.

Soccer is a game played as a result of the symmetric interaction of offense and defense. During attack, offensive players show their improvization skills, and their individual skills are important. Both teams start the match with one point. First they must maintain this situation. Defence is a workable parameter in soccer and is not affected by individual players' skills.

A statistically significant correlation in the positive direction was found between match outcomes and the positive shoot rate. To enter the goal zone and to shoot are two of the attack principles of soccer. If teams have better shoot quality, they will easily score. Erdil et al. stated that in their study that Spain, which was the champion of the 2010 World Cup, had twice more accurate shoot rate when compared to opponents [3]. Arıkan et al. in their study stated that the winning team had higher percentage of the last shoots [16].

In this study, via some improvement, the z bench value for Six Sigma was increased from 0.47 to 0.59. In a study made in the USA, matches had been played four seasons, and a play-off season of the basketball team was examined, and some faults were found. As a method, DPMO (defects per million opportunities) value was used for every season and the calculated sigma level. By improvements for every fault in the game, they tried to increase the process performance. In season one and two, the DPMO value was 151,133.5; in season three and four, the DPMO value was 120,786.5, and in the play-off season, the DPMO value was 106,339.5. As a result of the improvements as faults decreased, the process sigma level was increased from 2.50 to 2.75 [9].

Cheng & Shih in their study, which aimed to minimize service faults at sports center by the Six Sigma methodology, emphasized customer focused principles which is one of Six Sigma principles and emphasized that control and improvement plans need to be prepared by sports centers [17].

In another study made in Turkey, it was investigated whether managers working in sports federations have the necessary managerial perspective to successfully apply the Six Sigma management model in sports federations, and the applicability of the six sigma management model was tested at the departments of management, organization, service, manufacturer and human resources. 298 managers from 56 sports federations filled in questionnaires about six sigma fundamental principles and quality work in organizations. As a result of the questionnaires, it was found that the six sigma management model was applicable [18].

In their study, Çavuşoğlu et al. investigated 50 sports clubs in Istanbul for total quality management, and they found that eight sports clubs implemented total quality management [19]. In another study, Yılmaz & Akay investigated sports managers in Antalya for total quality management, and they found that most of them had not implemented it [20].

In the sports fields where competitions are getting fiercer than ever, enhancing the coaches' professional abilities to upgrade training results is critical to sports-related organizations and can also serve as an example for elevating professional abilities for sport coaches [7].
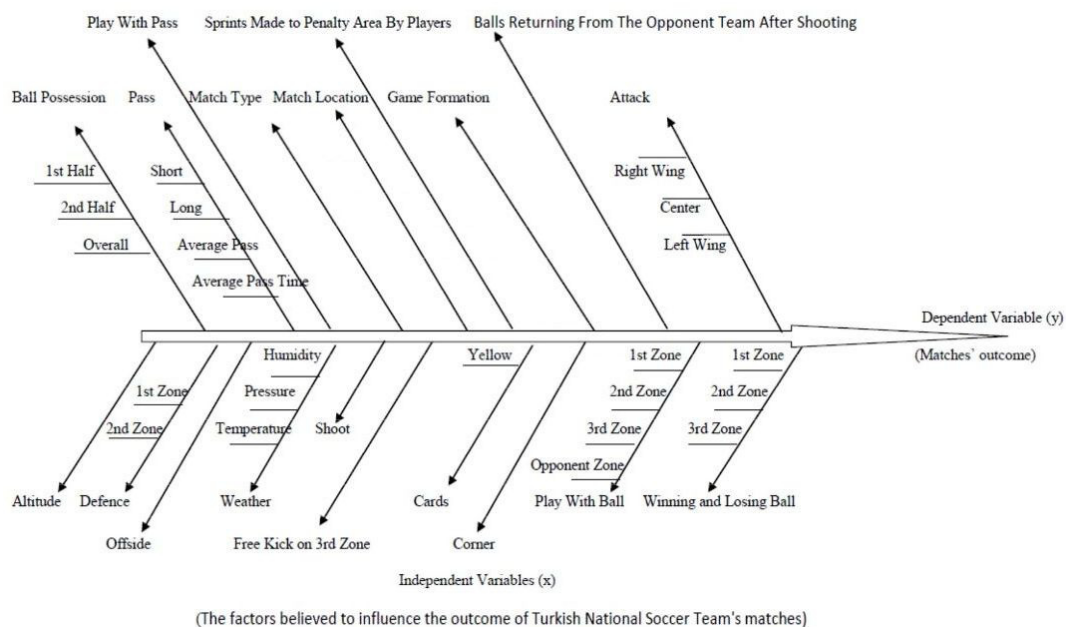
CONCLUSIONS

In conclusion, as a result of the research, it can be said that the six sigma management model is applicable for coaching or training in soccer. It can be considered that this application will be a model for the other research which will be done in the future.

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APPENDIX 1. FISHBONE DIAGRAM

(The factors believed to influence the outcome of Turkish National Soccer Team's matches)