Data Analysis for Field Orienteering Heat Training

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Abstract. Orienteering is a kind of intelligent sport that the athletes are selected on the base of integrative evaluation of the physical, skill and psychological qualities. In this paper, a method is supposed to evaluate and select the seeded player with data such as total time consumption, split time, positioning efficiency and operation efficiency. It can be concluded with data series collected from two distinctive heat training courses that, 1) the operation efficiency and it’s standard deviation of 5th player achieved the optimization, and 2) the solution in this paper can be popularized for selective heat training in common primary school or college with limited training equipment.

1. Introduction
Map and compass are the main equipment for field orienteering which is a comprehensive test of the candidates’ ability including map reading, physical and psychological quality. During the match or training course, candidates should punch at the crossing points in the shortest time. In order to choose excellent candidate, 15 selected candidates were trained within 48 hours for orientation, positioning and other related basic knowledge, as well as special basic skills such as map reading, map walk along the road, march on needle, etc. Each candidate was ready skilled in certain ability such as map reading and map walking.

Area setting: two training routes in the area surrounding Daishan Lake in Feidong county were chosen. Totally, training area is featured with rich landform surface such as hill and plain. In the low visibility hill area with the sharp height climb and few roads, high mountains and knoll, depressions, saddles and slopes are covered by overgrown needle leaved forests intensively. About 30% of the punching points located in plain, the rest are located in hill terrain. Area near starting and finish area belong to plain, while the hilly area along middle leg is the core area of training. The leg interval between marked punching points are well distributed with relatively even interval distance of about 1km. The training map were printed with a scale of 1:50000 and the contour interval of 10m.

Training organization procedure and ranking standard: all candidates were required to march according to the predetermined route in the designated area, to search and distinguish interference points and punch points individually during the training. Those with high punch accuracy and less marching time are ranked first. The punch time is recorded manually by candidates.

Weather: the light rain and light snow lasted during the first training day, it’s cold with low visibility, and on the next training day, it’s sunny with rather good visibility, route surface was slippery and muddy.
2. Punch Efficiency and Performance Efficiency Analysis

2.1. Control Points Punch Efficiency Analysis
Control points punch efficiency $E_p$ is defined as the fraction of number of correct punch points $N_c$ dividing total number of control points $N_t$, standing for the punching accuracy rate during a training course, and showing the comprehensive and explicit performance of candidates' ability of map reading and interpretation. Figure 1 showed the position efficiency and corresponding standard deviation distribution of two training courses.

$$E_p = \frac{N_c}{N_t} \quad (1)$$

It can be seen from the figure 1 that: 1) the overall position efficiency of candidate 1, 2 and 5 is the highest candidate, the mark reached 0.94, 0.94 and 0.95 respectively, the corresponding standard deviation of the average position efficiency for two training courses were 0.08, 0.08 and 0.07. It means that these three candidates are qualified with relatively better and stable map recognition ability, and are able to judge the position comprehensively through orienteering, surface features and landform, and can distinguish punch points from nearby interference points with relatively high accuracy. 2) candidate 3, 4, 8, 10, 11, 12 and 13 also achieved more than 75% of the position punch efficiency with fine scores. On the contrary, candidates6, 14 and 15 got low position punch efficiency with relatively high standard deviation. It means that the comprehensive map reading and orienteering skills of candidates 6, 14 and 15 were rather poor and unstable. 3) Except march skill and physical fitness, weather is a key actor influencing the position punch efficiency. In the first training day, it was light rain and snow with low temperature and short visibility, and the training area was muddy and slippery. The next training, it was sunny after snow. 4) Some of the punch points were difficult to search because of the location in the deep valley covered by vegetation. In addition, due to the similar direction and shape of the valley and the slope near some punch points, it's difficult to locate accurately, and easy to punch by mistake.

![Figure 1](image_url). Position punching efficiency and standard deviation
2.2. Performance Efficiency Analysis
Performance efficiency $E_a$ is defined as fraction of punching efficiency $E_p$ dividing total time consumption $T$, also the ratio of point accuracy and total time consumption, it is a comprehensive evaluation of candidate’ ability of map reading, physical fitness and psychological quality, and also the major rule for candidate selection. Figure 2 shows the average value and standard deviation of the performance efficiency obtained from two heat races.

$$E_a = \frac{E_p}{T}$$ (2)

![Figure 2. Performance efficiency and standard deviation](image)

From figure 2, it can be concluded that: 1) candidate 1, 2, 5 and 11 obtained relatively high performance efficiency scores. These four candidates gained relatively high position punch efficiency through strong physical and psychological qualities, locating, orientation and racing abilities etc. Among them, candidate 5 gained high performance efficiency and it’s relatively low standard deviation during the two training courses, the comprehensive skill of candidate 5th is the most stable. 2) The standard deviation of performance efficiency of candidate 1, 2 and 11 is about 1-3 times higher than that of candidate 5, the degree of performance efficiency stability took the second place. candidate 13th obtained low performance efficiency scores but a rather good stability. 3) The rest candidates completed the training courses with a rather high level of performance efficiency standard deviation, indicating that some serious problems existed in the process of route planning, map reading, surface features and land-forms interpretation, distance estimation, marching direction control, physical energy allocation, and marching mistake correction etc.

