Structure of competitors' activities of top table tennis players

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Abstract Subject of this research is the structure of competitors' activities in sample of 62 top table tennis players (mostly leading World players - ranked in the first 100 at ITTF Rank list) in competing season 1996/97, 1997/98 and 1998/99.

Competitors' activities were analyzed in 61 activities (variables), grouping in 3 systems of activities (variables):

1. System of variables for evaluation of frequency, way of realization and effective of technical and tactical elements (30 variables)

frequency of technical and tactical elements
- Effect of these elements
- Stroke placement zone
- Stroke realization zone

2. System of variables for evaluation of realization service stroke (and returning of service) and effective after service stroke (and returning service) (23 variables)
- Realization of service stroke (type of service and service placement zone)
- Effect of service stroke and activity after the service
- Realization (type) of returning service
- Effect of returning stroke

3. System of variables for evaluation of movement activities (8 variables)
- Side and deep movements
- Change of forehand and backhand position
- Stroke in forehand/backhand position and arm swinging for forehand/backhand strokes

Research consists of the analysis of competitor's activities for all players, and from the aspect of :
1. success in play (winners and losers),
2. quality of players (position at ITTF Rank list) (better player, and lower ranked).

For every analyzed activity basic statistical data, frequency data, percentage in complete activity and group of activity, as a characteristic from the aspect of success of play and quality of player, are done.

The statistical importance differences between :
- winners and losers
- better and lower ranked are fortified.

The research consists of interpretation 3 part structure of competitors' activities of top table tennis players (as the results of Cluster analysis) and interpretation of the main factors of modern table tennis. The structure of analyzed players is fortified, also.

Basic aim of this research is rationalization and higher effectively of training process in table tennis. Considering these results of research, which are explaining modern concept of table tennis game, and factors which influence success of play and quality of play and players.

1 Problem, subject and aim of the research

Problems in this research are connected with the effort to discover and define lawfulness in the area of table tennis game, and mostly those which contribute to fortify exactly parameters which are, on the other way, important for the methodology of training process.

During the players training process, from the beginning to the end of his sport career, at competition he is trying to dominate in game and naturally to win his opponent. In his play during the game he apply (more or less) those technical and tactical activities which he learned and improved in his training and during the competition. Whole technical and tactical potential, as the result of programs of his training as the results which he get at competition, make unique whole of creative process which must be in close correlations and condition. How that potential will be used rationally and in function of competitors activities, mostly depending from the program's of the training process, and his connection with the game claim (requires).

From the aspects of possibilities of the rationalization of training process, it will be very important to define those importance thing in the structure of competitors activities, from the less important segments.

To get clue to get this problem in the area of technical and tactical activities, as for the whole competitors activities (which make the justifiableness of training programs), it is necessary, from the one hand studying practically effect of the training programs, and on the other hand structure of competitors activities (during the competition).

For the fortifying of the structure of competitors activities, I applied those cybernetic process, in which outgoing information regulate incoming information on the base, so called "negative returning connection", in the purpose of the exactly fortifying and defining of the activities during the competition in case of the table tennis players.

Main subject of this research is the competitors activities of top table tennis players. Considering previously research, and myself playing and coaching experience, I created the system for the appraisal of competitors activities of table tennis players, with the personal opinion that the quantity of table tennis game, may be analyzed thru the 3 quality of game. Complete competitors activities was analyzed on the base of the 3 system of activities (considering complexivity of table tennis game) :

1. System of activities for the appraisal of frequency, way of realization and

effective of technical and tactical elements,

2. System of activities for appraisal of realization of service stroke (and returning of service) and effective after service stroke (and after the returning the service),

3. System for the appraisal of movement activities.

In first two systems of activities, results have qualitative analyzes, beside the movements activities consists only the quantitative analyzes (without there importance for the effect of play).

Structure of competitors activities was study as a Complete activities of whole analyzed table tennis players, and from the aspects of success in play (winners/losers), and from the aspects of quality of analyzed players (position on the ITTF Rank List – better/lower ranked).

Major aim is new attitude to the table tennis game from the aspect of serious science principle of research. In this attitude table tennis game was looked thru the science and practical way.

Aim of the science attitude is, on the results of the analyses of competitors activities, establish the possibility of the exact definition of table tennis game, and possibility of the defining lawfulness in table tennis game of top table tennis players.

Practical aim of this research is analyzing table tennis game from the aspects of success (final score) and from the aspects of quality of players (the best players in the World, and those who are not the best) and relation between those.

In one sentence, the Aim of this research is improving of table tennis training process in way of rationalization and higher effect of play at competition.

