

SUSTAINABLE DESIGN OF SPORTS STADIUMS

Case study analysis of stadiums for the Olympic Games
2000 in Sydney, 2004 in Athens and 2008 in Beijing

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ABSTRACT

Sports stadiums have a considerable impact on the urban, environmental and social context. In particular, where several new stadiums are built within the same city for a single mega-event like the Olympic Games, Commonwealth Games or Soccer World Cup the implications are significantly higher. Therefore the requirements for operation of each stadium after the mega-event are of great importance to ensure sustainable integration into the urban, environmental and social context as well as maximized utilization on a long-term basis.

In the first part of this thesis a review of the subject is presented. A brief history of the development of stadium design in the Olympic context, evolving requirements for staging Olympic Summer Games, the structure of organizations involved, existing literature research and certification methods are summarized.

In the second part the methodology and development of the bespoke research tool based on existing certification systems such as BREEAM, LEED and DGNB is described. Subsequently, case studies for three different stadium types (Olympic Stadium, Indoor Stadium and Football Stadium) used for the Olympic Summer Games in Sydney (2000), Athens (2004) and Beijing (2008) are analysed based on literature research, field surveys and interviews. The comparative assessment of each stadium type is conducted with an evaluation matrix in three denominations: urban category, environmental category and social category. In each category two indicators with two respective parameters are evaluated based on a five-point score system. Subsequently the general applicability of the research tool is verified with an example appraisal of Wembley Stadium which was used for the Olympic Summer Games in London (2012).

Conclusions are drawn in the third part of the thesis, separately for each of the three denominations urban category, environmental category and social category. In the urban category sports stadiums built on a site previously used for sports venues or adjacent to other existing venues are rated significantly higher, because existing sites are already integrated into the urban context and located in proximity to the city centre as well as other mixed-use areas resulting in synergy effects with extended catchment areas and good connectivity.

In the environmental category sports stadiums are rated higher if specific requirements for operation of the sports stadium after the Olympic Games are already considered in the design to ensure maximised adaptability and flexibility. Dismantle of the overlay (tailor-made structures/installations required for staging the event) after the Olympic Games reduces energy consumption in subsequent operation. Overlay designed for permanent usage or reuse at a different venue further increases the level of sustainability. Usage of energy efficient systems with power generation and water conservation preserves resources.

In the social category sports stadiums are rated higher if a balanced proportion of sport usage and other usages is achieved. The long-term utilization of a sports stadium correlates with the level of urban integration, urban context, building type and usage mix. Sports stadiums utilized by more than one home team and integration of other usages (e.g. retail, commercial, recreation, etc.) achieve a significantly higher level of utilization.

The last chapter summarizes recommendations for stadium design in the Olympic context. To ensure a long-term utilization of each sports stadium after the Olympic Games it is suggested that applicant/candidate cities carry out comprehensive feasibility studies in collaboration with an operator to develop a bespoke project brief and business plan for operation of each venue at bidding stage. In order to enhance the existing knowledge base it is further recommended to collect and compare operational data (e.g. water, energy consumption etc.) from the different venues of the hosting cities to allow an independent assessment of the level of sustainability during long-term operation. Additional data to verify indicators relating to design efficiency such as average construction area per seat as well as dead loads of spectator stands and roof structures should be compared for establishment of benchmarks to verify the efficiency of the structural elements for an even more sustainable design of sports stadiums.

1 INTRODUCTION

1.1 Preamble

The Olympic Summer Games are staged every four years at different locations worldwide. Though the project brief for the sports facilities remains generally unchanged, the long-term utilization of the sports stadiums varies significantly amongst the different hosting cities. Due to the consistent project brief the Olympic Games could be considered as a repetitive urban field experiment which is aiming to build venues for specific sports events at different locations. This thesis compares case studies of the urban field experiments initiated by the Olympic Summer Games in 2000, 2004 and 2008 with a particular focus on the Urban, Environmental and Social Category.

1.2 Requirement and importance of this research

The Olympic Summer Games are the largest sporting event in the world with 28 different competitions held almost simultaneously within 16 days at multiple venue locations. "In the Olympics 2008 in Beijing 10,942¹ athletes participated and approximately 4,7 billion people worldwide were reached via television."²

For the opening ceremony of the Olympic Summer Games 2008 in Beijing on 08.08.2008 it is estimated that more than 2 billion people worldwide watched the event on television.³ The investments for the Summer Olympic Games in the 21st century have increased considerably. An overview of the combined public and private investments for the venues and infrastructure is given on the next page.

Sydney 2000	EUR 2 billion ⁴
Athens 2004	EUR 11 billion ⁵
Beijing 2008	EUR 32 billion ⁶
London 2012	EUR 11 billion ⁷ (Estimate)

The costs for operation and maintenance of sports facilities after the Games are a major expenditure, which in the long term is significantly higher than the initial construction costs. To cover (at least) the running costs for maintenance and operation a minimum number of events has to be held at each sports facility.

The diagram in Illustration 1 below shows the increasing Operational Costs of the Olympic Organising Committees. The operational costs have escalated due to the increasing complexity and security measures during the Games.

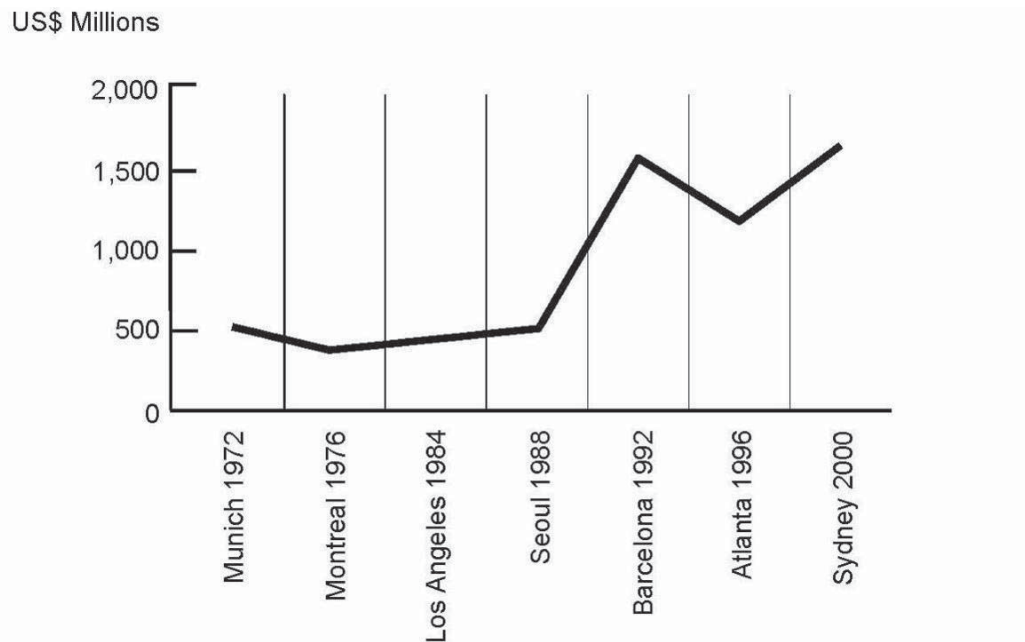


Illustration 1: Operational Costs of the Olympic Games Organising Committees⁸

Previous examples of the Olympic Summer Games have shown the requirement to develop new strategies in order to reduce operational costs and to achieve a higher level of sustainable integration and utilization after the Games.

The legacy of the Olympic Games tends to be criticized subsequent to the Games. One example is the Olympic Summer Games 2004 in Athens where the media discovered that "A staggering 21 out of 22 venues lie abandoned."⁹ This shows the importance to understand the key drivers for sustainable urban integration and economically sound operation of the stadiums in the post- Games stage.

1.3 Aims of this research

Aims of this research are the analysis and comparative assessment of stadiums used for the modern Olympic Summer Games in order to identify the key indicators (parameters) influencing the level of sustainability in the denominations: Urban Category, Environmental Category and Social Category.

The analysis is based on case studies of the most recent Olympic Summer Games, hosted 2000 in Sydney (Australia), 2004 in Athens (Greece) and 2008 in Beijing (China). The field research was carried out between 2010 and 2011. For the comparative assessment three different types of venues are selected: Olympic Stadium, Indoor Stadium and Football Stadium which are evaluated based on a 5-point score system.

The conclusions of this research could be considered for venues of future Olympic Games or for other single mega-events like the Commonwealth Games or Soccer World Cup in order to enhance the level of sustainability with a focus on the long-term operation of the sports facilities after the mega-event. In addition the conclusions could be incorporated for other stadiums developed independently of such mega-events. Large scale infrastructure developments initiated by the Olympic Summer Games, e.g. Olympic Summer Games 1992 in Barcelona, are not part of this research since main focus is on the actual stadium building and urban context of the precinct.

1.4 Objectives of this research

The objective of this research is to develop an Evaluation Matrix (Research Tool) for a comparative assessment of the case studies in order to provide quantitative and qualitative substantiated response to the following three research questions. The development of the Evaluation Matrix and selection of the examined indicators regarding the level of sustainability is carried out in consideration of existing certification systems such as BREEAM, LEED and DGNB.

1. Which are the indicators influencing the level of sustainability in the Urban Category, Environmental Category and Social Category?
2. How do the selected parameters influence the sustainability level of the case studies in Sydney, Athens and Beijing with respect to the three categories?
3. Which stadium of the selected stadium type is more sustainable than the others and what are the reasons?

1.5 Academic relevance of this research

Generally, these are written with the intent to achieve ‘academic relevance’. As Dr. Deryck D. Patton in his publication ‘Research Methodology’ is stating “research is an academic activity and as such the term should be used in a technical sense.”¹⁰ The meaning of relevance can be “categorized into the three categories: value, utility and importance of information. Value of information represents its internal integrity, validity and reliability. This meaning can be related to a process with emphasis on verification, authentication and credibility of information. Trustworthiness of the source and verity of information are also regarded as significant. Utility narrows the extension of value towards a more concrete use of information. Utility is embedded in the contexts of information use, namely in relation to topic, problem solving and time. Importance expresses qualities of relevance such as emphasis on the problem essence, priorities and the hierarchical division of information.”¹¹

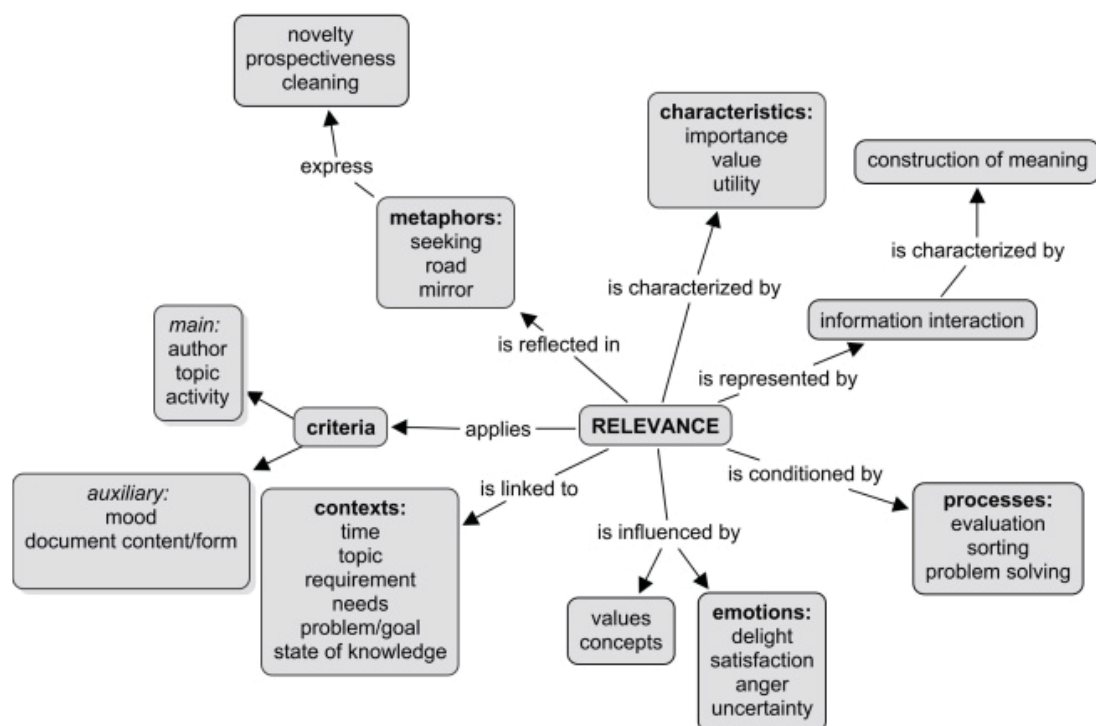


Illustration 2: Concept map for ‘Perception of relevance’¹²

Jela Steinerova describes the term ‘relevance’ and its interaction with the influencing and defining parameters which are stated as characteristics, processes, emotions, contexts, criteria and metaphors in Illustration 2.

The research article 'The Relevance of Knowledge Management and Intellectual Capital Research' states that "currently, very few academic recommendations can be directly used by practitioners. The 'operational validity' depends on the practitioner's ability to take academic findings and apply them. Consistent with prior research (Ankers and Brennan, 2002), most respondents said that they could not translate academic recommendations into reality either because they included factors beyond their control or they ignored the constraints of real world settings. Timing affects some topics more than others. So the longevity of research is a factor of the topic covered. Articles that address topics of enduring interest to practitioners will be always well received (Benbasat and Zmud, 1999). Academic training, prior industry exposure, and current industry involvement form the awareness of business reality that, in turn, shape the direction of scholarly research. It is stated that, in extreme cases, some researchers had strong scholarly training but little, if any, prior or current industry experience. As a result, their research was highly theoretical with no applicable managerial insights: Most academics have not worked in business so their lens of reality is less relevant and judgments to extrapolate context often missing."¹³

According to the citations above regarding 'relevance' and 'operational validity' it is assumed that this thesis is meeting the expectations of a relevant academic contribution as value, utility and importance of information are well accounted. Furthermore the subject itself is an 'evergreen' and of current interest as the Olympics is a repeated phenomenon which is celebrated every four years.

The Lingayas Institute of Management and Technology refers to the term 'research' as "an art of scientific investigation" and an original contribution to the existing stock of knowledge making for its advancement."¹⁴ Therefore "an original work is one not received from others nor one copied based on the work of others. It is a work created with an unique style and substance."¹⁵

In 2002 the IOC organised the 'International Symposium on Legacy of the Olympic Games: 1984-2000' which in their conclusions calls for more attention to be paid to the research of the legacy of the Games. "There is a clear need for more research of a longitudinal nature into all aspects relating to Olympic legacy, beginning well before the Games and lasting for a sustained period after their completion."¹⁶

There are not many researches on the long term impacts of sports facilities used for the Olympic Games. Most of the existing studies analyse the pre- and post effects of the Olympic Games but there are no studies comparing the long-term impacts among consecutive Olympic Summer Games with regard to Urban, Environmental and Social Category.

“Several authors note that in the bid process it is common to overestimate the long-term other benefits that accompany hosting the games, but none of the authors completely answers the question of whether the Olympics are worthwhile for cities in the long run. This demonstrates the need for further research on the experience of cities years and decades after hosting the games.”¹⁷

The analysis and comparative assessment of selected stadiums used for the first three Olympic Games in the 21st century in 2000, 2004 and 2008 provide new and important results. This research is based on data obtained through the unique opportunity to review the archives at the Olympic Studies Centre in Lausanne.

The author of this research was granted a scholarship by the Olympic Studies Centre (OSC) of the International Olympic Committee (IOC) as the subject of this thesis was considered to be significant. For the 2007 Scholarship four out of 28 candidates from 18 countries were selected by a committee comprising renowned experts. This research and three others were chosen “for their academic excellence”^{18, 19} on 21.02.2007 as per the standards of the Grant Programme Selection Committee composed of experts, who are world-renowned for their involvement in Olympic studies, the OSC officers and other professionals.

The sighted literature for this research is of exclusive and unrivalled value, contributing to the thesis verity and trustworthiness, which are important criteria for academic relevance. Furthermore, case studies were carried out for which the author of this thesis inspected selected venues of previous Olympic Games. Three consecutive Olympic Games countries were consciously selected to achieve the aspect of longitudinal research. Through personal interviews with the operators an utmost veritable evaluation of the field research with a clear as well as realistic assessment is ensured.

The subject of this research is of great interest to the architectural community as the phenomenon of staging the Olympic Games is an 'evergreen' and a recurrent event with the characteristic longevity.

The conclusions of this thesis are essential for the understanding of long-term impacts on the urban context with regard to Urban Category, Environmental Category and Social Category. Especially the applied Evaluation Matrix has a general validity as a prototype for assessment of the sustainability level of sports venues during the design stage and operation.

The results of this research contribute also to the already existing knowledge for the design of stadiums which are not necessarily linked to the Olympic Games or similar events.

1.6 Research methodology

The methodology of this thesis is a combined assessment of the obtained knowledge on the subject consisting of the results of the library research as well as the findings of the field research, surveys and personal interviews. The flowchart of the thesis is shown in Illustration 3.

Chapter 1 'Introduction' presents Preamble, Requirement and importance of this research, Aims of this research, Objectives of this research, Academic relevance of this research, Research methodology, Sources used in this research and Structure of this research.

Chapter 2 'Review of the subject' comprises of Review of existing studies and researches, Historic background of the Olympic Games, Requirements for the hosting city staging the Games, Election process of the host for the Olympic Games, Transfer of Knowledge Programme, Sustainable urban development and the Olympic Games, Greening the Olympic Games and Certification methods.

Chapter 3 'Stadium design' in the Olympic context elaborates the Historic development of the stadium, Changing venue locations for the Olympic Games and Stadium design in the 21st century.

Chapter 4 'Development research tool' describes Definition of sustainability, Method of evaluation, Methodology development of research tool, Evaluation with rating system, Description Evaluation Matrix and Criteria for selecting the case studies.

Chapter 5 'Case studies' presents Analysis case studies, Overview selected venues for the case studies, Selected venues of the Olympic Games 2000 in Sydney, Selected venues of the Olympic Games 2004 in Athens and Selected venues of the Olympic Games 2008 in Beijing.

Chapter 6 'Analysis' assesses the results in Evaluation A Urban Category, Evaluation B Environmental Category and Evaluation C Environmental Category.

Chapter 7 'Discussion' evaluates Comparison case study results, Discussion results A Urban Category, Discussion results B Environmental Category and Discussion results C Social Category.

Chapter 8 'Comparative assessment' presents a comparison of the case study results, Comparative assessment A Urban Category, Comparative assessment B Environmental Category, Comparative assessment C Social Category and Comparative assessment stadium types.

Chapter 9 'Example Olympic Games 2012' applies the developed Evaluation Matrix on Wembley Stadium and consists of Introduction Wembley Stadium, Application sustainability indicators on Wembley Stadium, Evaluation Urban Category Wembley Stadium, Evaluation Environmental Category Wembley Stadium and Evaluation Social Category Wembley Stadium.

Chapter 10 'Conclusions' elaborates General conclusions, Conclusions comparative assessment case studies and Recommendations stadium design in the Olympic context.

Chapter 11 'Appendix' includes Template for Evaluation matrix, Rating matrix for comparative assessment, Sydney 2000 event schedules, Athens 2004 event schedules and Beijing 2008 event schedules.

Chapter 12 'References' lists all sources and references used in this research.

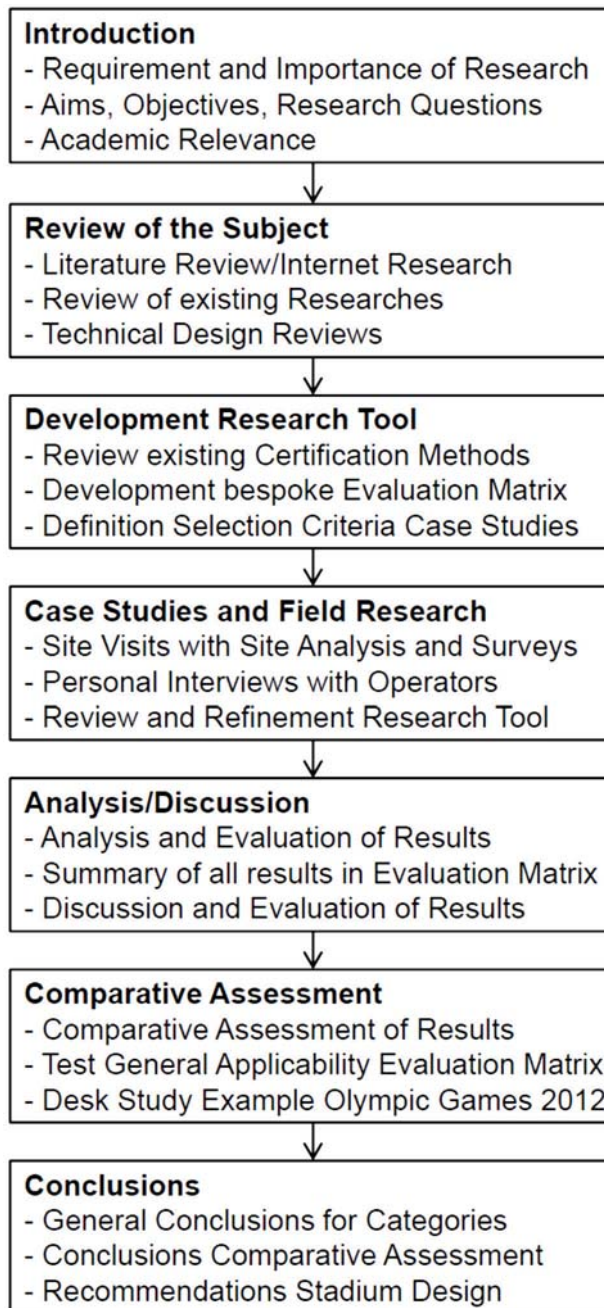


Illustration 3: Flowchart thesis

The results are analysed based on a comparative assessment through a 5-point score system. The process is illustrated in the diagram above and further described in this chapter. The research questions are summarized in Chapter 1.4 ‘Objectives of this research’.ⁱ In the analytical research three denominations are established: ‘A Urban Category’, ‘B Environmental Category’ and ‘C Social Category’.

ⁱ 1.4 Objectives of this research, page 5

The analytical research is based on a combined evaluation of “library research, including historical research with utilization of historical sources like documents and remains”²⁰, as well as on a “field research including case studies and personal interviews.”²¹ The analytical aspect is integral part of this thesis as “the researcher had to use facts or information already available and analyze these to make a critical evaluation of the material.”²²

An analytical research can generally be described as “an exercise in exploration and evaluation. Though his topic may be debatable and controversial, it is not the student's intent to persuade the audience that his ideas are right while those of others are wrong. Instead, his goal is to offer a critical interpretation of primary and secondary sources throughout the paper- sources that should, ultimately, buttress his particular analysis of the topic.”²³

In accordance with Dr. Deryck D. Pattron’s publication ‘Research Methodology’ the applied research methods in this thesis are qualitative as well as quantitative. The qualitative aspect is carried out by the method of survey- here applied by personal interviews with the operator- and the quantitative approach is defined by the case study research. The data collection can be described as a mixed matrix of categorical data through ordinal observations which are ranked and continuous data which are measured and counted. A critical and action orientated evaluation of the findings is performed as the results shall ideally have a practical impact on the future planning of the staging of the Olympic Games culminating in the final conclusion which is drawn by critical analysis of all data and results.²⁴

The field research criteria and related Evaluation Matrix for selecting suitable case studies are based on the initial findings in the analytical research further described in Chapter 4.5 ‘Description Evaluation Matrix’ which also elaborates the development of the Evaluation Matrix.

The process for selection of the relevant case studies Sydney, Athens and Beijing is summarized in Chapter 4.6 ‘Criteria for selecting the case studies’.ⁱⁱ During the subsequent analysis of data the proposed criteria are verified and modified in order to focus on the specific aspects of the research questions.

ⁱⁱ 4.6 Criteria for selecting the case studies, page 90-93

In the literature research evidence is received from primary sources supplemented with secondary sources. The majority of literature was obtained from the Olympic Studies Centre in Lausanne (Switzerland) as part of the scholarship.²⁵ In addition the literature research was complemented with a review of documents available in other libraries and also on the Internet under consideration of published design reviews.

As part of the analytical research the criteria for evaluation of the findings during the literature research as well as the field research are prepared and summarized in Chapter 4.5 'Description Evaluation Matrix'.ⁱⁱⁱ Subsequent to the case studies the Evaluation Matrix was refined and substantiated to identify only the most relevant aspects of the research. For this purpose every research category was divided into two sub-categories each consisting of two different parameters.

1.7 Sources used in this research

The Olympic Studies Centre (OSC) of the International Olympic Committee (IOC) supports international research through its Postgraduate Researchers Scholarship Programme. For the 2007 Scholarship four out of 28 candidates from 18 countries were selected by a committee comprising renowned experts. This research and three others were chosen "for their academic excellence"^{26, 27} on 21.02.2007. The scholarship allowed access to the Olympic Studies Centre in Lausanne which provided unique collections of more than one million archived documents, publications, official reports, photos and films. The programme included four weeks of studies at the Olympic Studies Centre in Lausanne with access to all documents in the Olympic Library and other institutions.

The analytical research is based on a literature research mainly obtained from the Olympic Studies Centre in Lausanne (Switzerland) as part of the scholarship.²⁸ In addition the literature research was complemented with a review of documents available in other libraries and on the Internet under consideration of the published design reviews.

ⁱⁱⁱ 4.5 Description Evaluation Matrix, page 74-89

The field research was carried out at the venues selected for the case studies. The Evaluation Matrix was derived from other existing comparative qualitative and quantitative assessment methods identified during the literature research further described in Chapter 4 'Development Research Tool'.

The qualitative and quantitative results of the field research were documented with site pictures, site plans and notes for the subsequent analysis of the data. During the site visits in 2010 and 2011, each of about seven days duration, interviews with the operators were conducted in order to verify the findings of the field research.^{iv}

With exception of two venues in Beijing (Beijing Indoor Stadium and Beijing Football Stadium) personal interviews with the operators of the stadium were carried out in order to verify the findings of the site surveys and receive additional input for the Evaluation Matrix.

1.8 Structure of this research

This thesis is sub-divided into twelve chapters. The 'Abstract' summarizes the results of the comparative assessment and conclusions. Chapter 1 'Introduction' provides a brief overview of the requirement and importance of this research as well as the aims along with the research questions. In addition the sources used for this research as well as the structure of the research are summarized.

In Chapter 2 'Review of the subject' the existing studies are summarized and the historic background of the Olympic Games from 776 B.C. until 2010 A.D. is reviewed. This includes a brief description of the organisations involved in the Olympic Games as well as the election process of the hosting city and selected initiatives of the International Olympic Committee (IOC) concerning the subject of this research.

The topic 'Stadium design in the Olympic context' is reviewed in Chapter 3 summarizing the evolution of the stadium design for the Olympic Games with a subsequent brief analysis of new trends in stadium design in the 21st century.

^{iv} Sydney 12.02.-19.02.2011, Athens 21.10-26.10.2010, Beijing 26.02.-05.03.2011

Chapter 4 'Development research tool' describes and illustrates the methodology for development of the research tool, evaluation system and evaluation criteria. The general applicability of the Evaluation Matrix is demonstrated on Wembley Stadium in Chapter 9.

'Case Studies' in Chapter 5 presents the selected venues used for Olympic Games in Sydney (2000), Athens (2004) and Beijing (2008). Chapter 6 'Analysis' comprises the individual results of the evaluation for each venue. For comparison purposes all results are listed and compiled in an Evaluation Matrix. In Chapter 7 'Discussion' the results of the case study analysis are discussed and deliberated.

In Chapter 8 'Comparative assessment' the findings for each category as well as the lessons learned are summarized.

In Chapter 9 'Example Olympic Games 2012' the sustainability indicators developed and used for the three case studies in this thesis are implemented on the desk study example of Wembley Stadium for demonstration of general applicability.

In Chapter 10 'Conclusions' the conclusions of the comparative assessment are given and recommendations for stadium design in the Olympic context are drawn.

A list of relevant data collected for analysis of 'C Social Category' and a template as well as a rating matrix are compiled in Chapter 11 'Appendix'. All references used in this thesis are listed in Chapter 12 'References'.

1.9 Summary chapter introduction

The Olympic Summer Games are the largest sporting event in the world with 28 different competitions held almost simultaneously within 16 days at multiple venue locations. In addition to the significant construction costs, the costs for operation and maintenance of the sports stadiums after the Games are a major expenditure, which in the long term is significantly higher than the initial construction costs. To cover the operational costs for maintenance and operation, a minimum number of events has to be held at the sports stadium and/or alternative types of utilization are required to generate income.

The aim of this research is the analysis, evaluation and comparative assessment of three different types of sports stadiums used for the most recent modern Olympic Summer Games in order to identify key parameters influencing the level of sustainability in the Urban Category, Environmental Category and Social Category after the Games.

The objective of this research is to develop an evaluation matrix for a comparative assessment of the key indicators (parameters) influencing the level of sustainability in the respective three categories and to understand the differences between the selected sports stadiums for the Olympic Games in Sydney, Athens and Beijing as well as to determine which stadium of the selected stadium type is more sustainable than the others.

With regard to academic relevance it was verified that this thesis is meeting the expectations of a relevant academic contribution as value, utility and importance of information are well accounted. Furthermore the subject itself is an 'evergreen' and of current interest as the Olympics is a repeated mega-event which is celebrated every four years. In 2002 the IOC organised the 'International Symposium on Legacy of the Olympic Games: 1984-2000' which in its conclusions calls for more attention to be paid to the research of the legacy of the Games. "There is a clear need for more research of a longitudinal nature into all aspects relating to Olympic legacy, beginning well before the Games and lasting for a sustained period after their completion."²⁹

The analysis and comparative assessment of selected stadiums used for the first three Olympic Games in the 21st century in 2000, 2004 and 2008 provide new and important results. The author of this research was granted a scholarship from the Olympic Studies Centre (OSC) as the International Olympic Committee (IOC) considered the subject of this thesis to be significant. Accordingly the literature review of this research is predominantly based on data and references obtained through the unique opportunity to utilize the archives at the Olympic Studies Centre in Lausanne. In addition the literature research was complemented with a review of documents available in other libraries and also on the Internet under consideration of published design reviews.

2 REVIEW OF THE SUBJECT

This chapter summarizes some of the most relevant literature on sustainable sports venues developed for the Olympic Summer Games. In 2007, when the research for this thesis was initiated, literature on this topic was limited. After the Beijing Olympic Games in 2008 an increasing number of studies were initiated.

2.1 Review of existing studies and researches

'A Framework for Evaluating Olympic Urban Development for Sustainability' was written by Hanwen Liao in 2006. This thesis includes a systematic collection of data with an assessment of factors defining environmental sustainability. The evaluation framework considers nine themes (e.g. Energy Consumption, Water Consumption, etc.) and is based on a multi-criteria assessment method (MCA).³⁰ The thesis provides an evaluation matrix, however without detailed and complete case studies for which the proposed framework has been used. Only one indicator, evaluating mainly the topic urban context and urban planning, is tested for Beijing 2008 and London 2012. This assessment is focused on the existing urban structures and circumstances without any specific and retrospective sports facilities evaluation. In the conclusions Liao summarizes "for future work, the promotion of knowledge transfer is an important aspect, there is also a need to use the outcomes in examining and hence amending the current set of Olympic rules, and through the impacts of the IOC and the International Federations to steer the infrastructural preparation for the future Games. The overriding aim of the study is to define an integrating framework that can be used to guide Olympic urban development in an environmental sustainable way by benchmarking and evaluating the interwoven aspects involved in the planning and design process."³¹

The German thesis 'Die Bewerbung um die Spiele der XXVIII Olympiade 2004' ('Application for the Games of the XXVIII Olympiad 2004') by Peter Schollmeier is a comprehensive historic review of the election process in general and a detailed analysis of the election process for the Olympic Games in 2004. The complex criteria for the election of Athens are thoroughly analysed and discussed within the historic context. Schollmeier's assessment of the election concludes that the reasons why Athens was selected in the 106. IOC Session were not only based on rational, technical and economical criteria but also on "Emotional Criteria, which become particularly important, in case the applicants like Athens and Rome are not

fundamentally different.”³² Another important conclusion is that the continuous modifications of election procedures are required due to the increasing level of complexity for hosting the Games as well as the economic impact for the Host City and the IOC.

Peter Anthony Haxton has emphasized the role of community involvement with regard to the Olympic Games in his thesis ‘The perceived role of community involvement in the Mega-Event hosting process: a case study of the Atlanta 1996 and Sydney 2000 Olympic Games.’³³ He summarizes that “the concept of hosting an Olympics is often prompted by the perception that doing so will provide an opportunity to promote economic development and urban redevelopment, fast track the development of sporting facilities and other infrastructure and provide a legacy of sport and recreation opportunities for locals. All of these perceived benefits are promoted as contributing to overall community development, one of the major aims of mega-event hosting. Following the floating of the initial idea, the model suggests that concept initiators examine the proposed host city/region to determine the compatibility of hosting the Olympics with the history, culture and values of the potential host community. If considered compatible a preliminary situation analysis may be undertaken and used, for example, to determine levels of community support and the facilities and infrastructure required to successfully host the Games. In addition a preliminary feasibility study, examining aspects such as the potential economic, social, cultural and environmental impacts, may also be prepared. Such a study also serves as a rough assessment of the affordability or profitability of hosting the Games. As with the impacts of mega-events the opportunities created as a result of hosting a mega-event may be perceptible for many years, even decades, to come. Examples of opportunities created as a result of hosting an Olympic Game include the long-term use of sporting facilities and related infrastructure.”³⁴

The thesis ‘Sustainable IOC-Sustainable Society’ by Birte Berlemann and Mitchell Rhodes examines the primary question “In what way could the IOC contribute to a global movement to a socio-economic sustainability?”³⁵ and concludes with recommendations for the International Olympic Committee (IOC). The authors state that “the ideals and values of Olympism and social sustainability are partly overlapping and complimentary. With worldwide networks firmly established, the IOC is well positioned to take a leading role in helping move society towards sustainability and potentially leave a legacy to humanity even greater than that of the Olympic Games and Olympism. While the opportunity for such leadership role

exists, there is little evidence to support that the IOC will become systemic and use its influences to help move society towards sustainability. If the decline of societal and environmental capacity continues, at some point in the future, conditions will be such that the staging of the Olympic Games will be difficult or even impossible.”³⁶

David Chernushenko’s book ‘Sustainable Sport Management: Running an environmentally, socially and economically responsible organization’, is a “comprehensive guide to managing sport organizations of all types and sizes in a more responsible manner. This book, sponsored by the United Nations Environment programme, takes up the torch from ‘Greening our Games’, David Chernushenko’s 1994 book, which introduced many in the sporting world to the concept of sustainable sport.”³⁷ The author summarizes that “In 1992, the Sydney bid committee was persuaded by environmental groups, spearheaded by Greenpeace, to develop a ‘Green Games’ bid, using the environment as an unique selling point to IOC voters. The bid featured innovative facility designs, notably an Athletes Village that was solar-powered, conserved resources, use of non-toxic and recycled materials, wisely use of land and profiled leading environmental technologies. A set of ‘Environmental Guidelines for the Summer Olympic Games’ was developed by a team of experts including Greenpeace, alternative power and waste experts, sustainable building designers, academics and government regulators. The Guidelines were submitted as part of the bid, with Sydney committing to implement them, if it won. Sydney won, by a mere two votes, over notoriously polluted Beijing. IOC President Juan Antonio Samaranch later observed, ‘The Olympic Games in the year 2000 were awarded to the city of Sydney, Australia, partly because of the consideration they gave to environmental matters’.”³⁸ In chapter ‘Lessons from Sustainable Sports Forerunners’ Chernushenko states that “Sydney 2000 took the boldest possible approach, announcing far-reaching intentions to pursue sustainable development in all aspects of planning, construction and operations- and paid the price: very high public expectations. Subject to the most intense scrutiny imaginable- a sign of public and professional interest, as well as local and international concerns- the legacy for the city, for the region and for the ‘cause’ of promoting sustainable development has been a positive one overall. That Sydney 2000 achieved or partially achieved most of its goals is remarkable. Notable benefits of the Games include such ‘bricks and mortar’ accomplishments as rehabilitated sites, facilities that use relatively little energy and water, successful integration of sustainable design features, innovative materials and renewable energy systems. Arguably even more important is the contribution of the Games to the spread of

awareness and knowledge among a range of professional and trades people, suppliers, regulators and the public. This knowledge has been underscored by a wealth of practical experience gained and retained by many of the hands-on participants in planning, construction and operations.”³⁹

Natalie Essig’s research ‘Nachhaltigkeit von Olympischen Sportbauten’ (‘Sustainability of Olympic sports facilities’) is a thesis, which was subsequently published as a book in 2010, analyzing the practicability and measurability of sustainability aspects with regard to competition facilities of the Olympic Games. The thesis evaluates whether “Olympic Games and their sports facilities are a ‘Greenwash Marketing Tool’ or could be termed as ‘sustainable’. The definition, assessment and measurement of ‘Sustainability of Olympic Games’ is surveyed. Essig’s intention is to verify if existing planning and assessment methods are a sufficient basis for the planning, construction and operation of ecological, economical and social Olympic venues or if only a common and mandatory assessment tool can promote and assure sustainable building performance of Olympic venues. The dissertation reviews 12 case studies of the modern Olympic Summer and Winter Games in chapter ‘Olympic competition venues and sustainable planning concepts’. Furthermore environmental evaluations, reports and guidelines of different Non-Government Organizations (NGOs) as well as such for applicant and candidate cities established by the IOC in the 1990s are investigated. International assessment methods like BREEAM, LEED and DGNB are evaluated with regard to criteria and applicability for Olympic sports facilities.”⁴⁰ In chapter ‘Evaluation and certification of sustainable building quality regarding Olympic competition venues: Procedures for implementation of sustainable sports facilities’ Essig concludes her resume with four theses. “The first thesis states that Olympic Games can not be considered sustainable because of the high additional environmental burden on the host city. Only a reduction of the extent of the Olympic construction activity (competition venues) is a guarantee for success for future sustainable Olympic Games. The second thesis concludes that lack of regulations and criteria on the part of the IOC for sustainable Olympic sports venues in the Olympic bid process impede an implementation of ecologic, economic and social sports facilities at an international level. The third thesis explains that only development of evaluation criteria for sustainable Olympic sports venues regarding functionality, sustainability, design and consecutive usage would enable measurability of sustainability of Olympic sports venues. The fourth thesis reveals that only a mandatory adoption of a standardized international seal of approval for

assessment and certification of sustainable building quality of Olympic sports venues by the IOC leads to effective implementation of sustainable sports venue architecture on international level.”⁴¹ In accordance with Essig’s findings a bespoke Evaluation Matrix for the specific assessment of sports facilities for the Olympic Games has been developed in this thesis. Furthermore practical recommendations leading to a more sustainable legacy of the Olympic Games derived from lessons learned through insights of the case studies evaluations are compiled.