3. Split Time Consumption Analysis

3.1. Analysis of Split Time Consumption
In this paper, only the split time consumption of the second training course was analyzed and discussed, as shown in figure 3, 4 and 5.
Shown in figure 3, the starting leg and leg 1, 2 are the initial training stages during which each candidate should work out route planning, physical fitness allocation planning and other action strategies, is the early reflection of skills including psychological quality and map reading, is the candidates’ performance and confidence building stage. As seen in the figure 3, 1) in this stage, candidate 6th spent the least time followed by candidate 1, 2 and 5, candidate 15 spent the longest time. 2) The split time spent in the initial stage of candidate 2 and candidate 6 was much shorter, and longer for candidate 1, 5, 11 and 14. The data fully presented great differences in the knowledge preparation, skill preparation and the marching adjustment ability for each candidate. 3) The time consumption of candidate 15 in leg 1 and 2 reached 32 and 24 minutes, the maximum for all legs. The terrain of this leg is relatively plain, and the landform is clear for distinguishing, punch points distributed near the roads, canals, ponds and other land features with little obvious changes. The two split time fully showed that the ability of map reading and terrain recognition ability of this candidate is rather poor, he did not fully take use of his skill in location determination.
As shown in figure 4, Leg 3 to 7 are the five core marching legs, the most punch points densely distributed areas, the most complicated distribution areas of land-forms and vegetation, the core areas to test the marching skills, physical fitness and psychological abilities of each candidate. The average distance of each leg is about 800 meters. The three legs belong to hilly and wavy terrain with high mountains and dense forests, with deep valleys and few scattered ponds or waterholes, with no residential sites, and with sparse roads. The terrain features distributed basically in conformity with the map. The twisty roads went zigzagged up and down obviously. However, due to the vegetation coverage and the similarity of length, shape, depth, it is not easy to identify accurately the slope, saddle/re-entrant, valley, knoll, earth bank, erosion gully, depression, and so on with the map and compass. It can be seen from figure 4 that the quite different average time consumed by each candidate in these marching legs is 15.40, 13.20, 12.60, 10.80, 14.60, 12.60, 15.40, 14.80, 12.60, 11.40, 12.00, 12.20, 15.80, 15.80 and 16.00 minutes respectively. The candidate 4 spent the least time, followed by candidate 3, 6, 9, 11 and 12. candidate 1, 7, 13 and 14 spent the longest time, their average marching time interval between legs reached more than 3 minutes, it means that these 4 candidates are weak skilled in map reading and terrain recognition.

As shown in figure 5, Leg 8, 9 and the sprint leg are the last three legs to test the candidates' marching strategy and physical fitness and mental will. Especially the sprint leg, a minor road with a distance of about 1.5km, is key important for candidates’ physical assignment strategy and sprint performance. From figure 5, It can be concluded that the obvious different average split time of each candidate in these three legs is 10.33, 16.33, 16.67, 18.00, 13.33, 10.00, 18.33, 12.00, 8.33, 16.00, 7.00, 14.67, 18.67, 17.00 and 9.67 respectively. The candidate 11 spent the least average time, the average time of the candidates 2, 3, 4, 7, 10, 13 and 14 exceeded 15 minutes, especially the candidate 4 and 14 spent 26 minutes and 24 minutes respectively in the sprint leg, the consumed time showed that physical consumption of candidate 4 and 14 was rather high, and their physical assignment was imperfect.