By the results of research I fortified following :

1. Complete competitors activities is fortified.

2. Factors of the competitors activities of table tennis players are fortified and the variables for the evaluation of competitors activities (structure variables).

3. Differences between the competitors activities from the aspects of success in play (winners/losers) and from the aspects of player's quality (better/lower ranked) are fortified and defined.

2   Methodology of research

2.1 Research methods

As the major (dominate) research method the unexperimental systematic observation was used.

2.2 Sample of analyzed matches and players

Analyzed matches and players :

There were analyzed 35 matches (70 top table tennis players in competing seasons 1995-1998/99.) in folowing competitions :

- WC World Champioship
- EC European Championship
- TT Bundesliga (German Championship)
- ITTF Pro Tour Tournaments

●   European Champions League

2.3 Technique and instruments for the collecting data for research

In research following technique and instruments for the collecting data were used :

1. INQUIRY

By the instruments for the collecting data – questionnaire - which consist 9 question (short and clear answers were asked). Questionnaire was at English, and requiring time was 10 minutes.

2. OBSERVING

Was done with the technical equipment :

1 video tape (which are make during the competition by the vide cameras, and the other video material was taken thru the live broadcast o from TV and SATELLITE program.)

2 VCR (reproduction of video tapes was done by the VCR with the abilities for fine regulation of reproduction speed (slow motion effect,...))

As the instruments fro the collecting data, 3 lists were formed :

LIST 1 –   For appraisal of frequency, way of realization and effective of technical and tactical elements

LIST 2 –   For appraisal of realization of service stroke (and returning of service) and effective after service stroke (and after the returning the service)

LIST 3 –   For appraisal of movement activities.

2.4 Analyzed activities

Considering table tennis specific characteristic, as also and subject and the aim of the research, competitors activities of top table tennis player's was evaluate on the base of 3 systems of activities.

1. SYSTEM OF ACTIVITIES FOR APPRAISAL OF FREQUENCY, WAY OF REALIZATION AND EFFECTIVE OF TECHNICAL AND TACTICAL ELEMENTS (30)

Frequency of technical and tactical elements

1. SERVIC	-	Service stroke
2. FHCONT	-	Forehand counter stroke (with small rotation, smash,...)
3. FHBLOC	-	Forehand block stroke
4. FHFLIC	-	Forehand flic stroke
5. FHSPIN	-	Forehand top spin
6. FHSPBS	-	Forehand top spin on backspin
7. FHBCSP	-	Forehand backspin stroke
8. FHOTHE	-	Forehand others stroke (defense stroke far away from table, backspin defense from the table,...)
9. BHCONT	-	Backhand counter stroke (with small rotation, smash,...)
10. BHBLOC	-	Backhand block
11. BHFLIC	-	Backhand flic stroke
12. BHSPIN	-	Backhand top spin

13. BHSPBS   -   Backhand top spin on backspin
14. BHBCSP   -   Backhand backspin stroke
15. BHOTHE   -   Backhand others stroke (defense strokes far away from table, backspin defense from table,...)

Effect of technical and tactical elements

16. ACESTR   -   Ace stroke (opponent had been in play out situation)
17. WINSTR   -   Winning stroke (opponent had contact with ball)
18. NORSTR   -   Normal stroke (opponent return stroke in game)
19. ERRORS   -   Error stroke
20. PLYOUT   -   Play out (players didn't make contact with his racket)

Stroke placement zone

21. OUTBPS   -   Outside backhand zone placement stroke
22. MIDBPS   -   Middle backhand zone placement stroke
23. MIDFPS   -   Middle forehand zone placement stroke
24. OUTFPS   -   Outside forehand zone placement stroke

Stroke realization zone

25. OUTBHS   -   Outside backhand zone stroke
26. MIDBHS   -   Middle backhand zone stroke
27. MIDFHS   -   Middle forehand zone stroke
28. OUTFHS   -   Outside forehand zone stroke
29. NEARTS   -   Stroke made in zone near the table (until 1.5 meter zone)
30. FARFTS   -   Stroke made in zone far from table (from 1.5-4 meter zone)

2. *SYSTEM OF ACTIVITIES FOR APPRAISAL OF REALIZATION SERVICE STROKE (AND RETURNING OF SERVICE) AND EFFECTIVE AFTER SERVICE STROKE (AND RETURNING SERVICE) (23)*

Realization of service stroke (type of service and service placement zone)

