

Research on Urban Marathon Track Planning

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Abstract: Based on the organization and operation rules of marathon events, this paper uses research methods such as literature review, expert interviews, and field investigations to comprehensively analyze the types of urban marathon tracks and the influencing factors of track planning. Based on this, the track design of Beijing Marathon is analyzed. Research results: The race track types of China's gold medal full marathon events are mainly single lap and circular, which have a significant impact on urban transportation but can fully showcase the city's style; The planning of urban marathon tracks should not only focus on the urban landscape, but also consider three factors: transportation, track difficulty, and athlete safety; The design of the Beijing Marathon track has two shortcomings. Firstly, there are many sharp turns and turns in the last 5 kilometers of the Beijing Marathon, which greatly consumes the physical energy of the athletes. This not only hinders the athletes from achieving excellent results, but also easily leads to injury accidents. Secondly, the landscape of the Beijing Marathon track is mainly based on modern buildings in Beijing, which does not fully showcase the historical and cultural landscape of Beijing.

Keywords: urban marathon, track planning, Beijing Marathon, empirical analysis

1. Introduction

Every marathon organizer hopes that the track design can fully showcase the city's landmark architecture, historical style, and natural scenery, in order to promote the city and market it, and promote the development of local tourism, transportation, accommodation, catering and other industries. However, while showcasing the urban scenery, the track design also needs to meet various requirements such as competition organization, medical assistance, safety management, transportation, etc., while also taking into account the participation experience of the participants. Therefore, the track design is not just enough to create a beautiful 42.195 kilometer race. Therefore, the design and planning of the track should comprehensively consider multiple influencing factors, and combine multiple factors to form the best plan. At present, there is relatively little research on marathon track planning, and most of the research focuses on the planning and design of track landscapes, lacking comprehensive analysis and research on marathon track planning. Based on this, this article takes marathon track planning as the research object. Based on a comprehensive analysis of well-known types of marathon tracks at home and abroad, it deeply analyzes the influencing factors that need to be considered in marathon track design. On this basis, it empirically analyzes the advantages and disadvantages of Beijing marathon track design, in order to provide some visible reference for the differentiated development of marathon events in China.

2. Analysis of types of urban Marathon track design

Table 1: 2019 China Gold Medal Full Marathon Track Types

Type	Point to point type	Single circle ring type	Reentrant type	Multi-circle ring type
quantity	24	31	19	0

Marathon tracks are generally divided into four types: point-to-point, turnaround, single lap, and multi lap [1]. The type of track chosen by the event organizer needs to consider various factors such as the city's scenic landmarks, transportation, safety guarantees, and event scale, and different track types have different requirements for event organization. From the 74 gold medal marathons (full course) held in China in 2019, the single lap circular track had the most, reaching 31 races, accounting for 41.9% of all gold medal full course marathons. The point-to-point and turnaround types were relatively similar, with 24 and 19 races respectively. The multi lap circular track is currently rare in urban

marathons in China. As is shown in Table 1.

2.1 Point-to-point track

A point-to-point track is a runner running from one point to another. This type of track is divided into two categories: straight point-to-point and curved point-to-point track. The straight point to point track is about the runners running in one direction and the finish point is far from the starting point. The representative events are China's Zheng Kai Marathon, Nanning International Marathon and the world-famous Boston Marathon. The records set by such tracks are generally not recognized because the Track Rules stipulate that the straight line distance between the start and end of the track should not exceed 50 percent of the distance of the race [2]. The reason for this rule is to consider the wind direction, altitude, etc., so as to avoid athletes running with the wind or downhill in one direction. And curve point-to-point track is very good to avoid the problem, players change in running into the direction, not always along the direction, starting point, the linear distance between no more than 50% of the distance, meet the requirements of the track and field competition rules, representative events have Beijing marathon, Wuhan marathon, Wuxi marathon, and the world grand slam event marathon in Tokyo. The point-to-point track has many advantages, with an extended range of 42.195 kilometers for the marathon, which can fully showcase the overall appearance of the city. This type of track, which is not prone to causing traffic congestion, can gradually control traffic during the race, allowing runners to run and gradually relax the management of the track, while avoiding widespread urban traffic paralysis. For athletes, the direction of the race is relatively fixed, with fewer turns or turns, which is conducive to a stable rhythm and saves energy. Due to the long distance from the starting point to the finish line of the point-to-point track, there are many challenges in event organization, with the biggest difficulty being the transportation of personnel and materials. Because after the start of the competition, the organizing committee must have staff, referees, and athletes register for the event. From the starting point to the finish line, there are usually 30000 competition transport vehicles, which may reach hundreds. How to ensure the orderly progress of transportation work requires detailed planning and orderly scheduling during the competition.