3.2. Analysis of Average Split Time
The average split time of all candidates in different racing legs were computed and shown in table 1.
Table 1. Average split time of candidate.

| Candidate ID | Leg1 | Leg2 | Leg3 | Leg4 | Leg5 | Leg6 | Leg7 | Leg8 | Leg9 | Leg10 | Leg11 |
|--------------|------|------|------|------|------|------|------|------|------|-------|-------|
| 1            | 15   | 7    | 15   | 9    | 19   | 14   | 18   | 17   | 9    | 12    | 10    |
| 2            | 5    | 14   | 13   | 10   | 11   | 15   | 14   | 16   | 9    | 22    | 18    |
| 3            | 8    | 14   | 10   | 20   | 12   | 10   | 10   | 11   | 12   | 24    | 14    |
| 4            | 11   | 10   | 10   | 8    | 14   | 9    | 13   | 10   | 12   | 16    | 26    |
| 5            | 13   | 10   | 7    | 19   | 18   | 6    | 16   | 14   | 6    | 23    | 11    |
| 6            | 6    | 5    | 8    | 18   | 11   | 8    | 9    | 17   | 13   | 9     | 8     |
| 7            | 9    | 12   | 14   | 13   | 24   | 5    | 20   | 15   | 17   | 23    | 15    |
| 8            | 8    | 14   | 18   | 12   | 17   | 18   | 23   | 4    | 9    | 9     | 18    |
| 9            | 10   | 9    | 13   | 10   | 17   | 14   | 10   | 12   | 8    | 13    | 4     |
| 10           | 11   | 17   | 12   | 10   | 12   | 15   | 14   | 6    | 15   | 20    | 13    |
| 11           | 13   | 6    | 16   | 13   | 11   | 13   | 13   | 10   | 7    | 7     | 7     |
| 12           | 7    | 11   | 14   | 9    | 17   | 14   | 10   | 11   | 12   | 17    | 15    |
| 13           | 8    | 10   | 13   | 16   | 21   | 12   | 14   | 16   | 24   | 20    | 12    |
| 14           | 13   | 11   | 17   | 13   | 22   | 9    | 15   | 20   | 13   | 14    | 24    |
| 15           | 7    | 32   | 25   | 17   | 23   | 16   | 12   | 12   | 6    | 11    |       |

Average split time: 9.60 12.13 13.67 13.13 16.60 11.87 14.07 12.73 11.87 15.67 13.73

From the figure 6, one can see that the average split time of all the candidates is relatively long in the 5th leg of the core leg and the 10th leg in the sprint leg. The reasons for the long time-consumption in 5th leg are expressed as follows: firstly, the terrain is featured with sparse distributed surface features, dense vegetation, low visibility, and close distributed hills and valleys on both sides of the route. The length, width and depth and other external shape of the spur and valley resemble greatly. Without obvious hilltop and road fork as a reference, it is difficult for the candidates to locate accurately their punch points; Secondly, leg 5th is a leg terrain transforming form flat to hill with dense vegetation and jungle, accordingly, the transition window for the candidates' marching and map reading and terrain recognition was obvious, after that transition window, the average split time of the following leg 6th, 7th and 8th were relatively stable. The reason for the long time-consuming of the leg 10th is that: firstly, the punch point located near the residential area with significant change between the actual roads and the roads on the map in the direction, trend and junction, etc.; secondly, because the real distribution scope of the residential area expanded greatly to the distribution scope on the map, the candidates need to read the map repeatedly when searching and recognizing surface features, and to correct themself when using the residential buildings as location determination reference, these procedures above took a long time. Totally, the original intention of these two legs and punch points setting is to test the map reading and terrain recognition ability of candidates under complex and changing terrain conditions.
4. Discussion
Due to the differences of map reading skills, racing ability and psychological quality of orienteering candidates and the influence of terrain factors, the scores of 15 candidates during two training courses showed obvious different distribution in the two key factors indicating candidate’s comprehensive performance efficiency and its stability. The score series provided a data reference for the athlete selection, establishment and training of later teams. Considering comprehensively the terrain, physical and psychological factors, this paper put forward a model for the selection of orienteering candidates using comprehensive performance efficiency and its stability. The results are useful to enhance the scientific degree in the selection of orienteering candidates.

In addition to the terrain, physical fitness and psychology factors influencing orienteering training results, the terrain selection and training procedure should be more scientific organized. Firstly, the mark on punch point was sprayed by outdated paint in red or blue color, it is not easy to find and identify mark sprayed in low visibility on the punch point hided under or on the back the ground features, such as the wall, grave base, electric pole, boulder, culvert and thick trunk on the way. In order to increase the punching speed and reduce the training risk, one can set the punch point using hard ink-jet pasteboard printed by more obvious bright symbol. Secondly, the punch time was sometime inaccurate because of recording by candidates by hand. A more advanced orienteering timing and punching system should be used to record and monitor the candidate's movement in real time, and to achieve more accurate data collection and safer personnel training monitoring. Thirdly, the training process of candidates was not monitored, so some candidates exceeded the planed time significantly, and the training safety is a big challenge.

Limited by the comprehensive organization conditions, in this paper, only the data of two orienteering training procedure was analyzed, the accuracy and designed data analysis can be improved by increasing training times to gain more sample data.

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