31. FLONSE   -   Forehand long service
32. FSHOSE   -   Forehand short service
33. BLONSE   -   Backhand long service
34. BSHOSE   -   Backhand short service
35. SEROBZ   -   Service placed in outside backhand zone
36. SERMBZ   -   Service placed in middle backhand zone
37. SERMFZ   -   Service placed in middle forehand zone
38. SEROFZ   -   Service placed in outside forehand zone

Effect of service stroke and activity after the service

39. SERACE   -   Ace service
40. SERWFS   -   Point won with first stroke after service
41. SERACT   -   Point won with action after service (more than one stroke)
42. SERLOS   -   Point lost after service
43. SERERR   -   Service error

Realization (type) of returning service

44. FFLICR   -   Forehand flic return service

45. FSPINR	-	Forehand topspin return service
46. FBCSPR	-	Forehand backspin stroke return service
47. BFLICR	-	Backhand flic return service
48. BSPINR	-	Backhand topspin return service
49. BBCSRE	-	Backhand backspin stroke return service

Effect of returning stroke

50. RSEACE	-	Returning service ace stroke (as a ace and winning stroke)
51. RSEWPO	-	Point won by the returning service (in action after returning)
52. RSLSPO	-	Point lost after returning service
53. RSERRO	-	Returning service error

3. SYSTEM FOR APPRAISAL OF MOVEMENT ACTIVITIES

54. DEPMOV	-	Deep movements
55. SIDMOV	-	Side movements
56. CHSBTP	-	Change from service to basic table tennis position
57. CHFBBP	-	Change of forehand/backhand position during point
58. STFHBP	-	Stroke made in basic forehand position
59. STBHBP	-	Stroke made in basic backhand position
60. ASFHST	-	Arm swinging for forehand stroke
61. ASBHST	-	Arm swinging for backhand stroke

3 Statistical analyses

For all analyzed activities (variables) following statistical parameters are done :

Descriptive statistics :

1 Arithmetic Middle
2 Standard Deviation
3 Variation (Maximum and Minimum results)
4 simple and relative Frequency

Percentage in complete activity and group of activity are done.

Interco relation was realized by the *Linear (Spearman) Correlation* (Pearson product moment correlation coefficient).

Analysis of Variance (ANOVA) (model One-way Between Groups) was used for the defining of existing differences between analyzed groups of players (winner/loser ; better/lower ranked).

For defining of the structure of competitors activities of table tennis players, research in latent space, *Cluster analysis* is used (*model K-means Clustering*).

All the results of research are presented with appropriate text, graphs and tabs.

4 Results of descriptive statistics

4.1 Descriptive statistic analysis for group winners (model of play)

Players members of the Winners group have in their competitors activities following characteristics (some of these characteristics are compare with model of play of the Loser group) :

1. CHARACTERISTICS OF FOREHAND STROKES

Mostly used forehand stroke in Winners play is forehand topspin (FHSPIN), than forehand backspin (FHBCSP) and forehand topspin on backspin (first attack stroke) (FHSPBS). It is observed that Winners in front of the players from Loser group use less forehand flick (FHFLIC), but much more use forehand topspin, and less from Loser's forehand topspin on backspin.

2. CHARACTERISTICS OF BACKHAND STROKES

Mostly used backhand stroke is backhand block (BHBLOC), than backhand counter stroke (BHCONT), backhand topspin on backspin (BHSPBS), backhand topspin (BHSPIN) and backhand backspin (BHBCSP). In comparation with Losers, Winners much more use offensive backhand strokes, as a backhand topspin on backspin and backhand topspin, and less mostly defensive stroke which are used only in purpose to stay in game (rally), without possibility of taken initiative, as backhand block, counter stroke and backspin stroke.

3. QUALITATIVE ANALYSIS OF REALIZED STROKES

Mostly strokes realized by Winners are Normal strokes (NORSTR). Following are Ace strokes (ACESTR) and Winning strokes (WINSTR). As a consequence of large number of successfully realized strokes, the difference between Winner and Loser group are observed in winners advantage. Winner have a small percentage of Error stroke in comparation to Loser. There are no differences in play out situation.

4. STROKE PLACEMENT ZONE

Winner usually their strokes place in Outside backhand zone (OUTBPS) and Outside forehand zone (OUTFPS). In comparation to Loser, they less use the outside backhand zone.

5. STROKE REALIZED ZONE

Most of their strokes Winner realize from Outside backhand zone (OUTBHS), little bit less from Middle backhand zone (MIDBHS) and from Outside forehand zone (OUTFHS). In comparation with Loser, Winner have less realization from outside backhand and outside forehand zone, probably as a consequence of bad placement stroke (to outside line of table) by Loser's. Winner's have a little bit more strokes realized from the zone far away from table (FARFTS).