Uwe Fitschen’s publication with the title ‘Umweltmanagement ausgewählter Grossveranstaltungen- Effektiver Umweltschutz oder Greenwashing?’ (‘Environmental management of selected mega events- effective environmental protection or Greenwashing?’) examines concepts for environmental management in mega events based on the evaluation of the Sydney Olympic Games 2000, Athens Olympic Games 2004 and the World Cup 2006 in Germany. He concludes that “concepts for environmental management at mega events are partly utilized to ensure environmental protection but also exploited for Greenwashing. The concept of the Sydney Olympics can be considered as mostly successful and Greenwashing is only marginally implemented, whereas at the Athens Olympics the environment protection concept is considered ineffective despite of good intentions with a significant Greenwashing component.”⁴²

The book ‘Olympic Cities: Urban Planning, City Agendas and the World's Games, 1896 to the present’ is a compendium of essays by John R. Gold and Margaret M. Gold published in 2007 which highlights “the relationship between the Olympic Games and its host cities from the first modern Olympiad in Athens in 1896 through the early planning stages of London 2012, focusing mostly on the Summer Olympics. The problem of sustainability after the Games is addressed. In his chapter about London 2012, Graeme Evans predicts that London will experience post-Games regeneration that is uneven and not beneficial to the local community, citing previous regeneration efforts that were incomplete and the Millennium Dome that remained unused for years. He also argues that unless the Olympics move toward a less costly, less cumbersome Olympics and Olympics that would be more viable for developing countries instead of the mega-events designed to put the host city on the map of the global commercial and consumer economy then there needs to be a body to keep tabs and ensure that the games live up to their regeneration promises. In addition several authors note that in the bid process it is common to overestimate the long-term other benefits that accompany hosting the games, but none of the

authors completely answers the question of whether the Olympics are worthwhile for cities in the long run. This demonstrates the need for further research on the experience of cities years and decades after hosting the games.”⁴³

Markus Pfisterer's Case study 'Sustainable Icons for Mega Events: FIFA WC 2010, UEFA EURO 2012, FIFA WC 2014' examines the Moses Mabhida Stadium in Durban as a FIFA venue for the South African World Cup 2010, the National Stadium in Warsaw built for the UEFA EURO 2012 in Poland as well as the Arena da Amazonia in Manaus built for the 20th FIFA World Championship 2014 in Brazil. “The Arena de Amazonia will be one of the first LEED certified stadiums regarding location, construction sequence, transportation routes and primary energy content of all materials, water management, energy consumption, regulation and control technology, waste management and ongoing monitoring of operations. Pfisterer states that social value is aimed which transcends major events to earn social acceptance, create regional identities, shape urban development or rather find integration and increase the positive image of sporting events. In this context sustainability is not limited to energy efficiency in operations and construction, but also in the maximum of flexibility and long-term utilization of stadiums meeting multifunctional requirements, not only for sports, but also for other mega events like concerts etc. or for office use, hotel and other touristic or commercial purpose. Pfisterer concludes that multifunctional purpose is crucial in terms of life-cycle, attracting public interest and activities. Considering the ecological aspects as an integral part of the design from the very beginning creates strong synergy between technical demands of the Games and long-term responsibilities for future generations.”⁴⁴

Kay Killmann describes in his publication 'Good, Better, Certified? How can green building labels help planning sustainable buildings?' that the idea of sustainability governs the ecological, economic and social behaviour of most public and private sectors. The most used common building certification systems DGNB, BREEAM and LEED differ in the way they focus on the different aspects of the building process and from experience it can be assumed that regardless of a factor's weighting within a given system each factor can have a powerful impact on costs and environmental benefits. Killmann conducts an example for evaluation with the three certification systems on the parameter potable water. He summarizes that compared to the energy efficiency or materials, the importance of potable water consumption seems relatively low. Nevertheless, buildings with a LEED or BREEAM

label use less water than an average building and therefore contribute to a more responsible handling of a precious resource.”⁴⁵

2.2 Historic background of the Olympic Games

According to the Official Website of the Olympic Movement the “referred date as the first written mention of the Olympic Games is 776 B.C.. The event was celebrated for more than a millennium every four years, a time period known as an ‘Olympiad’. The Games were held in Olympia near Athens, located in ancient Greece, which was not only a sports complex but at the same time a sanctuary.

The Olympic Games were celebrated in honour of Zeus, the king of the gods. The venue consisted of a sacred area including the majestic temple of Zeus, as well as of a secular area. During the Olympics it is estimated that athletes, priests, staff and merchants totalling to some 40,000 people were present on site.”⁴⁶

The era of the ancient Olympic Games ended with the decree of Christian Emperor Theodosius in 393 A.D. as he prohibited pagan cults.”⁴⁷

The modern Olympic Games were restored by Baron Pierre de Frédy de Coubertin and in 1896 the first modern Olympics were held at their origin in Athens. Baron Pierre de Frédy de Coubertin was a French educationalist and renowned humanist. He wrote the founding texts of modern Olympism, including the Olympic Charter.”⁴⁸ The Factsheet of the Olympic Movement states that “The Olympic Movement and the International Olympic Committee were officially established on 23. June 1894 at the Paris International Congress which was organised by Coubertin at the Sorbonne. Coubertin’s vision was to ennoble and strengthen sports, to ensure their independence and duration, and thus to enable them better to fulfil the educational role incumbent upon them in the modern world.”⁴⁹

The Olympic Charter defines the essential fundamental principles. “Olympism is a philosophy of life, exalting and combining in a balanced whole the qualities of body, will and mind. Blending sports with culture and education, Olympism seeks to create a way of life based on the joy found in effort, the educational value of good example and respect for universal fundamental ethical principles. The goal of Olympism is to place sport at the service of the harmonious development of humankind, with a view to promoting a peaceful society concerned with the preservation of human dignity.”⁵⁰

As per specification of the Olympic Charter the Summer Olympic Games are celebrated in the first year of the Olympiad, defined as a period of four consecutive calendar years while the Winter Olympic Games are held in its third year. The celebration shall not exceed 16 days.⁵¹ Including the Olympic Games 2008 in Beijing a total of 26 Summer Olympic Games took place in 18 countries and 22 different cities around the world.⁵²

2.3 Requirements for the hosting city staging the Games

The requirements for staging the Games are defined by the International Olympic Committee (IOC) in the manuals. Apart from defining outlines for the bidding process the manuals are specifying the operational and technical requirements for staging the Games. The requirements of all stakeholders in the Games e.g. athletes, spectators, press and security for the last 26 Summer Olympic Games have constantly increased compared to the previous Games. Accordingly the specifications have been extended and further developed which is reflected in the manual.

Schollmeier is stating in his assessment regarding the historic development of the IOC requirements for hosting cities that initially the “foundation congress in 1894 did not define specific rules or requirements for staging the Games formulated by the IOC. In 1924 the IOC issued a brochure including 27 topics which defined the requirements for staging the Paris Games in the same year. This brochure was considered also as a protocol for the Games to come. In 1954 an information script was published including the first questionnaire with 13 points to be answered.”⁵³ Furthermore Schollmeier is mentioning that “in the late 1960s members of the Olympic Administration issued a manual of 110 pages including complex questions on request of the IOC which remained a relevant document for future Olympic Committees for the following years. Until 1997 due to the increasing professionalism of the Candidate Cities the questionnaire was extended and finally removed from the Olympic Charter as an independent document. For the Games 2000 a special ‘Manual for cities bidding for the Olympic Games’ was created.”⁵⁴

The manuals issued by the IOC for the Games in 2004 and 2008 have been further developed and will be described in Chapter 2.6 ‘Sustainable urban development and the Olympic Games’ as well as in Chapter 2.7 ‘Greening the Olympic Games’.

2.4 Election process of the host for the Olympic Games

According to the Official Website of the International Olympic Committee (IOC) the election of the Host City for the Summer Olympic Games is one of the most important decisions of the IOC which is taken every four years. The election takes place seven years before the Olympic Games. The result of the election initiates a transformation of the Host City over a period of seven years to meet the specifically defined IOC requirements for staging the Olympic Games.

The IOC members (in 2009 consisting of 112 members, 28 honorary members and 1 honour member⁵⁵) meet at least once a year for the so called 'Session'. "The quorum required for a Session is half the total membership of the IOC, plus one. The choice of the Host City is the prerogative of the Session, which is considered the IOC's supreme organ. The election of a host city must take place in a country not having a candidate for the Olympic Games in question. A city is declared elected when it obtains the majority of the votes cast. If there is no majority, the city with the fewest votes is eliminated and IOC members proceed to another round of voting. The procedure is repeated until an absolute majority is obtained."⁵⁶

The IOC election process has been developed parallel to the constantly increasing operational and technical requirements for staging the Games. There are various examples showing that the IOC has transferred the 'lessons learned' into the bid documents for the following Games.

In the following sections a historic overview on the election process is given and subsequently the current 2-phase election process first used for the 2008 Beijing Games is summarized.

2.4.1 Organisations involved in the modern Olympic Games

The Olympic Charter is by definition "the codification of the Fundamental Principles of Olympism with Rules and Bye-Laws adopted by the International Olympic Committee. It governs the organisation, action and operation of the Olympic Movement and sets forth the conditions for the celebrations of the Olympic Games."⁵⁷ The latest edition of the Olympic Charter is in force since 8th July 2011 and classifies 61 Rules on 103 pages. According to the Olympic Charter "The goal of the Olympic Movement is to contribute to building a peaceful and better world by

educating youth people through sport practised in accordance with Olympism and its values.”⁵⁸ The construction and consolidation of the Olympic Movement was essential for the existence and development of the modern Olympic Games. “Under the supreme authority of the International Olympic Committee, the Olympic Movement encompasses organisations, athletes and other persons who agree to be guided by the Olympic Charter.”⁵⁹

The Olympic Movement

- International Federations (IF)
- National Olympic Committees (NOCs)
- Organising Committees of the Olympic Games (OCOGs)
- Athletes
- Judges, referees, coaches, technicians
- Associations and clubs recognised by the IOC
- Organisations and institutions recognised by the IOC

The Olympic Charter states that “the IOC is an international non-governmental not-for-profit organisation, of unlimited duration, in the form of an association with the status of a legal person, recognised by the Swiss Federal Council in accordance with an agreement entered into on 1st November 2000.”⁶⁰

“The mission of the IOC is to promote Olympism throughout the world and to lead the Olympic Movement.”⁶¹ The International Sports Federations (IFs) “are international non-governmental organisations recognised by the IOC as administering one or more sports at world level. When the IOC was established in 1894, only a very small number of IFs existed. There are 28 Summer IFs, 7 Winter IFs, and 32 Recognised Sports Federations that are currently affiliated to the Olympic Movement. The IFs are responsible for overseeing the technical aspects and management of their sport at the Olympic Games. They also establish the eligibility criteria for the competitions of the Games, in accordance with the Olympic Charter. They likewise play an active role in the applicant and candidate city evaluation process.”⁶²

The 204 National Olympic Committees (NOCs) “belonging to the Olympic family are essential ‘ambassadors’ of the Olympic Movement in their respective countries and the tasks assigned to them are clearly stipulated under Rule 27 of the Olympic Charter. The NOCs are responsible for sending participants to the Games and endorsing potential future Olympic host cities within their countries. Furthermore, they are assigned the task of promoting the Olympic Movement, its work, and its fundamental principles in their day-to-day activities. The NOCs form five continental associations, which are represented within the Association of National Olympic Committees (ANOC).”⁶³

“The organisation of the Olympic Games is entrusted by the IOC to the NOC of the country of the host city as well as to the host city itself. The NOC forms, for that purpose, an Organising Committee for the Olympic Games (OCOGs), which, from the time it is constituted, communicates directly with the IOC, from which it receives instructions.”⁶⁴

2.4.2 Historic development of the election process of the host

The four following different phases with regard to the application and election process of the host city can be seen since 1894.⁶⁵ The general outlines were described in the Thesis ‘Die Bewerbung um die Spiele der XXVIII Olympiade 2004’ (‘Application for the Games of the XXVIII Olympiad’) by Peter Schollmeier and are briefly summarized below.

During the first phase from 1894 to 1939 Coubertin “appointed the Host Cities by acclamation with the motivation that these cities should have certain qualifications and preconditions to support the establishment of the Olympic Games. An election procedure was introduced by the third IOC President Baillet-Latour for the Olympic Games 1936. The first anonymous elected Host City was London for the Games in 1944.”⁶⁶

The second phase from “1946 to 1963 is defined by a considerable increase of the number of Applicant Cities. The spirit of time after World War II was affected by the wish of international understanding which went well with the universal and global character of the Olympic Games. The initial emphasis on ‘locations in the western culture area’ came to an end with Tokyo in 1964.”⁶⁷

The third phase from 1966 to 1981 shows a significant “decrease of the number of Applicant Cities. The increasing costs and the political interference with several boycotts discouraged potential Applicant Cities. Hosting the Olympic Games became a task of national dimension representing a national status. The Olympic Games in Los Angeles 1984 with a profit of 227,7 million USD, derived from an Olympia related budget, put an end to the ‘spiral of increasing deficits’ and initiated a turning point.”⁶⁸

The fourth phase from 1986 to 1997 is marked by an extremely “professionalized application procedure. A strong competition occurred between the Candidate Cities as the benefits of the Olympic Games namely as the glory, the positive image, the improvement of infrastructure and consequently the improvement of quality of life in the city are recognized with a chance of a remarkable revenue. The seventh IOC President Jose Antonio Samaranch initiated a radical change as he established a central commercialisation regarding the rights of Olympic Games which led to a multiplication of the profit.”⁶⁹

2.4.3 Current host city election process for the Olympic Games

“The election of any Host City is the prerogative of the Session.”⁷⁰ In the 110th IOC Session in December 1999 a 2-phase-system with a process duration of about two years was initiated by the IOC. “The reforms have created an improved Host City election process that clarified both the qualifications necessary to bid for the Games and the responsibilities and obligations of all parties involved in the process. The intention for introduction of the 2-phase system is to ensure that only interested cities, that the IOC judges to be capable, are approved to proceed to the candidature phase, thereby avoiding unnecessary expenditure for those cities which are judged to be insufficiently prepared at the time.”⁷¹

The new bidding process has a total duration of 24 months and can be summarized as following. The first phase is the Application: “Any application to host Olympic Games must be submitted to the IOC by the competent public authorities of the Applicant City together with the approval of the NOC of the country. Such authorities and the NOC must guarantee that the Olympic Games will be organised to the satisfaction of and under the conditions required by the IOC.”⁷² “The ‘Applicant Cities’ have to fill out a questionnaire which contains various data regarding the ability of the Applicant Cities including their countries to host, organise and stage

high level international multi-sports events.⁷³ After a group of experts has studied their answers, the IOC Executive Board decides which Applicant Cities will be accepted as Candidate Cities.”⁷⁴

The second phase is the Candidature: “The Candidate Cities have several months in which to submit a file in response to a second IOC questionnaire. In line with the IOC reforms of 1999, an Evaluation Commission, consisting of experts like IOC members, representatives of International Federations (IFs), the NOCs, the IOC Athletes’ Commission, is given the job of analysing the files submitted by the Candidate Cities and making inspection visits to the cities (four days per city). The Commission then produces a report for the IOC members to enable them to judge the ability of the each city to host the Games. This report is made public no later than one month before the start of the IOC Session, e.g. the general assembly of IOC members, one of whose roles is to elect the Host Cities of the Olympic Games (only the active members vote).”⁷⁵ The first Host City which was elected in 2001 based on this 2-phase process was Beijing for the Olympic Games in 2008.

2.5 Transfer of Knowledge Programme

The idea of sharing and passing over the knowledge and experience to future Games organisers led to the establishment of ‘IOC’s transfer of knowledge (TOK) programme’ which was set up during the preparations for the Sydney Games in 2000 in cooperation with the Sydney Organising Committee (SOCOG). The TOK programme was further enhanced in order to develop its knowledge management initiatives and the IOC established an independent company called ‘Olympic Games Knowledge Services’ (OGKS) in 2002. In 2005 these services were renamed to ‘Olympic Games Knowledge Management’ (OGKM). The OGKM works with the OCOGs and the Bid Cities. Their programme is offering different activities such as “observer programmes, interactive workshops, technical manuals, Games evaluation, building knowledge capabilities, IOC debrief, OGKM extranet, cross-cultural awareness and secondary programmes.”⁷⁶

2.6 Sustainable urban development and the Olympic Games

Due to the increasing importance of environmental issues “the Olympic Charter was amended in 1996 in order to include the following paragraph in Rule 2: The International Olympic Committee (IOC) sees that the Olympic Games are held in conditions which demonstrate a responsible concern for environmental issues and encourages the Olympic Movement to take measures to reflect such concern in its activities and educate all those connected with the Olympic Movement as to the importance of sustainable development.”⁷⁷

Consequently the Olympic Movement’s Agenda 21 was established “as a useful reference tool for the sports community at all levels in the protection of the environment and enhancement of sustainable development.”⁷⁸

“In Rio de Janeiro in 1992, at the UN Conference on Environment and Development (UNCED), most of the world’s nations committed themselves to the pursuit of economic development in ways that would protect the earth’s environment and non-renewable resources and adopted the Agenda 21 as a global action plan to fulfil this commitment. The Agenda 21 was adopted by the IOC at its Session in June 1999 in Seoul and subsequently endorsed by the entire Olympic Movement at the Third World Conference on Sport and the Environment in Rio de Janeiro in October 1999. The ‘Rio Statement’ made by this conference charts the course of action for the implementation of the Agenda 21. A joint UNEP/IOC Working Group has been set up and will have the task of piloting and following this implementation.”⁷⁹

The general principle of this philosophy is ‘sustainable development’ which may be defined according to the ‘Brundtland’ Report from 1987: “Sustainable development satisfies the needs of the present generation without compromising the chance for future generations to satisfy theirs.”⁸⁰

The Agenda 21 was developed on a “global approach addressing the problems of human development and the preservation of our ecological heritage. This document contains almost 300 pages in 40 chapters divided into four sections:

1. Social and Economic Dimensions
2. Conservation and Management of Resources for Development
3. Strengthening the Role of Major Groups
4. Means of Implementation”⁸¹

The Olympic Movement elaborated an action programme in order to meet the objectives of Agenda 21 with the following guidelines:

I. Improving socio-economic conditions

- "Emphasising the values of Olympism and its action on behalf of sustainable development which is to place sport everywhere at the service of the harmonious development of man with a view to encouraging the establishment of a peaceful society concerned with the preservation of human dignity."⁸²
- "Stronger international cooperation for sustainable development as the challenges presented by the environment and development can only be met by establishing a new world partnership which will make it possible to overcome differences and promote a genuine climate of cooperation and solidarity.
- Combating exclusion in the sense that an environmental policy which aims at efficient and sustainable management of resources must take account of those who depend upon those resources and ensure that they can live with the dignity to which every individual is entitled.
- Changing consumer habits as unsustainable consumption patterns are imposing considerable burdens on the environment, while marginalized groups are unable to satisfy their fundamental needs for food, health care, housing and education.
- Health protection as this is an essential factor in the harmonious development of humankind and is closely related to the sustainable development of our society.
- Viable model for human habitat and settlements as in industrialised countries human settlements generate heavy pressure on the environment and on natural resources whereas in the developing countries they fail to offer access to the raw materials and energy necessary for economic development.
- Integrating the concept of sustainable development into sports policies following the example of the Sport and Environment Commission of the IOC and similar commissions of some IFs and NOCs. All sports organizations will set up institutional structures to ensure that environmental and development issues are duly taken into account in their regulatory and decision-making procedures."⁸³

II. Conservation and management of resources for sustainable development

- “Methodology of environmental action for the Olympic Movement in the sense that all the actions undertaken by the Olympic Movement must take place with due respect for the environment and in the spirit of sustainable development, encourage environmental education and allow specific activities to help preserving the environment.”⁸⁴
- "Protection of conservation areas and countryside as sports activities, facilities and events must be so arranged as to ensure protection of conservation areas, the countryside, the cultural heritage and natural resources as a whole.
- Special effort for best possible use of existing sports facilities as well as to keep them in good condition and to improve them by increasing safety and reducing their environmental impact. The creation of new sports facilities must be confined to cases in which demand cannot be satisfied by using or renovating existing facilities.
- Preference of sports equipment which is environment friendly and makes use of renewable natural products.
- Promotion of non-polluting means of transport and public transport as it contributes beneficially to various environmental problems, including air pollution, the consumption of non-renewable energy and excessive use of land for highways and parking areas.
- Reducing energy consumption and promotion of use of renewable non-polluting sources as access to energy is a motor of development, but its excessive, pollutive or uncontrolled use mortgages the long-term future of that development and is contrary to the principles of sustainable development.”⁸⁵
- “Adequate accommodation and catering policy at major sports events in consideration of hygienic conditions, use of goods and foods that have been created with due respect for the development of the local population and the protection of the environment as well as recycling and processing of used products.
- Careful water management encouraging and supporting world-wide and local activities intended to protect water reserves and preserve the quality of natural

waters as water reserves are limited and form part of a closed system. They are essential for farming activities, drinking and hygiene. In an increasing number of regions of the world, the quantity and quality of water reserves are under threat.

- Responsible management and avoiding the use of hazardous or toxic products in order to minimize all kinds of pollution, including noise pollution, as in most human activities, potentially hazardous products may be used and waste as well as pollutants are produced. This is equally true of activities associated with sport."⁸⁶

- "Preserving the quality of the biosphere and maintenance of biodiversity. The earth is our habitat, our biosphere, the only one we have. Our future is totally dependent on the preservation of natural, physical and biological resources of the biosphere."⁸⁷

III. Strengthening the role of major groups

- "Advancement of the role of women. UNCED Agenda 21 makes very specific mention of a global campaign to encourage the participation of women in sustainable and equitable development.

- Promoting the role of young people as they represent nearly one third of the world's population and are the population group most concerned by the environment and development as well as by the practice of sport."⁸⁸

- "Recognition and promotion of indigenous populations in the sense to encourage their sporting traditions and to contribute to the use of their traditional knowledge and know-how in matters of environmental management as they have strong historical ties to their environment and have played an important part in its preservation."⁸⁹

2.7 Greening the Olympic Games

Sydney was one of the first cities to recognize and address the importance of eco-friendly Games and invited Greenpeace to help create the outlines for an 'eco-efficiency guide for sports and recreation'. Consequently 'Greening our Games' by David Chernushenko was published in 1994 as an United Nations Environmental Programme.

The consideration and implementation of these guidelines had a great influence on Sydney's successful candidature for the Olympics in 2000. Twelve Principles for Sustainable Sports have been developed:

"I. Conservation

Conservation of elements essential to the maintenance of life and health such as clean air, clean water and good soil, as well as the animals and plants we require for food, clothing and shelter. Modern societies have added to their list materials as fossil fuels and minerals. Also to be conserved are such vanishing natural features as forests, wetlands and other habitat- and most recently the ozone layer which performs essential functions in keeping the biosphere and local ecosystems in balance. The pillar of a sports conservation ethic, as Lillehammer environmentalist Olav Myrholt argues in a submission to the IOC, is the recognition that 'we are all in the same arena which is planet earth. Any harm done by the sport industry to the planet is thus a strike against the future of sport itself'.⁹⁰

"II. Stewardship

Environmental stewardship is the belief that all individuals, organizations, companies and countries are stewards of the environment, and must be responsible managers of those resources and regions on which our activities have an impact. Good environmental stewardship is good management of resources, restoration of resources, which we have despoiled, and the safe-keeping of significant resources for posterity. 'When in doubt refrain from doing!'⁹¹

"III. Eco-Efficiency

The most economically efficient and environmentally responsible way to carry out any task or make any product is to develop a system which minimizes the amount of materials required as input, the amount of processing required for those materials and the amount of non-productive output beyond the desired end product. The ultimate eco-efficient system buys only what it needs, reuses material as many times as possible and recycles or sells whatever may go unused. By producing no unsellable waste and pollution disposal costs are avoided.⁹²

"IV. Partnership

The idea of forming partnerships is to maximize the use of physical and intellectual resources which is nothing new to the sports community with a tradition of groups and individuals working together like sponsor an event or share a facility.

Appropriate innovative partnerships are now formed between non-traditional partners and partnerships are becoming long-term arrangements being established at an earlier stage in a project."⁹³

"V. Leadership

The sporting industry can demonstrate leadership on any number of social issues by showing that change is possible. We don't have to accept the Status quo if we're not satisfied with it. 'Whenever we are forced to change we often find potential opportunities'."⁹⁴

"VI. Quality

The sporting industry must shift its emphasis from size and quantity to quality if it expects its events to continue to hold the interest of competitors, spectators and sponsors. We can only go 'higher, faster and stronger' to a point. Athletic performances cannot be pushed much beyond this point without unnatural, synthetic and dangerous means. Similarly, events and facilities reach a point in size, with an environmental impact where they may be doing more harm than good."⁹⁵

"VII. Responsibility

In any sphere the possession of power brings with it a responsibility. The institutions of sport have become so highly regarded that top athletes have eclipsed politicians, scientists and humanitarians as idols and role models in our society. Sport now has an inordinate amount of influence, and with such influence comes responsibility: to show leadership, to educate and motivate and to set a positive example in particular for youth."⁹⁶

"VIII. Democratization

Typical decision issues include the allocation of money, design and location of facilities, scheduling of events and hiring of coaches. One of the principal demands of athletes is to be granted more direct involvement in decisions that affect them. Although athletes do not want to become managers they do want to see that their knowledge, experience and insight are taken seriously."⁹⁷

"IX. Investing in the future

It is essential to understand that the success of an event or a professional team depends heavily on community support. Money can be spent on facilities for the community, on support for local sports clubs or programmes and on promising

individual athletes. Funding can also be provided for restoring any natural sites which may have been damaged by construction or heavy use."⁹⁸

"X. Equity and Access

Nowadays a growing number of people have limited options when it comes to sport. For the middle classes the choice of what sport to pursue may be based less on preference than on cost. For lower-income people and in poorer countries the choice may not be what sport to play but whether to play sport at all. Sport for all has led to an emphasis on simpler, inexpensive sports and activities with less stress on competition and organizational structures. Where facilities and equipment are required, an effort is made to ensure that all users have equitable access."⁹⁹

"XI. Diversity

Any vibrant culture has in common diversity with any equally vibrant ecosystem. In human society diversity and variety ensure that the needs of the majority of people can be satisfied whether in language, career, entertainment or recreation. In the natural world, biological diversity ensures that individual species are provided with the conditions they need to survive, thus guaranteeing the viability of the ecosystem as a whole. If that diversity in the natural world is removed as we have seen in mono-cultural forestry and agriculture the risk is a complete collapse; remove diversity and variety from human society and risk alienation, boredom and tunnel vision. In sports if one or several forms of recreation dominate all others, the variety and unpredictability of experience which are one of its principal attractions are likely to be lost. In this case sports experiences are so uniform as to be described by some athletes as sterile, non-distinct and the ultimate non-experience."¹⁰⁰

"XII. Active living

Active living is a way of life that recognizes and values physical activity as an essential part of each day. It is an idea which fits naturally with and supports the principal goals and priorities of a healthy community such as equity, personal choice and the appreciation and protection of the natural environment. Active living is a philosophy of sport and recreation that does not depend on sophisticated and expensive equipment and facilities or complex organization."¹⁰¹

2.8 Certification methods

The most important certification methods are described in this chapter. Some criteria used in the Evaluation Matrix in this thesis are developed in consideration of similar criteria of the certification methods BREEAM, LEED, DGNB and GOBAS and further discussed.

“The main internationally recognized certification systems mostly build up on each other and were further developed based on the cumulative experience and knowledge. Initially the British BREEAM (Building Research Establishment’s Environmental Assessment Method) was published as an evaluation catalogue in 1990. Subsequently the French HQE (Haute Qualité Environnementale) was released in 1996, however it is still mainly in French. LEED (Leadership in Energy & Environmental Design) was published by the US Green Building Council in 1998. The Japanese CASBEE (Comprehensive Assessment System for Building Environmental Efficiency) originated from BREEAM and LEED experiences. It is an assessment system which is primarily used in Japan as it is based on local Japanese norms, standards and regulations. The Australian Green Star followed in 2002. These systems are regarded as first generation systems which focused on the assessment of ecological and energy efficiency criteria of a building. The second generation systems like the German DGNB (Deutsche Gesellschaft für Nachhaltiges Bauen) which was issued in 2008 and is based on the works of expert groups, or GOBAS, which is a green building assessment system sponsored by the Chinese Ministry for Science and Technology and published in 2003 for the Olympic Games 2008 in Beijing, have an emphasis on a holistic approach including the consideration of the ecological situation as well as energy efficiency of a building but also economical aspects, sociocultural criteria, technical criteria, location and process quality in regard of the whole lifecycle.”¹⁰²

2.8.1 Building Research Establishment’s Environmental Assessment Method

The Building Research Establishment’s Environmental Assessment Method (BREEAM) “is the world’s leading and most widely used environmental assessment method for buildings. BREEAM has certified over 200,000 buildings since it was first launched in 1990. BREEAM New Construction Non-Domestic Buildings Technical Manual is a BREEAM Scheme Document implementing an environmental performance standard against which new, non-domestic buildings in the UK can be

assessed, rated and certified.”¹⁰³ A new version of the BREEAM environmental performance standard shall be launched in 2014.¹⁰⁴

“The Scheme Document is property of BRE Global Limited (part of the BRE Group) which is an independent third party approval body offering certification of fire, security as well as sustainability products and services to an international market. BRE Global Limited’s mission is to protect people, property and the planet. Its scope of work is researching and writing standards, testing and certification in the areas of fire, electronics, security and sustainability, developing world leading sustainability assessment methods, undertaking research and consultancy for clients and regulators, promulgating standards and knowledge throughout the industry through publications and events as well as developing and delivering training. BEEAM 2011 incorporates the majority of environmental performance measures proposed for evaluation by CEN (European Committee for Standardisation) in CEN/TC 350 standards, together with a significant number of the social performance and some economic measures. Obvious examples include using Life Cycle Assessment (LCA) based data through the application of the Green Guide, Energy consumption in use through the application of SBEM (Simplified Building Energy Model), the UK’s EPBD (Energy Performance of Buildings Directive) compliant National Calculation Methodology and water consumption through the BREEAM water calculator tools. Outputs give KPIs (Key Performance Indicators) on Energy and Water in compliance with the draft standards and BRE Global will be introducing others following the final release of the CEN/TC 350 Standards.”¹⁰⁵

The 'BREEAM New Construction Non-Domestic Buildings Technical Manual' could not be applied for an evaluation of the case studies in Sydney, Athens and Beijing in this thesis because the editors of BREEAM intended to provide an evaluation only for New Buildings constructed in the United Kingdom which are assessed based on “built environmental performance” and optionally may get further certified with “excellent or outstanding rating which represents best and exemplary practice in the design and construction of new buildings in the UK”. These buildings shall further be rated with regard to the “maintenance of their environmental performance” by the 'BREEAM In Use Asset scheme assessment' during operation in a recommended time period of 3 years.¹⁰⁶

However, although as per definition not applicable for the case studies of this thesis, the BREEAM 2011 New Construction environmental sections and assessment have been taken into consideration during selection of the evaluation criteria and

parameters for establishment of indicators regarding the integration of major sports facilities especially in the respective environmental but also urban and social context. As per BREEAM definition “the assessment can be carried out for non-domestic building types including Assembly and Leisure buildings (Indoor and Outdoor Sports Facilities, Concert Hall, Conference Hall, Exhibition Hall), Non-residential buildings (Museum), Retail buildings (Shopping Centre, Restaurants, Cafes, Bars) which are in accordance with the sports facilities and their extended mixed-use profile considered in the case studies.”¹⁰⁷

Location Type, Proximity, Connectivity

In this thesis the parameter Location Type is assessed as an indicator for Urban Integration.^v For appraisal of the indicator for Urban Context the parameters Proximity and Connectivity are evaluated.^{vi} These criteria feature also the basis for the BREEAM 2011 analysis. Illustration 4 shows that Site selection as well as Public transport accessibility and Proximity to the amenities are important criteria for the BREEAM 2011 assessment scheme.

Overlay, Adaptability/Flexibility

With regard to environmental indicators for Building in this thesis the parameter Overlay is assessed considering Overlay with post- Games removal and permanent Overlay with post- Games utilization.^{vii} The parameters Adaptability and Flexibility are analyzed through the criteria Reconfiguration of the playing field, Retractable seating and Removable turf.^{viii} Illustration 4 shows that Innovation and New technology, process and practices are factors of consideration for BREEAM.

BREEAM “aims to support innovation within the construction industry through the recognition of sustainability related benefits which are not rewarded by standard BREEAM issues. It considers approved innovation as any technology, method or process that can be shown to improve the sustainability performance of a building’s design, construction, operation, maintenance or demolition, and which is approved as innovative by BRE Global.”¹⁰⁸

^v 4.5.1 Classification A Urban Category, Sub-category A.1, Urban Integration, Parameter A.1.1 Location Type, page 76-78

^{vi} 4.5.1 Classification A Urban Category, Sub-category A.2, Urban Context, Parameter A.2.1 Proximity, A.2.2 Connectivity, page 79-82

^{vii} 4.5.2 Classification B Environmental Category, Sub-category B.1, Building, Parameter B.1.1 Overlay, page 82-83

^{viii} 4.5.2 Classification B Environmental Category, Sub-category B.1, Building, Parameter B.1.2 Adaptability/Flexibility, page 83-84

Energy Efficiency

Referring to Building Services in this thesis the parameter Energy Efficiency including Renewable energy usage, Energy efficient air-conditioning, Energy efficient lighting or Photovoltaic power as well as Environmentally friendly building materials is assessed.^{ix} Illustration 4 shows that Energy monitoring, Energy efficient external lighting, Energy efficient equipment and Materials are also important criteria in the BREEAM 2011 assessment scheme.

Water Conservation

With reference to parameter Water Conservation the factors Rainwater harvesting, Water Recycling and Water-efficient appliances are evaluated in this thesis.^x Illustration 4 shows that Water consumption, Water monitoring and Water efficient equipment are also important criteria in the BREEAM 2011 assessment scheme.

Other Usage

With regard to indicators in the social context the parameter Other Usage is assessed through verification of the factors Retail, Commercial facilities and Tourist attraction in this research.^{xi} Illustration 4 shows that Proximity to amenities including Amenities within assessed buildings are also important criteria in the BREEAM 2011 assessment scheme.

