

# Model of competitive activity of highly qualified decathlers

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Dr. Hab., Associate Professor **A. L. Ogandjhanov**<sup>1</sup>

PhD, Associate Professor **M. B. Salamatov**<sup>2</sup>

PhD, Associate Professor **E.S. Tsyplenkova**<sup>3</sup>

Postgraduate student **S.E. Loktionov**<sup>1</sup>

<sup>1</sup> Moscow City University, Moscow

<sup>2</sup>The Russian University of Sport «GTSOLIFK», Moscow

<sup>3</sup> Tula State University, Tula

Corresponding author: Oga2106@mail.ru

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## Abstract

**Objective of the study** was to develop a model of competitive activity of highly qualified decathletes, to formulate a technology for managing the training process of track and field all-round athletes based on the model.

**Methods and structure of the study.** Instrumental research methods included analysis of documentary materials, video recording and video analysis, photodiode timing, and methods of mathematical statistics.

**Results and conclusions.** Based on a statistical analysis of indicators of competitive activity in certain types of decathlon of the world's leading all-around athletes, a model of competitive activity of highly qualified male all-around athletes was formed. The model allows, based on a comparison of an athlete's performance with model parameters, to analyze the results of a decathlete in individual events, to identify lagging and dominant types of an athlete. This creates opportunities for planning results in individual types of decathlon for the next macrocycle of training and, on this basis, programming the special training of a multi-athlete at the stages of the macrocycle.

**Keywords:** *athletics, all-around, modeling, control of competitive activity.*

**Introduction.** The current stage of development of the theory and methodology of sports is characterized by a transition to program-targeted planning of the training process using models that reflect the structure of competitive activity in the sport, the special physical, technical and tactical readiness of athletes for a specific sports result [4, 6]. The competitive model is one of the important components of program-targeted training planning. At the first stage, the training of male all-around athletes should be based on planning indicators in individual types of all-around for the result planned for the next macrocycle in the decathlon [1-4]. This requires the coach and athlete to make a thoughtful and reasonable forecast of results in certain types of all-around events for the next sports season [1, 3, 5, 7].

**Objective of the study** was to develop a model of competitive activity of highly qualified decathletes

and, on its basis, to formulate a technology for managing the training process.

**Methods and structure of the study.** Instrumental research methods included analysis of documentary materials, video recording and video analysis of competitive activity (Dartfish software), BROWER photodiode chronometers, and methods of mathematical statistics. The study was carried out by employees of a comprehensive scientific group of the Russian national track and field athletics team (multi-event group) as part of the scientific and methodological support for the training of the country's leading all-around track and field athletes.

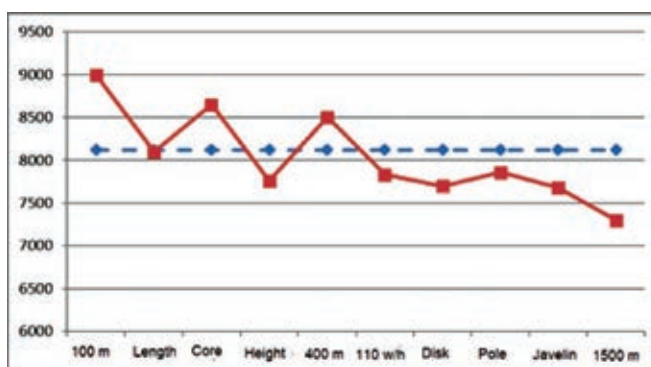
**Results of the study and discussion.** At the first stage of research, the task was set to develop an average model of competitive activity in men's all-around in the range of results of 7700-8700 points. This problem was solved by analyzing the results



in certain types of decathlon of the world's strongest all-around athletes based on performances at all World Championships in the period 1983-2019. For the analysis, the 10 best results of decathletes at each of the seventeen past World Championships in Athletics were taken (the sample included only the results of athletes who competed in all ten types of the all-around program).

The regression analysis of the performance indicators of athletes in individual types of decathlon, carried out at the next stage, allowed us to obtain regression equations on the basis of which model indicators in individual types of decathlon were calculated for a certain competitive result in the decathlon in the range of results of 7700-8700 points (Table 1).

The model of competitive activity can serve as the basis for managing the training process of multi-athletes at various stages of preparation. Using the example of competitive activity indicators in certain types of decathlon, the winner of the 2023 Russian All-Around Cup, International Master of Sports A. K-va, an analysis of competitive activity, the athlete's technical readiness is presented, and recommendations are given for managing the training process for the next stage of preparation. Lagging and strong types of athletes have been identified, limiting factors that hinder the growth of a decathlete's skill have been identified, and promising areas of training have been formed. The diagram shows indicators of an athlete's competitive activity in individual events relative to model parameters.