2.2 Return track

The starting and ending points of a turn back track are usually at the same position. Participants will turn back at the halfway point and return to the finish line in the opposite direction on the same road. This type of competition usually uses a two-way split lane road for competition, where a separate lane can be used for round-trip in both directions, and the turning point can be made use of the turning area of the central median of the road itself. Its representative events include Xiamen Marathon, Chongqing Marathon, etc. The turnaround track belongs to the energy-saving track, and personnel and materials can be reused. Firstly, the starting and ending points of the turnaround track are in the same position, and arches, podiums, functional rooms, exhibition boards, etc. do not need to be built repeatedly; Secondly, medical stations and toilets can be set up in the middle of the road in the central isolation zone, and can be used together when running in both directions; Thirdly, volunteers, referees, and staff from around 10 kilometers before the competition can participate in the opposite stage of work after the contestants have run. Fourthly, the transportation of personnel and materials is relatively convenient, which is also the biggest advantage compared to point-to-point tracks. The disadvantages of this type of track are mainly reflected in the following two aspects. Firstly, the traffic control time on the track is relatively long, and it cannot be lifted step by step like point-to-point tracks, which has a significant impact on the traffic in the nearby area. The second reason is that the surrounding scenery of the turnaround track is relatively repetitive, and the process of athletes running in is relatively dull.

2.3 Single ring type

The starting and ending points of a single lap circular race track are in the same position or are relatively close, and the entire race route is a circular race. Representative domestic events include the Hangzhou Marathon, Guangzhou Marathon, Nanjing Marathon, Lanzhou Marathon, etc. The world-renowned Berlin Marathon and Chicago Marathon are also single lap circular tracks. This type of track has fewer repetitive routes and a wider range of traffic control coverage, which can easily cause paralysis in the host city's transportation. However, there are some exceptions. Circular tracks revolve around rivers or lakes in the city, which do not have much impact on urban transportation. Instead, they are more conducive to showcasing the city's scenery and scenery, which is also conducive to improving the participant's participation experience.