^{ix} 4.5.2 Classification B Environmental Category, Sub-category B.2, Building Services, Parameter B.2.1 Energy Efficiency, pages 84-85

^x 4.5.2 Classification B Environmental Category, Sub-category B.2, Building Services, Parameter B.2.2 Water Conservation, pages 85-86

^{xi} 4.5.3 Classification C Social Category, Sub-category C.1, Usage Mix, Parameter C.1.2 Other Usages, page 87

Energy	Water
Reduction of CO ₂ emissions	Water consumption
Energy monitoring	Water monitoring
Energy efficient external lighting	Water leak detection and prevention
Low or zero carbon technologies	Water efficient equipment (process)
Energy efficient cold storage	Waste
Energy efficient transportation systems	Construction waste management
Energy efficient laboratory systems	Recycled aggregate
Energy efficient equipment (process)	Operational waste
Drying space	Speculative floor and ceiling finishes
Transport	Materials
Public transport accessibility	Life cycle impacts
Proximity to amenities	Hard landscaping and boundary protection
Cyclist amenities	Responsible sourcing of materials
Maximum car parking capacity	Insulation
Travel plan	Designing for robustness
Land use and ecology	Pollution
Site selection	Impact of refrigerants
Ecological value of site / protection of ecological features	NO _x emissions from heating/cooling source
Mitigating ecological impact	Surface water run-off
Enhancing site ecology	Reduction of night time light pollution
Long term impact on biodiversity	Noise attenuation
Health and wellbeing	Management
Visual comfort	Sustainable procurement
Indoor air quality	Responsible construction practices
Thermal comfort	Construction site impacts
Water quality	Stakeholder participation
Acoustic performance	Service life planning and costing
Safety and security	Innovation
	New technology, process and practices

Illustration 4: BREEAM 2011 New Construction environmental sections and assessment issues¹⁰⁹

The 5-point evaluation score used in this thesis allows a general comparison with the BREEAM rating benchmark system which is shown in Illustration 5 and comprises a 5-scale assessment method (outstanding, excellent, very good, good,

pass). “BREEAM consists of forty nine individual assessment issues spanning the nine environmental categories, plus a tenth category called ‘innovation’. Each issue addresses a specific building related environmental impact or topic and has a number of ‘credits’ assigned to it. Furthermore it adapts a balanced-score-card and defines minimum standards.”¹¹⁰ Illustration 5 demonstrates the weighting applied in ‘Environmental Section’, Illustration 6 explains the benchmarks and Illustration 7 describes BREEAM Minimum standards.

The evaluation matrix of this thesis has no weighting because the relevance of the 12 parameters is considered to be equally important. The parameters were carefully selected based on the assumption of providing objective evaluation through general validity, relevance as well as measurable, objective and procurable data acquisition.^{xii}

Environmental section	Weighting
Management	12%
Health & Wellbeing	15%
Energy	19%
Transport	8%
Water	6%
Materials	12.5%
Waste	7.5%
Land Use & Ecology	10%
Pollution	10%
Total	100%
Innovation (additional)	10%

BREEAM Rating	% score
OUTSTANDING	85
EXCELLENT	70
VERY GOOD	55
GOOD	45
PASS	30
UNCLASSIFIED	<30

Illustration 6: BREEAM benchmarks¹¹¹

Illustration 5: BREEAM Environmental section weightings¹¹²

^{xii} 4.4 Evaluation with rating system, page 73

Minimum standards by BREEAM rating level					
BREEAM issue	PASS	GOOD	VERY GOOD	EXCELLENT	OUTSTANDING
Man 01: Sustainable procurement	One credit	One credit	One credit	One credit	Two credits
Man 02: Responsible construction practices	None	None	None	One credit	Two credits
Man 04: Stakeholder participation	None	None	None	One credit (Building user information)	One credit (Building user information)
Hea 01: Visual comfort	Criterion 1 only	Criterion 1 only	Criterion 1 only	Criterion 1 only	Criterion 1 only
Hea 04: Water quality	Criterion 1 only	Criterion 1 only	Criterion 1 only	Criterion 1 only	Criterion 1 only
Ene 01: Reduction of CO ₂ emissions	None	None	None	Six credits	Ten credits
Ene 02: Energy monitoring	None	None	One credit (First sub-metering credit)	One credit (First sub-metering credit)	One credit (First sub-metering credit)
Ene 04: Low or zero carbon technologies	None	None	None	One credit	One credit
Wat 01: Water consumption	None	One credit	One credit	One credit	Two credits
Wat 02: Water monitoring	None	Criterion 1 only	Criterion 1 only	Criterion 1 only	Criterion 1 only
Mat 03: Responsible Sourcing	Criterion 3 only	Criterion 3 only	Criterion 3 only	Criterion 3 only	Criterion 3 only
Wst 01: Construction waste management	None	None	None	None	One credit
Wst 03: Operational waste	None	None	None	One credit	One credit
LE 03: Mitigating ecological impact	None	None	One credit	One credit	One credit

Illustration 7: Minimum BREEAM standards by BREEAM rating level¹¹³

2.8.2 Leadership in Energy & Environmental Design

Leadership in Energy & Environmental Design (LEED) certification is one of the most recognized and implemented verification methods developed and maintained by the U.S. Green Building Council. “LEED is a program that provides third-party verification of green buildings. Building projects satisfy prerequisites and get points to achieve different levels of certification. Prerequisites and credits differ for each rating system and teams choose the best fit for the project. Comprehensive and flexible, LEED is a green building tool that addresses the entire building lifecycle recognizing best-in-class building strategies.”¹¹⁴

“U.S. Green Building Council (USGBC) invests over \$30 million a year to maintain, operate and improve LEED and its customer delivery. No other rating system has an infrastructure that comes close to LEED. Behind the LEED program is an immense infrastructure developed to support the leaders in the industry as they innovate and create cutting-edge, high performance buildings, homes and neighbourhoods. LEED certification provides assurance as a third-party, verifies that the project is designed, built and operating the way it was intended. It is also a first step towards managing a building through its entire lifecycle. 10 billion square feet of space has been certified using LEED, with 1.7 million more square feet certifying daily. Furthermore the ongoing performance of a building can be measured, ensuring continuation of energy, water and money saving. LEED certification provides unrivalled visibility as it is recognized across the globe as the premier mark of achievement in green building. Overall it can be stated that LEED-certified buildings cost less to operate, reducing energy and water bills by as much as 40%. Businesses and organizations across the globe use LEED to increase the efficiency of their buildings, freeing up valuable resources that can be used to create new jobs, attract and retain top talent, expand operations and invest in emerging technologies.”¹¹⁵

LEED has established rating systems for five different building categories. “The first category is Building Design and Construction (BD+C) which applies to buildings that are being newly constructed or going through a major renovation with following subcategories: New Construction, Core and Shell, Schools, Retail, Healthcare, Data Centres, Hospitality, Warehouses and Distribution Centres. The second category is Interior Design and Construction (ID+C) which applies to projects which are a complete interior fit-out with following subcategories: Commercial Interiors, Retail and Hospitality. The third category is Building Operations and Maintenance”¹¹⁶

"(O+M) which applies to projects which are existing buildings undergoing improvement work or little to no construction with the following subcategories: Existing Buildings, Data Centres, Warehouses and Distribution Centres, Hospitality, Schools and Retail. The fourth category is Neighbourhood Development (ND) which applies to new land development projects or redevelopment projects containing residential uses, non-residential uses or a mix. Projects can be at any stage of the development process, from conceptual planning to construction with the following subcategories: Plan, Project. The fifth category is Homes which applies to single family homes, low-rise multi-family (one to three stories), or mid-rise multi-family (four to six stories) with the following subcategories: Homes and Multifamily Lowrise, Multifamily Midrise."¹¹⁷

Although not applicable for the case studies of this thesis, as per definition LEED is a specific green building tool as well as a third party verification for green buildings, the LEED assessment criteria from 2009 with their continuous amendments and updates in Addenda¹¹⁸ have been taken into consideration during the selection of the evaluation criteria, parameters and establishment of indicators regarding the integration of major sports facilities not only in the respective environmental but also the urban and social context since the LEED program can be considered as a state of the art standard. As per LEED definition the evaluation can be carried out for new or existing building types including Retail and Hospitality buildings. In addition LEED can be used for assessment of Neighbourhood Development which can be seen in accordance with the sports facilities, their surroundings and the extended mixed-use profile of the sports complex considered in the case studies. However, the LEED assessment focuses on projects under development and not on existing projects which have been developed in the past. LEED uses a credit system and assesses the following main, additional and bonus categories.¹¹⁹ There are four levels of certification. The number of points a project earns, determines the level of LEED certification that the project will receive. Typical certification thresholds are: Certified (40-49 Points), Silver (50-59 Points), Gold (60-79 Points) and Platinum (80+ Points).

"Main LEED credit categories:

- Sustainable sites credits encouraging strategies that minimize the impact on ecosystems and water resources
- Water efficiency credits promoting smarter use of water, inside and out, to reduce potable water consumption"¹²⁰

- "Energy and atmosphere credits promoting better building energy performance through innovative strategies
- Materials and resources credits encouraging usage of sustainable building materials and reducing waste
- Indoor environmental quality credits promoting better indoor air quality and access to daylight and views

Additional LEED credit categories for Neighbourhood Development:

- Smart location and linkage credits promoting walkable neighbourhoods with efficient transportation options and open space
- Neighbourhood pattern and design credits emphasizing compact, walkable, vibrant, mixed-use neighbourhoods with good connections to nearby communities
- Green infrastructure & buildings credits reducing the environmental consequences of the construction and operation of buildings and infrastructure

Two bonus credit categories:

- Innovation in design or innovation in operations credits address of sustainable building expertise as well as design measures not covered under the five LEED credit categories.
- Regional priority credits address of regional environmental priorities for buildings in different geographic regions"¹²¹

The interrelation between the LEED criteria and the parameters used for the Evaluation Matrix in this thesis is described further below.

Location Type, Building Type, Proximity, Connectivity

In this thesis the parameter Location Type as an Existing Site, Brownfield Site or Greenfield Site as well as the parameter Building Type as an Existing Building, New

Building or Temporary Structure is assessed as an indicator for Urban Integration.^{xiii} As indicators regarding Urban Context the parameters Proximity and Connectivity are evaluated through the linear distance of the stadium to mixed use areas (retail, commercial, recreational or residential) within the urban context and the availability of public transport with assessment of the linear distance to a metro station or provision of bus connection.^{xiv} With regard to indicators in the social context the parameter Other Usage is assessed through verification of the factors Retail, Commercial facilities and Tourist attraction.^{xv}

“LEED has an integrative process credit ‘Materials and resources’ with the parameter ‘Building life-cycle impact reduction’ which encourages adaptive reuse and optimization of the environmental performance of products and materials. The requirements therefore are to demonstrate reduced environmental effects during initial project decision-making by reusing existing building resources or demonstrating a reduction in material use through life-cycle assessment. This can be achieved by historic building reuse, renovation of abandoned or blighted building or building and material reuse. LEED assesses under the integrative process credit ‘Location & Transportation’ with parameter ‘LEED for Neighbourhood Development’ the location of the project with the intention to avoid development on inappropriate sites and to reduce vehicle miles travelled as well as to enhance liveability and improve human health by encouraging daily physical activity. The requirements therefore are to locate the project within the boundary of a development certified under LEED for Neighbourhood Development. Furthermore as parameter ‘High priority land’ shows, there is the intention to encourage project location in areas with development constraints and promote the health of the surrounding area for example by use of a brownfield where soil or groundwater contamination has been identified, and where the local, state, or national authority requires its remediation. In consideration of parameter ‘Surrounding density and diverse use’ the intention is to conserve land and protect farmland and wildlife habitat by encouraging development in areas with existing infrastructure as well as to promote walkability, transportation efficiency and reduce vehicle distance travelled. With parameter ‘Access to quality transit’ the intention is to encourage development in locations shown to have

^{xiii} 4.5.1 Classification A Urban Category, Sub-category A.1, Urban Integration, Parameter A.1.1 Location Type, Parameter A.1.2 Building Type, page 76-79

^{xiv} 4.5.1 Classification A Urban Category, Sub-category A.2, Urban Context, Parameter A.2.1 Proximity, A.2.2 Connectivity, page 79-82

^{xv} 4.5.3 Classification C Social Category, Sub-category C.1, Usage Mix, Parameter C.1.2 Other Usages, page 87

multimodal transportation choices or otherwise reduced motor vehicle use, thereby reducing greenhouse gas emissions, air pollution, and other environmental and public health harms associated with motor vehicle use. The requirements therefore are to locate any functional entry of the project within a ¼-mile (400-meter) walking distance of existing or planned bus, streetcar, or rideshare stops, or within a ½-mile (800-meter) walking distance of existing or planned bus rapid transit stops, light or heavy rail stations, commuter rail stations or ferry terminals.”¹²²

Overlay, Adaptability/Flexibility

With regard to environmental indicators for Building in this thesis the parameter Overlay is assessed considering the criteria Overlay with post- Games removal and permanent Overlay with post- Games utilization.^{xvi} The parameters Adaptability and Flexibility are analyzed through the criteria Reconfiguration of the playing field, Retractable seating and Removable turf.^{xvii}

“LEED incorporates the integrative process credit ‘Innovation’ with parameter ‘Innovation’ which has the intention to encourage projects to achieve exceptional or innovative performance. As requirements the project teams can use any combination of innovation, pilot, and exemplary performance strategies to achieve significant, measurable environmental performance using a strategy not addressed in the LEED green building rating system.”¹²³

Energy Efficiency

Referring to Building Services in this thesis the parameter Energy Efficiency including Renewable energy usage, Energy efficient air-conditioning, Energy efficient lighting or Photovoltaic power as well as Environmentally friendly building materials is assessed.^{xviii} “LEED has the integrative process credit ‘Energy & atmosphere’ and parameter ‘Renewable energy production’ evaluates the intention to reduce the environmental and economic harms associated with fossil fuel energy by increasing self-supply of renewable energy. The requirements therefore are the use of renewable energy systems to offset building energy costs. Furthermore the integrative process credit ‘Indoor environmental quality’ with parameter ‘Daylight’

^{xvi} 4.5.2 Classification B Environmental Category, Sub-category B.1, Building, Parameter B.1.1 Overlay, page 82-83

^{xvii} 4.5.2 Classification B Environmental Category, Sub-category B.1, Building, Parameter B.1.2 Adaptability/Flexibility, page 83-84

^{xviii} 4.5.2 Classification B Environmental Category, Sub-category B.2, Building Services, Parameter B.2.1 Energy Efficiency, page 84-85

intends to connect building occupants with the outdoors, reinforce circadian rhythms and reduce the use of electrical lighting by introducing daylight into the space.”¹²⁴

Water Conservation

With reference to parameter Water Conservation the factors Rainwater Harvesting, Water Recycling and Water-efficient appliances are evaluated in the thesis.^{xix} “LEED applies the integrative process credit ‘Water efficiency’ with parameter ‘Indoor waste use reduction’ supporting the intention to reduce indoor water consumption. The necessary requirements are defined fixtures and fittings, as applicable to the project scope which reduce aggregate water consumption by 20% from the baseline. All newly installed toilets, urinals, private lavatory faucets, and showerheads that are eligible for labelling must be WaterSense labelled (or a local equivalent for projects outside the U.S.). Also the installation of appliances, equipment, and processes within the project scope that meet the requirements accordingly is intended.”¹²⁵

2.8.3 German Sustainable Building Council

Deutsche Gesellschaft für Nachhaltiges Bauen e.V. or German Sustainable Building Council (DGNB) was established in 2007 with the intention to promote sustainable and economically efficient building. The non-profit non-government organization has 1,100 members and the vision is to “understand sustainability as the obligation of the whole of society to shoulder responsibility for current problems such as climatic change and resource depletion instead of merely leaving them for future generations to deal with”.¹²⁶

DGNB has established three business areas which are the DGNB Academy with the purpose to gain and pass on knowledge, the DGNB System developed in 2008 for planning and assessment of sustainable buildings as well as the DGNB Navigator which is an instrument for providing relevant information.¹²⁷

The DGNB certification systems assess “up to 50 sustainability criteria from the quality sections ecology, economy, socio-cultural aspects, technology, process work flows and site. If a performance requirement is met, the DGNB awards the DGNB certificate with a minimum of 35% of total performance index or further in bronze,

^{xix} 4.5.2 Classification B Environmental Category, Sub-category B.2, Building Services, Parameter B.2.2 Water Conservation, page 85-86

silver and gold according to the total performance index of 50%, 65% or 80%.¹²⁸ In addition, there is the option of simple pre-certification in the planning phase.”¹²⁹

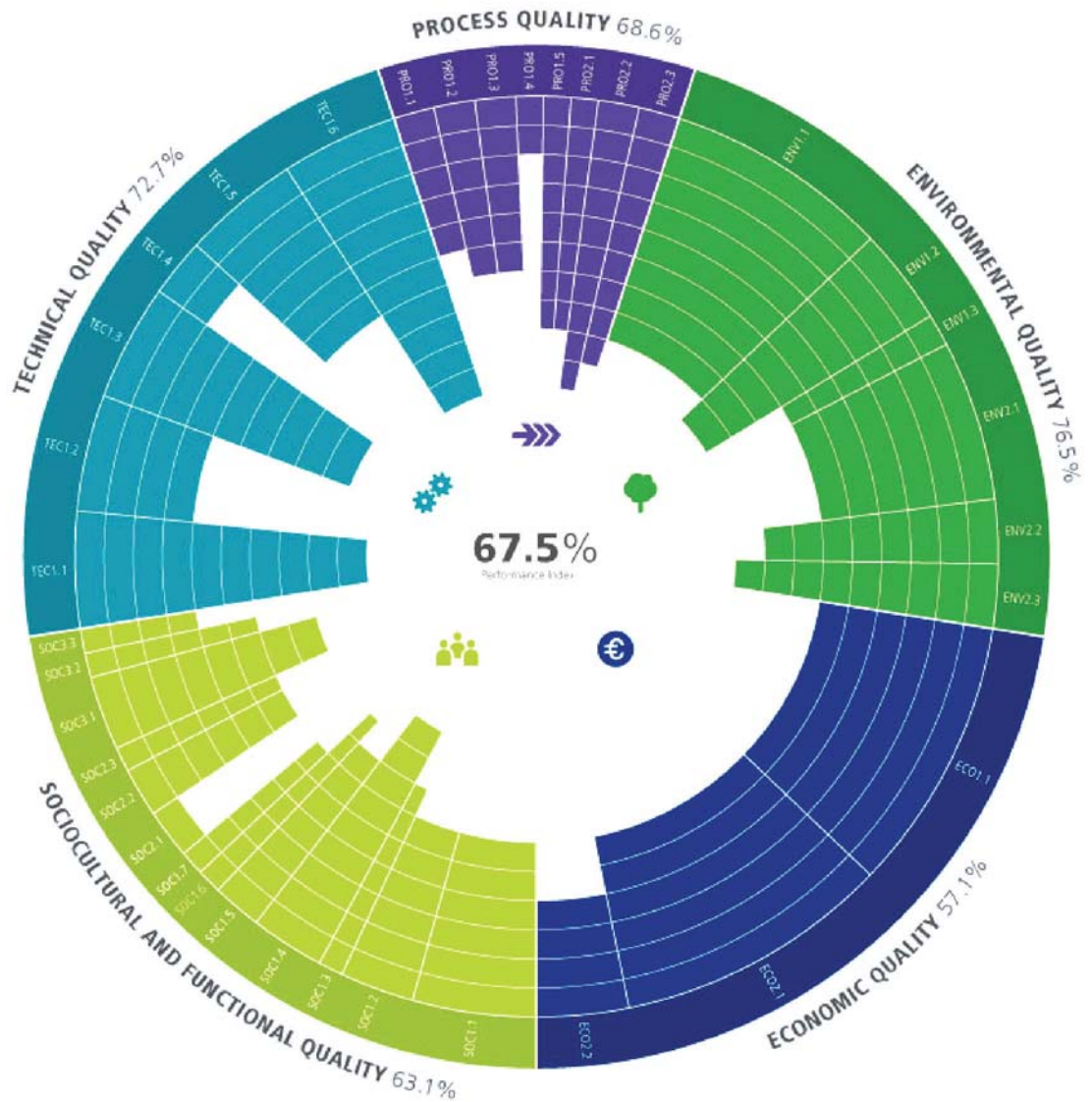


Illustration 8: DGBN Evaluation Graph¹³⁰

The certification is conducted through an appointed auditor. DGNB uses for criteria assessment a weighting scale which considers the following sections: Environmental, Economic, Sociocultural and Functional as well as Technical Quality with each 22,5% and Process Quality with 10% respective Site Quality which contributes to Technical and Process Quality as shown in Illustration 8.¹³¹ An overview of the criteria for buildings and urban districts is given in Illustration 9.

Environmental Quality

- Life Cycle Assessment
- Local Environmental Impact
- Environmentally Friendly Material Production
- Primary Energy Demand
- Drinking Water Demand and Wastewater Volume
- Land Use
- Life Cycle Assessment
- Water and Soil Protection
- Change in City District Climate
- Biodiversity and Interaction
- Consideration of Possible Environmental Impacts
- Land Use
- Total Primary Energy Demand and Renewable Primary Energy
- Energy-Efficient Development Structure
- Infrastructure with Low Resource Consumption, Groundwater Management
- Local Food Production
- Water Cycle

Economic Quality

- Building-Related Lifecycle Costs
- Value Retention, Suitability for Third Party Use
- Lifecycle Costs
- Fiscal Effects on Municipality
- Value Retention
- Efficient Use of Space

Sociocultural and Functional Quality

- Thermal Comfort
- Indoor Air Quality
- Acoustic Comfort
- Visual Comfort
- User Influence on Building Operation
- Quality of Outdoor Spaces
- Safety and Security
- Handicapped Accessibility
- Efficient Use of Floor Area
- Suitability for Conversion
- Public Access
- Cycling Convenience
- Design and Urban Planning Quality through Competition
- Integration of Public Art
- Site Features
- Social and Functional Diversity
- Social and Labour Infrastructure
- Objective / Subjective Security
- Quality of Open Areas in Public Spaces
- Noise Protection
- Proportion of Open Areas
- Handicapped Accessibility
- Occupancy Flexibility and Development Structure
- Adaptation to Urban Development Plan
- Urban Planning Design
- Use of Existing Buildings
- Public Art

Illustration 9: Overview of the criteria for buildings and urban districts¹³²

Technical Quality

- Fire Prevention
- Indoor Acoustics and Sound Insulation
- Building Envelope Quality
- Backup Capacity of Technical Building Systems
- Ease of Cleaning and Maintenance
- Resistance to Hail, Storms, and Flooding
- Ease of Dismantling and Recycling
- Pollution Control
- Noise Emission Control
- IT and Communication Infrastructure
- Energy Technology
- Waste Management
- Rainwater Management
- Dismantling, Sorting, and Recycling of the Infrastructure
- Maintenance, Servicing, Cleaning
- Quality of Transport Systems
- Quality of Road Infrastructure
- Quality of Public Transport Infrastructure
- Quality of Cycling Infrastructure
- Quality of Pedestrian Infrastructure

➔➔ Process Quality

- Comprehensive Project Definition
- Integrated Planning
- Comprehensive Building Design
- Sustainability Aspects in Tender Phase
- Documentation for Facility Management
- Environmental Impact of Construction Site / Construction Process
- Construction Quality Assurance / Quality Control Measures
- Systematic Commissioning
- Participation
- Concepts Developed in Competitive Bids
- Integrated Planning
- Community Involvement
- Controlling
- Environmental Impact of Construction Site / Construction Process
- Marketing
- Quality Assurance and Monitoring

Site Quality

- Site Location Risks
- Site Location Conditions
- Public Image and Social Conditions
- Access to Transportation
- Access to Specific-Use Facilities
- Connections to Utilities
- Integrated as a Criterion for Assessment

Illustration 9: Overview of the criteria for buildings and urban districts¹³³

The DGNB scheme for Existing buildings includes Office and Administrative buildings, Retail buildings, Industrial buildings and Residential buildings. The DGNB scheme for New buildings comprises Educational facilities, Office and Administrative buildings (with modernization measures), Retail buildings, Hotels, Industrial buildings, Hospitals, Laboratory buildings, Tenant fit-out, Assembly buildings,

Residential buildings and Small residential buildings. The DGNB scheme for New Districts applies to New urban districts, Industrial locations and New business districts.¹³⁴

Although not applicable for the case studies in this thesis, as DGNB was founded only in 2008 and does not specifically include sports facilities as well as per definition “assesses buildings and urban districts which demonstrate an outstanding commitment to meeting sustainability objectives”¹³⁵, the DGNB assessment criteria have been taken into consideration during selection of the evaluation criteria, parameters and establishment of indicators regarding the integration of major sports facilities not only in the respective environmental but also urban and social context since the DGNB program can be considered as a state of the art standard.

Location Type, Building Type, Proximity, Connectivity

In this thesis the parameter Location Type as an Existing Site, Brownfield Site or Greenfield Site as well as the parameter Building Type as an Existing Building, New Building or Temporary Structure are assessed as indicators for Urban Integration.^{xx} As indicators regarding Urban Context the parameters Proximity and Connectivity are evaluated through the linear distance of the stadium to mixed use areas (retail, commercial, recreational or residential) within the urban context and through the availability of public transport with assessment of the linear distance to a metro station or provision of bus connection.^{xxi} With regard to indicators in the social context the parameter Other Usage is assessed through verification of the factors Retail, Commercial facilities and Tourist attraction.^{xxii}

DGNB considers similar criteria in section Site Quality with parameter Site location conditions, Access to Transportation, Access to Specific-use Facilities and Connections to Utilities. In section Technical quality parameter Quality of Public Transport Infrastructure is assessed. In section Sociocultural and Functional Quality parameter Use of Existing Buildings is evaluated. In section Environmental Quality parameter Land Use is reviewed.

^{xx} 4.5.1 Classification A Urban Category, Sub-category A.1, Urban Integration, Parameter A.1.1 Location Type, Parameter A.1.2 Building Type, page 76-79

^{xxi} 4.5.1 Classification A Urban Category, Sub-category A.2, Urban Context, Parameter A.2.1 Proximity, A.2.2 Connectivity, page 79-82

^{xxii} 4.5.3 Classification C Social Category, Sub-category C.1, Usage Mix, Parameter C.1.2 Other Usages, page 87

Overlay, Adaptability/Flexibility

With regard to environmental indicators for Building in this thesis the parameter Overlay is assessed considering the criteria Overlay with post- Games removal and permanent Overlay with post- Games utilization.^{xxiii} The parameters Adaptability/Flexibility are analyzed through the criteria Reconfiguration of the playing field, Retractable seating and Removable turf.^{xxiv}

In accordance DGNB is rating parameter Suitability for conversion and Occupancy. Flexibility and Development Structure in section Sociocultural and Functional Quality are evaluated.

Energy Efficiency

Relating to Building Services in this thesis the parameter Energy Efficiency including Renewable energy usage, Energy efficient air-conditioning, Energy efficient lighting or Photovoltaic power as well as Environmentally friendly building materials is assessed.^{xxv}

DGNB has equivalent evaluation in section Environmental Quality through parameters Environmentally friendly Material Production, Consideration of possible environmental impacts, Total Primary Energy Demand and Renewable Primary Energy as well as Energy-Efficient Development Structure. Additionally in section Technical Quality parameter Energy technology is evaluated.

Water Conservation

With reference to parameter Water Conservation the factors Rainwater Harvesting, Water Recycling and Water-efficient appliances are evaluated in the thesis.^{xxvi}

DGNB reviews in section Technical Quality parameter Rainwater Management.

Sport Usage, Other Usage

In terms of indicators for integration into the social context the thesis analyzes criteria Usage Mix with the parameters Sport Usage and Other Usages. Furthermore criterion Utilization is evaluated through parameter Diversity of events.^{xxvii}

^{xxiii} 4.5.2 Classification B Environmental Category, Sub-category B.1, Building, Parameter B.1.1 Overlay, page 82-83

^{xxiv} 4.5.2 Classification B Environmental Category, Sub-category B.1, Building, Parameter B.1.2 Adaptability/Flexibility, page 83-84

^{xxv} 4.5.2 Classification B Environmental Category, Sub-category B.2, Building Services, Parameter B.2.1 Energy Efficiency, page 84-85

^{xxvi} 4.5.2 Classification B Environmental Category, Sub-category B.2, Building Services, Parameter B.2.2 Water Conservation, page 85-86

DGNB provides similar investigation through parameter Social and Functional Diversity, Site features, Social and Labour Infrastructure as well as Occupancy Flexibility and Development Structure.

2.8.4 Green Olympic Building Assessment System

Green Olympic Building Assessment System (GOBAS) is a green building assessment system sponsored by the Chinese Ministry for Science and Technology issued in 2003 and developed for the Olympic Games 2008 in Beijing. It is a combination of CASBEE (Comprehensive Assessment System for Building Environmental Efficiency) and LEED which takes in consideration the Chinese urban construction requirements.¹³⁶

GOBAS addresses “two different aspects, which are the establishment of Green Olympic building standards based on the green building concept and Olympic building requirements as well as an operational assessment method that secures the higher standards of Olympic buildings through design and construction. The assessment process has four levels which are building planning, building design, building construction and quality acceptance as well as building operation. Building environment, energy, water resource, materials and internal environmental quality are well examined in the process. GOBAS uses the Quality- load grading method with a combination of assessments in two categories. The first category is Group Q comprising parameters Site Quality, Services and Functions provided (Civil infrastructure and facilities provision, Public transportation provision, Applicability of the building) and External physical environment. Group L consists of parameters Necessity study of the project (Necessity demonstration, Usage of temporary facilities), Environmental Affect Analysis (Land resource control, Civil infrastructure affect control), Energy Consumption Analysis (Energy planning), Materials and Resources (Existing buildings, Building materials) and Water Resources (Water planning, Rainwater control). Both groups are evaluated with a 5-point scale. Importance related weightings are applied and a Q-L Green score is obtained.”¹³⁷

^{xxvii} 4.5.3 Classification C Social Category, Sub-category C.1, Usage Mix, Parameter C.1.1 Sport Usage, Parameter C.1.2 Other Usages, Sub-category C.2, Parameter C.2.2 Diversity of events, page 86-89

Although GOBAS was introduced for assessment of the Olympic Buildings in Beijing 2008 an implementation or assessment of results could not be found despite of thorough research. This finding was also acknowledged by Natalie Essig in her thesis 'Nachhaltigkeit von Olympischen Sportbauten' ('Sustainability of Olympic sports facilities').¹³⁸

2.9 Summary chapter review of the subject

In the literature review the existing studies, researches and certification systems are summarized and discussed. The most relevant literature relating to the aims and objectives of this thesis are briefly mentioned below.

'A Framework for Evaluating Olympic Urban Development for Sustainability' was written by Hanwen Liao in 2006. The thesis includes a systematic collection of data with an assessment of factors defining the environmental sustainability. The evaluation framework considers nine themes (e.g. Energy Consumption, Water Consumption, etc.) and is based on a multi-criteria assessment method (MCA).¹³⁹

Natalie Essig's research 'Nachhaltigkeit von Olympischen Sportbauten' ('Sustainability of Olympic sports facilities') is a thesis, which was subsequently published as a book in 2010 and analyses the practicability and measurability of sustainability aspects with regard to competition facilities of the Olympic Games. International assessment methods and certification systems like BREEAM, LEED and DGNB are evaluated with regard to applicability for Olympic sports facilities.

The book 'Olympic Cities: Urban Planning, City Agendas and the World's Games, 1896 to the present' is a compendium of essays by John R. Gold and Margaret M. Gold published in 2007. It states that "several authors note that in the bid process it is common to overestimate the long-term and other benefits that accompany hosting the games, but none of the authors completely answers the question of whether the Olympics are worthwhile for cities in the long run. This demonstrates the need for further research on the experience of cities years and decades after hosting the games."¹⁴⁰

Subsequently the historic background of the Olympic Games and the outstanding accomplishments of Baron Pierre de Frédy de Coubertin in founding the modern Olympism in 1894 are reviewed and briefly summarized. In this context the requirements for the hosting city for staging the Games, the election process with its historic development as well as the introduction of a 2-phase-system in 1999 with a process duration of about two years and the organisations involved are described.

Furthermore the topic of 'Green Olympics' with reference to David Chernushenko's work, and the principles of Olympic Movement's Agenda 21 "as a useful reference tool for the sports community at all levels in the protection of the environment and enhancement of sustainable development"¹⁴¹ are elaborated.

Certification methods such as BREEAM, LEED, DGNB and GOBAS are reviewed and described at the end of this chapter. It was noted that these complex certification systems as a whole were not fully applicable for existing stadiums. In consideration of the aims and objectives of this research, the relevant evaluation criteria of BREEAM, LEED, DGNB and GOBAS and their implementation on the case studies are identified. The selected criteria are considered for development of the Research Tool further described in Chapter 4.

3 STADIUM DESIGN IN THE OLYMPIC CONTEXT

3.1 Historic development of the stadium

The review and analysis of the historic development of stadiums refers to sports stadiums constructed for the modern Olympic Games from 1896 onwards. Focus is on few selected examples specifically relating to the case studies in this thesis.

3.1.1 Olympic stadium for the modern Olympic Games 1896

The Panathenaic (or Panathenian) Stadium widely known as "Kallimarmaro", built for the first modern Olympic Games 1896 in Athens with a capacity of 69,000 seats¹⁴² (13 inch seat width), was used for the first modern Olympic Games in 1896.

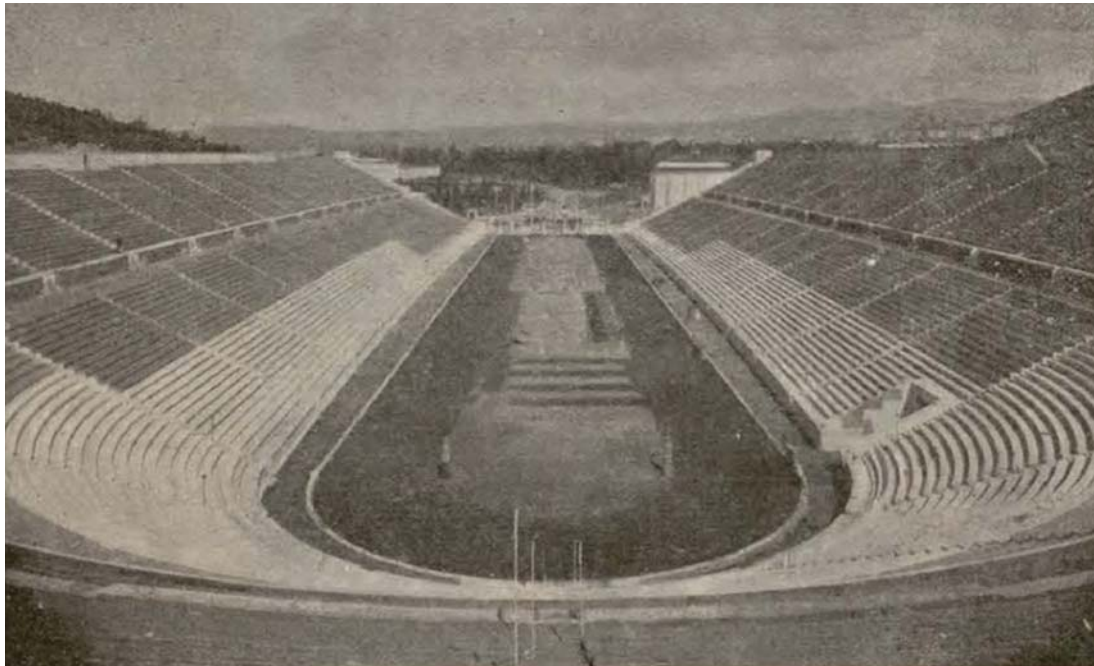


Illustration 10: Panathenaic Stadium¹⁴³ built for the Olympic Games 1896 and also used for the Olympic Games 2004 in Athens

The Panathinaiko Stadium was also venue for the Archery competition with a reduced capacity of 7.500 seats and the Marathon finish with a capacity of 34,500 seats during the Olympic Games 2004. For this purpose "renovations that took place under the responsibility of the General Secretariat of Sports and the Ministry of Culture, included upgrades and modifications on its infrastructure, mainly in the scope of restoration of the monument, configuration of the track and surrounding areas, incorporation of lighting and establishment of fire-fighting systems."¹⁴⁴

3.1.2 Mono stadium for the Olympic Games 1908

The early mono stadium model was mainly hosting sports of “basic physical exertion belonging to the oldest disciplines such as running, jumping, throwing and swimming as well as sports of the so called civilised era with its conflicts and wars including physical exercise in a battlefield manner such as archery, shooting, fencing, boxing, judo and equestrianism. Later on especially the team played popular ‘ballgames’ such as football, basketball, hockey and lawn tennis created a dynamic spectacle and a social phenomenon.”¹⁴⁵

Liao is stating that “the infield of the Olympic Stadium was accordingly adapted to the requirements with portable turf for the football tournament, set up with hurdles and obstacles for the equestrian routine, erected with a demountable podium for boxing, gymnastics, wrestling and weightlifting contests. In the event of the London 1908 and the Amsterdam 1928 Games the Olympic Stadium was even excavated for a swimming pool or ringed by a cycling track.”¹⁴⁶

The ‘White City’ Olympic Stadium of the London Games 1908 planned by architect James Black Fulton was the first stadium specially developed for the Olympic Games and designed as a monostadium with a capacity of approx. 68,000 spectators (including 20,000 covered seats) during the Olympic Games. “The running track was surrounded by a 604-metre concrete cycling track, the playfield was augmented by a swimming pool with dimensions of 17m by 100m and a special collapsible tower was erected for the diving disciplines. Due to the space conditions and increased density of activities a visualisation was difficult resulting in a lack of contact between spectators and athletes.”¹⁴⁷

Illustration 11 showing the Olympic Stadium 'White City Stadium', also referred to as 'The Stadium', demonstrates the big distance between the spectators and athletes. This was considered a disadvantage, resulting in the development of dedicated single-purpose sports stadiums rather than one multi-purpose stadium or a monostadium. During the Olympic Games in 1908 the majority of competitions were held at the monostadium 'White City Stadium' including: Archery, Athletics, Cycling (Track), Diving, Field Hockey, Football, Gymnastics, Lacrosse, Rugby Union, Swimming, Tug of War, Water Polo and Wrestling.