6. CHARACTERISTICS OF REALIZED SERVICES AND SERVICE PLACEMENT ZONES

In Winner's play mostly used is forehand short service (FHSHSE), following is forehand long service (FHLOSE) and in some cases there is at third place backhand short service (BHSHSE). In comparation with Loser's forehand short service is in less use, while forehand long service is more used.

Mostly service is placed in middle backhand zone (SERMBZ), middle forehand zone (SERMFZ) and outside forehand zone (SEROFZ). In comparation with Loser's, Winner's less use zone of middle forehand and backhand, but more

use service placement in zone of outside forehand (usually as a forehand long service of surprise).

7. EFFECT IN REALIZATION OF SERVICE STROKE

Winner's are usually realized a point on their service by first attacking stroke (SERWFS), than with ace service (SERACE) and something less in action after service (SERACT). In comparison with Loser's, Winner's much more realized their points by first attacking stroke after service and by ace service, while less points they won by attacking action after service in stead of Loser's.

In comparison with Loser's they have much less number of lost point after service (SERLOS) and they make less number of service error (SERERR).

8. CHARACTERISTICS AND EFFECT OF RETURN STROKES

Winner's mostly use as a return stroke forehand backspin (FBCSPR) and forehand topspin (FBSPINR). In comparison with Loser's, Winner's much more use forehand backspin for return, while forehand topspin is less used. This is caused by Loser's dominating short services in play.

Larger number of points won after return services (RSEWPO) and return ace strokes (RSEACE) are notes in Winner's play. Number of points lost after return of service are equal for winner's and loser's, while winner's making less number of return error strokes than loser.

9. CHARACTERISTICS OF ANALYZED MOVEMENTS ACTIVITIES

In comparison with Loser's, Winners have less number of side movements (SIDMOV) and a little bit larger number of deep movements (DEPMOV).

Than lees change forehand/backhand basic position during point (CHFBBP), and much number strokes realized in basic forehand position (STFHBP) and forehand arm swinging (ASFHST). All these data give us clear picture of much more realized forehand play of Winner's in stead of Loser's.

Generally, Winner's in play dominate with forehand strokes, which are very effective (as a one possibility of good effective is and a fact of very good precision of strokes – placement). They have good realization of their services and have good effectively of return service strokes. Movements activities are connected with forehand play near the table.

4.2 Descriptive statistic analysis for group better (model of play)

Players members of the Better group have in their competitors activities following characteristics (some of these characteristics are compare with model of play of the Lower ranked group) :

1. CHARACTERISTICS OF FOREHAND STROKES

Mostly used forehand stroke in Better play is forehand topspin (FHSPIN), than forehand backspin (FHBCSP) and forehand topspin on backspin (first attack stroke) (FHSPBS). It is observed that Better in front of the players from Lower ranked group use less forehand flick (FHFLIC), but much more use forehand topspin, which is a consequence of offensive tactic play.

2. CHARACTERISTICS OF BACKHAND STROKES

Mostly used backhand stroke is backhand block (BHBLOC), than backhand counter stroke (BHCONT), backhand backspin (BHBCSP), backhand topspin on backspin (BHSPBS), and backhand topspin (BHSPIN). In comparation with Lower ranked, Better much less use all backhand's strokes.

3. QUALITATIVE ANALYSIS OF REALIZED STROKES

Mostly strokes realized by Better are Normal strokes (NORSTR). Following are Winning strokes (WINSTR) and Ace strokes (ACESTR). There is difference in number of normal stroke between Better and Lower ranked (in Better advantage). In case of Better player's there is also evident larger number of Error stroke (ERRORS), this can be explained with much more risk in play of Better player.

In play out (PLYOUT) situation there is no some large difference, but following the numbers we can conclude than Better player's are less in this situation than Lower ranked players.

4. STROKE PLACEMENT ZONE

Better usually their strokes place in Outside backhand zone (OUTBPS) and Outside forehand zone (OUTFPS) . In comparation to Lower ranked, they much more use the outside forehand placement zone.

5. STROKE REALIZED ZONE

Most of their strokes Better realize from Outside backhand zone (OUTBHS), little bit less from Middle backhand zone (MIDBHS) and from Outside forehand zone (OUTFHS). In comparation with Lower ranked, Better have less number of realized stroke from outside backhand and outside forehand zone. Better have a little bit more strokes realized from the zone near the table (NEARTS), which is a consequence of their offensive and dominated play.