*Indicators of competitive activity of Master of Sports K-va A. in certain types of all-around relative to the average statistical model for a result of 8119 points. in the decathlon (dashed line – model values; solid line – athlete's indicators)*

**Stage 1.** Analysis of competitive results in certain types of decathlon. An athlete with a pronounced emphasis on the types of the first day of the decathlon (Fig. 1), the basis for success in which is the high level of development of the all-around speed abilities, which is manifested in the results of the 100 m and 400 m sprint, as well as in the long jump. The athlete's relatively lagging events in the decathlon are the events of the second day - long throws (discus and javelin), as well as the 1500-meter run.

**Stage 2.** Analysis of competitive activity in certain types of all-around. At this stage, based on the analysis of the indicators of the athlete's competitive activity using video analysis and photodiode timing, based on comparison with model indicators in certain types of all-around, conclusions are drawn about the effec-

*Table 1. Model characteristics of competitive activity of all-around athletes in certain types of decathlon in the range of results of 7700-8700 points*

| Decathlon, points | Types of decathlon |           |         |           |          |                       |         |         |            |           |
|-------------------|--------------------|-----------|---------|-----------|----------|-----------------------|---------|---------|------------|-----------|
|                   | 100 m, s           | Length, m | Core, m | Height, m | 400 m, s | 110 m with hurdles, s | Disk, m | Pole, m | Javelin, m | 1500 m, s |
| 7700              | 11,20              | 7,20      | 14,05   | 1,92      | 50,30    | 15,00                 | 44,50   | 4,40    | 58,80      | 277,0     |
| 7800              | 11,16              | 7,24      | 14,19   | 1,93      | 50,08    | 14,91                 | 44,70   | 4,47    | 59,45      | 276,5     |
| 7900              | 11,12              | 7,28      | 14,32   | 1,95      | 49,85    | 14,82                 | 44,90   | 4,54    | 60,10      | 276,0     |
| 8000              | 11,07              | 7,32      | 14,46   | 1,96      | 49,60    | 14,73                 | 45,10   | 4,61    | 60,75      | 275,5     |
| 8100              | 11,03              | 7,36      | 14,60   | 1,98      | 49,35    | 14,64                 | 45,30   | 4,68    | 61,40      | 275,0     |
| 8200              | 10,99              | 7,40      | 14,73   | 1,99      | 49,10    | 14,55                 | 45,50   | 4,75    | 62,05      | 274,5     |
| 8300              | 10,95              | 7,44      | 14,86   | 2,01      | 48,85    | 14,46                 | 45,70   | 4,82    | 62,70      | 274,0     |
| 8400              | 10,91              | 7,48      | 15,00   | 2,02      | 48,60    | 14,37                 | 45,90   | 4,89    | 63,35      | 273,5     |
| 8500              | 10,87              | 7,52      | 15,13   | 2,03      | 48,35    | 14,28                 | 46,10   | 4,96    | 64,00      | 273,0     |
| 8600              | 10,83              | 7,56      | 15,26   | 2,04      | 48,10    | 14,19                 | 46,30   | 5,03    | 64,65      | 272,5     |
| 8700              | 10,79              | 7,60      | 15,40   | 2,06      | 47,90    | 14,10                 | 46,50   | 5,10    | 65,30      | 272,0     |



Table 2. Timing indicators for the 110 m hurdles race of decathlete A. K-va at the Russian All-Around Cup 2023

| Competitive result, s    | Before 1 bar | Before 2 bar | Before 3 bar | Before 4 bar | Before 5 bar | Before 6 bar | Before 7 bar | Before 8 bar | Before 9 bar | Before 10 bar | Finish |
|--------------------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|---------------|--------|
| Time between barriers, s |              | 1,16         | 1,12         | 1,10         | 1,10         | 1,10         | 1,10         | 1,13         | 1,14         | 1,15          | 1,42   |
|                          | 2,80         | 3,96         | 5,08         | 6,18         | 7,28         | 8,38         | 9,48         | 10,61        | 11,75        | 12,90         | 14,32  |

tiveness of the athlete's performance in all all-around disciplines. As an example, based on the analysis of hurdle running based on the timing indicators of sections of the hurdle distance and comparison with model indicators, a characteristic of the special preparedness of an athlete in the sixth event of the decathlon is given (Table 2).

Below is a step-by-step analysis of an athlete's competitive activity at a hurdle distance.

1. According to the model of the generalized characteristics of technical readiness in hurdle running (Kudu F., 1981), the normative indicator of the difference in results in the 110 m hurdle race and the 100 m sprint run for a result in the hurdle race of 14.32 s is 3.60 s. The all-around athlete has a difference in results of 3.67 s (100 m – 10.65 s, 110 m s/b – 14.32 s). This is slightly less than the standard indicator, which indicates a satisfactory level of hurdling technique.