Illustration 11: 'White City Stadium' in London for 68,000 spectators (original capacity 88,000 spectators) at Shepherd's Bush (now called White City) built for the Olympic Games 1908 in London¹⁴⁸

The crucial impulse for creating a new kind of sports venue was the time schedule. The Olympic time was restricted to “16 days for the Los Angeles Games 1932 and thereafter which made a simultaneous performance at different locations inevitable. One of the first stadiums to be separated was the Natatorium. The Paris Games 1924 presented the first Olympic Swimming Stadium with filtering and heating facilities. The establishment of the today known Velodrome began with the Helsinki Games 1952 followed by the first ‘all-seated’ 15,000 spectator stadium in Rome in 1960 and the first indoor Velodrome in 1976 in Montreal. The first real equestrian venue was designed for Helsinki 1952 with the final events being held in the Olympic Stadium as a tradition until the 1980s. Subsequently other disciplines like archery and shooting were moved to locations providing larger space and gymnastics, wrestling, boxing or fencing became ‘indoor sports’ hosted in halls. Today’s Olympic Stadium has the privilege to host only the classic athletic disciplines as well as ceremonies and festivities.”¹⁴⁹

3.1.3 Development of the multi-purpose stadium

Following the separation of the facilities for swimming events, cycling and equestrian the Olympic Stadium remained the largest and most important venue in most cases, staging the athletic competitions as well as the opening and closing ceremony. Subsequent to the Olympic Games the playing field is usually used for soccer, union rugby, American football and other non-sports events like concerts.

One example for a multi-purpose stadium is the Berlin Olympic Stadium, shown in Illustration 12, which was built from 1934 to 1936. Architect Werner March designed it for the Olympic Games 1936 in Berlin. The Olympic Stadium was constructed on the remains of the National Stadium built by his father Otto March. “On December 14th 1933, Hitler himself decided to have the third design by the brothers March, called ‘solution option B’, implemented. This plan called for the demolition of the National Stadium. The new stadium was designed to be build ten metres below and 13 metres above the ground- creating a commanding, highly visible building. The layout of the stands for the audience was planned above and below a circular middle gallery on ground level. All of the architectural features actually built later, can already be found in this initial plan: The Olympischer Platz, the Olympic Stadium itself, the parade grounds with the so-called ‘Führerloge’ and the Bell Tower on the East-West-Axis, the Coubertinplatz as well as the swimming pool stadium on the North-South-Axis.”¹⁵⁰



Illustration 12: Berlin Olympic Stadium built for the Olympic Games 1936 in Berlin ¹⁵¹

The trend to further utilize the stadium for additional functions by integrating facilities for recreation, hotels, offices, retail and other functions started towards the end of the 20th century. Main reason for adding and combining different functions is to maximise the utilization of the building beyond sports events on a day-to-day ideally 24-hour basis. For this purpose and in order to comply with the FIFA requirements the Berlin Olympic Stadium¹⁵² was completely refurbished and upgraded with a new roof structure from 1999 to 2004 for the Soccer World Cup 2006 in Germany. It now includes other functions such as a museum, chapel, fan shops and VIP boxes which

could be used as offices. In addition regular sight-seeing tours are organized on a daily basis. "Since its reopening in August of 2004, more than 300.000 visitors from around the world come to the Olympiastadion Berlin every year, thus making the stadium one of the most frequented sights of Berlin."¹⁵³

3.2 Changing venue locations for the Olympic Games

Schollmeier is stating in his thesis that "Coubertin associated the Olympic Games and the Olympic Movement with the three major principles Internationality, Continuity and Independence. The idea of Internationality is emphasized by the election of multinational IOC members and the approach to celebrate the Olympic Games in the world's different capitals. From his point of view changing venues allow the Olympic Games to remain independent regarding people, nations and organisations involved in the process. Coubertin also believed that various places of staging the Games would attract more and different groups of spectators."¹⁵⁴

"The idea of re-establishing a permanent venue in Greece was introduced several times by the Greek side. In the beginning of the modern era Coubertin justified his refusal with the assumption that it would be a high financial burden for the hosting country. In 1976, after several boycotts affected the celebration of the Olympic Games, the Greek Minister President at that time Mr. Konstantin Karamanlis suggested former IOC president Lord Killanin the permanent establishment of the Games in Greece in order to avoid such trouble for the future."¹⁵⁵

This proposal called 'Hellas Plan' was rejected by the 84. IOC Session in Baden-Baden with the following resolution: 'The International Olympic Committee is deeply grateful to the Greek People, its government, and above all, to the President of the Republic of Greece, who offered a completely neutral region close to the ancient Olympia as a permanent site for the Olympic Games of modern times, subject to the control of the International Olympic Committee. Los Angeles has been chosen to host the Olympic Games in 1984 and Seoul in 1988. Several Candidate Cities have already been registered for 1992. We hope that the city which had the privilege to organise the first Games of modern times, Athens, will be chosen for 1996.'¹⁵⁶

3.3 Stadium design in the 21st century

Selected important facts referring to the development of stadium design in the 21st century are highlighted below considering the aims and objectives of this research.

3.3.1 Future use of buildings for singular events

Building structures constructed for single non-reoccurring events, for instance trade fairs like the World Exhibition EXPO¹⁵⁷, which takes place every five years, shall be utilized after the event to avoid vacancies. Recent concepts for future use of buildings have been showcased at the EXPO 1998¹⁵⁸ in Lisbon (Portugal) and EXPO 2000¹⁵⁹ in Hanover (Germany). The EXPO 1998 in Lisbon¹⁶⁰ was built from scratch covering 50 hectares. Every building was pre-sold for the use after the event ensuring that the site would not be left abandoned, as it had happened with previous exhibitions for instance at the EXPO 1992 in Seville, and to offset the costs for the EXPO. “The EXPO 1998 attracted ten million visitors within 132 days and closed on 30. September 1998. Five months later in February 1999, the venue reopened as ‘Parque das Nações’ (Park of the Nations) as a free-access park. Most of the buildings were re-used or converted into office or living space. The main entrance (Sun Door) was converted into the ‘Centro Vasco da Gama’, a regional shopping mall and the main exhibition pavilions were transformed into the ‘Feira Internacional de Lisboa’ (Lisbon International Exhibition Fair). The ‘Utopia Pavilion’ was converted to ‘Pavilhão Atlântico’, Lisbon’s main multi-purpose indoor arena. The area previously used for the EXPO 1998 is attracting approximately 18 million tourists per year to its gardens, museums, commercial areas and has become permanent residency for up to 150,000 people.”¹⁶¹ For the EXPO 2000 in Hanover the concept for re-use of buildings has been further developed. One example is the ‘Christ Pavilion’.¹⁶² The 2,000 sqm building complex was designed for the EXPO 2000 and then re-used at a different location. The entire complex, with exception of the crypt, colonnade and water basin was disassembled after the EXPO 2000 and reassembled in the cloister of Volkenroda in 2001.

3.3.2 Adaptability of sports venues

The key drivers for enhancing the adaptability of stadiums are the operational requirements to stage different types of sports events and non-sports events with differing and partly conflicting requirements at the same venue. One of the major

limitations for the adaptability of the largest venue out of the three selected venues in this research, the Olympic Stadium, is the 400m running track which encircles the natural turf field. Due to the dimensions of the track, the playing field inside can be mainly utilized for soccer events (playing field 68m x 105m), union rugby (playing field max. 70m x 100m) and, with adjustments of the running track to fit in the 100 yard field, for American football (playing field 110m x 48m).

3.3.3 Transformation of sports venues

The requirements for the Olympic Games venues are defined by the International Olympic Committee (IOC). Among other outlines the spectator capacities for the different venues, sports disciplines and ceremonies are specified. The capacity of the Olympic Stadium is defined with a minimum of 60,000 spectators. Most of the recent Olympic Stadiums have a higher capacity for the Games like the Sydney Olympic Stadium^{xxviii} with 115,600 spectators, Olympic Stadium Athens^{xxix} with 71,030 spectators and Olympic Stadium Beijing^{xxx} with 91,000 spectators which are then reduced after the Games. One example for introduction of temporary seating is Sydney Olympic Stadium¹⁶³, which was the main stadium for the Sydney Olympic Games 2000, with 115,600 spectators during the Games and was reconfigured to 80,000 seats after the Games.

The increasing importance to reduce the spectator capacity is also considered for the Olympic Games 2012 in London where all athletic events as well as the opening and closing ceremonies will take place in the Olympic Stadium.^{164, 165} Out of the total capacity of 80,000 spectator seats more than 65% are demountable. Accordingly the stadium will have 25,000 permanent seats and 55,000 temporary seats. After the Games the stadium shall be transformed into a venue with a smaller capacity of 25,000 seats for athletics, other sporting, community and educational usages. Reasons for the reduced capacity are the differing long-term requirements for the operation after the Games, usually resulting in a significantly lower demand. Another important aspect for the smaller capacity is the reduction of operational and maintenance costs. The large fraction of temporary demountable elements proposed for the London Olympic Stadium has not been constructed before.

^{xxviii} 5.3.2 Sydney Olympic Stadium, pages 99-101

^{xxix} 5.4.2 Athens Olympic Stadium, pages 106-108

^{xxx} 5.5.2 Beijing Olympic Stadium, pages 114-116

3.3.4 Temporary stadiums

For the Olympic Summer Games 2004 in Athens a temporary arena¹⁶⁶, shown in Illustration 13, for Taekwondo, Basketball, Baseball, Beach Volleyball, Softball, Fencing, Hockey and Cycling with 45,000 seats was constructed.



Illustration 13: Athens Olympic Games 2004 temporary arena with 45,000 seats¹⁶⁷

Another example for temporary constructions built for the XXVII Summer Olympic Games 2000 in Sydney is displayed in Illustration 14. For the competitions in Beach Volleyball a temporary venue¹⁶⁸ with 10,000 seats was constructed.

The modified table below, as Illustration 14, adopted from Hanwen Liao's thesis 'A Framework for Evaluating Olympic Urban Development for Sustainability' compares the number of permanent venues and temporary venues. For certain sports activities, required for the Olympic Games, but not common in the Host City, the construction of temporary venues is an interesting alternative. However, temporary sports venues are not subject of this thesis.

City Games	No. of venues in total	No. of venues in Host City	New built venues in Host City	Existing venues used in Host City	% of existing venues	Temp. venues in Host City	% of temporary venues	% of new permanent venues
Rome'60	24	17	12	5	29	4	24	47
Tokyo'64	30	25	14	11	44	4	16	40
Mexico'68	22	17	7	10	59	0	0	41
Munich'72	32	21	13	8	38	4	19	43
Montreal'76	26	17	10	7	41	0	0	59
Moscow'80	27	23	11	12	52	0	0	48
Los Angeles'84	33	23	7	16	70	2	9	22
Seoul'88	32	23	13	10	44	2	9	48
Barcelona'92	40	23	11	12	52	2	9	39
Atlanta'96	32	24	16	8	33	5	21	46
Sydney'00	37	33	26	7	21	3	9	70
Athens'04	39	33	22	11	33	3	9	58
Beijing'08	37	31	12	11	32	8	24	43
London'12	38	28	6	17	61	5	18	21
Average	32	24	13	10	44	3	12	45

Illustration 14: Extract from table prepared by Hanwen Liao: "The use of existing and temporary venues, Rome '60 to London '12", here Information added for Olympic Games 2004 in Athens, 2008 in Beijing and 2012 in London accordingly^{169, 170, 171}

3.4 Summary chapter stadium design in the Olympic context

In this chapter the historic development of sports stadiums is briefly reviewed and summarized. Considering the fundamentally different requirements for the design and operation of sports stadiums in the 21st century, especially with regard to urban, social and environmental context, focus in the review of the historic evolution is on aspects relevant for the analysis and assessment of the case studies. Referring to the historic development the emphasis is on the evolving requirements for staging the Olympic Games in consideration of the aims and objectives of this research.

For the early monostadium model the example of the 'White City' Olympic Stadium of the London Games 1908 is given. The consecutive development of the multi-purpose stadium took place following the separation of the facilities for swimming events, cycling and equestrian. The Olympic Stadium remained the largest and most important venue staging the athletic competitions as well as the opening and closing ceremony. Subsequent to the Olympic Games the playing field is usually used for soccer, union rugby, American football and other non-sports events like concerts.

The alternative to provide one permanent location for the Olympic Games in Greece, known as the 'Hellas Plan', is mentioned with reference to the research of Peter Schollmeier¹⁷² and it is described why this proposal was not accepted by the International Committee.

The trend to further utilize the stadium for additional functions by integrating facilities for recreation, hotels, offices, retail and other functions started towards the end of the 20th century. Main reason for adding and combining different functions is to maximise the utilization of the building beyond sports events on a day-to-day ideally 24-hour basis. One example for stadiums where additional facilities became integral part of the stadium complex, but are operating independently, is the Olympic Stadium in Berlin.¹⁷³ This structure was built for the Summer Olympic Games 1936 in Berlin and completely refurbished as well as upgraded between 1999 and 2004 for the Soccer World Cup 2006 in Germany. It now includes a museum, chapel, fan shops and VIP boxes which could be used as offices.

The stadium design of the 21st century is described with special attention to the key drivers for enhancing the adaptability of stadiums to stage various types of sports events and non-sports events with differing and partly conflicting requirements at the

same venue. The transformation of sports venues with reduction of the spectator capacity as well as dismantle of the overlay to minimize operational and maintenance costs is described with reference to the case studies.

In addition examples of temporary arenas and their use are shown as paradigms for temporary venues at the Olympics 2000 in Sydney and 2004 in Athens. However, temporary sports venues are not subject of this thesis.

4 DEVELOPMENT RESERACH TOOL

This chapter starts with a definition of the term 'sustainability'. Subsequently the method of evaluation and methodology for development of the research tool in consideration of the aims and objectives of this research are described. Reference is made to the conclusions of Chapter 2, where relevant criteria of existing certification systems such as BREEAM, LEED and DGNB were identified and integrated in the bespoke Evaluation Matrix.

4.1 Definition of Sustainability

"The English word 'sustain' is based on the Latin word 'sustenare', meaning to 'keep' or 'hold up'. The modern use of the word can be traced to German forestry science of the 17th century, in which it was the precursor to today's 'sustainable yield': a level of resource extraction that can be maintained over time. The meaning of the word 'sustainable' could be described with 'capable of being maintained at a certain level'".¹⁷⁴

With reference to environmental issues the most commonly cited definition is from the United Nations report 'Our Common Future', also known as the 'Brundtland' Report from 1987: "Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs."¹⁷⁵ This particular definition is consciously selected in this thesis as the "Brundtland' Report concept became one of the most successful approaches to be introduced in many years. In fact, it helped to shape the international agenda and the international community's attitude towards economic, social and environmental development. An enormous amount of academic, administrative and political effort has been put into trying to find a more precise definition of sustainable development than the one put forward by the Brundtland Commission, but to no avail."¹⁷⁶ The concept of sustainable development changed with time and according to the circumstances "giving further emphasis to practical solutions that can be implemented on the ground. Also the identification of key problem areas has become more specific and the conclusions more action-oriented."¹⁷⁷

The intent of this thesis is similarly to identify key drivers for a more sustainable legacy of the Olympic Games, ideally through practical implementation of the findings described in the comparative assessment and in consideration of the conclusions.

4.2 Method of evaluation

The methodology of this thesis, described in section 1.6 'Research methodology', is a combined assessment of the obtained knowledge on the subject consisting of the results of the library research as well as the findings of the field research, surveys and personal interviews. Based on the literature research and technical review of drawings as well as project relevant information a preliminary Evaluation Matrix^{xxxix} was developed. The initial findings of the literature research were then reviewed during the field research (each of about seven days duration) for all nine venues between 2010 and 2011.^{xxxix} In addition a comprehensive survey together with an operator representative of the stadium was conducted for seven out of nine venues (except Beijing Indoor Stadium and Beijing Football Stadium). Subsequent to the survey, personal interviews (approximately 90 minutes) with operator representatives at senior management level were carried out in order to discuss and verify the findings of the field research and also to obtain first-hand information about the Overlay^{xxxix} and day-to-day operation of the venue.

In the interviews assumptions made during the literature review with regard to the key drivers for sustainability were discussed. After completion of each field research the results consisting of site pictures, drawings, site plans, maps, measurements, etc. were analysed and evaluated. Based on the documentation for all three case studies the comparative assessment was carried out using a bespoke Evaluation Matrix with a 5-point score system^{xxxix} further described in the following sections of this chapter.

4.3 Methodology development of research tool

The requirement for development of a bespoke Evaluation Matrix resulted from the fact that none of the existing certification methods could be fully applied as a whole for sports stadiums already in use and from the difficulty that the required data, for example documentation of the actual resources consumption (e.g. electricity bills), for the application of such complex certification systems were not discretionary.

^{xxxix} 4.5 Description Evaluation Matrix, pages 74-76

^{xxxix} Sydney 12.02.-19.02.2011, Athens 21.10-26.10.2010, Beijing 26.02.-05.03.2011

^{xxxix} 4.5.2 Classification B Environmental Category, Sub-category, B.1, Building, Parameter B.1.1 Overlay, pages 82-83

^{xxxix} 4.4 Evaluation with rating system, page 73

Furthermore the editors of BREEAM intended to provide an evaluation only for New Buildings constructed in the United Kingdom which are assessed based on “built environmental performance” and optionally may get further certified with “excellent or outstanding rating which represents best and exemplary practice in the design and construction of new buildings in the UK”. LEED is a green building tool as well as third party verification for green buildings. DGNB was founded only in 2008 and does not specifically include sports facilities as well as per definition “assesses buildings and urban districts which demonstrate an outstanding commitment to meeting sustainability objectives”.^{xxxv}

The flowchart in Illustration 15 describes the methodology and sequence of the development of the assessment method and research tool. In consideration of the aims and objectives of the research the literature review was carried out. Based on the analysis of the literature and other already existing researches, several assessment methods and certification systems were evaluated. It was noted that existing certification systems such as BREEAM, LEED and DGNB were not applicable for existing stadiums and the required data for using such complex certification systems were not discretionary. Therefore it was required to develop a research tool with a bespoke Evaluation Matrix for comparative assessment of the case studies. Parameters of existing certification systems were integrated in this tailor-made Evaluation Matrix where applicable and where the required data was expected to be available.

The Evaluation Matrix was used for the field researches in Sydney, Canberra, Athens and Beijing. Findings of the site analysis and site surveys as well as personal interviews were incorporated in the Evaluation Matrix for subsequent evaluation and comparative assessment.

In consideration of the actual findings during the field research the assessment method and Evaluation Matrix were refined and simplified. Sub-categories and parameters where sufficient data could not be obtained were removed. Thereupon the results of the case studies were analyzed with the revised Evaluation Matrix for the Urban, Environmental and Social Category. Discussion and comparative assessment of the results for each parameter of the respective stadium type was undertaken subsequently.

^{xxxv} 2.8 Certification methods, pages 37-56

For verification of the general applicability of the Evaluation Matrix for other sports stadiums one additional case study of the London 2012 Olympic Games was carried out and showed that no further refinement of the used Evaluation Matrix was necessary. Lastly conclusions for each category with the respective stadium type and lessons learned were drawn for the case studies in Sydney, Athens and Beijing.

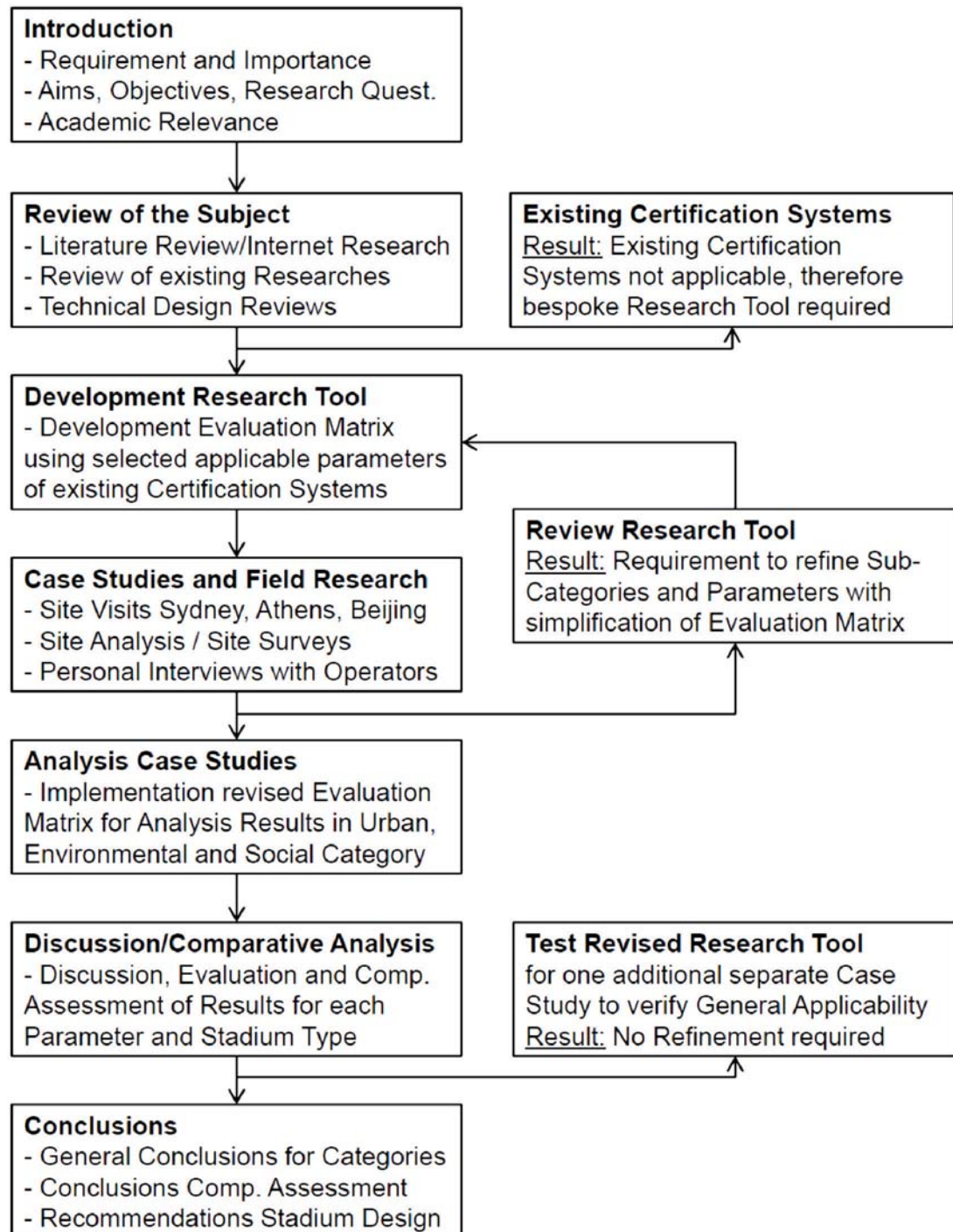


Illustration 15: Flow chart development of research tool

4.4 Evaluation with rating system

A 5-point score system was elaborated (5= very good, 4= good, 3= fair, 2= poor, 1= very poor) in order to assess the data in a most objective and unbiased way. The decision for the 5-point score system was taken in consideration and referring to the recommendations given in the publication 'Rating the rating scale' by Professor Hershey H. Friedman and Taiwo Amoo. This scale seemed also appropriate after consideration and review of the collected data as a finer scale with more points would not have contributed to additional benefits or more significant insights.

"Ideally, a rating scale should consist of enough points to extract the necessary information. There is evidence that the more scale points are used, the more reliable the scale (Churchill and Peter 1984). Using too few points will result in a scale that is less reliable. However, using more points than subjects can handle will probably result in an increase in variability without a concomitant increase in precision. In a literature review, Cox (1980) concluded that there is no single number of points for a rating scale that is appropriate for all situations. In general, however, he suggested the use of five to nine points. Friedman and Friedman (1986) conclude that researchers should consider using anywhere from 5- to 11-point scales."¹⁷⁸ For the assessment of the results of the case studies in this research a balanced rating scale has been developed. The ratings are defined as following:

1 point = very poor

2 points = poor

3 points = fair

4 points = good

5 points = very good

The three categories in this research, each with two sub-categories based on two respective parameters, are described in the following chapters. The overall weighting of each of the three categories is summarized below and the detailed breakdown for the assessment and rating of the various parameters is shown in Chapter 4.5 'Description Evaluation Matrix'.

33.3% = A Urban Category (Max. 20 points)

33.3% = B Environmental Category (Max. 20 points)

33.3% = C Social Category (Max. 20 points)

100.0 % = Rounded total (Max. 60 points)

4.5 Description Evaluation Matrix

The Evaluation Matrix is used for assessment and subsequent comparison of the specific location conditions and other given factors at the different selected venues used for the Olympic Games 2000, 2004 and 2008. The Evaluation Matrix and rating system were developed as a research tool in preparation of the field research and derived from other existing comparative qualitative and quantitative assessment methods identified during the literature research.

The results are compiled in three denominations A Urban Category, B Environmental Category and C Social Category. In order to achieve a detailed fact based evaluation each category is divided into two sub-categories with the respective two parameters. The evaluation of each parameter in the sub-category is based on a 5-point score system with a scale from 1 to 5 points. Every criterion, further specified by the parameter of the correspondent sub-category, has the same criterion weighting of the factor 1. Furthermore, through prior selection by capacity and characteristics of the inspected venues (Olympic Stadium, Indoor Stadium, Football Stadium) the so called 'mandatory' criteria were already set and the assessment was performed according to the 'Second Level Evaluation' approach further described below.

"The use of an evaluation matrix is one method of objectively evaluating a number of options against a number of criteria. Criteria should be generated and be representative for the current 'problem' under investigation. When establishing the criteria, every effort shall be made not to reflect on the options under consideration to help ensure that the criteria are developed without bias. Care should be taken in the wording of each criterion such that there is consistent interpretation by all involved in the evaluation process. Each criterion should be distinct from all others and each should be inspected to ensure that none are in conflict with another. A 'Second Level Evaluation' evaluation matrix assesses the options that have met all of the mandatory criteria against the desired criteria. Each option is assigned a score reflecting how well the option satisfies each criterion. As with the weightings, the team can determine the method of scoring. A simple approach would be to score each option as exceeds, full compliance, partial compliance, non-compliance with assigned values of 5, 3, 1 and 0 respectively. If finer granularity is required, a ten-point scale can be used as long as each unit of the scale is defined such that scores can be applied consistently. Once all options have been scored for all criteria, each

individual score is multiplied by the appropriate criterion weighting. The total score is then calculated for each option. The greater the score, the better the option satisfies the criteria. Options that score within 10% of one another should be considered relatively equal in satisfying the criteria.”¹⁷⁹

The Evaluation Matrix with the maximum number of points which can be achieved for each denomination, category, sub-category and respective parameters is shown on the following pages of this chapter with a comprehensive description of each category, sub-category and respective parameters.

A	Urban Category	Max. 20 pt
A.1	Urban Integration	Max. 10 pt
A.1.1	Location Type	1-5 pt
A.1.2	Building Type	1-5 pt
A.2	Urban Context	Max. 10 pt
A.2.1	Proximity	1-5 pt
A.2.2	Connectivity	1-5 pt
B	Environmental Category	Max. 20 pt
B.1	Building	Max. 10 pt
B.1.1	Overlay	1-5 pt
B.1.2	Adaptability/Flexibility	1-5 pt
B.2	Building Services	Max. 10 pt
B.2.1	Energy Efficiency	1-5 pt
B.2.2	Water Conservation	1-5 pt
C	Social Category	Max. 20 pt
C.1	Usage Mix	Max. 10 pt
C.1.1	Sport Usage	1-5 pt
C.1.2	Other Usages	1-5 pt
C.2	Utilization	Max. 10 pt
C.2.1	Average number of events	1-5 pt
C.2.2	Diversity of events	1-5 pt

Illustration 16: Evaluation Matrix

All ratings of the comparative assessment are summarized in a more detailed Summary of Results^{xxxvi} developed based on the Evaluation Matrix shown in Illustration 16 above. The rating for each parameter is shown in Illustration 74 in Chapter 11 'Appendix', 11.2 'Rating matrix for comparative assessment'.

4.5.1 Classification A Urban Category

Urban Category is analysed based on the following two sub-categories: A.1 Urban Integration (max. 10 points) and A.2 Urban Context (max. 10 points). The maximum number of points allocated for A Urban Category is 20 points.

Sub-category A.1 Urban Integration

Sub-category A.1 Urban Integration is analysed based on the following two parameters: A.1.1 Location Type (1-5 points) and A.1.2 Building Type (1-5 points). The maximum number of points for each of the two parameters is 5 points resulting in a maximum total number of 10 points in sub-category A.1 Urban Integration for each venue of the respective Olympic Games.

Parameter A.1.1 Location Type (1-5 points)

Parameter Location Type is analysed based on three different types of location: Existing Site, Brownfield Site and Greenfield Site. The assessment of Existing Site is done irrespective of Building Type- whether the existing stadium will be used or demolished for construction of a new stadium.

Existing Site: Usage of an Existing Site with existing infrastructure for access and egress (e.g. public transport, road network, etc.) and utilities (e.g. electricity, water, sewage, gas etc.). Utilization of an Existing Site with existing infrastructure is considered to result in a higher sustainability level compared to a Brownfield or Greenfield Site. The longer venues are operated at an Existing Site the higher is the actual level of integration into the urban context. Accordingly a comparatively higher sustainability level can be achieved. Therefore 4 or 5 points are allocated.

^{xxxvi} 6.4 Summary of all ratings for each stadium, page163

Brownfield Site: Redevelopment of a Brownfield Site with construction of a new stadium and new related infrastructure. The longer the Brownfield Site was unused the more points are allocated. The redevelopment of a Brownfield Site is considered to be less sustainable than an Existing Site but more sustainable compared to the usage of a Greenfield Site which consumes undeveloped land. Therefore 2 or 3 points are allocated.

Greenfield Site: Conversion of undeveloped land for construction of a new sports facility with new infrastructure. This option is considered to result in the lowest level of sustainability. Therefore 1 or 2 points are allocated.

According to the above mentioned criteria the following classifications for assessment of Location Type are defined:

Existing Site	4-5 pt
Brownfield Site	2-3 pt
Greenfield Site	1-2 pt

The parameter Location Type features also the basis for the BREEAM 2011 analysis. Illustration 4 shows that Site selection is an important criterion for BREEAM 2011 assessment scheme.¹⁸⁰

“LEED assesses under the integrative process credit ‘Location & Transportation’ with parameter ‘LEED for Neighbourhood Development’ the location of the project with the intention to avoid development on inappropriate sites and to reduce vehicle miles travelled as well as to enhance liveability and improve human health by encouraging daily physical activity. The requirements therefore are to locate the project within the boundary of a development certified under LEED for Neighbourhood Development. Furthermore as parameter ‘High priority land’ shows, there is the intention to encourage project location in areas with development constraints and promote the health of the surrounding area for example by use of a brownfield where soil or groundwater contamination has been identified, and where the local, state, or national authority requires its remediation. In consideration of parameter ‘Surrounding density and diverse use’ the intention is to conserve land and protect farmland and wildlife habitat by encouraging development in areas with existing infrastructure as well as to promote walkability, transportation efficiency and reduce vehicle distance travelled.”¹⁸¹

DGNB considers similar criteria in the section Site Quality with parameter Site location conditions, Access to Transportation, Access to Specific-use Facilities and Connections to Utilities. In section Environmental Quality parameter Land Use is reviewed.¹⁸²

Parameter A.1.2 Building Type (1-5 points)

Parameter Building Type is analysed based on three different types: Existing Building, New Building and Temporary Structure. Depending on the specific conditions of the existing building the refurbishment and renovation of an existing sports facility is considered to result in a higher sustainability level compared to the construction of a new sports facility which consumes a significant amount of resources. Temporary Structures could eventually result in a high sustainability level depending on the number of repeated usages, but this type of building structure was not part of the selected sports facilities for the case studies.

Existing Building: Renovation and/or rehabilitation of an existing sports facility to meet the requirements of the Olympic Games and future events. This assumes that the basic structure of the existing building is generally in a sound condition. Only modifications and/or additional elements like a new roof structure, hospitality facilities or athlete's areas, etc. to meet the IOC requirements are needed. Therefore 4 or 5 points are allocated.

New Building: Construction of a new sports facility either on an Existing Site, Brownfield Site or Greenfield Site. It is assumed that the construction of a new stadium results in a lower sustainability level compared to renovation and/or redevelopment of an existing stadium as it takes up significantly more resources. Therefore 2 or 3 points are allocated.

Temporary Structure: Construction of a temporary sports facility which is dismantled after the event and reused at other locations. This category is not applicable for the selected case studies. However, this type of building structure is considered to be an important parameter for evaluation and assessment of other projects which may utilize the Evaluation Matrix developed for this thesis. Therefore 1 to 5 points are allocated.

According to the above mentioned criteria the following classifications for assessment of Building Type are defined:

Existing Building	4-5 pt
New Building	2-3 pt
Temporary Structure	1-5 pt

The parameter Building Type features also the basis for the LEED assessment. "LEED has an integrative process credit 'Materials and resources' with the parameter 'Building life-cycle impact reduction' which encourages adaptive reuse and optimization of the environmental performance of products and materials. The requirements therefore are to demonstrate reduced environmental effects during initial project decision-making by reusing existing building resources or demonstrating a reduction in materials use through life-cycle assessment. This can be achieved by historic building reuse, renovation of abandoned or blighted building and material reuse."¹⁸³

DGNB considers similar criteria in section Sociocultural and Functional Quality as parameter Use of Existing Buildings is evaluated. In section Environmental Quality parameter Land Use is reviewed.¹⁸⁴

Sub-category A.2 Urban Context

Sub-category Urban Context is analysed based on two different parameters: A.2.1 Proximity (1-5 points) and A.2.2 Connectivity (1-5 points). The maximum number of points for each of the two parameters is 5 points resulting in a maximum total number of 10 points in sub-category A.2 Urban Context for each venue of the respective Olympic Games.

Parameter A.2.1 Proximity

Proximity is analysed with reference to the Urban Context surrounding the stadium. For this purpose the linear geographical distance of the sports facility to urban areas such as retail, commercial, recreational and residential areas is analysed. The linear distance is measured by using Google Maps and was also verified during the site visit of the respective venues.

It is assumed that commercial areas like the city centre, with mixed-use, residential areas or other areas of attraction (e.g. public parks) are catchment areas with potential users, which could positively affect the operation of the sports facility. These areas act as a catalyst to attract more visitors to the stadium and vice versa visitors of the stadium could utilize the areas before and/or after the event for shopping, recreation, etc. resulting in a higher sustainability level.

Proximity to residential areas could result in positive effects allowing the users convenient access, but also in negative effects due to traffic congestions, parking issues and other disturbance during events (e.g. noise).

According to the above mentioned criteria the following classifications for assessment of Proximity are defined:

Integrated venue location	4-5 pt
Mixed-use areas e.g. retail, commercial, recreational and residential areas within the immediate urban context of the stadium in a linear distance of approximately 0-2 km.	

Adjoining venue location	2-3 pt
Stadium location adjoining mixed-use areas e.g. commercial, retail, recreational and residential areas in a linear distance of approximately 2-4 km.	

Isolated venue location	1 pt
Distance to mixed-use areas more than approximately 4 km or surrounded by single-use areas such as industrial areas.	

Parameter A.2.2 Connectivity (1-5 points)

Connectivity of the stadium is analysed with regard to available type of public transportation and distance from the stop to the stadium. The connection of the venue to the city centre as well as to potential users in other areas within the proximity is provided through different modes of transportation such as public transportation systems, roads, bicycle tracks and walkways. The evaluation includes an analysis of public transport connections to the venues supporting a day-to-day operation of the sports facility. The linear distance is measured by using Google Maps and was also verified during the site visit of the respective venue.