6. CHARACTERISTICS OF REALIZED SERVICES AND SERVICE PLACEMENT ZONES

In Better play mostly used is forehand short service (FHSHSE), following is forehand long service (FHLOSE) and in some cases there is at third place backhand short service (BHSHSE). In comparation with Lower ranked forehand short service is in less use, while forehand long service is much more used.

Mostly service is placed in middle backhand zone (SERMBZ), middle forehand zone (SERMFZ) and outside forehand zone (SEROFZ). In comparation with Lower ranked, Better less use zone of middle forehand and backhand, but more use service placement in zone of outside forehand (usually as a forehand long service of surprise).

7. EFFECT IN REALIZATION OF SERVICE STROKE

Better are usually realized a point on their service by first attacking stroke (SERWFS), than by action after service (SERACT) and something less with ace service (SERACE). In comparation with Lower ranked, Better much more realized their points by first attacking stroke after service and by ace service, while less points they won by attacking action after service in stead of Lower ranked.

In comparation with Lower ranked they have near equal number of lost point after service (SERLOS) and they make less number of service error (SERERR).

8. CHARACTERISTICS AND EFFECT OF RETURN STROKES

Better players mostly use as a return stroke forehand backspin (FBCSPR) and forehand topspin (FBSPINR). In comparation with Lower ranked, Better much more use forehand backspin for return, while forehand topspin is equally used. This can be explained as a tactic play for a safe return of short services and taking a possibility of attacking by forehand topspin on every long opponent's service.

Larger number of points won after return services (RSEWPO) and return ace strokes (RSEACE) are notes in Better play. Number of points lost after return of service are something more than in Lower ranked play, while Better making less number of return error strokes than Lower ranked players.

9. CHARACTERISTICS OF ANALYZED MOVEMENTS ACTIVITIES

In comparison with Lower ranked, Better have larger number of side movements (SIDMOV) and deep movements (DEPMOV), which can be explained by a better footwork (which allow longer stay in point and success in hard and complicated situation, as a better position for stroke realization – which implicate better quality of stroke and play).

Much larger number of stroke realized in basic forehand position (STFHBP) and larger number of arm swinging for forehand stroke (ASFHST), which indicate much more forehand play in stead the Lower ranked play.

Generally, Better player's in play dominate with forehand strokes, which are very effective (as a one possibility of good effective is and a fact of very good precision of strokes – placement). They have good realization of their services and have good effectively of return service strokes. Movements activities are connected with forehand play near the table.

5 Results of analysis of variance (ANOVA) for factors winner/loser

From the results of *Analysis of Variance*, we can get conclusion that there is a statistical significant deference between the analyzed groups (on p level p = .00 -.05). Statistically significant differences are isolated in 6 analyzed activities (variables).

Statistically significant difference on level $p = .00 - .01$ are :

39. ACESER	(.00)
19. ERRORS	(.01)
42. SERLOS	(.01).

Statistically significant difference on level $p = .02 - .05$ are :

30. FSHOSE	(.02)
46. FBCSPR	(.03)
53. RSERRO	(.05).

We can get conclusion that Winners are dominated in point won directly from service (ACESER), they more use forehand backspin return (FBCSPR).

In Loser's case there is larger number of error stroke (ERRORS), more use of forehand short service (FHSHSE), larger number of lost point on their service (SERLOS) and larger number of return error (RSERRO).

Differences can be interpret ate as following :

1. ACESER (Ace service)

Values of arithmetic middle are much larger in Winner group players, which indicate to much larger effect of their services (quality of service) and at the other hand at very unsuccessful return of Lost players.

2. ERRORS (Error stroke)

Values of arithmetic middle are much larger into Loser group, which is one of the most dominated factor of their lost in game.

3. SERLOS (Lost point after service)

Values of arithmetic middle of lost point after serving are larger in Lost group, which indicate poor possibility of taking initiative by service and winning point in following action.

4. FSHOSE (Forehand short service)

Values of arithmetic middle of forehand short service are larger in Loser group than the Winner players. This is a consequence (this is only generated by the conclusion about the analyzed matches) by the fact that Loser players tried in theirs matches to take initiative in their game after short services and make small possibility of first attacking of their opponents (attack stroke at their services), while Winner players were in situation of more use of longer service, and easy control of game and taking the initiative in play after that.

5. FBCSPR (Forehand backspin return stroke)

Values of arithmetic middle of forehand backspin return stroke are much larger in Winner group. We can conclude that Winner in their matches use this way of return which give them not only safety in return, also and good chance to take the initiative in following action (by precise placement of ball). Also this give us a picture, that this way of return is used as the answer to short service tactic of Loser, and that the quality of their service is not good to make some return problems to Winner players.