3. The influencing factors of urban marathon track planning

3.1 Urban landscape factors

Urban landscape is the primary consideration in marathon track design. Generally speaking, urban landscape includes three categories: landmark buildings, natural scenery, and scenic spots and historical sites. Different landscape types can reflect the different characteristics of the city. Many city managers have actively participated in the early planning and design of marathon tracks, hoping to showcase the most beautiful side of the city to contestants, in order to meet the demand of promoting the city [3]. In 2019, there were 11 marathon events in China that were certified by the World Athletics Federation Gold Standard. From the track planning and design of these 11 events, landmark buildings representing the city's image are essential elements of the track design. For example, the Bird's Nest in Beima, the Oriental Pearl TV Tower in Shangma, and the World Trade Twin Towers in Xiamen and Malaysia all represent the city's economic and technological strength, and can fully reflect the external image of a city. While demonstrating the modern civilization of the city, another common feature of China's 11 gold standard marathon races is that the race track is generally around or near the waters. The Shanghai Marathon is along the Huangpu River, the Guangzhou Marathon is along the Pearl River, the Hangzhou Marathon is along the West Lake, the Lanzhou Marathon is along the Yellow River, the Chongqing Marathon is along the Yangtze River, and the Xiamen Marathon is along the coast. Rivers and Lakes have become another important element in the design of the marathon race track [4], which can not only show the natural scenery of the city, but also make the race track more spiritual and enhance the contestants' participation experience. On the basis of the above two factors, the scenic spots and historical sites in cities are the elements that best reflect the characteristics of the race track. In China's 11 Golden Mark Marathon races, only 3 tracks pass through the scenic spots and historical sites in cities, and the historical and cultural atmosphere of the tracks is insufficient. This not only has a direct relationship with China's urban construction planning, but also reflects that our race track design concept focuses more on showcasing natural landscapes and modern buildings, and lacks exploration of the historical and cultural landscape of the city, which cannot well showcase the historical style of the city [5]. The competition in cities usually goes through three stages: competing for economy, competing for management, and competing for culture. Cultural heritage is the key to sustainable development, and it is also the key to whether a city can achieve greatness and glory. The six world-renowned Grand Slam Marathons all have local cultural characteristics in their track design. Taking the London Marathon, which is the same age as the Beijing Marathon, as an example, starting from Greenwich, where world time and geographic longitude are calculated, they pass through multiple historical buildings such as Tower Bridge, Tower of London, St. Paul's Cathedral, Waterloo Bridge, London Eye, Big Ben, Parliament Building, Buckingham Palace, etc., which are highly British in style. As is shown in Table 2.

Table 2: Scenic types of the Golden Standard Marathon Track in China

Competition	The main landscape around the track	Landscape type
Beijing Marathon	Tian 'anmen Square, National Grand Theatre, Water Cube, Bird's Nest, etc	Places of interest, landmark buildings
Shanghai Marathon	Huangpu River, Jing'an Temple, a major meeting site, Oriental Pearl, etc	Natural landscape, places of interest, landmarks
Chongqing marathon	The Yangtze River, Chaotianmen Bridge, Sheraton Hotel, Liberation Monument, etc	Natural landscape, landmark buildings
Hangzhou marathon	West Lake, Qiantang River, Liuhe Tower, Qiantang River Bridge and so on	Natural landscape, places of interest, landmarks
Xiamen marathon	East China Sea, International Convention and Exhibition Center, wtowers, etc	Natural landscape, landmark buildings
Guangzhou marathon	Pearl River, Guangzhou Tower, Nanfang Tower, etc	Natural landscape, landmark buildings
Hengshui Lake Marathon	Hengshui Lake, Luli ancient town, Jiuzhou Square, etc	Natural landscape, landmark buildings
Lanzhou marathon	The Yellow River, Yantan Yellow River Bridge, Zhongshan Bridge and so on	Natural landscape, landmark buildings
Taiyuan marathon	Fenhe River, Changfeng Business District, Shanxi Provincial Sports Center, etc	Natural landscape, landmark buildings
Shenzhen Baoan Marathon	Baoan Arena, International Convention and Exhibition Center, etc	landmark building
Yellow River mouth marathon	International Convention and Exhibition Center, Wanda International Building, etc	landmark building

3.2 Track difficulty factors

The difficulty of the track is an important factor to consider in the early planning stage. If the difficulty of the track is too high, it is not conducive to athletes creating good results, and it will also bring greater challenges to the personal health of participants, increasing the risk of the competition [6]. The indicators for measuring the difficulty of the track mainly include the number of turns along the track, the number of turns, and changes in altitude. This paper analyzes the three full marathon events that first became the gold medal of the International Association of Athletics Federations. In terms of track turns or turns, the overall number of turns and turns in Xiamen Marathon is relatively small, with 6 turns below 90 degrees and 2 turns, respectively. In terms of the flatness of the marathon track, the standard deviation of the altitude throughout the entire marathon in Beijing, Xiamen, and Shanghai is relatively small, with no significant uphill or downhill runs. The track is relatively flat, with the Xiamen Marathon having an altitude standard deviation of only 2.6 meters, which is significantly better than the six Grand Slam races. Based on these two indicators, the overall Xiamen Marathon track is relatively flat and smooth, with relatively low difficulty, which is beneficial for athletes to maintain their speed and rhythm. As is shown in Table 3.