It is assumed that sufficient public transport systems, e.g. metro stations close to the stadium, result in a higher sustainability level compared to transportation by bus, car or other modes of transportation. According to the above mentioned criteria the following classifications for assessment of Connectivity were defined:

Metro station in less than 100m	5 pt
Metro station in less than 500m	4 pt
Metro station in less than 800m	3 pt
No metro connection but bus connection	2 pt
No public transport provided on a daily basis	1 pt

The parameters Proximity and Connectivity feature also the basis for the BREEAM 2011 analysis. Illustration 4 shows that Proximity as well as Public transport accessibility to the amenities are important criteria for BREEAM 2011 assessment scheme.¹⁸⁵

“LEED assesses under the integrative process credit ‘Location & Transportation’ with parameter ‘LEED for Neighbourhood Development’ the location of the project with the intention to avoid development on inappropriate sites and to reduce vehicles miles travelled as well as to enhance liveability and improve human health by encouraging daily physical activity. The requirements therefore are to locate the project within the boundary of a development certified under LEED for Neighbourhood Development. Furthermore as parameter ‘High priority land’ shows, there is the intention to encourage project location in areas with development constraints and promote the health of the surrounding area for example by use of a brownfield where soil or groundwater contamination has been identified, and where the local, state, or national authority requires its remediation. In consideration of parameter ‘Surrounding density and diverse use’ the intention is to conserve land and protect farmland and wildlife habitat by encouraging development in areas with existing infrastructure as well as to promote walkability, transportation efficiency and reduce vehicle distance travelled.

With parameter ‘Access to quality transit’ the intention is to encourage development in locations shown to have multimodal transportation choices or otherwise reduced motor vehicle use, thereby reducing greenhouse gas emissions, air pollution, and other environmental and public health harms associated with motor vehicle use. The requirements therefore are to locate any functional entry of the project within a ¼-mile (400-meter) walking distance of existing or planned bus, streetcar, or rideshare

stops, or within a ½-mile (800-meter) walking distance of existing or planned bus rapid transit stops, light or heavy rail stations, commuter rail stations or ferry terminals.¹⁸⁶

DGNB considers similar criteria in section Site Quality with parameter Site location conditions, Access to Transportation, Access to Specific-use Facilities and Connections to Utilities. In section Technical quality parameter Quality of Public Transport Infrastructure is assessed.¹⁸⁷

4.5.2 Classification B Environmental Category

Environmental Category is analysed based on the following two sub-categories: B.1 Building (max. 10 points) and B.2 Building Services (max. 10 points). The maximum number of points which is allocated for denomination B Environmental Category is 20 points.

Sub-category B.1 Building

Sub-category B.1 Building is analysed based on the following two parameters: B.1.1 Overlay (1-5 points) and B.1.2 Adaptability/Flexibility (1-5 points).

The maximum number of points for each of the two parameters is 5 points resulting in a maximum total number of 10 points in sub-category B.1 Building for each venue of the respective Olympic Games.

Parameter B.1.1 Overlay (1-5 points)

Overlay of a venue is analysed with reference to the general design approach and post- Games planning for the main components of the stadium. This includes a review of the areas for circulation and special features of the stadium which have an impact on the operation of the stadium. It is assumed that a venue with an Overlay which is removed or modified after the Olympic Games, in order to meet the requirements of home teams and of the respective day-to-day use, or a venue which has been originally constructed as a perfect match for post- Games use has a higher sustainability level. According to the above mentioned criteria the following classifications for assessment of Overlay are defined:

Tailor-made Overlay with post- Games removal or perfect match	4-5 pt
Permanent Overlay with post- Games utilization	2-3 pt
No Overlay, no post- Games modifications or Overlay to disadvantage	1-2 pt

Parameter B.1.2 Adaptability/Flexibility (1-5 points)

Adaptability/Flexibility of a venue is analysed with reference to conversion of the stadium or spectator stands to allow usage for different types of sports and non-sports events. To some extent there may be contrary requirements, according to the sports activities which are common in the city/region, enabling home teams to utilize the sports facilities on a day-to-day basis.

It is assumed that provisions for reconfiguration of the playing field, retractable seating and removable flooring/modular turf result in a more frequent usage of the sports facility and a higher sustainability level. According to the above mentioned criteria the following classifications for assessment of Adaptability/Flexibility are defined:

Reconfiguration playing field, retractable seating, removable flooring/turf	5 pt
Retractable seating, removable flooring/turf	4 pt
Removable flooring/turf	3 pt
Option for modifications but out of use	2 pt
No options for modifications	1 pt

The context of parameters Overlay as well as Adaptability/Flexibility features also the basis for the BREEAM 2011 analysis. Illustration 4 shows that Innovation and New technology process and practices are factors of consideration for BREEAM.¹⁸⁸ BREEAM “aims to support innovation within the construction industry through the recognition of sustainability related benefits which are not rewarded by standard BREEAM issues. It considers approved innovation as any technology, method or process that can be shown to improve the sustainability performance of a building’s design, construction, operation, maintenance or demolition, and which is approved as innovative by BRE Global.”¹⁸⁹

“LEED incorporates the integrative process credit ‘Innovation’ with parameter ‘Innovation’ which has the intention to encourage projects to achieve exceptional or innovative performance. As requirements the project teams can use any

combination of innovation, pilot, and exemplary performance strategies to achieve significant, measurable environmental performance using a strategy not addressed in the LEED green building rating system.”¹⁹⁰ Similarly DGNB is rating parameter Suitability for conversion and Occupancy. Flexibility and Development Structure in section Sociocultural and Functional Quality are evaluated.¹⁹¹

Sub-category B.2 Building Services

Sub-category B.2 Building Services is analysed based on the following two parameters: B.2.1 Energy Efficiency (1-5 points) and B.2.2 Water Conservation (1-5 points). The maximum number of points for each of the two parameters is 5 points resulting in a maximum total number of 10 points in sub-category B.2 Building Services for each venue of the respective Olympic Games.

Parameter B.2.1 Energy Efficiency (1-5 points)

Usage of energy-efficient systems for power generation and conservation (e.g. solar power, photovoltaic power, heating system with heat recovery, heat pumps, heat storage), AC/Ventilation (e.g. natural ventilation), lighting (e.g. natural lighting, automatic control for lighting devices, light fittings, etc.) and environmentally friendly building materials (e.g. recycling materials, etc.) as well as technically advanced materials are evaluated.

It is assumed that concurrent usage of passive and active state-of-the-art systems reduces energy consumption and together with usage of sources for renewable energy results in a higher sustainability level. According to the above mentioned criteria the following classifications for assessment of Energy Efficiency are defined:

Renewable energy usage, energy efficient air-conditioning, energy efficient lighting, environmentally friendly building materials	5 pt
Energy efficient air-conditioning, energy efficient lighting, environmentally friendly building materials	4 pt
Energy efficient lighting or photovoltaic power, environmentally friendly building materials	3 pt
Environmentally friendly building materials	2 pt
No provisions for energy efficiency or environmentally friendly materials	1 pt

The context of parameter Energy Efficiency features also the basis for the BREEAM 2011 analysis. Illustration 4 shows that Energy monitoring, Energy efficient external lighting, Energy efficient equipment and Materials are also important criteria in the BREEAM 2011 assessment scheme.¹⁹²

“LEED has the integrative process credit ‘Energy & atmosphere’ and parameter ‘Renewable energy production’ evaluates the intention to reduce the environmental and economic harms associated with fossil fuel energy by increasing self-supply of renewable energy. The requirements therefore are the use of renewable energy systems to offset building energy costs. Furthermore the integrative process credit ‘Indoor environmental quality’ with parameter ‘Daylight’ intends to connect building occupants with the outdoors, reinforce circadian rhythms and reduce the use of electrical lighting by introducing daylight into the space.”¹⁹³

DGNB has equivalent evaluation in section Environmental Quality through parameters Environmentally friendly Material Production, Consideration of possible environmental impacts, Total Primary Energy Demand and Renewable Primary Energy as well as Energy-Efficient Development Structure. Additionally in section Technical Quality parameter Energy technology is evaluated.¹⁹⁴

Parameter B.2.2 Water Conservation (1-5 points)

Usage of systems for water conservation (e.g. rainwater harvesting) and reduction of wastage of water (e.g. water recycling, separate systems for potable water and grey water supply for toilet flushing, usage of grey water for irrigation of the landscape) as well as water-efficient appliances are evaluated.

It is assumed that reduction of wastage of water and water recycling result in a higher sustainability level. According to the above mentioned criteria the following classifications for assessment of Water Conservation are defined:

Rainwater harvesting, water recycling, water-efficient appliances	5 pt
Rainwater harvesting, water recycling	4 pt
Rainwater harvesting	3 pt
Water-efficient appliances	2 pt
No provisions for water conservation	1 pt

Parameter Water conservation features also the basis for the BREEAM 2011 analysis. Illustration 4 shows that Water consumption, Water monitoring and Water efficient equipment are also important criteria in the BREEAM 2011 assessment scheme.¹⁹⁵

“LEED applies the integrative process credit ‘Water efficiency’ with parameter ‘Indoor waste use reduction’ supporting the intention to reduce indoor water consumption. The necessary requirements are defined fixtures and fittings, as applicable to the project scope which reduce aggregate water consumption by 20% from the baseline. All newly installed toilets, urinals, private lavatory faucets, and showerheads that are eligible for labelling must be WaterSense labelled (or a local equivalent for projects outside the U.S.). Also the installation of appliances, equipment, and processes within the project scope that meet the requirements accordingly is intended.”¹⁹⁶ DGNB reviews in section Technical Quality parameter Rainwater Management.¹⁹⁷

4.5.3 Classification C Social Category

Social Category is analysed based on the following two sub-categories: C.1 Usage Mix (max. 10 points) and C.2 Utilization (max. 10 points). The maximum number of points allocated for denomination C Social Category is 20 points.

Sub-category C.1 Usage Mix

Sub-category C.1 Usage Mix is analysed based on the following two parameters: C.1.1 Sport Usage (1-5 points) and C.1.2 Other Usages. The maximum number of points for each of the two parameters is 5 points resulting in a maximum total number of 10 points in sub-category C.1 Usage Mix for each venue of the respective Olympic Games.

Parameter C.1.1 Sport Usage

The usage of the venue for sports events is evaluated based on the number of home teams and number of different sports types. It is assumed that sports facilities which are used by different home teams have more regular sports events. Options for different sports types result in a higher number of events and therefore in a higher level of sustainability.

According to the above mentioned criteria the following classifications for assessment of Sport Usage are defined:

Minimum 4 home teams, 3 sports types	5 pt
Minimum 3 home teams, 2 sports types	4 pt
Minimum 2 home teams, 1 sports type	3 pt
Minimum 1 home team, 1 sports type	2 pt
No home team, rarely used for sports events	1 pt

Parameter C.1.2 Other Usages

The utilization of the venue for other usages is evaluated based on the number of different retail/commercial facilities and tourist attractions.

It is assumed that integration of retail/commercial concepts (e.g. fan shop, tourist shop, church, coffee shop, restaurants, offices, hotel, spa, etc.) enhance the utilization of the sports facility during non-events significantly. Also the incorporation of tourism as well as of cultural aspects resulting in a transfer of knowledge and insights about local culture (e.g. Olympic Museum, Sports Museum) with provisions for sightseeing tours for national/international tourists is considered to add value. These additional usages result in a higher level of sustainability. According to the above mentioned criteria the following classifications for assessment of Other Usages are defined:

Minimum 4 retail/commercial facilities and tourist attraction	5 pt
Minimum 3 retail/commercial facilities and tourist attraction	4 pt
Minimum 2 retail/commercial facilities and tourist attraction	3 pt
Minimum 1 retail/commercial facility and tourist attraction	2 pt
No additional attractions	1 pt

The context of parameter Other usage features also the basis for the BREEAM 2011 analysis. Illustration 4 shows that Proximity to amenities, including amenities within assessed buildings, is also an important criterion in the BREEAM 2011 assessment scheme.¹⁹⁸

DGNB provides similar investigation through parameter Social and Functional Diversity, Site features, Social and Labour Infrastructure as well as Occupancy Flexibility and Development Structure.¹⁹⁹

Sub-category C.2 Utilization

Sub-category C.2 Utilization is analysed based on the following two parameters: C.2.1 Average number of events (1-5 points) and C.2.2 Diversity of events (1-5 points). The maximum number of points for each of the two parameters is 5 points resulting in a maximum total number of 10 points in sub-category C.2 Utilization for each venue of the respective Olympic Games.

Parameter C.2.1 Average number of events (1-5 points)

The average number of events is evaluated and compared based on the total number of events per month resulting in an assessment of the post- Games usage of the sports facility. Spectator occupancy per event and average occupancy for the respective venue is given where available.

It is assumed that the higher the number of events hosted at a venue the better post- Games usage is achieved resulting in a higher level of sustainability. According to the above mentioned criteria the following classifications for assessment of Average number of events are defined:

Minimum 4 events per month	5 pt
Minimum 3 events per month	4 pt
Minimum 2 events per month	3 pt
Minimum 1 event per month	2 pt
Less than 1 event per month	1 pt

Parameter C.2.2 Diversity of events (1-5 points)

The Diversity of events is evaluated based on comparison of the ratio of sports and non-sports events hosted at the venue. It is assumed that a balanced percentage of sports events and non-sports events is indicating more variety with regard to usage options ensuring different utilization alternatives and therefore results in a higher level of sustainability. According to the above mentioned criteria the following classifications for assessment of Diversity of events are defined:

Minimum 50% non-sports events	5 pt
Minimum 25% non-sports events	4 pt

Minimum 5% non-sports events	3 pt
Minimum 3% non-sports events	2 pt
No non-sports events	1 pt

The parameters indicating the utilization with special focus on post-Games usage in this thesis were carefully selected in consideration that they have to be objective, tangible, generally valid, timeless, easily obtainable and significant. Therefore the parameters have been extracted from countable data such as event schedules with specification of event types, home teams and sports types as well as the presence, number and type of additional attractions.

“Legacy facilities are the permanent facilities which will remain and must be realistic for long-term use and benefit to the community.”²⁰⁰

In this context the above mentioned approach is furthermore validated with literature. The meaning of relevance can be “categorized into the three categories: value, utility and importance of information. Value of information represents its internal integrity, validity and reliability. This meaning can be related to a process with emphasis on verification, authentication and credibility of information. Trustworthiness of the source and verity of information are also regarded as significant. Utility narrows the extension of value towards a more concrete use of information. Utility is embedded in the contexts of information use, namely in relation to topic, problem solving and time. Importance expresses qualities of relevance such as emphasis on the problem essence, priorities and the hierarchical division of information.”²⁰¹ Mitchell summarised eight criteria commonly used to assess sustainable indicators.²⁰² The indicators should be:

1. Relevant to the issues of concern and scientifically defensible
2. Sensitive to change across space and across social groups
3. Sensitive to change over time
4. Supported by consistent data
5. Understandable and if appropriate resonant
6. Measurable
7. Expressed in a way that makes sense
8. Identifying targets and trends that allow progress towards or away from sustainability to be determined

4.6 Criteria for selecting the case studies

For this research (field research was carried out between 2010 and 2011) the first three Olympic Summer Games of the 21st century have been selected: Olympic Games 2000 in Sydney, Olympic Games 2004 in Athens and Olympic Games 2008 in Beijing. The three hosts are located on different continents and have fulfilled the requirements of the International Olympic Committee. The Winter Olympic Games are not part of this research due to the significantly different climate requirements and the limited number of locations worldwide where they can be held.

4.6.1 Selection criteria spectator capacity and building type

For the case studies three different types of permanent stadiums were selected, each with a minimum spectator capacity of 15,000 spectators after the Olympic Games: Olympic Stadium, Indoor Stadium and Football Stadium. The comparison of three different stadium types shall provide more general conclusions than a focus only on one type of stadium. Regarding the selection of the individual stadiums for the case studies it is assumed that a minimum capacity of 15,000 spectators²⁰³ is appropriate to provide measurable and tangible results for assessment of the parameters in the respective sub-category.

For the selection of case studies it is differentiated between existing stadiums which have been redeveloped²⁰⁴ for the Olympic Games and new stadiums specifically built for the Olympic Games after election of the Host City by the International Olympic Committee (IOC).

In order to assess different types of buildings, one new stadium as well as one existing stadium redeveloped for the Olympic Games with a minimum capacity of 15,000 spectators is evaluated. In addition the Olympic Stadium with a minimum capacity of 60,000 spectators is selected. The main stadium is considered to have a significant impact on the urban context due to its size. The minimum capacity of 60,000 spectators is a requirement of the IOC since the Olympic Stadium is usually the venue for the opening and closing ceremony.

4.6.2 Venues of the Olympic Games 2000, 2004 and 2008

With regard to the selection of the stadiums for each case study a comprehensive chart of all venues built for the Olympic Games in Sydney, Athens and Beijing was prepared based on the table in Hanwen Liao's research 'A Framework for Evaluating Olympic Urban Development for Sustainability'.²⁰⁵ Illustration 17 below summarises the spectator capacities of each sports stadium used for the Olympic Games in Sydney, Athens and Beijing.

	Sport Type	Sydney 2000 206,207,208	Athens 2004 209,210,211	Beijing 2008 212,213,214	Remarks
-	Ceremony	*115,600	72,000 ²¹⁵	80,000	*30,000 ²¹⁶ temp. seats
1	Aquatics	17,500	11,500	*16,000	*12,000 temp. seats
2	Archery	4,500	7,500 ²¹⁷	*5,000	* temp. seats
3	Athletics	115,600	72,000	80,000	-
4	Badminton	6,000	*4,100	*7,500	* temp. seats
5	Baseball	11,000 4,000	*8,700 4,000	15,000 *10,000	* temp. seats
6	Basketball	21,00 10,000	19,250	16,000 *4,000	* temp. seats
7	Boxing	7,500	8,000	*12,000	*1,000 temp. seats
8	Canoeing	22,000	14,000	*20,000	*16,000 temp. seats
9	Canoe-slalom	8,500	7,600	*15,000	* temp. seats
10	Cycling	6,000	5,250	*5,000	*2,500 temp. seats
11	Equestrian	20,000	5,000	30,000	*23,000 temp. seats
12	Fencing	5,000 6,000	3,800 5,000	*10,000	-
13	Football	115,600 42,000 37,000 40,000 20,000 98,000	33,000	80,000 72,000 40,000 60,000 35,000 60,000 80,000	-
14	Gymnastics	21,000	17,500	22,000	*3,000 temp. seats
15	Handball	10,000 6,000	8,100	19,000 7,000	*3,000 temp. seats
16	Hockey	15,000	**9,400	*15,000	**3,000; *7,000 temp. seats
17	Judo	9,000	9,000	9,000	-

	Sport Type	Sydney 2000 218	Athens 2004 219	Beijing 2008 220	Remarks
18	Pentathlon	-	19,600 ²²¹	*40,000 6,000	*5,000 temp. seats
19	Rowing	27,000	14,000 ²²²	*20,000	*16,000 temp. seats
20	Sailing	10,000 ²²³	1,600	*9,000	*9,000 temp. seats
21	Shooting	7,000	4,000	2,500 *6,500	*5,000 temp. seats
22	Softball	8,000	4,800 T	11,000 3,500	*3,500 temp. seats
23	Swimming	10,000	2,500	*17,000 6,000	*13,000 temp. seats
24	Table Tennis	5,000	6,500	10,000	-
25	Taekwondo	5,000	8,100	9,000	-
26	Tennis	10,000 4,000 3,400		12,000 *5,000 **3,000	*5,000; **3,000 temp. seats
27	Triathlon		3,600	8,000 *2,000	*2,000 temp. seats
28	Volleyball	11,000 6,000	13,200	16,000 3,000	*3,000 temp. seats
29	Beach Volleyball	10,000	9,600		-
30	Water Polo	17,500 3,900		11,500 6,200	-
31	Weightlifting	3,800	5,100	3,400 *2,000	*2,000 temp. seats
32	Wrestling	9,000	9,000	*10,000	*10,000 temp. seats

Illustration 17: Extract of table 'Seating capacity of Olympic venues from Rio' 60 to Sydney 2000' prepared by Hanwen Liao from the PhD thesis 'A Framework for Evaluating Olympic Urban Development for Sustainability'²²⁴

4.6.3 Application sustainability indicators on Wembley Stadium

The sustainability indicators developed in this thesis for the Urban Category, Environmental Category and Social Category shall be applied for an exemplary evaluation of a stadium used for the most recent Olympic Games in 2012. A detailed assessment is given in Chapter 9 'Example Olympic Games 2012'.

At Wembley Stadium in London, eight football matches including the finals during the London 2012 Olympics²²⁵ were hosted and it was chosen as an additional example to the three case studies Sydney 2000, Athens 2004 and Beijing 2008.

Purpose of this independent assessment is to verify the general applicability of the selected indicators for other sports stadiums beyond the case studies.

4.7 Summary chapter development research tool

In this chapter the term 'sustainability' is defined and further described with reference to the United Nations report 'Our Common Future', also known as the 'Brundtland' Report. The methodology of this thesis is elaborated as a combined assessment of the obtained knowledge on the subject, consisting of the findings of the analytical research, which is based on an evaluation of literature review and field research including case studies and personal interviews. In accordance with Dr. Deryck D. Pattron's publication 'Research Methodology' the applied research methods in this thesis are qualitative as well as quantitative.

The rationale and methodology for development of a bespoke Evaluation Matrix is visualized in a flow chart (Illustration 15) and further elaborated with reference to existing certification systems such as BREEAM, LEED and DGNB. It is further explained why these existing complex certification systems are not fully applicable for existing sports stadiums. Subsequently the relevant criteria selected for the Evaluation Matrix are presented in detail with their respective rating and correlation to those used in BREEAM, LEED and DGNB.

Other important parameters such as usage of low energy and low carbon materials, energy/water consumption per seat and event or average construction area per seat could not be evaluated due to the limited data available for the existing sports venues.

The criteria 'spectator capacity' and 'building type' established for selection of the venues of the three respective case studies in Sydney, Athens and Beijing are elaborated. Subsequently an overview on all venues of the Olympic Games 2000, 2004 and 2008 is presented. In order to verify the applicability of sustainability indicators developed for this thesis reference is made to the Wembley Stadium rebuilt for the Olympic Games 2012 in London.

5 CASE STUDIES

5.1 Analysis case studies

In preparation of the field research, analogical literature research and technical review of relevant drawings as well as of other project information for the case studies were carried out. This chapter summarizes the relevant key project information compiled in a project brief along with three pictures (satellite picture, exterior view and interior view) for each of the selected three venues (Olympic Stadium, Indoor Stadium and Football Stadium) used for the respective Olympic Summer Games in 2000, 2004 and 2008.

The majority of information was obtained from official bidding documents and other reports of the Olympic Games provided by the Olympic Studies Centre in Lausanne (Switzerland) as part of the Postgraduate Research Grant Programme 2007.²²⁶

In addition other information from documents available in libraries, publications and on the Internet as well as documents collected during the field survey (e.g. maps, site plans, site pictures, etc.) is presented in this chapter.

The field research in Sydney, Athens and Beijing (each of about seven days duration) was carried out for all nine venues between 2010 and 2011.^{xxxvii} Subsequent to the thorough assessment of the precinct of all nine stadiums an additional survey was conducted together with an operator representative for seven out of nine stadiums (except Beijing Indoor Stadium and Beijing Football Stadium).

Following the venue evaluation, personal interviews (each approximately 90 minutes) with operator representatives at senior management level were held in order to discuss and verify the findings of the field research and also to obtain first-hand information about the Overlay^{xxxviii} and day-to-day operation of the venue.

^{xxxvii} Sydney 12.02.-19.02.2011, Athens 21.10-26.10.2010, Beijing 26.02.-05.03.2011

^{xxxviii} 4.5.2 Classification B Environmental Category, Sub-category B.1, Building, Parameter B.1.1 Overlay, page 82-83

5.2 Overview selected venues for the case studies

5.2.1 Olympic Stadiums

Illustration 18 below summarizes the project brief of the selected Olympic Stadiums used for the Olympic Games 2000 in Sydney, 2004 in Athens and 2008 in Beijing and is further analysed in the case studies.

Olympic Stadiums	Sydney	Athens	Beijing
Location type	Brownfield site	Existing site	Greenfield site
Building type	New building	Existing building	New building
Construction period	1996-1999	1979-1982	2003-2008
Year of opening	1999	1982, 2004	2008
Cost of construction	EUR 533 million	EUR 265 million	EUR 361 million
Cost of Olympic overlay	EUR 12 million	NA	-
Operator after the Games	Stadium Australia Management	OAKA	BSAM, CITIC
Use before the Games	Rugby league, rugby union, American football, football, concerts, athletics, etc.	Athletic events, football matches and concerts	-
Use during the Games	Opening/closing ceremonies, athletics, football final	Opening/closing ceremonies, athletics, football men's finals	Opening/closing ceremonies, athletic events and football final
Use after the Games	Australian rules football, rugby league, rugby union, football, cricket, concerts	Athletics events, football matches and concerts	Football, track and field, concerts, Ice and Snow festivals, sports meetings, functions
Tenants	9	2	0
Capacity before the Games	110,000 seats	75,000 seats	-
Capacity during the Games	115,600 seats	71,030 seats	91,000 seats
Capacity after the Games	80,000 seats	56,700 seats	80,000 seats

Illustration 18: Summary of key project information for Olympic Stadiums, sources/ references for the respective information are specified on page 99-101, 106-108 and 114-116.

5.2.2 Indoor Stadiums

Indoor Stadium	Sydney	Athens	Beijing
Location Type	Brownfield site	Existing site	Greenfield site
Building Type	New building	Existing building	New building
Construction period	1997-1999	1989-1998, 2003-2004	2005-2007
Year of opening	1999	1998, 2004	2007
Cost of construction	EUR 148 million	EUR 145 million	EUR 81 million
Cost of Olympic overlay	EUR 6 million	NA	-
Operator after the Games	AEG Ogden	OAKA	Government PRC
Use before the Games	Multi-use indoor arena for events, functions, exhibitions, basketball, indoor soccer, concerts, volleyball, gymnastics	Artistic gymnastics and trampoline	-
Use during the Games	Basketball finals, artistic, trampoline	Basketball finals 2004 Olympic Games	Gymnastics, trampoline and handball
Use after the Games	Multi-use indoor arena for events, functions, exhibitions, basketball, indoor soccer, concerts, volleyball, gymnastics	Basketball club Panathinaikos Athens and Maroussi Athens for European Cup matches, also the primary home court of Greek national basketball team, concerts	Concerts (proposed)
Tenants	1	2	1
Capacity before the Games	21,000 seats	17,600 seats	-
Capacity during the Games	Basketball: 20,000, gymnastics: 16,900	19,250 seats	20,000 seats
Capacity after the Games	21,000 seats	17,600 seats	18,000 seats

Illustration 19: Summary of key project information for Indoor Stadiums sources/ references for the respective information is specified on pages 101-103, 108-110 and 116-118.

5.2.3 Football Stadiums

Illustration 20 below summarizes the project brief of the selected Football Stadiums used for the Olympic Games 2000 in Sydney, 2004 in Athens and 2008 in Beijing and further analysed in the case studies.

Football Stadiums	Sydney	Athens	Beijing
Location type	Existing site	Existing site	Existing site
Building type	Existing building	New building	Existing building
Construction period	1974-1977	1895-1856, 2003-2004	1988-1990
Year of opening	1977	1856, 2004	2007
Cost of construction	EUR 26 million	EUR 60 million	NA
Cost of Olympic overlay	EUR 0,8 million	NA	NA
Operator after the Games	Australian Capital Territory Government	Olympiacos	NA
Use before the Games	Canberra Raiders, ACT Brumbies (union), Matildas (Nat. women's football team)	Olympiacos F.C. football team	Hosted 11 th Beijing Asian Games
Use during the Games	Interstate football	Preliminaries, football quarter finals, semi finals, women's football final	Football matches, cross country, show jumping discipl. of Pentathlon
Use after the Games	Home to Canberra Raiders (league), ACT Brumbies (union) and the Matildas (National women's football team)	Operated as a movie theatre, concerts	-
Tenants	2	1	NA
Capacity before the Games	25,000 seats	NA	18,000 seats
Capacity during the Games	40,000 seats	32,500 seats	36,000 seats
Capacity after the Games	25,000 seats	33,500 seats	36,000 seats

Illustration 20: Summary of key project information for Football Stadiums, sources/ references for the respective information are specified on pages 103-105, 110-112 and 118-120.

5.3 Selected venues of the Olympic Games 2000 in Sydney, Australia

5.3.1 Sydney Olympic Park

The Olympic Park is a redevelopment of a 640 hectare Brownfield Site, previously an industrial zone called Homebush Bay. The redevelopment was part of the comprehensive Masterplan for the Sydney Olympic Games in 2000. The Excerpt masterplan for Sydney Olympic Park is shown in Illustration 21.

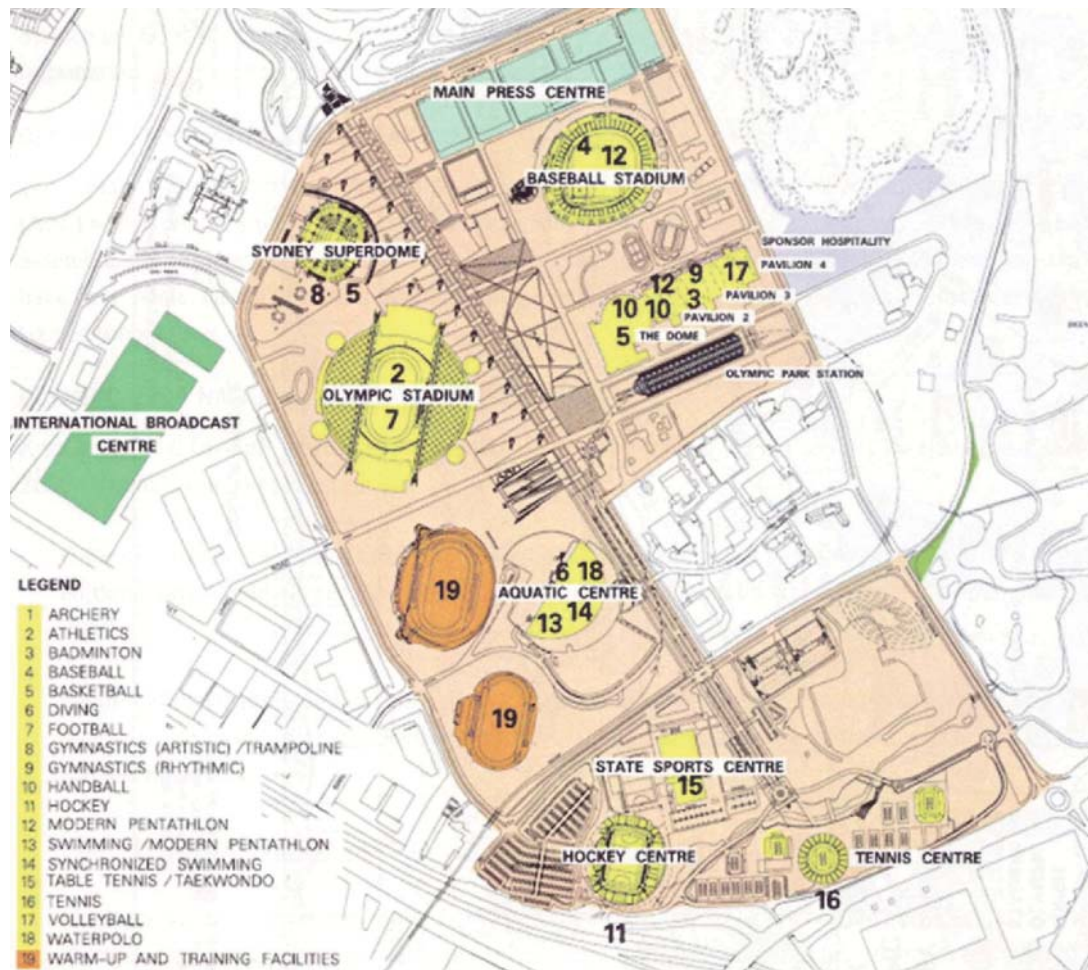


Illustration 21: Excerpt masterplan for Sydney Olympic Park submitted as part of the original bidding document of Sydney Organizing Committee for the Olympic Games in 2000.²²⁷ Before redevelopment of the Brownfield Site various industries were located in the Homebush Bay area e.g. State Abattoirs (1907-1988), the State Brickworks (1911-1988) and the Navy's armaments depot. Two of the selected venues, Sydney Olympic Stadium and Sydney Indoor Stadium are located within the Olympic Park. The following satellite picture in Illustration 22 shows the entire precinct after redevelopment.