6. RSERRO (Return stroke error)

Values of arithmetic middle of return stroke error are on side of Loser players. This fact can be consequence of better quality of Winner services, but in the other hand can be also consequence of higher risk in Loser game (when they are convinced that they are not dominate in play, and that they must play with more risk to change the way of game, and as a fact of poor realization of their services).

6   Results of analysis of variance (anova) for factors better/lower ranked

From the results of *Analysis of Variance*, we can get conclusion that there is a statistical significant deference between the analyzed groups (on p level $p = .00$ -.05). Statistically significant differences are isolated in 8 analyzed activities (variables).

Statistically significant difference on level $p = .00 - .01$ are :

09. FHBCSP	(.00)
46. FBCSPR	(.00)
26. MIDBHS	(.01)
58. STFHBP	(.01).

Statistically significant difference on level $p = .02 - .05$ are :

60. ASFHST	(.02)
06. FHSPBS	(.03)
54. DEPMOV	(.05)
55. SIDMOV	(.05).

We can get conclusion that Better dominated in forehand backspin play (FHBCSP) which is correlated with forehand backspin return (FBCSPR), they

realize more stroke from middle backhand zone (MIDBHS), and in their play dominate forehand play (stroke realized in forehand basic position (STFHBP) and arm swinging for forehand strokes (ASFHST). Also, there are a larger number of movements activities (deep movements (DEPMOV) and side movements (SIDMOV)), which indicate better footwork technique.

In Lower ranked case there is only larger number of forehand topspin on backspin (FHSPBS), and in all others significant differences they are in lower position than Better players.

Differences can be interpret ate as following :

1. FHSPBC (Forehand topspin on backspin)
Values of arithmetic middle are much larger in Loser players group. They need more aggressive play so they use every possibility to start with attack (mostly trying to won point by first attacking stroke or taking the initiative in play). But as we analyzed before in Model of play of best players, there is a fact that their tactic is based on forehand backspin precise placement, so this first attack topspin performed by not quality equal players, are not so successful, and good control of these strokes is possible, the same as a possibility of taking over the initiative by counter topspin play (and initiative in play).

2. FHBCSP (Forehand backspin stroke)
Values of arithmetic middle of forehand backspin stroke are much larger in Better players group, as a consequence of more forehand backspin return strokes in play.

3. FBCSPR (Forehand backspin return stroke)
Values of arithmetic middle of forehand backspin return are much larger into Better group. About this fact it was many conclusion before (safe and precise placement from best players).

4. MIDBHS (Middle backhand realized stroke)
Values of arithmetic middle of middle backhand realized stroke is larger in Better group. This is a consequence from poor placement by Lower ranked players (not able to place ball precisely to outside zone of table – so this is a fact more about the quality of best player's stroke), so that is co used by more realized strokes of Better from middle backhand zone (mostly by forehand offensive strokes).

5. DEPMOV (Deep movements)
Values of arithmetic middle of deep movements are much larger in Better case. They have larger quantity of footwork and radius of movements in stead of Lower ranked, which give them advantage of better basic position for stroke realization (rising the quality of stroke) and they are staying longer in point (by reaching and returning hard ball for complicated situation).

6. SIDMOV (Side movements)
Values of arithmetic middle of forehand backspin return stroke are much larger in Winner group. We can conclude that Winner in their matches use this way of return which give them not only safety in return, also and good chance to take the initiative in following action (by precise placement of ball). Also this give us a picture, that this way of return is used as the answer to short service tactic of Loser, and that the quality of their service is not good to make some return problems to Winner players.

7. STFHBP (Stroke realized in basic forehand position)

Values of arithmetic middle of stroke realized in basic forehand position are larger in Better group, which implicate of domination of forehand stroke play.

8. ASFHST (Arm swinging for forehand stroke realization)

Values of arithmetic middle of arm swinging for forehand stroke realization are larger in Better group of player's, same as in the previously case, by tactical play by forehand strokes during the game (which are most effective in stead of backhand stroke in modern table tennis).