Table 3: Conditions of the three major marathons in China

Competition	Turn below 90 degrees (a)	Turn back (one)	Altitude (m)
Beijing Marathon	22	3	46.5±4.3
Xiamen marathon	6	2	6.5±2.6
Shanghai Marathon	27	1	20.2±4.9

3.3 Transportation factors

The hosting of a large-scale marathon event involves a large amount of people and logistics, and the efficiency of their movement is directly related to the quality of the event [7]. However, problems such as urban traffic paralysis and a large number of athletes being stranded after the race often occur due to unreasonable planning in the early stage of the track. Therefore, the organizers of the race need to fully consider the transportation service software and hardware conditions of the track and the surrounding starting and ending points during the planning stage of the track, ensuring orderly arrival and departure of participants and avoiding too much impact on urban traffic. The Berlin Marathon, one of the six world-renowned Grand Slam events, not only boasts beautiful scenery on the track, but also can achieve two consecutive days of road closures, all of which depend on the city's developed underground rail transit and urban transportation capacity. Therefore, the organizers of the event need to fully consider the transportation service software and hardware conditions around the track and the starting and ending points during the planning stage of the track. When planning the race track, it is important to consider the impact of the event on urban traffic and avoid traffic congestion caused by event traffic control. The focus should be on two aspects. Firstly, if the traffic pressure in the city is high, it is best to use a point-to-point race track, which generally adopts a segment by segment traffic control method. As the competition progresses, the traffic control is gradually lifted, which has a relatively small impact on the city's traffic; Secondly, track planning should avoid passing through key social public service departments such as hospitals, firefighting, and public security as much as possible. At the same time, it should also avoid public transportation hubs such as train stations and long-distance bus stations as much as possible to minimize the impact on the lives of citizens.

3.4 Safety factors for athletes

The Yellow River Shilin Mountain Marathon 100 kilometer cross-country race held in Baiyin City, Gansu Province in 2021, encountered extreme weather conditions, and the organizing committee did not provide timely assistance, resulting in the deaths of 21 athletes due to hypothermia. This has become the most devastating public safety incident in China in recent years, attracting widespread attention from all sectors of society. The safety issues of marathons and related sports events have once again become a hot topic of discussion in society. Although there are significant differences between urban marathons and mountain marathons, the painful lessons of the "Silver Incident" are worth reflecting on and learning from by urban marathon organizers. Therefore, marathon organizers should focus on examining the safety environment around the track during the track planning phase, and try to avoid passing through dangerous areas such as chemical plants, dangerous buildings, and cliffs. Some

marathon events in our country overly consider the scenery along the track and neglect the safety of the participants. For example, some marathons are held in natural scenic areas, and the track is adjacent to cliffs, which is prone to the risk of falling rocks from high altitude. In addition, there is a gas station next to the finish line of a marathon race, which poses certain risks and hazards. Therefore, in the design of marathon tracks, it is not only necessary to meet the needs of competition and urban promotion, but also to take into account the evacuation conditions of the starting and ending points, as well as the safety of the surrounding environment.

4. Analysis of Beijing Marathon track planning

Although the track route of the Beijing Marathon has undergone multiple adjustments from 1981 to 2022, each adjustment was made to showcase the overall urban landscape of Beijing while meeting the needs of the competition organization. Below is a comprehensive analysis of the advantages and disadvantages of the 2022 Beijing Marathon track plan from five aspects.