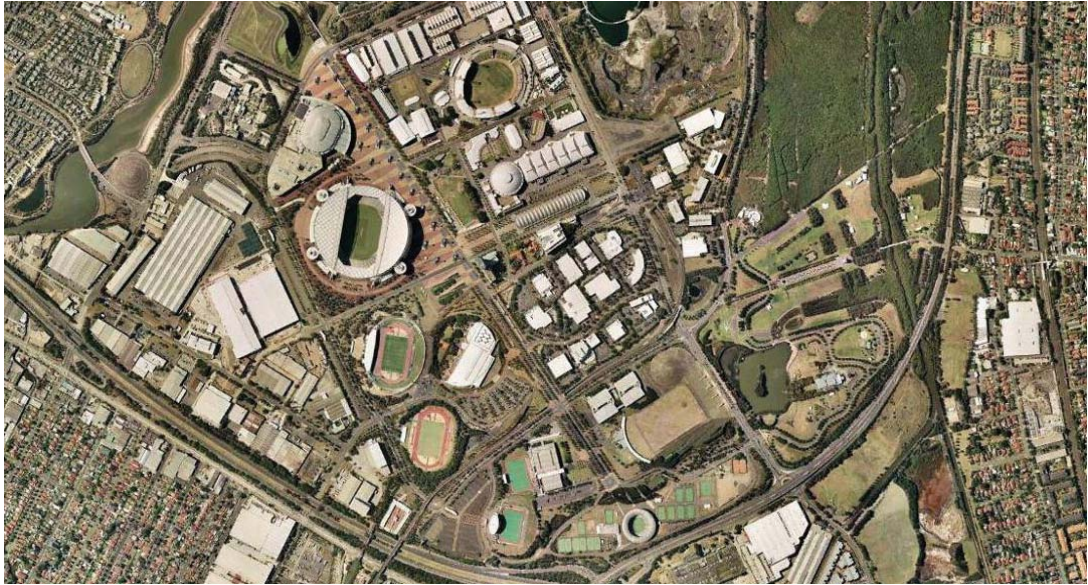


Illustration 22: Satellite picture of the Olympic Park with Sydney Olympic Stadium and Sydney Indoor Stadium after the Olympic Games in 2000²²⁸

5.3.2 Sydney Olympic Stadium (ANZ Arena/Telstra Stadium), Australia

Selection Criteria	New outdoor stadium ($\geq 60,000$ spectators)
Architect	Populous Architects (previously Bligh Lobb Sports Architecture), Australia
Location	Sydney Olympic Park, Homebush Bay
Location Type	Brownfield Site
Construction commenced	September 1996
Construction completed	February 1999
Opened	06.03.1999
Cost of construction	USD 710 million (approx. EUR 533 million)
Cost of Olympic overlay ²²⁹	USD 16.3 million (approx. EUR 12 million)
Operator after the Games	Stadium Australia Management Limited
Use before Games	Rugby league, rugby union, American football, football, concerts, athletics, etc.
Use during Games	Opening/closing ceremonies, athletics, football final
Use after Games	Australian rules football, rugby league, rugby union, football, cricket, concerts
Tenants	Qantas Wallabies ²³⁰ , HSBC Waratahs ²³¹ , Qantas Socceroos ²³² , NSW State of Origin Blues ²³³ , Sydney Swans ²³⁴ , Bulldogs ²³⁵ ,

Tenants (continued)	South Sydney Rabbitohs ²³⁶ , Pirtek Parramatta Eels ²³⁷ , Sydney Thunder ²³⁸
Capacity before Games	110,000 seats
Capacity during Games	115,600 seats
Capacity after Games	80,000 seats



Illustration 23: Satellite picture of Sydney Olympic Stadium with reduced spectator capacity of 80,000 spectators after the Olympic Games in 2000²³⁹



Illustration 24: Sydney Olympic Stadium with maximum seating capacity of 115,600 during Olympic Games in 2000 with temporary seating capacity on the north and south spectator stands²⁴⁰



Illustration 25: Sydney Olympic Stadium with reduced seating capacity of 80,000 after Olympic Games and new roofs above modified north and south spectator stands²⁴¹

5.3.3 Sydney Indoor Stadium (ACER Arena/Super Dome), Australia

Selection Criteria	New indoor stadium ($\geq 15,000$ spectators)
Architect	Cox Richardson, Devine Yaeger, Australia
Location	Sydney Olympic Park, Homebush Bay
Location Type	Brownfield Site
Construction commenced	September 1997
Construction completed	August 1999
Opened	04.09.1999
Cost of construction	USD 197 million ²⁴² (approx. EUR 148 million)
Cost of Olympic overlay	USD 8 million ²⁴³ (approx. EUR 6 million)
Operator after the Games	AEG Ogden (Anschutz Entertainment Group)
Use before Games	Multi-use indoor arena for events, functions, exhibitions, basketball, indoor soccer, concerts, volleyball, gymnastics
Use during Games	Basketball finals, artistic and trampoline gymnastics
Tenants	1999-2000 Sydney Kings ²⁴⁴ (NBL) 2001-2008 Sydney Swifts ²⁴⁵ (CBT) 2008-Present NSW Swifts ²⁴⁶
Use after Games	Same as before

Capacity before Games	21,000 seats
Capacity during Games	Basketball: 20,000 seats, gymnastics: 16,900 seats
Capacity after Games	21,000 seats



Illustration 26: Satellite picture of Sydney Indoor Stadium with parking structure (centre) and Sydney Olympic Stadium (below) after the Olympic Games in 2000²⁴⁷



Illustration 27: Sydney Indoor Stadium with parking structure in front, background Sydney Olympic Stadium with underground metro station in the far left during the Olympic Games 2000²⁴⁸



Illustration 28: Sydney Indoor Stadium with 21,000 seats capacity after the Olympic Games 2000. Red colour of seat covers selected for the Olympic Games is not ideal for concerts and functions where black colour is preferred²⁴⁹

5.3.4 Canberra Football Stadium (Bruce Stadium), Australia

(used for the Olympic Games 2000 in Sydney)

Selection Criteria	Existing redeveloped outdoor stadium (≥ 15,000 spectators)
Architect	Phillip Cox & Partners, Australia
Location	Bruce, Canberra, Australian Capital Territory
Location Type	Existing Site
Opened	1977 ²⁵⁰
Construction commenced	1974 ²⁵¹
Construction completed	1977
Cost of construction	Not available
Redevelopment	USD 33.5 million ²⁵² (approx. EUR 26 million)
Cost of Olympic overlay	USD 1.1 million (approximately EUR 0,8 million)
Operator after the Games	Territory Venues and Events, Department of Territory and Municipal Services, Australian Capital Territory Government
Use before Games	Home to Canberra Raiders (league), ACT Brumbies (union) and the Matildas (National women's football team)

Use during Games	Interstate football
Use after Games	Same as before
Tenants	Canberra Raiders Rugby ²⁵³ , ACT Brumbies Rugby ²⁵⁴
Seating capacity before Games	25,000 seats
Seating capacity during Games	40,000 seats
Seating capacity after Games	25,000 seats

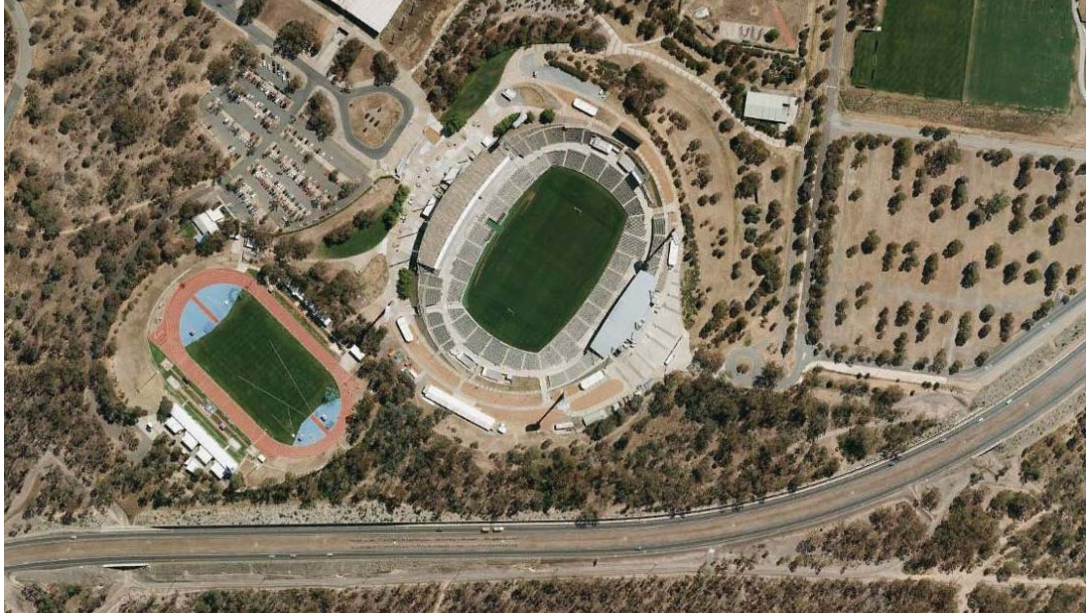


Illustration 29: Satellite picture of Canberra Football Stadium after Olympic Games 2000²⁵⁵



Illustration 30: Canberra Football Stadium with spectator capacity of 25,000 seats after completion Olympic Overlay (roof above grand stand as permanent overlay)²⁵⁶



Illustration 31: Canberra Football Stadium with roof above the grand stand with 8,000 covered seats constructed for the Olympic Games in 2000²⁵⁷

5.4 Selected venues of the Olympic Games 2004 in Athens

5.4.1 Athens Olympic Park, Greece

Two of the selected venues, Olympic Stadium and Indoor Stadium are located in the Athens Olympic Park (Athens Olympic Sports Complex). The development of the existing Athens Olympic Park was already initiated earlier for the previous bid of Athens for the Olympic Games 2000.

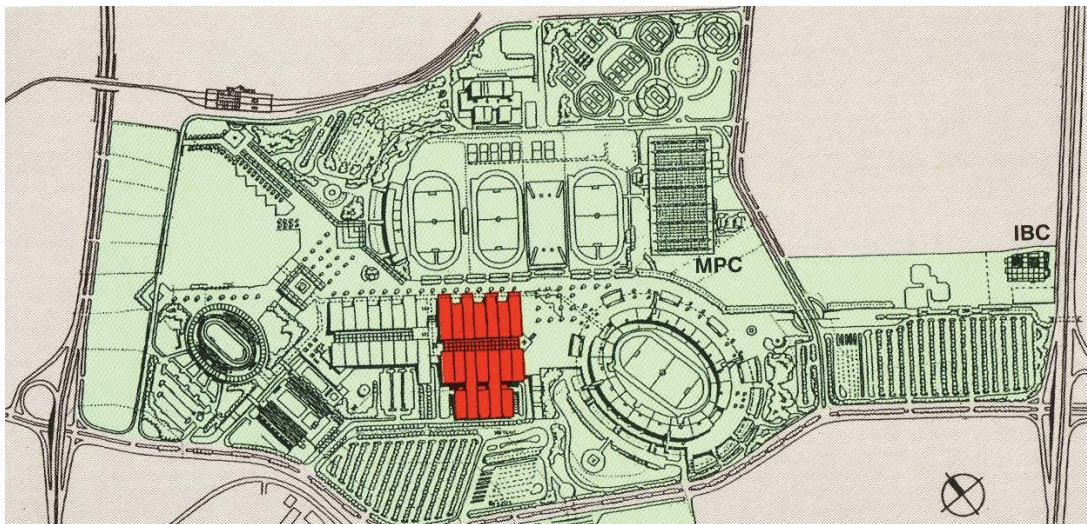


Illustration 32: Excerpt masterplan of Athens Olympic Sports Complex submitted as part of the original bidding document of the Athens Organizing Committee for the Olympic Games in 2004, new Indoor Stadium highlighted in red colour²⁵⁸



Illustration 33: Satellite picture of the Athens Olympic Park (Athens Olympic Sports Complex) with metro station in the north after the Olympic Games in 2004²⁵⁹

5.4.2 Athens Olympic Stadium, Greece

Selection Criteria	Redevelopment existing outdoor stadium (≥ 60,000 spectators)
Architect Stadium ²⁶⁰	Rudolf Moser in collaboration with Weidleplan Consulting with H. Stalhout, F. Herre and D. Andrikopoulos
Architect Roof	Santiago Calatrava, Spain
Location	Maroussi, Athens, Greece
Location Type	Existing Site
Construction commenced	1979
Construction completed	1982
Opened	08.09.1982, reopened 30.07.2004
Cost of construction ²⁶¹	EUR 265 million (Renovation 2004)
Cost of Olympic overlay	Not available
Operator after the Games	OAKA
Use before Games	Athletics events, football matches and concerts
Use during Games	Opening/closing ceremonies, athletics, football men's finals
Use after Games	Same as before
Tenants ²⁶²	Panathinaikos FC ²⁶³ , AEK FC ²⁶⁴ (football, Greek Super League, UEFA Champions League), Greek national football team (selected matches),

Tenants (continued)	intl. football competitions (e.g. 2007 UEFA Champions League final), track and field events (e.g. IAAF Athens Grand Prix) and concerts
Capacity before Games	75,000 seats
Capacity during Games ²⁶⁵	71,030 seats (incl. 16 VIP suites, 3,000 press)
Capacity after Games	56,700 seats

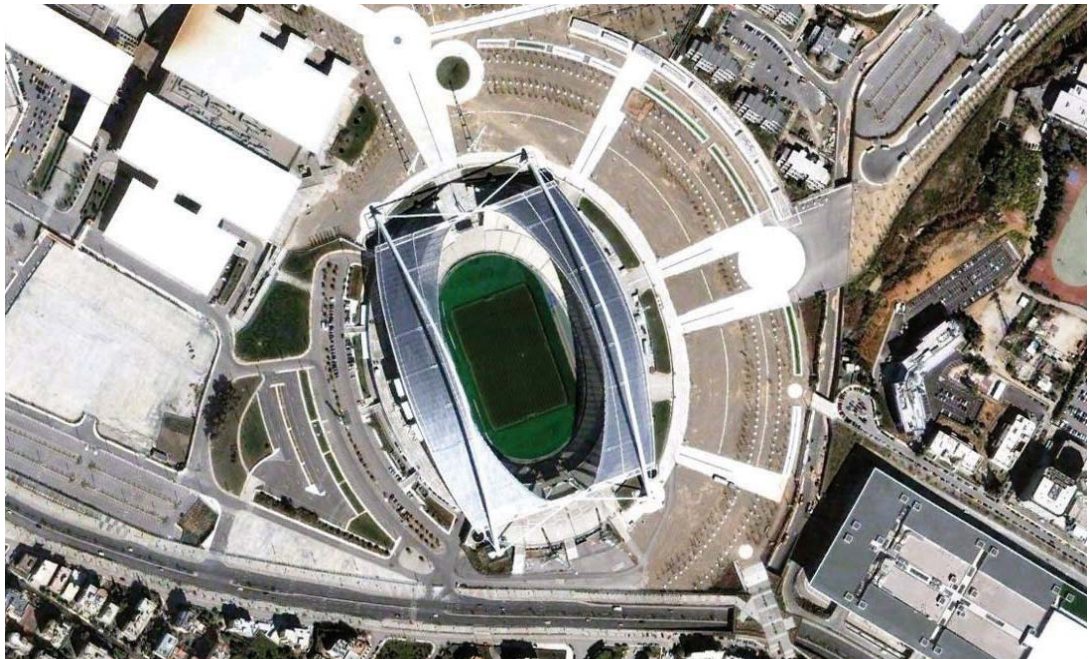


Illustration 34: Satellite picture Athens Olympic Stadium with spectator capacity of 71,030 seats during construction. New Athens Indoor Stadium adjacent on the left²⁶⁶



Illustration 35: Athens Olympic Stadium with spectator capacity of 71,030 seats during construction²⁶⁷



Illustration 36: Athens Olympic Stadium with a capacity of 72,000 seats and new roof structure during the Olympic Games in 2004²⁶⁸

5.4.3 Athens Indoor Stadium, Greece

Selection Criteria	Existing redeveloped indoor stadium ($\geq 15,000$)
Architect	Santiago Calatrava, Spain
Location	Maroussi, Athens, Greece
Location Type	Existing Site (next to existing Olympic Stadium)
Construction commenced ²⁶⁹	1989
Construction completed	May 1998
Refurbishment completed	2003-30.06.2004
Opened	10.08.2004
Cost of construction ²⁷⁰	EUR 144.7 million
Cost of Olympic overlay	Not available
Operator after the Games	OAKA
Use before Games	Artistic gymnastics and trampoline
Use during Games	Basketball final of 2004 Summer Olympics
Use after Games ²⁷¹	Home court of the Greek A1 league professional basketball club Panathinaikos Athens and Maroussi Athens for European Cup matches, also the primary home court of the Greek national basketball team, concerts

Tenants	Panathinaikos BC ²⁷² , Hellenic Basketball Federation ²⁷³
Capacity before Games	17,600 seats
Capacity during Games	Basketball: 18,500 seats (incl. fan seats) 18,800 seats (incl. media seats) 19,250 seats (incl. media and VIP seats)
Seating capacity after Games	17,600 seats



Illustration 37: Athens Indoor Stadium (centre) adjacent to the Athens Olympic Stadium (right) and Swimming Complex (left) after the Olympic Games in 2004²⁷⁴



Illustration 38: Athens Indoor Stadium (centre) with warm-up hall in the front and Athens Olympic Stadium in the background before the Olympic Games in 2000²⁷⁵



Illustration 39: Athens Indoor Stadium with a spectator capacity of 19,250 seats during the Olympic Games in 2004²⁷⁶

5.4.4 Athens Football Stadium (Karaiskakis Stadium), Greece

Selection Criteria	New outdoor stadium ($\geq 15,000$ spectators)
Architect	Stelios Aghiostratitis, aa Associates Architects
Location Type	Existing Site
Construction commenced	1895, 1952
Construction completed	1896, 1954
New construction	2003-2004
Opened	02.08.2004
Cost of construction ²⁷⁷	EUR 60 million
Cost of Olympic overlay	Not available
Operator after the Games	Olympiacos
Use before Games	Home ground of Olympiacos F.C.
Use during Games	Preliminaries, quarter finals and semi finals football, women's football final
Tenants	Olympiacos FC ²⁷⁸
Capacity during Games	32,500 seats
Capacity after Games	33,500 seats
Use after Games ²⁷⁹	Operated as a movie theatre, concerts

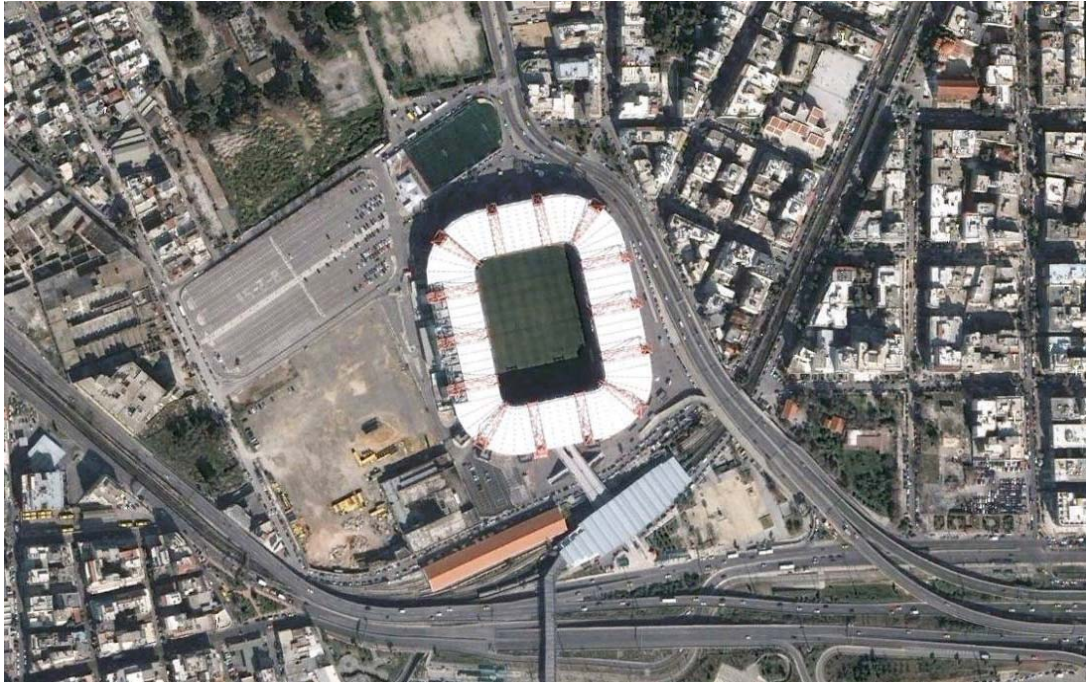


Illustration 40: Satellite picture Athens Football Stadium after the Olympic Games²⁸⁰



Illustration 41: Athens Football Stadium during construction on existing site before the Olympic Games in 2004. The original stadium was constructed 1895-1896 on this site for the world's 1st Olympic Games 1896.^{xxxix} Between 1952-1954 it was replaced with another stadium which was then demolished for this new stadium.²⁸¹

^{xxxix} 2.2 Historic background of the Olympic Games, page 23-24



Illustration 42: Spectator stands Athens Football Stadium with a spectator capacity of 33,500 after the Olympic Games in 2004²⁸²

5.5 Selected venues of the Olympic Games 2008 in Beijing, China

5.5.1 Beijing Olympic Park

Two of the selected venues, Olympic Stadium and Indoor Stadium are located in the Beijing Olympic Park (Olympic Green) which was developed for the Olympic Games 2008. The Masterplan in Illustration 43 was fully revised after Beijing was selected to host the Games in 2008. The satellite pictures in Illustration 44 show the entire precinct of the Olympic Park.

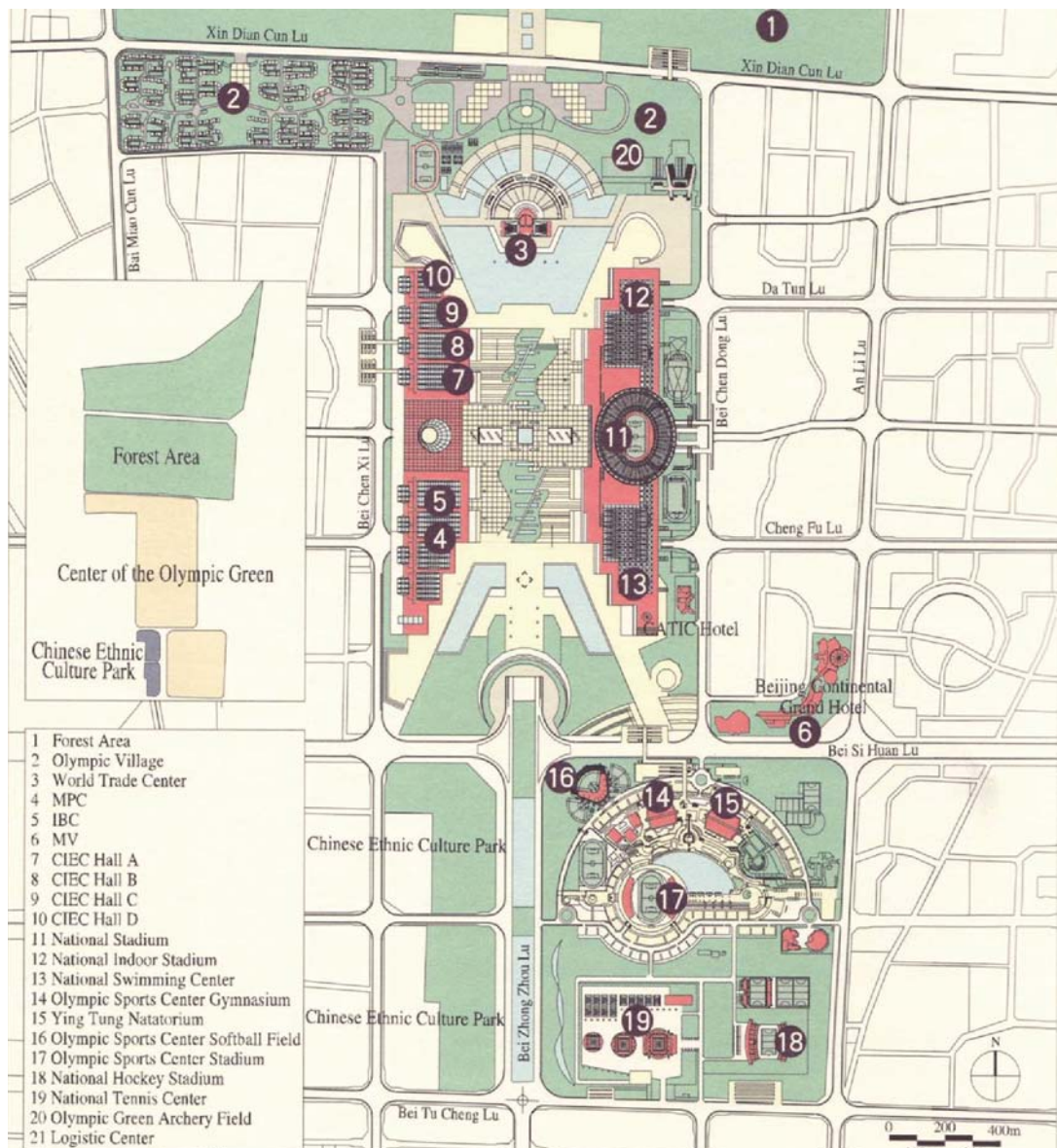


Illustration 43: Excerpt masterplan for Beijing Olympic Park submitted as part of the original bidding document of the Beijing Organising Committee for the Olympic Games in 2008²⁸³

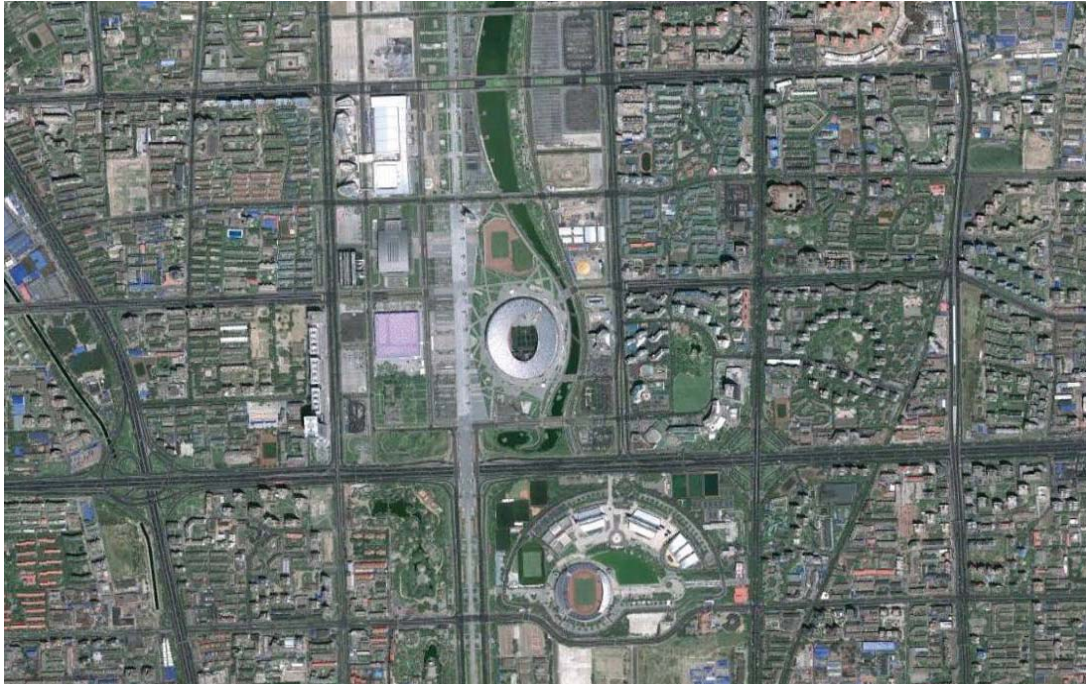


Illustration 44: Satellite picture Beijing Olympic Park (Olympic Green) with Olympic Stadium (centre), Indoor Stadium (left, above swimming stadium) and Football Stadium (right below). Metro with stops for Beijing Olympic Stadium and separately for Beijing Football Stadium is underground²⁸⁴

5.5.2 Beijing Olympic Stadium (National Stadium), China

Selection Criteria	New outdoor stadium (selection criteria: capacity more than 60,000 spectators)
Architect	Herzog & de Meuron, Switzerland
Location	Beijing, China
Location Type	Greenfield Site
Construction commenced	December 2003
Construction completed	March 2008
Opened	28.06.2008
Cost of Olympic overlay	No Olympic overlay
Cost of construction ²⁸⁵	USD 480 million (approx. EUR 361 million)
Operator after the Games	Beijing State-Owned Assets Management Co. Ltd (BSAM), China International Trust and Investment (CITIC) Consortium
Use before Games	-
Use during Games	Opening/closing ceremonies, athletic events and football final

Use after Games ²⁸⁶	Football, track and field, concerts, Ice and Snow Festival, sports meetings, functions
Tenants	No tenants
Seating capacity before Games	-
Seating capacity during Games	91,000 seats including 11,000 temporary seats
Seating capacity after Games	80,000 seats



Illustration 45: Satellite picture of Beijing Olympic Stadium with swimming stadium (left) after the Olympic Games in 2008²⁸⁷



Illustration 46: Beijing Olympic Stadium (front), Beijing Indoor Stadium (far right)²⁸⁸



Illustration 47: Beijing Olympic Stadium with spectator capacity of 80,000 seats in preparation for the Olympic Games in 2008²⁸⁹

5.5.3 Beijing Indoor Stadium (National Indoor Stadium), China

Selection Criteria	New indoor stadium ($\geq 15,000$ spectators)
Architect	Beijing Institute of Technology Design, Beijing Urban Engineering Design & Research Institute
Location	Beijing, China
Location Type	Greenfield Site
Construction commenced	March 2005
Construction completed	October 2007
Opened	26.11.2007
Cost of construction ²⁹⁰	EUR 81 million
Cost of Olympic overlay	No Olympic overlay
Operator after the Games	Government of the PRC
Use before Games	-
Use during Games	Gymnastics, trampoline and handball
Use after Games	Concerts (proposed)
Tenants	Chinese Olympic Committee
Capacity during Games	20,000 seats
Capacity after Games	18,000 seats



Illustration 48: Satellite picture of Beijing Indoor Stadium (centre) and precinct with swimming stadium below²⁹¹



Illustration 49: Beijing Indoor Stadium during construction (front) with Beijing Olympic Stadium (behind) before the Olympic Games 2008²⁹²



Illustration 50: Beijing Indoor Stadium with spectator capacity of 20,000 seats during the Olympic Games in 2008²⁹³

5.5.4 Beijing Football Stadium (Olympic Sports Centre), China

Selection Criteria	Redeveloped existing outdoor stadium (≥ 15,000 spectators)
Architect	China Third Construction Energy Division
Location	Beijing, China
Location Type	Existing Site
Construction commenced	1988
Construction completed ²⁹⁴	1990
Opened	04.09.2007
Cost of construction	Not available
Cost of Olympic overlay	Not available
Operator after the Games	Not available
Use before Games	Hosted 11 th Beijing Asian Games
Use during Games	Football matches, cross country and show jumping disciplines of modern pentathlon events
Use after Games	-
Tenants	Not available
Capacity before Games	18,000 seats
Capacity during Games	36,000 seats (same after the Games)



Illustration 51: Satellite picture of Beijing Football Stadium after the Olympic Games 2008²⁹⁵



Illustration 52: Beijing Football Stadium with spectator capacity of 36,000 seats during construction of the new roof for the Olympic Games in 2008²⁹⁶



Illustration 53: Beijing Football Stadium with new roof structure (permanent overlay) after the Olympic Games in 2008²⁹⁷

5.6 Summary chapter case studies

In this chapter the relevant key project information are compiled in a table separately for each stadium type. Subsequently the project brief along with three pictures (satellite picture, exterior view and interior view) for each of the selected three stadium types (Olympic Stadium, Indoor Stadium and Football Stadium) used for the respective Olympic Summer Games in 2000, 2004 and 2008 is summarized.

The project brief presented for each venue comprises of the following details:

Selection Criteria

Architect

Location

Location Type

Construction period

Year of opening

Cost of construction

Cost of Olympic overlay

Operator after the Games

Use before the Games
Use during the Games
Use after the Games
Tenants
Capacity before the Games
Capacity during the Games
Capacity after the Games

The majority of information was obtained from official bidding documents and other reports of the Olympic Games provided by the Olympic Studies Centre in Lausanne (Switzerland) as part of the Postgraduate Research Grant Programme 2007.²⁹⁸ In addition other information from documents available in libraries, publications and on the Internet as well as documents collected during the field survey (e.g. maps, site plans, site pictures, etc.) is presented in this chapter.

The field research in Sydney, Athens and Beijing was carried out for all nine venues between 2010 and 2011. Subsequent to the assessment of the precinct of all nine stadiums from outside and inside an additional survey was conducted together with an operator representative for seven out of nine stadiums (except Beijing Indoor Stadium and Beijing Football Stadium). Following the site survey, personal interviews with operator representatives at senior management level were held in order to discuss and verify the findings of the literature review as well as the field research and also to obtain first-hand information about the Overlay^{xi} and day-to-day operation of the venue.

The findings were incorporated into the Evaluation Matrix for subsequent analysis, evaluation and assessment described in the following Chapter 6. In consideration of the actual findings during the field research the assessment method and Evaluation Matrix were refined and simplified. Sub-categories and parameters where sufficient data could not be obtained were removed. Subsequently the findings of the case studies were integrated into the revised Evaluation Matrix.

^{xi} 4.5.2 Classification B Environmental Category, Sub-category B.1, Building, Parameter B.1.1 Overlay, page 82-83

6 ANALYSIS

In this chapter the analysis for each sports stadium is presented in the respective category, sub-category and parameters. The sequence for the comparative analysis is first Olympic Stadium, second Indoor Stadium and third Football Stadium. The comparative evaluation and assessment of the venues is carried out for two parameters in each sub-category. Based on the Evaluation Matrix developed in Chapter 4 'Development research tool' (please also refer to Illustration 74-76 Rating matrix) each parameter is evaluated in comparison with the respective parameters of the nine different venues and subsequently weighted based on the 5- point score system. The total number of points for each sports stadium is summarised in Chapter 6.4 'Summary chapter analysis'.

6.1 Evaluation A Urban Category

6.1.1 A Urban Category

Sub-category A.1 Urban Integration

Evaluation Parameter A.1.1 Location Type

A.1.1 Sydney Olympic Stadium/Sydney Indoor Stadium 3 out of 5 points
Regeneration and redevelopment of a 640 hectare Brownfield Site, previously an industrial zone called Homebush Bay, for Sydney Olympic Stadium and Sydney Indoor Stadium which are part of the Olympic Park. The redevelopment included a comprehensive Masterplan for the Sydney Olympic Games 2000. Before redevelopment various industries were located at Homebush Bay area e.g. State Abattoirs (1907-1988), State Brickworks (1911-1988) and Navy armaments depot.²⁹⁹
Evaluation result: Considering that an abandoned industrial partially contaminated Brownfield Site has been redeveloped for Sydney Olympic Stadium and Sydney Indoor Stadium a total of 3 points out of 5 points is allocated.

A.1.1 Athens Olympic Stadium 4 out of 5 points
The original Athens Olympic Stadium³⁰⁰ was constructed 1980-1982 on the site to host the 1982 Athletic European Championship. For the Olympic Games in 2004 the existing stadium was redeveloped. Evaluation result: Considering that an Existing Site has been utilized for Athens Olympic Stadium a total of 4 points out of 5 points is allocated. The reason why the maximum number of points is not allocated is

because the site was developed less than 30 years ago, this is a considerably shorter period of time and therefore less sustainable compared to Athens Football Stadium, which is in use for sports venues since more than 100 years.

A.1.1 Beijing Olympic Stadium/Beijing Indoor Stadium

1 out of 5 pts



Illustration 54: Satellite picture of Beijing Olympic Stadium site dated 09.05.2002 before start of construction works for the Beijing Olympic Park³⁰¹



Illustration 55: Satellite picture of Beijing Olympic Stadium dated 18.08.2005 during construction works for the Beijing Olympic Stadium and Olympic Park³⁰²



Illustration 56: Satellite picture of Beijing Olympic Stadium dated 28.06.2009 after completion of works and after the Olympic Games in 2008³⁰³

Beijing Olympic Stadium and Beijing Indoor Stadium were constructed on a Greenfield Site. The satellite pictures in Illustration 54, Illustration 55 and Illustration 56 show that the green open space- partially used for agriculture with several existing building structures- was demolished for the construction of the new stadiums.

Evaluation result: Considering that a Greenfield Site partially used for agriculture was utilized for Beijing Olympic Stadium and Beijing Indoor Stadium a total of 1 point out of 5 points is allocated.

A.1.1 Athens Indoor Stadium 3 out of 5 points

Athens Indoor Stadium was constructed 1989-1998 adjacent to the Existing Site of Athens Olympic Stadium (constructed 1980-1982) before the bidding process for the Olympic Games in 2000. Although the site of Athens Indoor Stadium is adjacent to the existing Athens Olympic Stadium it is considered as a Greenfield Site.

Evaluation result: Considering that a Greenfield Site has been utilized for Athens Indoor Stadium 2 points are applicable but a total of 3 points out of 5 points are allocated. This is in appreciation of the fact that the existing infrastructure for access, egress and utilities, which has been already built for the Olympic Stadium, is also utilized for the new Indoor Stadium.

A.1.1 Canberra Football Stadium 4 out of 5 points

The original Canberra Football Stadium was constructed for the Pan Pacific Games in 1977 on this site. The stadium was mainly used for track and field activities e.g. the 4th IAAF World Cup in Athletics. For the Athletics World Cup in 1985 the stadium was redeveloped and the seating capacity increased to 11,500. In 1990 the running track was removed allowing playing of Australian rules football (AFL). In preparation for the Olympic Games in 2000 extensive renovation works were carried out from 1997 onwards.

Evaluation result: Considering that an Existing Site has been utilized for Canberra Football Stadium a total of 4 points out of 5 points is allocated. The reason why the maximum number of points is not allocated is because the site was developed less than 30 years ago, this is a considerably shorter period of time and therefore less sustainable compared to Athens Football Stadium, which is in use for sports venues since more than 100 years.

A.1.1 Athens Football Stadium

5 out of 5 points

The original stadium was constructed 1895-1896 on this site. The stadium was used as a velodrome for the world's 1st Olympic Games of the modern era in 1896.^{xii}

In 1952-1954 the original stadium was demolished and a new stadium with track and field was constructed. In preparation for the Olympic Games 2004 the existing stadium was demolished and in 2003-2004 the new Athens Football Stadium³⁰⁴ was constructed.

Evaluation result: Considering that an Existing Site of more than 100 years is used for Athens Football Stadium a maximum of 5 points out of 5 points is allocated.

A.1.1 Beijing Football Stadium

4 out of 5 points

Beijing Football Stadium was constructed 1988-1990 for the 11th Beijing Asian Games. For the Olympic Games in 2008 the existing stadium was redeveloped.

Evaluation result: Considering that an Existing Site has been utilized for Beijing Football Stadium a total of 4 points out of 5 points is allocated. The reason why the maximum number of points is not allocated is because the site was developed less than 30 years ago, this is a considerably shorter period of time and therefore less sustainable compared to the site of Athens Football Stadium, which is in use for sports venues since more than 100 years

6.1.2 A Urban Category

Sub-category A.1 Urban Integration

Evaluation Parameter A.1.2 Building Type

A.1.2 Sydney Olympic Stadium

2 out of 5 points

Construction of Sydney Olympic Stadium as a new stadium on a Brownfield Site. For the Olympic Games the seating capacity was 115,600 seats which was then reduced to 80,000 seats after the Games.

Evaluation result: Considering that Sydney Olympic Stadium is a new structure which allowed for a considerable reduction of the capacity after the Olympic Games a total of 2 points out of 5 points is allocated because of the necessity for major changes of the stadium after the Olympic Games.

^{xii} 2.2 Historic background of the Olympic Games, page 23-24

A.1.2 Athens Olympic Stadium

4 out of 5 points

Redevelopment of Athens Olympic Stadium with upgrade and redevelopment of the existing stadium built in 1979-1982, various modifications for the Olympic overlay e.g. resizing of the press room facilities (the original press rooms were bigger before the Olympic Games) and construction of a new roof structure above the existing spectator stands. In preparation for the Olympic Games in 2004 the roof structure³⁰⁵ was constructed in 2002-2004 to cover all seats as per the requirements of the International Olympic Committee (IOC). Illustration 57 and Illustration 58 below show Athens Olympic Stadium after completion without roof in 1982 (left) and after redevelopment with the new roof in 2004 (right).

Evaluation result: Considering that Athens Olympic Stadium as an existing stadium was redeveloped and upgraded but was constructed less than 30 years ago, which is a considerably shorter period of time and therefore less sustainable in comparison to Canberra Football Stadium a total of 4 points out of 5 points is allocated.