7 Results of cluster analysis (model K-means Clustering)

In this case of Cluster Analysis (by K-means Clustering model), hypothetically was set 3 isolation of 3 Clusters (Factors) of competitors activities of top table tennis players, as it was at the beginning of research (but without any prediction, these systems were set only because of easier analyzing of collected data and interpretation of results) :

1. System of activities for the appraisal of frequency, way of realization and effective of technical and tactical elements,

2. System of activities for appraisal of realization of service stroke (and returning of service) and effective after service stroke (and after the returning the service),

3. System for the appraisal of movement activities.

1 Every fortified Cluster (Factor) was analyzed from several point of view :

2 From the success of playing (winner/loser) and quality of players (better/lower ranked)

3 Characteristics of Factors in stead of hypothetically set of 3 systems of activities

4 Characteristics of players with larger and lower value of Arithmetic middle of Clusters (way of racket hold (plying style), lefthander or right-hander play, quality of competition and which phase of competition, number of played sets in match and number of played points (in match and sets))

5 Comment in front of Analysis of Variance results - by Clustering of players.

In following text will be presented only the basic conclusion and exponation.

FACTOR No 1 (4 VARIABLES)

Inside the Factor No 1., 4 variables are isolated (grouped) :
1. NEARTS
2. STFHBP
3. SIDMOV
4. ASFHST

This Factor can be interpreted as *modern concept of table tennis game* of top tennis player's as a strong forehand play near table, with good side movements

for one side play.

Factor No 1. is named as a CONCEPT OF MODERN TABLE TENNIS PLAY - (Attacking forehand play).

This factor by the analyzed players is connected with a player's quality (of play), because mostly connected are best players in their matches.

FACTOR No 2 (48 VARIABLES)

Inside the Factor No 2., 48 variables are isolated (grouped) :

1. FHCONT	15. ACESTR	29. BSHOSE	43. BSPINR
2. FHBLOC	16. WINSTR	30. SEROBZ	44. BBCSRE
3. FHFLIC	17. ERRORS	31. SERMBZ	45. RSEACE
4. FHSPIN	18. PLYOUT	32. SERMFZ	46. RSEWPO
5. FHSPBS	19. MIDBPS	33. SEROFZ	47. RSLSPO
6. FHBCSP	20. MIDFPS	34. SERACE	48. RSERRO
7. FHOTHE	21. OUTFPS	35. SERWFS	
8. BHCONT	22. MIDBHS	36. SERACT	
9. BHBLOC	23. MIDFHS	37. SERLOS	
10. BHFLIC	24. OUTFHS	38.SERERR	
11. BHSPIN	25. FARFTS	39. FFLICR	
12. BHSPBS	26. FLONSE	40. FSPINR	
13. BHBCSP	27. FSHOSE	41. FBCSPR	
14. BHOTHE	28. BLONSE	42. BFLICR	

This Factor can be interpreted as a *whole competitors activities of table tennis player's*, where are all kind of activities (from technique, tactic, activities with service and return of service) except the movements activities.

Factor No 2. is interpreted as a GENERAL COMPETITORS ACTIVITIES OF TABLE TENNIS PLAYERS.

This factor by the analyzed players is connected with whole sample of analyzed players and make the elements of structure of table tennis game.

FACTOR No 3 (9 VARIABLES)

Inside the Factor No 3., 9 variables are isolated (grouped).

1. NORSTR	6. OUTBHS
2. CHSBTP	7. STBHBP
3. SERVIC	8. OUTBPS
4. ASBHST	9. CHFBBP
5. DEPMOV	

This Factor can be interpreted as a *global table tennis game* (the most use activities in today's top table tennis) which consist service as a beginning stroke, normal strokes as a most used strokes and backhand play, which today is characterized as a very safe stroke (not winning stroke) but in first place used as a normal stroke (with very small percentage of error).

Factor No 3. is named as a BASIC COMPETITORS ACTIVITIES OF TABLE TENNIS PLAYERS.

This Factor (variables) are defining the quality of play (game) and players,

because mostly connected with this factor are good players which played their matches unpredictable until the end of game.

8   Resume

Sample of 70 top table tennis players in 35 matches at leading World, European and Yugoslavian competitions was analyzed with aim of fortifying of structure of competitors activities of top table tennis players and existing of factors which influence at success in modern top table tennis.

In previously stage all analyzed players were grouped in 4 group (WINNER; LOSER; BETTER and LOWER RANKED) including the success in play and quality of players.

This way of grouping implicate parallels analyses of technical and tactical activities, activities connected with serving and return of service and movements activities, in area of applied activities (variables).

After the analysis of results, we can get following resume :

1. Results of analyses of descriptive statistics show that a level of success in play (effect) in realization of technical-tactical activities, and especially activities connected with serving and return of service (include the average valuation) in line with the effect of play (final results) and quality of analyzed players (specially in relation of players from group winner/loser).