4.1 In terms of landscape around the track

From 1981 to 2022, the Beijing Marathon held a total of 40 races, and the track underwent nearly 20 adjustments. Among them, 29 races started from Tiananmen Square, and the other 11 races passed through Tiananmen Square. As a symbol of Beijing, Tiananmen Square has always been a must pass historical building on the Beijing Marathon track. The 2022 Beijing Marathon starts from Tiananmen Square, passes through the National Theatre, Military Museum, Central Television Tower, Orson Park, and finally reaches the National Stadium Bird's Nest. Overall, the landscape along the track is mainly composed of modern buildings in Beijing, but the display of Beijing's historical and cultural style is not sufficient. Because the Second Ring Road is the old urban area of Beijing, a complex of buildings that have undergone planning, construction, and improvement during the Yuan, Ming, and Qing dynasties, with red walls and green tiles everywhere, best showcases the charm of old Beijing. It is a great witness to the long history of Chinese civilization and has unparalleled historical, cultural, and social value. It is the most important carrier and foundation for Beijing to build a world cultural city and a national cultural center. However, the current Beijing Marathon track does not fully showcase the old city of Beijing. Except for Tian'an, most of the tracks showcase the achievements of Beijing's modern construction, which cannot showcase the city's 800 year history and civilization. Therefore, in future track design, further optimization can be made to better integrate the new and old cities of Beijing, blending history and modernity, and making the 42.195 kilometer track a shortened version of Beijing's city display.

4.2 In terms of track difficulty

The overall surface of the Beijing Marathon race track is relatively flat. Although it passes through Fuxingmen Overpass, Muxidi Overpass, Lanxiangou Bridge, Changchun Bridge, and Kehui Bridge, the overall undulation is small, and the standard deviation of altitude change is only 4.327 meters. The most challenging stage of the entire journey may be the Kehui Bridge, which starts at approximately 30.4 kilometers and ends at 31.1 kilometers. During this stage, athletes generally enter a "wall collision period", posing a significant challenge to their physical and mental abilities. In addition, there are 22 turns of 90 degrees or less and 3 turns throughout the entire North Malaysia race, with an average of 0.52 turns and 0.07 turns per kilometer, which is within a reasonable range overall. However, in the last 5 kilometers of the North Malaysia track, there are 8 turns and 2 point turns, with a relatively dense number of turns and turns, accounting for 34.78% and 66.67% of the total number of turns and turns, respectively. The physical fitness of the last 5 kilometers of the marathon is generally close to the limit, and significant turns and turns consume a lot of physical energy for the athletes. This is also where the Beijing Marathon route needs further optimization.

4.3 In terms of transportation

Beijing is an international metropolis with enormous traffic pressure. How to minimize the impact of events on urban transportation and the lives of citizens is also a key focus of the Beijing Marathon track planning. In terms of reducing the impact of events on traffic, Beijing Marathon has three advantages. Firstly, since its opening to the public in 1998, Beijing Marathon has always adopted a point-to-point track. This type of track can be controlled segment by segment according to the progress

of the competition, and the control can be lifted segment by segment after the athletes run, avoiding prolonged occupation of urban roads. Moreover, the straight-line distance between the starting and ending points of Beima is about 11 kilometers, which does not exceed 50% of the competition distance and meets the requirements of the Athletics Competition Rules. Secondly, in recent years, the routes of the Beijing Marathon have all started from Tiananmen Square to the National Stadium, and the entire race track uses one side of the two-way road to enter, while the other side of the road is normally passing [8], reducing the impact of the race on traffic. Moreover, most of the surrounding roads along the race track are distributed in a well shaped pattern, with branches densely distributed among them. The secondary main road alleviates the impact of traffic control on the race track. Thirdly, Beijing has a developed underground transportation system, which facilitates the arrival and departure of athletes and the travel of citizens around the track.