Illustration 57, left: Existing Athens Olympic Stadium without roof in 1982³⁰⁶

Illustration 58, right: Athens Olympic Stadium with new roof structure in 2004³⁰⁷

A.1.2 Beijing Olympic Stadium

2 out of 5 points

Construction of Beijing Olympic Stadium as a new stadium on a Greenfield Site. For the Olympic Games the total seating capacity was 91,000 seats which was reduced to 80,000 seats after the Games.

Evaluation result: Considering that Beijing Olympic Stadium is a new structure on a Greenfield Site a total of 2 points out of 5 points is allocated.

A.1.2 Sydney Indoor Stadium

2 out of 5 points

Construction of the new Sydney Indoor Stadium on a Brownfield Site adjacent to the new Sydney Olympic Stadium.

Evaluation result: Considering that Sydney Indoor Stadium is a new structure on a Brownfield Site and underwent major changes after the Olympic Games a total of 2 points out of 5 points is allocated.

A.1.2 Athens Indoor Stadium 4 out of 5 points

Redevelopment of Athens Indoor Stadium with upgrade of the existing stadium built on a Greenfield Site in 1989-1998 in anticipation of a successful bid for the Olympic Games in 2000 with minor modifications for the Olympic Games in 2002-2004.

Evaluation result: Considering that Athens Indoor Stadium as an existing stadium was redeveloped and upgraded a total of 4 points out of 5 points is allocated. The reason why the maximum number of points is not allocated is because the existing Athens Indoor Stadium was constructed less than 30 years ago, which is a considerably shorter period of time and therefore less sustainable in comparison to Canberra Football Stadium.

A.1.2 Beijing Indoor Stadium 2 out of 5 points

Construction of Beijing Indoor Stadium as a new stadium on a Greenfield Site adjacent to the new Beijing Olympic Stadium.

Evaluation result: Considering that Beijing Indoor Stadium is a new structure on a Greenfield Site a total of 2 points out of 5 points is allocated.

A.1.2 Canberra Football Stadium 5 out of 5 points

Redevelopment of Canberra Football Stadium (initially constructed in 1974-1977) with upgrade and redevelopment of the existing stadium between 1997-1999 in order to meet the requirements of the International Olympic Committee (IOC) for the Olympic Games. The redevelopment included lowering of the playing field to build additional spectator seats closer to the playing field with conversion from an oval to a rectangular shape. In addition a new spectator stand opposite the existing Grand Stand was constructed. The total costs were approximately 47 million Australian Dollars (approximately 36 million EUR).³⁰⁸ Other works included the upgrading of the existing Grand Stand.

Evaluation result: Considering that Canberra Football Stadium as an existing stadium was redeveloped as well as upgraded and constructed more than 30 years ago the maximum of 5 points out of 5 points is allocated.

A.1.2 Athens Football Stadium

3 out of 5 points

The existing stadium was constructed in 1952-1954 and demolished for construction of Athens Football Stadium as a new building on an Existing Site in 2003-2004.

Evaluation result: Considering that Athens Football Stadium is a new building and remained mostly unchanged after the Olympic Games a total of 3 points out of 5 points is allocated.

A.1.2 Beijing Football Stadium

4 out of 5 points

Redevelopment of Beijing Football Stadium with upgrade and redevelopment of the existing stadium built in 1988-1990 with additional spectator stands and new roof structure to cover the main spectator stands. Illustrations 59 and Illustration 60 below show Beijing Football Stadium after completion without roof in 1992 (left) and after redevelopment in 2008 (right).

Evaluation result: Considering that Beijing Football Stadium as an existing stadium was redeveloped and upgraded but was constructed less than 30 years ago, which is a considerably shorter period of time and therefore less sustainable in comparison to Canberra Football Stadium a total of 4 points out of 5 points is allocated.



Illustration 59, left: Beijing Football Stadium before redevelopment³⁰⁹

Illustration 60, right: Beijing Football Stadium after redevelopment³¹⁰

6.1.3 A Urban Category

Sub-category A.2 Urban Context

Evaluation Parameter A.2.1 Proximity

A.2.1 Sydney Olympic Stadium/Sydney Indoor Stadium

5 out of 5 points

The linear distance between Sydney Olympic Stadium as well as Sydney Indoor Stadium and the City Centre e.g. Central Station is approximately 14 km. The linear distance to a major tourist destination e.g. Sydney Opera House is approximately 17 km. The stadiums are fully integrated within the Olympic Park of 640 acres,

providing a significant number of different options for recreation and entertainment. Olympic Park is surrounded by residential areas which have been built in parallel construction and further developed subsequent of its completion.

Evaluation result: Considering that the location of Sydney Olympic Stadium and Sydney Indoor Stadium is within the immediate urban context of mixed-use areas e.g. commercial, retail, recreational and residential areas located in a linear distance of approximately 0-2 km the maximum of 5 points out of 5 points is allocated.

A.2.1 Athens Olympic Stadium/Athens Indoor Stadium 2 out of 5 points

The linear distance between Athens Olympic Stadium as well as Athens Indoor Stadium and the City Centre e.g. Central Station is approximately 11 km. The linear distance to a major tourist destination e.g. Acropolis is approximately 13 km. The surrounding 'common ground' provides no landscape or other amenities and therefore is not considered a public park attracting additional usage of the precinct. Current activities in these areas are small scale cycling and skating. The sports facilities are mainly surrounded by residential areas with one retail component ('The Mall'). In the interviews with the operator it was noted that regular complaints of neighbours were raised due to noise and parking issues during events.

Evaluation result: Considering that the location of Athens Olympic Stadium and Athens Indoor Stadium is adjoining mixed-use areas e.g. commercial, retail, recreational and residential areas in a linear distance of approximately 2-4 km and the surrounding area is mostly residential with only very few commercial elements a total of 2 points out of 5 points is allocated.

A.2.1 Beijing Olympic Stadium/Beijing Indoor Stadium 3 out of 5 points

The linear distance between Beijing Olympic Stadium as well as Beijing Indoor Stadium and the City Centre e.g. Central Station is approximately 17 km. The linear distance to a major tourist destination e.g. Tiananmen Square is approximately 14 km. The precinct of the Olympic Stadium provides various recreation areas. The main plaza connects Beijing Olympic Stadium with several other sports facilities and has become an independent tourist attraction for international tourists as well as for national tourists and the local community.

Evaluation result: Considering that the location of Beijing Olympic Stadium and Beijing Indoor Stadium is adjoining mixed-use areas e.g. commercial, retail, recreational and residential areas in a linear distance of approximately 2-4 km and Beijing Olympic Stadium is an independent tourist attraction with different commercial elements a total of 3 points out of 5 points is allocated.

A.2.1 Canberra Football Stadium

1 out of 5 points

The linear distance between Canberra Football Stadium and Central Railway Station, which is Canberra Station in Kingston, is approximately 16 km. The linear distance to a major tourist destination e.g. National Gallery Australia is approximately 12 km.

Evaluation result: Considering that Canberra Football Stadium is a comparatively isolated venue with a distance to mixed-use areas of more than approximately 4 km a total of 1 point out of 5 points is allocated.

A.2.1 Athens Football Stadium

5 out of 5 points

The linear distance between Athens Football Stadium and the City Centre e.g. Central Station is approximately 12 km. The linear distance to a major tourist destination e.g. Acropolis is approximately 8 km. The additional usages integrated within the Football Stadium are creating independent commercial areas. The visitors of the adjacent Velodrome³¹¹ regularly use the bars, cafés, and restaurants of the stadium before and after the events. Residential areas are located adjacent. The operator confirmed that there are rarely complaints from the neighbours of the residential areas. However, there are occasionally complaints from the Metropolitan Hospital which is in the vicinity of the sports facility.

Evaluation result: Considering that the location of Athens Olympic Stadium is within the immediate urban context of mixed-use areas e.g. commercial, retail, recreational and residential areas which are located in a linear distance of approximately 0-2 km the maximum of 5 points out of 5 points is allocated.

A.2.1 Beijing Football Stadium

2 out of 5 points

The linear distance between Beijing Football Stadium and the City Centre e.g. Central Station is approximately 13 km. The distance to a major tourist destination e.g. Tiananmen Square is approximately 16 km and the linear distance between Beijing Olympic Stadium and Beijing Football Stadium is approximately 3,4 km.

Evaluation result: Considering that the location of Beijing Football Stadium is adjoining mixed-use areas e.g. commercial, retail, recreational and residential areas in a linear distance of approximately 2-4 km and the surrounding area is residential with only few commercial elements as well as the relative far linear distance to Beijing Olympic Stadium with approximately 3,4 km a total of 2 points out of 5 points is allocated.

6.1.4 A Urban Category

Sub-category A.2 Urban Context

Evaluation Parameter A.2.2 Connectivity

A.2.2 Sydney Olympic Stadium 4 out of 5 points

The access via city rail network to Sydney Olympic Stadium is good. The station 'Olympic Park' connects the area with the City Centre. The distance to the closest public transport station e.g. metro is approximately 320m. The Olympic Park has 10,000 car spaces.

Evaluation result: Considering the connectivity of Sydney Olympic Stadium via metro system and linear distance of approximately 320m to the next metro station a total of 4 points out of 5 points is allocated.

A.2.2 Athens Olympic Stadium 3 out of 5 points

The access via metro system to Athens Olympic Stadium is good. Adjacent to the OAKA Olympic Park there are a number of different bus stops and three parking areas. Park and ride services are generally not available. The access for private transportation is very good. The distance to the closest public transport station e.g. metro is 800m.

Evaluation result: Considering the connectivity of Athens Olympic Stadium via metro system but the relative far distance of approximately 800m to the next metro station a total of 3 points out of 5 points is allocated.

A.2.2 Beijing Olympic Stadium 4 out of 5 points

The access via metro system to Beijing Olympic Stadium is good. In addition there are various buses providing connection. Park&Ride Services are not available. The connectivity with the public road network is very good and provides sufficient access to the stadium. The distance to the next public transport station e.g. metro is approximately 500m.

Evaluation result: Considering the connectivity of Beijing Olympic Stadium via metro system and linear distance of 500m to the next metro station a total of 4 points out of 5 points is allocated.

A.2.2 Sydney Indoor Stadium

3 out of 5 points

The access of Sydney Indoor Stadium via city rail network is good. The station 'Olympic Park' connects the area with the City Centre. The distance to the closest public transport station e.g. metro is approximately 560m. For Sydney Indoor Stadium an integrated car park with a total of 2,300 car parking spaces is allocated in a separate structure adjacent to the stadium.

Evaluation result: Considering the connectivity of Sydney Indoor Stadium via metro system but the relative far linear distance of approximately 560m to the next metro station a total of 3 points out of 5 points is allocated.

A.2.2 Athens Indoor Stadium

3 out of 5 points

The access via metro system to Athens Indoor Stadium is good. Adjacent to the OAKA Olympic Park there are a number of different bus stops and three different parking areas. Park&Ride services are generally not available. The access for private transportation is very good. The distance to the closest public transport station e.g. metro is approximately 520m.

Evaluation result: Considering the connectivity of Athens Indoor Stadium via metro system, but the relative far linear distance of approximately 520m to the next metro station a total of 3 points out of 5 points is allocated.

A.2.2 Beijing Indoor Stadium

4 out of 5 points

The access via metro system to Beijing Indoor Stadium is good. In addition various buses are providing connection to the Olympic Stadium. Park&Ride Services are not available. The connectivity with the public road network is very good and ensures sufficient access to the stadium. Distance to the next public transport station e.g. metro is approximately 350m.

Evaluation result: Considering the connectivity of Beijing Indoor Stadium via metro system and linear distance of approximately 350m to the next metro station a total of 4 points out of 5 points is allocated.

A.2.2 Canberra Football Stadium

2 out of 5 points

The access to Canberra Football Stadium is via one bus line from the City Centre. The distance to the next bus station is approximately 320m. Metro is not available. There are 11 parking lots in the precinct of the stadium.³¹²

Evaluation result: Considering the connectivity of Canberra Football Stadium only via bus a total of 2 points out of 5 points is allocated.

A.2.2 Athens Football Stadium

5 out of 5 points

The access to Athens Football Stadium is very good as it is connected via metro system and bus. The connection between metro station and stadium is convenient with two pedestrian bridges and direct access to the upper concourse and spectator stands. Distance to the next public transport station e.g. metro is approx. 62m. About 1,600 parking spaces are available close to the stadium. An empty plot of land (owned by a third party), reserved for construction of an office building, is currently utilised for additional parking. Once the new office building is constructed the currently available parking sites will be reduced by approximately 40%. Park&Ride facilities are generally not provided.

Evaluation result: Considering the connectivity of Athens Football Stadium via metro system and linear distance of 62m to the next metro station the maximum of 5 points out of 5 points is allocated.

A.2.2 Beijing Football Stadium

4 out of 5 points

The access via metro system to Beijing Football Stadium is good. In addition various buses are providing connection. Park&Ride Services are not available. The connectivity with the public road network is very good and ensures sufficient access to the stadium. Distance to the next public transport station e.g. metro is approximately 330m.

Evaluation result: Considering the connectivity of Beijing Football Stadium via metro system and linear distance of approximately 330m to the next metro station a total of 4 points out of 5 points is allocated.

6.2 Evaluation B Environmental Category

6.2.1 B Environmental Category

Sub-category B.1 Building

Evaluation Parameter B.1.1 Overlay

B.1.1 Sydney Olympic Stadium

5 out of 5 points

In consideration of the operational requirements of Sydney Olympic Stadium after the Olympic Games it was decided at an early design stage that as part of the Overlay the running tracks should be removed. Another component of Overlay was the spectator capacity of 115,600 spectators which was reduced to 83,500 (82,500 in oval mode) after the Games. For this purpose the north and south spectator

stands (seating capacity 15,000 spectators each) were constructed as temporary seating without roof. These 30,000 temporary seats were leased from the contractor (M/s. Multiplex/Obiashi) and after removal from Sydney Olympic Stadium in October 2001 the seats were reinstalled at another stadium in New Zealand. Subsequently the roof structures (steel members covered with polycarbonate panels with UV-protection) were constructed to cover the remaining seats on the north and south spectator stands. After removal of the running tracks the lower tiers of all spectator stands were extended and partially converted into retractable seating reducing the distance to the playing field to approximately 15 metres as shown in Illustration 61 and Illustration 62.³¹³ The Overlay was removed after the Olympic Games over a period of approximately 2.5 years and completed in 2003 with an estimated overall cost of approximately 80 million Australian Dollars (approximately 62 million EUR).³¹⁴

Evaluation result: Considering the conversion of Sydney Olympic Stadium through removal of the Overlay after the Olympic Games in order to meet the operational requirements e.g. retractable spectator stands for different types of sport and avoidance of spare spectator capacities the maximum of 5 points out of 5 points is allocated.



Illustration 61, left: Sydney Olympic Stadium with running tracks and temporary seating for 30,000 spectators (without roof) on the north and south spectator stands during an event of the Olympic Games in 2000³¹⁵



Illustration 62, right: Sydney Olympic Stadium after removal of the north and south spectator stands with new roofs. Subsequent to the removal of running tracks the lower spectator stands of all spectator stands were extended and partially converted into retractable spectator stands reducing the distance to the playing field to approximately 15 metres.³¹⁶

B.1.1 Athens Olympic Stadium

3 out of 5 points

For the Overlay a permanent new roof was constructed structurally independent to the existing spectator stands of Athens Olympic Stadium. The new roof structure was necessary to provide cover for all seats as per the requirements of the IOC. "The roof was mainly prefabricated off-site, then assembled and installed on-site to reduce on-site personnel and equipment."³¹⁷ The west arc was assembled approx. 72m and the east arc approx. 65m from their final position. Both arcs slid later into place. The roof is designed for a wind speed up to 120 km/h. "The bearing structure of each arc is tubular steel joined by cables to a torque tube, which supports a series of transverse ribs spaced at 5m (16.5ft) intervals. A system of secondary cables transfers the weight from the ends of the ribs and stabilizes the arc. The span of the arc is 304m (997ft), rising to a height of 72m (236ft) and the average width of the roof is some 50m (165ft)."³¹⁸ The surface covered by roof consisting of approx. 5,000 polycarbonate panels is approx. 23,500sqm and the total weight of the structure is approx. 18,000-19,000 tons.³¹⁹ The height between the roof structure and the last seat row on the upper spectator stands varies significantly between the sides and the centre where the highest point of the arc is located. The operator confirmed that the distance between the roof and the spectator stands causes discomfort during wind and rain, particularly for the upper seat rows. The big distance between the football playing field and spectators due to the running tracks was considered as a constraint since this increases viewing distances for football games.

Evaluation result: Considering that the roof structure of Athens Olympic Stadium, constructed as part of Overlay, became a permanent installation enhancing the quality and usability of the existing stadium a total of 3 points out of 5 points is allocated. Reason why no additional points are allocated is the missed opportunity to remove the running tracks after the Olympic Games which compromises the usability of Athens Olympic Stadium for the two existing home teams.

B.1.1 Beijing Olympic Stadium

1 out of 5 points

There has been no Overlay considered for the Olympic Games and Beijing Olympic Stadium generally remained unchanged after the Olympic Games in 2008. Installations such as the hydraulic lift, which was installed for the opening ceremony, were not used since then. It was also noted that the turf has been exchanged three times since the Olympic Games. Main reason why the turf had to be replaced is the usage of the playing field for winter activities such as ice skating.

Evaluation Result: Considering that Beijing Olympic Stadium had no Overlay and no provisions for adopting other usages subsequent to the Olympic Games a total of 1 point out of 5 points is allocated. The reason why the lowest number of points is allocated, is based on the fact that no modifications of the existing structure were undertaken to allow for a more regular usage for sports as well as non-sports events.

B.1.1 Sydney Indoor Stadium 2 out of 5 points

The main component of the Overlay was a gondola with four video screens (suspended from the roof structure), used for scoreboards during the Olympic Games, which was removed after the Games. This was required in order to host concerts and other non-sports events.

Evaluation result: Considering the limited enhancement of Sydney Indoor Stadium for operation after the Olympic Games a total of 2 points out of 5 points is allocated.

B.1.1 Athens Indoor Stadium 1 out of 5 points

There has been no Overlay considered for the Olympic Games and Athens Indoor Stadium remained generally unchanged after the Olympic Games in 2004.

Evaluation result: Considering the limited enhancement of Athens Indoor Stadium for operation after the Olympic Games a total of 1 point out of 5 points is allocated.

B.1.1 Beijing Indoor Stadium 1 out of 5 points

Limited information was available about the further usage of Beijing Indoor Stadium. Based on an elaborate research it appears that there has been no Overlay considered for the Olympic Games and Beijing Indoor Stadium remained generally unchanged after the Olympic Games in 2008.

Evaluation Result: Considering that Beijing Indoor Stadium had no provisions for adopting other usages subsequent to the Olympic Games a total of 1 point out of 5 points is allocated. The reason why the lowest number of points is allocated, is based on the assumption that no modifications of the existing structure were undertaken to allow a regular usage for sports as well as non-sports events.

B.1.1 Canberra Football Stadium 1 out of 5 points

For Overlay the playing field was lowered and converted from an oval to a rectangular shape in order to meet the requirements of the International Olympic Committee (IOC) for the Olympic Games. The operator considers this as a disadvantage for the usage after the Games. Due to Overlay and conversion of the

playing field Australian rules football (AFL) cannot be played anymore at Canberra Football Stadium. After the Olympic Games in 2000 other parts of Overlay were partially removed and the following modifications were executed: Removal of media centre, combination of VIP boxes into a combined club box, installation of CCTV, additional office space, new sign boards and additional security office.

Evaluation Result: Considering that Canberra Football Stadium has not removed Overlay of the playing field resulting in a disadvantage for the operation of the stadium for other sports than football a total of 1 point out of 5 points is allocated.

B.1.1 Athens Football Stadium 5 out of 5 points

Athens Football Stadium has been originally constructed for the requirements of the IOC but at the same time as a perfect match for post- Games use by the home team and respective day-to-day use. Therefore an Overlay has not been considered and Athens Football Stadium remained generally unchanged after the Olympic Games in 2004.

Evaluation result: Considering that Athens Football Stadium has been designed to be used only for football there is no requirement for Adaptability/Flexibility as the structure is a perfect match for post- Games use by the home team as well as the respective day-to-day use and therefore the maximum of 5 points out of 5 points is allocated.

B.1.1 Beijing Football Stadium 1 out of 5 points

There has been no Overlay considered for the Olympic Games in 2008 and Beijing Football Stadium remained generally unchanged after the Olympic Games in 2008.

Evaluation Result: Considering that Beijing Football Stadium has no provisions for adopting additional usages subsequent to the Olympic Games a total of 1 point out of 5 points is allocated. Reason why the lowest number of points is allocated is based on the fact that no modifications of the existing structure were undertaken to allow a more regular or additional usage for sports as well as non-sports events.

6.2.2 B Environmental Category

Sub-category B.1 Building

Evaluation Parameter B.1.2 Adaptability/Flexibility

B.1.2 Sydney Olympic Stadium 5 out of 5 points

For operation of Sydney Olympic Stadium the different requirements of nine home teams Qantas Wallabies (rugby), HSBC Warathas (rugby), NWS State of Origin

Blues (rugby), Sydney Swans (rugby), Bulldogs (rugby), South Sydney Rabbitohs (rugby), Pirtek Parramatta Eels (rugby), Qantas Socceroos (football) and Sydney Thunder (cricket) have to be considered. Therefore the lower spectator stands are retractable in order to meet the requirements of five different professional sporting codes played at Sydney Olympic Stadium: rugby league, rugby union, Australian rules football, football and cricket. "The stadium ranks among the best outdoor venues in the world. It received a number of awards for excellence and was chosen as best new commercial building by Master Builders because of its versatility and the ease of a possible conversion into a multi-functional facility."³²⁰ For rugby league and football played as per FIFA standards a rectangular playing field is necessary. Contrary to this the regulations for AFL, rugby and cricket require an oval shaped playing field. In order to meet these variable requirements the east and west spectator stands are retractable. Each spectator stand has a weight of approximately 1,300 t and is moved with 14 hydraulic motors by 15 m. The procedure to change the shape of the playing field from oval to rectangular or vice versa needs 50 people and approximately eight hours. The maximum duration to maintain the rectangular shape is approximately 36 hours otherwise the turf will be affected due to insufficient natural daylight and ventilation. The turf is constructed in removable modules of 2 m x 2 m. For cricket games the centre part can be exchanged with the wickets. Since the Olympic Games the turf has been exchanged three times (2000, 2005 and 2010).

Evaluation Result: Considering the Adaptability/Flexibility of Sydney Olympic Stadium with reconfiguration of the playing field for five different types of sport (e.g. rugby league, rugby union, Australian rules football, football and cricket) as well as retractable seating and removable turf a maximum of 5 points out of 5 points is allocated.

B.1.2 Athens Olympic Stadium

1 out of 5 points

The turf of the playing field has been accommodated in removable modules. For concerts these modules can be removed and replaced with a different flooring system. The modular turf system was changed to permanent turf in summer 2010. Reason for this change were difficulties in removal of the modules for concerts. There are no other provisions to enhance the Adaptability/Flexibility of the stadium.

Evaluation Result: Considering that the modular turf system at Athens Olympic Stadium has been replaced with a permanent turf system after the Games resulting in a reduced Adaptability/Flexibility a total of 1 point out of 5 points is allocated. The reason why the lowest number of points is allocated, is the fact that the originally

selected modular turf system did not fulfil the operational requirements and was then replaced with the permanent turf which limits the Adaptability/Flexibility of the playing field.

B.1.2 Beijing Olympic Stadium 1 out of 5 points

Limited information is available about the further usage of Beijing Indoor Stadium. Based on an elaborate research it appears that there are no provisions to modify the playing field nor the spectator stands for other types of sports or non-sports events in Beijing Olympic Stadium.

Evaluation Result: Considering the assumption that there is only limited Adaptability/Flexibility of Beijing Olympic Stadium for other types of events a total of 1 point out of 5 points is allocated.

B.1.2 Sydney Indoor Stadium 4 out of 5 points

The playing field can be modified to meet the different requirements for indoor soccer, volleyball, basketball, gymnastics, convention spaces and a ballroom. The different arrangements of the playing field can be achieved with retractable spectator stands in the first 14 rows. The operator stated that the seating rows 1-5 are easily adaptable while the remaining rows 6-14 have to be removed manually which requires 50 people and takes up to eight hours.

Evaluation result: Considering that Sydney Indoor Stadium provides the Adaptability/Flexibility for reconfiguration of the playing field as well as for retractable seating for different types of sports and non-sports events a total of 4 points out of 5 points is allocated.

B.1.2 Athens Indoor Stadium 3 out of 5 points

At Athens Indoor Stadium the existing playing field is only used for basketball but can be removed for other events. For concerts the flooring is removed and replaced with a different type of surface. The operator stated that the removal of the flooring is very time consuming. In addition it was noted that the spectator capacity can be decreased from 17,600 to 16,700.³²¹ In order to increase the size of the playing field the first seating rows of the spectator stands are retractable.

Evaluation result: Considering that Athens Indoor Stadium provides the Adaptability/Flexibility to change the flooring system of the playing field and decrease the spectator capacity a total of 3 points out of 5 points is allocated. The reason why no additional points are allocated, is the limitation stated by the operator as the removal of the flooring system is very time consuming.

B.1.2 Beijing Indoor Stadium 1 out of 5 points

Limited information is available about the further usage of Beijing Indoor Stadium. Based on an elaborate research it appears that there are no provisions for Adaptability/Flexibility to modify the playing field or spectator stands for other types of sports or non-sports events in Beijing Indoor Stadium.

Evaluation Result: Considering the assumption that there is only limited Adaptability/Flexibility in Beijing Indoor Stadium for other types of events a total of 1 point out of 5 points is allocated.

B.1.2 Canberra Football Stadium 1 out of 5 points

There are no provisions for Adaptability/Flexibility to modify the playing field or spectator stands for other types of sports or non-sports events at Canberra Football Stadium.

Evaluation Result: Considering the limited Adaptability/Flexibility of Canberra Football Stadium for other types of events a total of 1 point out of 5 points is allocated.

B.1.2 Athens Football Stadium 3 out of 5 points

Athens Football Stadium has no provisions to modify the playing field and spectator stands for other types of sports or non-sports events. In 2005 Athens Football Stadium was used as a movie theatre with an average of 300-400 spectators per movie. The operator stated that this was discontinued due to problems with the turf since the screen had to be constructed on the turf. For concerts the operator is using an Event Deck³²² system to cover the turf temporarily.

Evaluation Result: Considering that Athens Football Stadium does not allow for reconfiguration and usage for other types of sports activities but has extensive Adaptability/Flexibility for different non-sports usages e.g. restaurants, coffee shops and super market a total of 3 points out of 5 points is allocated.

B.1.2 Beijing Football Stadium 1 out of 5 points

Limited information is available about the further usage of Beijing Football Stadium. Based on an elaborate research it appears that there are no provisions to convert the playing field or spectator stands for other types of sports or non-sports events in Beijing Football Stadium.

Evaluation Result: Considering the assumption that there is limited Adaptability/Flexibility of Beijing Football Stadium for other types of events a total of 1 point out of 5 points is allocated.

6.2.3 B Environmental Category

Sub-category B.2 Building Services

Evaluation Parameter B.2.1 Energy Efficiency

B.2.1 Sydney Olympic Stadium

5 out of 5 points

Sydney Olympic Stadium has received the “National energy award for its use of natural lighting, two gas co-generation units and energy efficient lighting.”³²³ With regard to “air-conditioning, passive ventilation, that is ventilation without any mechanical devices, has been integrated into the design of the stadium. By minimising the extent of air-conditioning provided, valuable energy is conserved.”³²⁴

“Natural ventilation was maximised by the use of over-sized lift shafts, stairwells and escalator voids. The use of air-conditioning was minimised by about 40 percent.”³²⁵

With regard to “lighting, a computerised Clipsal C-BUS lighting system with programmable timing is used throughout ANZ Stadium- lighting in rooms with no motion or programmed activities automatically switches off after a set period. Energy efficient lighting in ANZ Stadium includes the use of compact fluorescent lighting and low voltage lights where appropriate and safe. The need for artificial lighting has been reduced, as the design of the stadium allows maximum intake of daylight through specially constructed light voids. In addition, the polycarbonate roofing material is translucent and allows maximum natural light during daytime events for player and spectator visibility. High glass window walls are used in entry foyers allowing increased natural light and reducing powered lighting requirements.”³²⁶

“Overall, natural lighting reduced energy needs by 20 percent.”³²⁷

With regard to “power, environmentally friendly gas fired co-generators serve as a backup to the main supply of electricity.”³²⁸ “The two gas co-generation units achieved an estimated saving of 5,000 tonnes of carbon dioxide emissions each year from when the venue was completed in 1999. With regard to building materials no PCBs (Polychlorinated Biphenyl) were used in the developments and the use of PCA was minimised and at the same time extensive use of recycled building materials was introduced. These initiatives have resulted in major environmental achievements such as a reduction in greenhouse gas emissions by about 10,000 tonnes a year compared to similar facilities.”³²⁹

Evaluation result: Considering that Sydney Olympic Stadium has renewable energy usage, energy efficient air-conditioning, energy efficient lighting and environmentally friendly building materials the maximum of 5 points out of 5 points is allocated.

B.2.1 Athens Olympic Stadium

1 out of 5 points

Currently no systems for renewable resources are used at Athens Olympic Stadium. The operator indicated that options for installation of a photovoltaic system of 2 megawatt are investigated. Once implemented the photovoltaic system shall be used to produce the power for day-to-day use.

Evaluation result: Considering that Athens Olympic Stadium has no provisions for energy efficient systems or environmentally friendly building materials a total of 1 point out of 5 points is allocated.

B.2.1 Beijing Olympic Stadium

5 out of 5 points

With regard to air-conditioning, lighting and power, Beijing Olympic Stadium “was constructed with an advanced energy-saving design and such environment-friendly features as natural ventilation and lighting, utilization of renewable geothermal energy resources and application of solar photovoltaic power generation technologies. Under the football field of Bird's Nest there are 312 GSHP (ground source heat pump) wells, which heat the stadium in winters by absorbing thermal energy from the soil through embedded heat exchange pipes, and cool the place in summers by absorbing cold energy from the soil, saving considerable amount of electric power.”³³⁰ “Waste water recycling was achieved in all the venues, and the goal of cutting energy consumption by 50 percent was realised.”³³¹

Evaluation result: Considering that Beijing Olympic Stadium has renewable energy usage, energy efficient air-conditioning, energy efficient lighting and environmentally friendly building materials the maximum of 5 points out of 5 points is allocated.

B.2.1 Sydney Indoor Stadium

5 out of 5 points

“Sydney Indoor Stadium was designed and constructed with very high environmental values and was awarded the prestigious national Banksia Award for Construction Practices in 1999.”³³² With regard to “air-conditioning, the system has been designed to cool only the air immediately surrounding the spectators, not the entire airspace in the venue, resulting in lower energy use for cooling. With regard to power, the stadium featured Australia's largest rooftop solar power system. Photovoltaic solar cells were installed on the 19 Olympic Plaza lighting towers on the Olympic Boulevard, providing light for major events at the Olympic Stadium and Sydney Indoor Stadium, both in the lead up to, and during the Sydney 2000 Games and a permanent clean energy legacy for the site. With regard to building materials, no PCBs (Polychlorinated Biphenyl) were used in the developments and the use of PCA was minimised. At the same time extensive use of recycled building materials

was introduced as well as maximum use of natural light and natural ventilation in the building design was implemented. These initiatives have resulted in major environmental achievements such as a reduction in greenhouse gas emissions by about 10,000 tonnes a year compared to similar facilities.”³³³

Evaluation Result: Considering that Sydney Indoor Stadium has renewable energy usage, energy efficient air-conditioning, energy efficient lighting and environmentally friendly building materials the maximum of 5 points out of 5 points is allocated.

B.2.1 Athens Indoor Stadium 1 out of 5 points

Currently no systems for renewable resources are used in Athens Indoor Stadium. Evaluation result: Considering that Athens Indoor Stadium has no provisions for energy efficiency systems or environmentally friendly materials a total of 1 point out of 5 points is allocated.

B.2.1 Beijing Indoor Stadium 3 out of 5 points

With regard to lighting and power “Beijing Indoor Stadium has a 19,000 sqm glass curtain wall. A point support glass curtain wall and aluminium glass cover the National Indoor Stadium. All of the glass is Low-emissivity (Low-E) glass, which provides isolation and improves energy efficiency by reducing the transfer of heat through the glass. Low-E glass also acts as a filter for ultra-violet rays. Behind the glass curtain wall lies a hidden solar photovoltaic system which uses 1,124 solar panels, each measuring 120 cm x 50 cm. The solar panels have a peak power output of 90 watts. The solar panels are able to produce 100 kilowatts of energy per day, which can be used to light the stadium during the day, reducing the stress on the state grid system.”³³⁴ With regard to building materials in Beijing Indoor Stadium “eco-friendly and energy-saving technologies and materials were adopted.”³³⁵

Evaluation result: Considering that Beijing Indoor Stadium has renewable energy usage and environmentally friendly building materials a total of 3 points out of 5 points is allocated.

B.2.1 Canberra Football Stadium 3 out of 5 points

Canberra Football Stadium is following the Environmental Guidelines for Sydney 2000 and has an environmental policy. With regard to power “the stadium is purchasing 50% Green Power accredited renewable energy and sourcing energy from 72 photovoltaic solar panels located around the stadium. Stadium staff is encouraged to act environmentally responsible in everyday office situations, such as

keeping office air-conditioning use to a minimum. With regard to light it is ensured that the stadium's playing field lights are only turned on out of necessity.”³³⁶

Evaluation Result: Considering that Canberra Football Stadium has renewable energy usage a total of 3 points out of 5 points is allocated.

B.2.1 Athens Football Stadium 3 out of 5 points

Currently no systems for renewable resources are used in Athens Football Stadium. The Building Management System allowing operation of different areas has been integrated after completion of the stadium and only after the Olympic Games. The operator stated that originally it was not possible to control lighting and air-conditioning of the specific office units/areas.

Evaluation result: Considering that Athens Football Stadium has a Building Management System allowing energy efficient control over air-conditioning and lighting supply to specific units a total of 3 points out of 5 points is allocated.

B.2.1 Beijing Football Stadium 3 out of 5 points

With regard to power, at Beijing Football Stadium “four pavilion-style rotating ramps were constructed. The ramps include amorphous silicon solar energy power generation boards which provide 56,280 kilowatt electrical power per year. The electricity is used for the landscape lighting and ramps. The CTCED states that the power generator board reduces consumption of 20 tons of coal, emission of 56 tons of CO², 666 kilograms of SO², 242 kilograms of nitrogen oxide, 15 tons of dusts and saves 225 tons of clean water.”³³⁷ With regard to building materials in Beijing Football Stadium “eco-friendly and energy-saving technologies and materials were adopted.”³³⁸

Evaluation result: Considering that Beijing Football Stadium has renewable energy usage and environmentally friendly building materials a total of 3 points out of 5 points is allocated.

6.2.4 B Environmental Category

Sub-category B.2 Building Services

Evaluation Parameter B.2.2 Water Conservation

B.2.2 Sydney Olympic Stadium 5 out of 5 points

At Sydney Olympic Stadium “water is conserved throughout Homebush Bay through the use of water conservation and recycling practices. The most important water conservation initiative is the Water Reclamation and Management Scheme

(WRAMS). Sewage generated from Olympic venues and facilities is collected, treated and cleansed for non-potable reuse. Reclaimed water is used for toilet flushing in venues, facilities and the Olympic Village as well as for irrigation across Sydney Olympic Park. WRAMS is designed to save 850 million litres of water annually that would otherwise be drawn from Sydney's main water supply, providing a permanent environmental and economic benefit and a useful model for other developments. As well, Olympic venues conserve water through water-efficient appliances, including water flow reduction valves and shower roses, roof-fed rainwater tanks and drip irrigation systems."³³⁹ "Rain water from the roof is collected in 4 tanks. The total capacity of rainwater harvesting is 3.2 million litres."³⁴⁰ "Australian native trees and shrubs have been planted across Sydney Olympic Park to reduce water needs."³⁴¹

Evaluation result: Considering that Sydney Olympic Stadium has rainwater harvesting and water recycling as well as water-efficient appliances the maximum of 5 points out of 5 points is allocated.

B.2.2 Athens Olympic Stadium 1 out of 5 points

Currently no systems for water conservation and recycling are used in Athens Olympic Stadium. The operator indicated that options for a desalination plant for sea water are investigated. The desalinated sea water could be mainly used for irrigation purposes, which should also allow for an extension of landscaped areas on the 'common ground'.

Evaluation result: Considering that Athens Olympic Stadium has no provisions for water conservation a total of 1 point out of 5 points is allocated.

B.2.2 Beijing Olympic Stadium 4 out of 5 points

"The roof of Beijing Olympic Stadium is equipped with a rainwater harvesting and recycling system, through which rainwater is collected for watering plants and grass, flushing toilets, fire fighting and even washing the tracks."³⁴²

Evaluation result: Considering that Beijing Olympic Stadium has rainwater harvesting and water recycling a total of 4 points out of 5 points is allocated.