This results, also, showed that the percentage of error (of technical and tactical elements, and of element connected with serving and return of service) is good parameter for the final effect of play (result). The lower percentage of error was fortified in group of players WINNER and BETTER.

Players from group WINNER and BETTER are dominate in play by effective forehand strokes, and have very effective service advantage as a successful return of opponents service.

Players from group LOSER and LOWER RANKED have characteristic of passive backhand play during the point and poor effective of their realized strokes. They don't get advantage on their service and have less success in returning of the opponents service.

2. Resuming the results of Analysis of Variance (ANOVA) we can conclude that the differences between analyzed groups in area of applied activities (variables) exists and they are statistically significant.

Results of Analysis of Variance between group Winner/Loser based at success in play (analyzing final result of play) show statistical significant difference in 6 activities (variables) :

1. ACESER   -   Ace service
2. ERRORS   -   Error stroke
3. SERLOS   -   Lost point after servicing
4. FSHOSE   -   Forehand short service
5. FBCSPR   -   Forehand backspin return stroke
6. RSERRO   -   Return service error

Results of Analysis of Variance between group Better/Lower ranked based at quality of players (by the position on ITTF Rank list) show significant difference

in 8 activities (variables) :

1. FHBCSP   -   Forehand backspin stroke
2. FBCSPR   -   Forehand backspin return of service
3. MIDBHS   -   Stroke realized in middle backhand zone
4. STFHBP   -   Stroke realized in forehand basic position
5. ASFHST   -   Arm swinging for forehand stroke
6. FHSPBS   -   Forehand topspin on backspin
7. DEPMOV   -   Deep movements
8. SIDMOV   -   Side movements

So, these isolated activities (variables) are representative activities of players effectively in play and his quality.

3. The results of Cluster Analysis of applied activities (variables) fortified existing of 3 Factor's of table tennis game :

FACTOR 1. - CONCEPT OF MODERN TABLE TENNIS PLAY (Attacking forehand play).

FACTOR 2. - GENERAL COMPETITORS ACTIVITY OF TABLE TENNIS PLAYERS.

FACTOR 3. - BASIC COMPETITORS ACTIVITY OF TABLE TENNIS PLAYERS.

4. The results of Cluster Analysis of analyzed players fortified existing of 2 Clusters of players (these analysis was made with a purpose of finding the difference between best player and those who are not so successful) :

CLUSTER 1. (27 players) – which represent those which survive much longer in system of play (tight matches).

CLUSTER 2. (43 players) – which represent those players which spent short time in system of play (effective matches or easy lost matches).

Conclusion is that these results are product of quantities of competitors activity, without implement of quality of players.

5. Results also fortified that applied system of activities (variables), which represents success in play (isolated differences between winner/loser group) and quality of player (isolated differences between better/lower ranked), is competent and valid for applying in evaluation of success of play and quality of players in table tennis.

In front of previously resumes, we can take the final, general conclusion :

1. Success in modern top table tennis is co used by effective of technical-tactical activities, and specially of successful realization of service and return of service elements.

2. Applied system for the analyzing competitors activities, as the system for analyzing success in play and quality of players can be successfully applied in table tennis.

Generally this research give us opportunity for see or better " to peep " into structure of competitors activities of top table tennis players. Probably one of the aim of this research is to contribute every following research in future, specially which are going to analyzed of effect of program of training process which is directed in development of those activities which will raise the effect at competition and quality of player's (by the results of this research (Factor 1. and Factor 3.).

9   Significance of research

Scientific significance
Is defining of structure of competitors activities of top table tennis players, exploration of table tennis game (as a sport), on the base of table tennis basic visible characteristics (extracted Factors).

Practical significance :
Is defining of modern concept of table tennis by top players, as the defining differences which implicate effect of play and quality of players. On the base of this results, can be modify a training process to reach a model of successful and quality player in modern table tennis.

Following tasks from this research :

1)   Realization of the experimental program (based on results of this research).

2)   Development and changes in table tennis during the long time period can be analyzed (or specifying the one time period) on the base of model of this research (video material is needed).

3)   This research give a lot of next research theme as :

● Fortifying structure of competitors activities at optimum sample of matches (about 180 players must be analyzed – and the leading statistical method's will be Factor Analysis and Discriminative Analysis)

● Fortifying the difference in competitors activities of European and Chinese players,

● Fortifying a tactic solution in play against lefthander, or penholder style players,...,

● Characteristics of service and activities after the service (and return of service),

● Fortifying differences in competitors activities in top junior and senior category (problem of change of age category),...