2. Model of the starting run - 2.73 s for a given result in the hurdles (the athlete has a starting run of 2.80 s), i.e. below the model parameter.

3. Stability of overcoming inter-barrier sections

(difference in time of the fastest and slowest of the nine inter-barrier sections). The athlete has this indicator - 0.06 s, which corresponds to the norm (normative indicator - less than 0.08 s).

4. Diagnosis of a failure at one or more barriers (standard – a drop in speed by 0.04 s relative to the previous inter-barrier section) – for the athlete this indicator corresponds to the norm (0.03 s), i.e., a relatively smooth passage of the distance without failures.

5. Diagnosis of special barrier endurance is characterized by maintaining speed until the last inter-barrier section (the normative indicator of the difference between the running time at the last inter-barrier section and the time of the best inter-barrier section is 0.06 s). The athlete has this indicator corresponding to the norm (0.06 s, A. L. Oganjanov, E. A. Morraru, 2022).

Thus, based on a video analysis of the competitive activity of an all-around athlete, it is concluded that the limiting factor that reduces the performance of an athlete's hurdle running is the starting segment before the first hurdle. In this regard, the athlete is rec-

Table 3. Indicators of technical readiness of all-around athlete A. K-va in the long jump at the Russian Cup 2023

| No. | Parameters  | A. K-ov 7,38 м | Model 7,50м |
|-----|---|----------------|-------------|
| 1   | Actual jump length, m   | 7,49           | 7,50        |
| 2   | Number of running steps   | 18             | 19          |
| 3   | Speed on the penultimate 5m of the run, m/s                       | 9,42           | 9,78        |
| 4   | Speed during the last 5m of the run, m/s                          | 9,67           | 9,83        |
| 5   | Speed increase in the last section, m/s                           | 0,25           | 0,05        |
| 6   | Average tempo activity, w/s                                       | 4,21           | 4,28        |
| 7   | Implementation coefficient of take-off speed, p.u.                | 0,774          | 0,760       |
| 8   | Setting angle on repulsion, degrees                               | 59,3           | 60,9        |
| 9   | Angle of flexion in the knee joint in the push-off phase, degrees | 137,7          | 139,4       |
| 10  | Angle of flexion in the hip joint in the push-off phase, degrees  | 154,5          | 157,3       |
| 11  | Angular movement of the supporting leg in repulsion, degrees      | 44,0           | 43,7        |
| 12  | Landing efficiency coefficient, p.u.                              | 7,6            | 8,5         |



ommended to work on improving the technique of the starting segment of the distance, as well as the emphasis in special physical training on speed-strength training, which largely determines the effectiveness of the starting run.

**Stage 3.** Analysis of technical readiness in technical all-around events. At the next stage, using the example of one of the technical all-around events (long jump), an analysis of the technical readiness of the all-around athlete in this event is carried out using video analysis and photodiode timing (Table 3). The athlete performs a jump at a speed that is “comfortable” for him, significantly inferior to the athlete’s sprinting capabilities. The speed model in the last section is 97% of the athlete’s sprint capabilities (A.L. Oganjanov, 2007), A. K-va’s implementation rate in the run-up speed is only 94%, which is significantly lower than the model.

Thus, increasing the realization of speed capabilities in take-off speed is an important area of technical training in this jumping discipline. One of the reasons for low performance is the lack of activity in the first part of the run, focusing only on the final part of the run. The athlete is recommended to have a more uniform increase in speed in the final part when activating the initial and middle parts of the run, which is more typical for the modern promising “tempo” version of the run used by the strongest long jumpers.

**Stage 4.** Analysis of special physical preparedness, identification of lagging aspects of preparedness that limit the growth of performance. With a high level of development of sprinting qualities, which determines success in sprint distances, long jump, hurdles, the athlete needs to pay special attention in special physical training to improving special aerobic endurance (running 1500 m), speed-strength qualities (starting run, jumping events, throwing), strength training to improve performance in long throws.

**Stage 5.** Adjusting training, planning the training process for the next stage of preparation. Based on the analysis of the athlete’s performance in certain types of the decathlon program, the identification of lagging and dominant types of the program, the analysis of competitive activity and technical readiness in certain types of decathlon, the strategy and tactics of step-by-step work on improving the all-around disci-

plines are determined, individual recommendations are developed for the athlete to improve the training process for the next preparation stage.

**Conclusions.** Based on a statistical analysis of indicators of competitive activity in certain types of decathlon of the world’s leading all-around athletes, a model of competitive activity of highly qualified male all-around athletes was formed. The model allows, based on a comparison of an athlete’s performance with model parameters, to analyze the results of a decathlete in individual events, to identify lagging and dominant types of an athlete. This creates opportunities for planning results in individual types of decathlon for the next macrocycle of training and, on this basis, programming the special training of a multi-athlete at the stages of the macrocycle.

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