4.4 In terms of track safety

The planning of the Beijing Marathon track fully considers safety factors, and both the track width and the design of backup channels have been reasonably planned in the early stage. Firstly, in terms of track width. Generally speaking, the width of the first 5 kilometers of the race track has a significant impact on the speed of the contestants. The width of the inner diameter of the starting arch should be equal to the width of the narrowest part of the first 5 kilometers of the track, so as to ensure that there will be no sudden deceleration caused by the narrowing of the track after starting the race. Especially for the Beijing Marathon with a participation capacity of 30000 people, sudden deceleration can easily cause collisions between contestants and even stampedes. The width of the arch at the start of the Beijing Marathon is 16 meters. After starting for about 600 meters, athletes enter Chang'an Street, and the width of the track increases to about 25 meters, which is very beneficial for athletes to reach the predetermined speed as soon as possible after starting. However, due to some athletes stopping to take photos and check in while passing through Tiananmen, the overall running speed is affected. Therefore, the width of the track near Tiananmen should be further widened to improve pedestrian flow speed, or a separate photo taking area can be set up to avoid affecting the overall running speed. In addition, the width of most tracks throughout the Beijing Marathon is over 10 meters, and the narrowest track is also over 7 meters. The length of the narrowest track does not exceed 2 kilometers, which meets the requirements of the Chinese Athletics Association for the width of marathon tracks. This width is conducive to timely medical assistance in case of accidents for athletes. Secondly, in terms of backup channel design. The entire race track of the Beijing Marathon uses one side of the two-way road for running in, while the other side of the road runs normally. In case of accidents, the other side of the road can be quickly used for rescue.

4.5 In terms of the surrounding atmosphere of the track

The atmosphere around the starting point of the Beijing Marathon is the most lively, with tens of thousands of contestants and surrounding spectators singing the national anthem together at Tiananmen Square before the start. The scene is very spectacular, instantly pushing the competition atmosphere to a high point. After starting off, the contestants ran westward along Chang'an Street, passing through Dongcheng District, Xicheng District, Haidian District, and Chaoyang District, and finally arrived at the celebration square in the central area of the Olympic Park Landscape Avenue. Along the way, there were bustling sections of Beijing, and the surrounding audience cheered and cheered one after another. Especially when the contestants ran to the college road about 30 kilometers away, their physical fitness was generally exhausted and they entered the most difficult "wall hitting period". The energetic cheers of college students on the track made the runners even more excited and worked hard to complete the race. Overall, the atmosphere around the Beijing Marathon track is more prominent in domestic marathon events, but there is still a certain gap compared to the world's six Grand Slam marathons. The main problem is that the distance between the Beijing Marathon main track and the surrounding audience is relatively large, and there is a lack of interaction between the athletes and the audience.

Overall, the design of the Beijing Marathon track has its unique advantages, but there are also some shortcomings, mainly reflected in the following two aspects. Firstly, there are many significant turns and turns in the last 5 kilometers of the Beijing Marathon, which greatly consumes the physical energy of the athletes. This not only hinders the athletes from achieving excellent results, but also easily leads to injury accidents. It is recommended to further optimize the track in subsequent races, reducing the number of deceleration turns and turns; Secondly, the landscape of the Beijing Marathon track is mainly based on modern architecture in Beijing, which does not fully showcase the historical and

cultural landscape of Beijing. It is recommended to better combine Beijing's modern civilization and historical style in the track design, so as to enrich the connotation of the event and form a unique sports event with Chinese cultural characteristics, showcasing cultural confidence.

5. Conclusion

The standards for marathon construction are of great significance to event organizers, participants, and spectators. Through reasonable track planning, effective safety measures, high-quality participant services, and comprehensive event promotion, marathon events can better showcase sportsmanship, promote healthy living, and attract more people to participate. Event organizers should actively abide by and implement marathon construction standards to ensure the quality of the competition and the satisfaction of participants.

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