B.2.2 Sydney Indoor Stadium 5 out of 5 points

At Sydney Indoor Stadium "water is conserved throughout Homebush Bay through the use of water conservation and recycling practices. The most important water conservation initiative is the Water Reclamation and Management Scheme (WRAMS). Sewage generated from Olympic venues and facilities is collected,

treated and cleansed for non-potable reuse. Reclaimed water is used for toilet flushing in venues, facilities and the Olympic Village as well as for irrigation across Sydney Olympic Park. WRAMS is designed to save 850 million litres of water annually that would otherwise be drawn from Sydney's main water supply, providing a permanent environmental and economic benefit and a useful model for other developments. As well, Olympic venues conserve water through water-efficient appliances, including water flow reduction valves and shower roses, roof-fed rainwater tanks and drip irrigation systems. Australian native trees and shrubs have been planted across Sydney Olympic Park to reduce water needs."³⁴³

Evaluation result: Considering that Sydney Indoor Stadium has rainwater harvesting and water recycling as well as water-efficient appliances the maximum of 5 points out of 5 points is allocated.

B.2.2 Athens Indoor Stadium 1 out of 5 points

Currently no systems for water conservation and recycling are used in Athens Indoor Stadium.

Evaluation result: Considering that Athens Indoor Stadium has no provisions for water conservation a total of 1 point out of 5 points is allocated.

B.2.2 Beijing Indoor Stadium 3 out of 5 points

At Beijing Indoor Stadium "waste water recycling was achieved."³⁴⁴

Evaluation result: Considering that Beijing Indoor Stadium has water recycling a total of 3 points out of 5 points is allocated.

B.2.2 Canberra Football Stadium 2 out of 5 points

At Canberra Olympic Stadium "Waterless urinals in the bathrooms to reduce excess water use have been installed."³⁴⁵

Evaluation result: Considering that Canberra Football Stadium has water-efficient appliances a total of 2 points out of 5 points is allocated.

B.2.2 Athens Football Stadium 1 out of 5 points

Currently no systems for water conservation and recycling are used at Athens Football Stadium.

Evaluation result: Considering that Athens Football Stadium has no provisions for water conservation a total of 1 point out of 5 points is allocated.

B.2.2 Beijing Football Stadium 3 out of 5 points
At Beijing Football Stadium "Waste water recycling was achieved."³⁴⁶
Evaluation result: Considering that Beijing Football Stadium has water recycling a total of 3 points out of 5 points is allocated.

6.3 Evaluation C Social Category

6.3.1 C Social Category

Sub- category C.1 Usage Mix

Evaluation Parameter C.1.1 Sport Usage

C.1.1 Sydney Olympic Stadium 5 out of 5 points
Sydney Olympic Stadium is used by nine different home teams: Qantas Wallabies (rugby), HSBC Warathas (rugby), NWS State of Origin Blues (rugby), Sydney Swans (rugby), Bulldogs (rugby), South Sydney Rabbitohs (rugby), Pirtek Parramatta Eels (rugby), Qantas Socceroos (football), Sydney Thunder (cricket).
Evaluation result: Considering that Sydney Olympic Stadium is used by nine home teams with three different sports types the maximum of 5 points out of 5 points is allocated.

C.1.1 Athens Olympic Stadium 3 out of 5 points
Athens Olympic Stadium is used by two local football clubs FC Panathinaikos and FC AEK. In average the stadium is used once every week for matches with exception of the months May, June and July.^{xiii} As both football clubs are the main users, the track and field in the Olympic Stadium are impairing the usage for football games due to the distance of the playing field. This issue was confirmed by the users to be a considerable disadvantage.
Evaluation result: Considering that Athens Olympic Stadium is used by two home teams of the same sports type a total of 3 points out of 5 points is allocated.

C.1.1 Beijing Olympic Stadium 1 out of 5 points
Beijing Olympic Stadium is rarely used for sports activities or other activities. Currently it does not have a home team. Subsequent to the Olympic Games in 2008 there was a total of 16 events from 2009 to 2012 which is 4 events per year in

^{xiii} 11.4.1 Athens Olympic Stadium event schedules, page 241-251

average. However, there is no regular usage schedule. The facilities are mainly utilized as a tourist attraction with 20.000 to 30.000 visitors per day.³⁴⁷ In comparison with the average number of visitors mentioned before, during the interview, the operator stated that between October 2008 and February 2011 approximately 15 million people³⁴⁸ (approximately 517,240 visitors per month) visited the Olympic Stadium for an entrance fee which created a total income of 350 million RMB (approximately 43 million EUR). This is equivalent to an average of approximately 17,241 visitors per day.

Evaluation result: Considering that Beijing Olympic Stadium is not used by a home team and has rarely sports events a total of 1 point out of 5 points is allocated.

C.1.1 Sydney Indoor Stadium 1 out of 5 points

Sydney Indoor Stadium has currently no home team. The previous home teams Sydney Kings discontinued the use of the stadium either because of their less prominent position in the league or because of the low spectator number which was in average only 5,000 spectators.³⁴⁹ Due to the absence of a home team the majority of events are concerts equivalent to approximately 90% of all events per year.³⁵⁰ According to intense internet research it was found that from 2001-2012 a total of 14 sports events and 31 non- sports events were held.

Evaluation result: Considering that Sydney Indoor Stadium is not used by a home team and has rarely sports events a total of 1 point out of 5 points is allocated.

C.1.1 Athens Indoor Stadium 2 out of 5 points

The local basketball club Panathinaikos uses Athens Indoor Stadium on a daily basis for training purposes. In average the stadium is used once every alternate week.^{xliii} It was also noted that the adjacent training halls are used by schools and a local fencing club on a daily basis.

Evaluation result: Considering that Athens Indoor Stadium is used by one home team with one sports type a total of 2 points out of 5 points is allocated.

C.1.1 Beijing Indoor Stadium 1 out of 5 points

No sports event was conducted in Beijing Indoor Stadium after the Olympic Games as per the available documentation.

Evaluation result: Considering that Beijing Indoor Stadium is not used by a home team and has no sports events a total of 1 point out of 5 points is allocated.

^{xliii} 11.4.2 Athens Indoor Stadium event schedules, page 252-257

C.1.1 Canberra Football Stadium 3 out of 5 points
Canberra Football Stadium is used by two local rugby clubs Canberra Raiders (NRL) and ACT Brumbies (Super 14). The stadium was used 22 times per year in 2012.³⁵¹

Evaluation result: Considering that Canberra Football Stadium is used by two home teams of the same sports type a total of 3 points out of 5 points is allocated.

C.1.1 Athens Football Stadium 2 out of 5 points
The local football club FC Olympiacos is the main user of Athens Football Stadium. In average the playing field is used for 30 to 35 games by the FC Olympiacos per season.^{xliv} In addition four to six games of the Greek National team are held.

Evaluation result: Considering that Athens Football Stadium is used by one home team with one sports type a total of 2 points out of 5 points is allocated.

C.1.1 Beijing Football Stadium 1 out of 5 points
No sports event was conducted in Beijing Football Stadium after the Olympic Games as per the available documentation.

Evaluation result: Considering that Beijing Football Stadium is not used by a home team and has no sports events a total of 1 point out of 5 points is allocated.

6.3.2 C Social Category

Sub-category C.1 Usage Mix

Evaluation Parameter C.1.2 Other Usages

C.1.2 Sydney Olympic Stadium 2 out of 5 points
There is no Olympic Museum or Sports Museum provided within Sydney Olympic Stadium. The 'Hall of Champions' is located at the Athletic Sports Centre. It was noted that the current set up of the 'Hall of Champions' is relatively basic. The operator advised that integration of an Olympic Museum has been discussed but concluded that this integration should have been done during the initial stages of the design. The fan shop 'Rebel Sport Shop' has independent access and is open every day in the week from 10.30am to 3.30pm (located inside Gate C).³⁵² The stadium is offering an 'Explore' guided tour for visitors at three different timings on weekdays, weekends and public holidays (except Christmas day, Boxing day, Australia day, Good Friday and Easter Sunday). The entrance fee is 28.5 Australian Dollars

^{xliv} 11.4.3 Athens Football Stadium event schedules, pages 258-263

(approximately 23 EUR). Furthermore the 'Gantry' guided tour, which is a walk on the steel mesh walkway, was introduced in 2011 with great success. This tour is operating once daily except Thursdays, public holidays and special events. The entrance fee is 49 Australian Dollars (approximately 38 EUR).³⁵³ Regarding day-to-day use by citizens the operator stated that this opportunity for additional revenue has been not addressed during the design. In consideration of the further development of Sydney Olympic Park the options for adding other facilities is currently under investigation.

Evaluation result: Considering that Sydney Olympic Stadium integrates a fan shop as one retail/commercial facility as well as guided tours and a cultural aspect with the 'Hall of Champions' as a tourist attraction a total of 2 points out of 5 points is allocated.

C.1.2 Athens Olympic Stadium

1 out of 5 points

At Athens Olympic Stadium no exhibition centre, neither about the Modern Olympic Games nor about the Ancient Olympic Games is available, although there have been various initiatives to provide an Olympic Museum- particularly since the Olympic Games are originating from Athens. OAKA Olympic Park is open to the public from 8am until 12pm. The operator of OAKA confirmed that in average 100 visitors are visiting the sports facilities per day. Occasionally concerts, theatres, weddings and other events are staged at the Olympic Park. Currently there are no points of attraction -apart from the sports facilities- available. The OAKA operator and user confirmed that the requirement for a coffee shop and restaurants has been identified but not realized. The operator is considering converting the paved areas in front of the Olympic Stadium and Olympic Indoor Stadium into a public park with landscape etc.. Regarding the day-to-day use by citizens it is noted that the preferred types of sport in Greece are football and swimming. The operator confirmed that the local community is utilising the swimming pools of the aqua centre on a day-to-day basis.

Evaluation result: Considering that Athens Olympic Stadium does not provide an additional attraction a total of 1 point out of 5 points is allocated.

C.1.2 Beijing Olympic Stadium

5 out of 5 points

At Beijing Olympic Stadium the museum was added after the Olympic Games. The operator mentioned that the museum should be extended soon. The exhibition itself was relatively basic. There are feasibility studies undertaken to integrate a hotel within Beijing Olympic Stadium in future. Currently the following facilities are

provided: one restaurant, four Food & Beverage stores, three shops, four souvenir shops, one Walt Disney Shop, one money exchange. Regarding the day-to-day use by citizens it is noted that the precinct of the Olympic Stadium is utilized by the local community e.g. for Taijiquan, skating as well as kite flying. The stadium itself is only accessible for sightseeing purposes with payment of entrance fees and therefore not utilized on a daily basis by the local community.

Evaluation result: Considering that Beijing Olympic Stadium integrates 14 retail/commercial facilities and a museum as a tourist attraction the maximum of 5 points out of 5 points is allocated.

C.1.2 Sydney Indoor Stadium 1 out of 5 points

Sydney Indoor Stadium does not provide an additional attraction. The operator noted that this is due to certain legal restrictions in operating facilities beyond the building line (perimeter of the building).

Evaluation result: Considering that Sydney Indoor Stadium does not provide an additional attraction a total of 1 point out of 5 points is allocated.

C.1.2 Athens Indoor Stadium 1 out of 5 points

OAKA Olympic Park is open to the public from 8am until 12pm. Occasionally concerts, theatres, weddings and other events are staged at the Olympic Park. Currently there are no points of attraction -apart from the sports facilities- available. The OAKA operator and user confirmed that the requirement for a coffee shop and restaurants has been identified but not realized. The operator is considering converting the paved areas in front of Athens Olympic Stadium and Athens Indoor Stadium into a public park with landscape etc.. Regarding the day-to-day use by citizens it is noted that local schools are using the warming up halls on a frequent basis.

Evaluation result: Considering that Athens Indoor Stadium does not provide an additional attraction a total of 1 point out of 5 points is allocated.

C.1.2 Beijing Indoor Stadium 1 out of 5 points

Beijing Indoor Stadium does not provide an additional attraction.

Evaluation result: Considering that Beijing Indoor Stadium provides no additional attraction a total of 1 point out of 5 points is allocated.

C.1.2 Canberra Football Stadium

1 out of 5 points

The operator has initiated extensive investigations for upgrading of Canberra Football Stadium through Populous Architects. Currently the idea to build a hotel and convention centre is discussed with the authorities.

Evaluation result: Considering that Canberra Football Stadium provides no additional attraction a total of 1 point out of 5 points is allocated.

C.1.2 Athens Football Stadium

5 out of 5 points

At Athens Football Stadium the revenue generated by guided tours is limited. Accordingly the operator is not promoting guided tours. In average there are 2,000 visitors per year. The museum of the local team Olympiacos is located below the spectator stands and accessible for the public.³⁵⁴ It is open six days per week (except Mondays) with approximately 5,000 visitors per year. The entrance fee is 2 EUR. It was noted that the museum is mainly relating to the local football club Olympiacos. Accordingly schools are not fully utilising the museum since the level of general information about sports history and the history of the stadium location is limited.³⁵⁵ The museum organised a 'Sculpture Symposium' in 2005 and ten artists participated in this symposium.³⁵⁶ The tenants of the VIP boxes are entitled to use the VIP box as offices or for meetings and conferences during working days for a maximum of ten hours. Tenants like Coca Cola are continuously using the VIP box for meetings and office purposes. Various additional functions are integrated within the stadium. The fan shop and in addition three coffee shops, two bars, one super market and one gymnasium are located below the spectator stands. They are open seven days per week and fully accessible for the public as shown in Illustration 63 and Illustration 64. In June 2005 Karaiskakis became a movie theatre (Cine Karaiskakis) with a cinema screen, 20 m long and 10 m wide, operating daily between 9pm and 11pm (6am and 8pm UTC) and later every weekend. The movie screen featured movies including 'Batman Begins' and others. The stadium operated as a movie theatre for the last time on Saturday August 13, 2005. Athens Football Stadium has 35 entrances and therefore many security check points are required. This stadium design allows maximum utilization of the circulation areas during non-events.

Evaluation result: Considering that Athens Football Stadium integrates 8 permanent retail/commercial facilities and had 2 temporary attractions like cinema and children's playing field as well as provides a museum as a tourist attraction and furthermore offers VIP Boxes for office use the maximum of 5 points out of 5 points is allocated.



Illustration 63, Illustration 64: Athens Football Stadium with open public access to all shops and other facilities (located below the lower spectator stand) during events and non-events

C.1.2 Beijing Football Stadium

1 out of 5 points

Beijing Football Stadium does not provide an additional attraction.

Evaluation result: Considering that Beijing Football Stadium does not provide an additional attraction a total of 1 point out of 5 points is allocated.

6.3.3 C Social Category

Sub-category C.2 Utilization

Evaluation Parameter C.2.1 Average number of events

C.2.1 Sydney Olympic Stadium

4 out of 5 points

Sydney Olympic Stadium hosts in average 3 events per month (192 events in 64 months equals to 3 events per month). As per the documentation made available by the operator of the venue the following events were held.

- 2010 35x sports events, 8x non-sports events
- 2009 25x sports events
- 2008 48x sports events, 2x non-sports events
- 2007 40x sports events
- 2006 34x sports events, 1x non-sports event

Evaluation result: Considering that Sydney Olympic Stadium hosts in average three events per month a total of 4 points out of 5 points is allocated.

C.2.1 Athens Olympic Stadium

4 out of 5 points

At Athens Olympic Stadium in average 3 football games per month are played (270 games in 84 months equals to 3 games per month) and including non-sports events a total of 3 events (282 events in 84 months equals to 3 events per month) are held. The main users FC Panathinaikos confirmed an average spectator capacity of 40,000 and FC AEK of 15,000 spectators per game. The operator confirmed that the Government is providing power and water supply for Athens Olympic Stadium free of charge. The costs for security inside the stadium have to be covered by the respective user. Costs for police outside the stadium premises are covered by the Government. As per the documentation made available by the operator of the venue in average the following events were held.

2010 40x sports events, 1x non-sports event
2009 39x sports events, 1x non-sports event
2008 42x sports events, 1x non-sports event
2007 39x sports events, 1x non-sports events
2006 40x sports events, 2x non-sports events
2005 39x sports events, 1x non-sports event
2004 36x sports events

Evaluation result: Considering that Athens Olympic Stadium hosts in average 3 events per month a total of 4 points out of 5 points is allocated.

C.2.1 Beijing Olympic Stadium

4 out of 5 points

Since the Olympic Games 2008 until 31.12.2012 a total of 23 sports events and 16 non-sports events were held at Beijing Olympic Stadium (during a period of 4 years in 2009-2012). This accounts to 8 sports events and 4 non-sports events per year which is an average of 1 event per month. Additionally the Ice & Snow Festival is annually held as a long-term event for a duration of two months. As per the documentation made available by the operator of the venue in average the following events were held.

2012 2x sports events, 2x non-sports events
2011 4x sports events, 6x non-sports events
2010 8x sports events, 11x non-sports events
2009 2x sports events, 4x non-sports events

The operator stated that between October 2008 and February 2011 approximately 15 million people³⁵⁷ (517,240 visitors per month) visited the Olympic Stadium for an entrance fee which created a total income of 350 million RMB (approximately 43 million EUR). According to the operator around 80 million people (2,758,600 visitors per month) visited the precinct of the Olympic Stadium which is free of charge.³⁵⁸ The operational costs per year are estimated with 75 million RMB (approximately 9 million EUR). In addition the loan has to be paid by the operator. Due to the significant number of tourists visiting Beijing Olympic Stadium approximately 70% of the revenue is generated by tourists.

Evaluation result: Considering that Beijing Olympic Stadium hosts in average only one event per month but provides an ice ring for two months per year and is also a major tourist attraction a total of 4 points out of 5 points is allocated.

C.2.1 Sydney Indoor Stadium

5 out of 5 points

The operator stated that in 2010 in average 85 to 110 events per year were held at Sydney Indoor Stadium. The exact number is confidential. Approximately 90% of the events were concerts which generate 80% of the revenue. The operator stated further that in previous years approximately 75 events per year with 5 sports events out of these were held. This would accumulate to 6 events per month (considering the lowest number of 75 events stated by the operator), out of which 93% are non-sports events and the remaining 7% are sports events. There is no documentation made available by the operator of the venue. For reference purposes the list of the TOP 100 indoor stadiums around the world has been reviewed.³⁵⁹ The ranking is done based on the number of spectators per year. "Sydney Indoor Stadium (Allphones Arena) consistently rates in the world's top 10 most successful concert arenas and at the end of June 2011 was number two in the world after the O2 in London and ahead of Madison Square Garden."³⁶⁰

2010 10-11x sports events, 75-99x non-sports events (454,344 spectators)

2009 5x sports events, 70x non-sports events (665,905 spectators)

2008 5x sports events, 70x non-sports events (522,696 spectators³⁶¹)

2007 (no data available)

Evaluation result: Considering that Sydney Indoor Stadium hosts in average more than six events per month the maximum of 5 points out of 5 points is allocated.

C.2.1 Athens Indoor Stadium

3 out of 5 points

Athens Indoor Stadium hosts in average 2 events per month (146 events in 84 months equals to 2 events per month). As per the documentation made available by the operator of the venue in average the following events were held as listed below.

2010 19x sports events
2009 16x sports events
2008 21x sports events
2007 22x sports events
2006 21x sports events, 5x non-sports events
2005 22x sports events, 4x non-sports events
2004 16x sports events

Evaluation result: Considering that Athens Indoor Stadium hosts 2 events per month a total of 3 points out of 5 points is allocated.

C.2.1 Beijing Indoor Stadium

1 out of 5 points

According to intense research only one concert in 2011 was held.

Evaluation result: Considering that Beijing Indoor Stadium hosted only one event since the Olympic Games in 2008 a total of 1 point out of 5 points is allocated.

C.2.1 Canberra Football Stadium

3 out of 5 points

Canberra Football Stadium hosts in average 2 events per month (280 events in 147 months equals to 2 events per month). As per the documentation made available by the operator of the venue in average the following events were held.

2012 22x sports events, 1x non-sports event
2011 22x sports events
2010 25x sports events
2009 22x sports events
2008 19x sports events
2007 19x sports events, 1x non-sports event
2006 22x sports events, 1x non-sports event
2005 21x sports events, 1x non-sports event
2004 8x sports events
2003 37x sports events, 2x non-sports events
2002 20x sports events, 1x non-sports event

2001 31x sports events
2000 5x sports events

Evaluation result: Considering that Canberra Football Stadium hosts in average 2 events per month a total of 3 points out of 5 points is allocated.

C.2.1 Athens Football Stadium 4 out of 5 points

The operator stated that Athens Football Stadium hosts 32 events per year equivalent to 3 events per month. In average 30 to 35 games of the main user FC Olympiacos are played in the stadium per year. In addition the Greek National Team holds approximately 4 to 6 games per season at the stadium. The local club 'FC Ethnikos'³⁶² has an option to utilise the stadium as well, but due to the limited number of spectators attending the games this has been discontinued. Accordingly there are no events held by FC Ethnikos at the stadium. The average spectator capacity for football games of the local team FC Olympiacos is 25,000 spectators in 2009 and 30,000 spectators in 2010. In addition an average of 500 spectators for the VIP areas is considered. Spectator capacity during movie theatres was 2,000 in 2006. For reference purposes according to the available documentation and thorough research the following events were stated.

2010 22x sports events, 2x non-sports events
2009 19x sports events, 1x non-sports event
2008 23x sports events, 3x non-sports events
2007 19x sports events, 2x non-sports events
2006 20x sports events, 3x non-sports events
2005 24x sports events, 34x non-sports events
2004 19x sports events

Evaluation result: Considering that Athens Football Stadium hosts in average 3 events per month a total of 4 points out of 5 points is allocated.

C.2.1 Beijing Football Stadium 1 out of 5 points

No event was conducted as per the available documentation.

Evaluation result: Considering that Beijing Football Stadium has no events a total of 1 point out of 5 points is allocated.

6.3.4 C Social Category

Sub-category C.2 Utilization

Evaluation Parameter C.2.2 Diversity of events

C.2.2 Sydney Olympic Stadium

2 out of 5 points

Sydney Olympic Stadium is mainly used for rugby matches. Other sports events are occasionally cricket and football matches. Apart from these a motorcar race has also been held once. As non-sports events concerts are the main functions.

167x Rugby NRL 2006, 2007, 2008, 2009, 2010

6x Rugby AFL 2009, 2010

8x Concert 2006, 2008, 2010

5x Rugby 2009, 2010

3x Football 2008, 2009, 2010

2x Cricket 2010

1x Motorcar Race 2010

Evaluation result: Considering that Sydney Olympic Stadium hosts 96% sports events and 4% non-sports events (total 192 events, 184 sports events, 8 non-sports events) a total of 2 points out of 5 points is allocated.

Athens Olympic Stadium

2 out of 5 points

Athens Olympic Stadium is mainly used for sports events. Both home teams Panathinaikos FC and AEK FC use the stadium on regular basis for football matches. Other sports events held at the stadium are athletics and rallies. Occasionally the stadium is staging non-sports events such as functions, parties or conferences.

270x Football Games 2004-2010

5x Concerts 2006, 2007, 2008, 2009, 2010

3x Athletics 2006, 2007, 2008

2x Functions 2005

2x Rally 2005, 2006

1x Conference 2006

Evaluation result: Considering that Athens Olympic Stadium hosts 97% sports and 3% non-sports events (total 282 events, 275 sports events, 7 non-sports events) a total of 2 points out of 5 points is allocated.

C.2.2 Beijing Olympic Stadium

4 out of 5 points

Beijing Olympic Stadium is occasionally used for sports as well as non-sports events. There is no home team and therefore no usage on regular basis. The sports events are football matches, sports meetings, races, snow board tours and track & field sports. As non-sports events concerts, contests, shows, festivals, celebrations and exhibitions are held. The stadium is staging every year the 'Bird's Nest Ice & Snow Festival' which is celebrated for two months and attracts millions of visitors.

- 10x Concert 2009, 2010, 2011, 2012
- 10x Football 2009, 2010, 2011, 2012
- 4x Ice & Snow Festival 2009, 2010, 2011, 2012
- 4x Sports Meeting 2010
- 1x Race of Champions 2009
- 1x Photo Contest 2010
- 1x Olympic Cultural Festival 2010
- 1x Photo Exhibition 2010
- 1x Celebration, Returning to Bird's Nest 2010
- 1x Track & Field Sports, Bird's Nest Cup 2010
- 1x Beijing International Equestrian Show 2011
- 1x Feast Patriotic Songs 2011
- 1x Youth Sports Mind Games, Bird's Nest Cup 2011
- 1x China X Open 2011
- 1x World Snow Board Tour 2011

Evaluation result: Considering that Beijing Olympic Stadium hosts 59% sports events and 41% non-sports events (total 39 events, 23 sports events with 4 Ice & Snow Festivals as long-term events, 16 non-sports events) a total of 4 points out of 5 points is allocated.

C.2.2 Sydney Indoor Stadium

5 out of 5 points

The operator stated that in 2010 in average 85 to 110 events per year were held at Sydney Indoor Stadium. The exact number is confidential. Out of these events 90% are concerts which generate 80% of the revenue. The operator stated further that in

previous years approximately 75 events per year with 5 sports events were hosted resulting in 93% non-sports events and 7% sports events. Based on a comprehensive internet research it was noted that primarily concerts and music award functions are held at Sydney Indoor Stadium (e.g. 'Hillsong' Conference is an annually repeated event since 2001). Occasionally the stadium hosts basketball games, roller skating, tennis and boxing as well as once a bull riding event. However, the following list of events acquired through online research is incomplete, as schedules of previous events were not made available by the operator.

- 10x Hillsong Conference, Annually 2000-2010
- 10x Music Awards 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2011
- 8x Concerts 2010, 2012
- 8x Netball 2003, 2004, 2005, 2006, 2007, 2008, 2012
- 2x Hillsong 'Colour Your World' Women's Conference 2007, 2008
- 1x Basketball 2004
- 1x Boxing 2009
- 1x Tennis 2001
- 1x Football 2012
- 1x Bull Riding 2012
- 1x Disney on Ice 2012
- 1x Roller Skating 2012

Evaluation result: Considering that according to the operator Sydney Indoor Stadium hosts 7% sports events and 93% non-sports events (total 75 events, 5 sports events, 70 non-sports events) the maximum of 5 points out of 5 points is allocated.

C.2.2 Athens Indoor Stadium 3 out of 5 points

Athens Indoor Stadium is mainly used for sports events. The home team Panathinaikos BC is having basketball games on a regular basis. The non-sports events are occasional concerts, functions, games and fairs.

- 136x Basketball 2004-2010
- 3x Concert, 2005, 2006
- 3x Function, 2005, 2006
- 2x Conference, 2005, 2006
- 1x Sports Game, 2006
- 1x Fair 2006

Evaluation result: Considering that Athens Indoor Stadium hosts 94 % sports and 6% non-sports events (total 146 events, 137 sports events, 9 non-sports events) a total of 3 points out of 5 points is allocated.

C.2.2 Beijing Indoor Stadium 1 out of 5 points

Beijing Indoor Stadium is not used on regular basis. The only event which was found during a thorough research was one concert in 2011.

Evaluation result: Considering that Beijing Indoor Stadium is not used on a regular basis for sports or non-sports events a total of 1 point out of 5 points is allocated.

C.2.2 Canberra Football Stadium 2 out of 5 points

Canberra Football Stadium is mainly used for sports events. The majority are rugby and eventually football matches as well as once motor cross. Rarely the stadium hosts non-sports events like ceremonies, functions, dance shows or concerts.

- 153x Rugby League 2001-2010
- 95x Rugby Union 2001-2010
- 20x Football Games 2000-2010
- 4x Rugby World Cup 2003-2006 (2003, 2004, 2005, 2006)
- 1x Motor Cross
- 3x Opening Ceremony 2003-2006
(2003 Masters Games, 2005 Kanga Cup, 2006 Kanga Cup)
- 1x Function 2007
- 1x Dance Show 2003
- 2x Concert 2002

Evaluation result: Considering that Canberra Football Stadium hosts 97% sports and 3% non-sports events (total 280 events, 273 sports events, 7 non-sports events) a total of 2 points out of 5 points is allocated.

C.2.2 Athens Football Stadium 4 out of 5 points

Athens Football Stadium is mainly used for sports events. The home team Panathinaikos FC is having football matches on regular basis. As non-sports events the stadium is hosting occasionally concerts and in 2005 it was frequently used as a cinema.

- 146x Football, 2004, 2005, 2006, 2007, 2008, 2009, 2010
- 12x Concert, 2005, 2006, 2007, 2008, 2009, 2010
- 33x Cinema, 2005

Evaluation result: Considering that Athens Football Stadium hosts 63% sports and 27% non-sports events (total 201 events, 146 sports events, 55 non-sports events) a total of 4 points out of 5 points is allocated.

C.2.2 Beijing Football Stadium 1 out of 5 points

No event was conducted at Beijing Football Stadium as per the available documentation.

Evaluation result: Considering that Beijing Football Stadium has no sports or non-sports events a total of 1 point out of 5 points is allocated.

6.4 Summary chapter analysis

The chapter analysis elaborates the findings obtained through literature review, site visits and operator interviews for nine respective venues of the Olympic Games 2000 in Sydney, 2004 in Athens and 2008 in Beijing. Each stadium of the three different stadium types is presented in detail. The sequence is Olympic Stadium, Indoor Stadium and Football Stadium according to the denominations A Urban Category, B Environmental Category and C Social Category with their respective sub-categories and parameters. Points are allocated according to the specifically developed Research Tool illustrated in Chapter 4.5 'Description Evaluation Matrix'. The evaluation and assessment is carried out following the predefined classifications in sections 4.5.1, 4.5.2 and 4.5.3.

Illustration 65 below gives an accurate overview on the evaluation of each sports stadium stating the points achieved in the respective denomination, category, sub-category and parameter. Based on the summary of results the appropriability of the findings regarding their plausibility were once again validated and considered satisfactory. The summary allows a direct comparison of all venues at first sight. Furthermore the sub-total for every stadium in the respective category is highlighted enabling a deeper understanding of the rating with regard to the subsections. For a precise determination of the results a total point account for each venue as well as for each hosting city is presented.

Illustration 65 below summarises all ratings of each stadium in the respective category, sub-category and related parameter with the overall rating of the host city.

	Sydney			Athens			Beijing			Max. possible points
	Olympic Stadium	Indoor Stadium	Football Stadium	Olympic Stadium	Indoor Stadium	Football Stadium	Olympic Stadium	Indoor Stadium	Football Stadium	
A Urban Category										
A.1 Urban Integration (Σ)	5	5	9	8	7	8	3	3	8	10
A.1.1 Location Type	3	3	4	4	3	5	1	1	4	5
A.1.2 Building Type	2	2	5	4	4	3	2	2	4	5
A.2 Urban Context (Σ)	9	8	3	5	5	10	7	7	6	10
A.2.1 Proximity	5	5	1	2	2	5	3	3	2	5
A.2.2 Connectivity	4	3	2	3	3	5	4	4	4	5
Sub-total	14	13	12	13	12	18	10	10	14	20
B Environmental Cat.										
B.1 Building (Σ)	10	6	2	4	4	8	2	2	2	10
B.1.1 Overlay	5	2	1	3	1	5	1	1	1	5
B.1.2 Adaptability/Flexibility	5	4	1	1	3	3	1	1	1	5
B.2 Building Services (Σ)	10	10	5	2	2	4	9	6	6	10
B.2.1 Energy Efficiency	5	5	3	1	1	3	5	3	3	5
B.2.2 Water Conservation	5	5	2	1	1	1	4	3	3	5
Sub-total	20	16	7	6	6	12	11	8	8	20
C Social Category										
C.1 Usage Mix (Σ)	7	2	4	4	3	7	6	2	2	10
C.1.1 Sport Usage	5	1	3	3	2	2	1	1	1	5
C.1.2 Other Usages	2	1	1	1	1	5	5	1	1	5
C.2 Utilization(Σ)	6	10	5	6	6	8	8	2	2	10
C.2.1 Average no. events	4	5	3	4	3	4	4	1	1	5
C.2.2 Diversity of events	2	5	2	2	3	4	4	1	1	5
Sub-total	13	12	9	10	9	15	14	4	4	20
Total each venue	47	41	28	29	27	45	35	22	26	60
Total hosting city	116			101			83			180

Illustration 65: Summary of all ratings for each stadium

A simplified Evaluation Matrix along with the corresponding Rating Matrix has been developed as a template for independent assessment of other sports venues and is compiled in Chapter 11. These templates allow an assessment of sports venues or potential sites where more detailed data is either not available or not accessible.

Where additional data is available, important parameters such as usage of low energy and low carbon materials or energy and water consumption per seat per event could be included in the Evaluation Matrix. Where further data can be obtained other indicators relating to design efficiency such as average construction area per seat and average dead load of spectator stands and roof structures could be added to the Evaluation Matrix.

7 DISCUSSION

7.1 Comparison case study results

In this chapter the results of the analysis are discussed and the ratings for the different stadium types^{xlv} Olympic Stadium, Indoor Stadium and Football Stadium of the Olympic Games 2000, 2004 and 2008 in response to the research questions of the thesis are compared. The ratings are discussed separately for each of the three denominations 'A Urban Category', 'B Environmental Category' and 'C Social Category' with reference to the respective sub-categories and parameters.

7.2 Discussion results A Urban Category

In denomination 'A Urban Category' consisting of sub-categories 'A.1 Urban Integration'^{xlvi} and 'A.2 Urban Context'^{xlvii} further described below, venues of the Olympic Games 2004 in Athens are rated with the highest score of 43 points, followed by venues of the Olympic Games 2000 in Sydney with 39 points and venues of the Olympic Games in Beijing 2008 with 34 points out of maximum 60 points.

7.2.1 Discussion results A Urban Category

Sub-category A.1 Urban Integration

In sub-category 'A.1 Urban Integration' consisting of two parameters 'A.1.1 Location Type'^{xlviii} and 'A.1.2 Building Type'^{xlix} venues of the Olympic Games 2004 in Athens are rated with the highest score of 23 points followed by venues of the Olympic Games 2000 in Sydney with 19 points and venues of the Olympic Games 2008 in Beijing with 14 points out of maximum 30 points.

^{xlv} 4.6.2 Venues of the Olympic Games 2000, 2004 and 2008, page 91-92

^{xlvi} 6.1.1-6.1.2 Evaluation A Urban Category, Sub-category A.1, Urban Integration, Parameter A.1.1 Location Type and Parameter A.1.2 Building Type, page 122-128

^{xlvii} 6.1.3-6.1.4 Evaluation A Urban Category, Sub-category A.1, Urban Context, Parameter A.2.1 Proximity and Parameter A.2.2 Connectivity, page 128-133

^{xlviii} 6.1.1 Evaluation A Urban Category, Sub-category A.1, Urban Integration, Parameter A.1.1 Location Type, page 122-125

^{xlix} 6.1.2 Evaluation A Urban Category, Sub-category A.1, Urban Integration, Parameter A.1.2, Building Type, page 125-128

Parameter A.1.1 Location Type

With regard to parameter 'A.1.1 Location Type' venues of the Olympic Games 2004 in Athens are rated with the highest score because two stadiums, Athens Olympic Stadium (built 1979-1982) and Athens Football Stadium (built 1996-1998), are existing venues with existing infrastructure for access and egress resulting in a very good level of integration into the Urban Context. The third stadium, Athens Indoor Stadium, is built on a Greenfield Site but since it is located adjacent to Athens Olympic Stadium in a linear distance of 100m, the new stadium is utilizing the already existing infrastructure constructed for Athens Olympic Stadium resulting in a fair level of integration into the Urban Context.

In comparison with the selected three venues of the Olympic Games 2000 in Sydney two of the three stadiums, Sydney Olympic Stadium and Sydney Indoor Stadium, are both newly constructed on a Brownfield Site resulting in a fair level of integration into the Urban Context. The third stadium, Canberra Football Stadium (built 1974-1977), is located on an Existing Site indicating a very good level of integration into the Urban Context. In further comparison with the selected three venues of the Olympic Games 2008 in Beijing two stadiums, Beijing Olympic Stadium and Beijing Indoor Stadium, were both constructed on a Greenfield Site resulting in a comparatively very poor level of integration into the Urban Context. The third stadium, Beijing Football Stadium (built 1990 and redeveloped 2006), is an existing venue resulting in a good sustainability level.

Parameter A.1.2 Building Type

With regard to parameter 'A.1.2 Building Type' venues of the Olympic Games 2004 in Athens are rated with the highest score because two stadiums, Athens Olympic Stadium (built 1972-1982) and Athens Indoor Stadium (built 1996-1998), are existing buildings which were redeveloped and upgraded for the Olympic Games resulting in a good sustainability level. The third stadium, Athens Football Stadium, is a new building on an Existing Site, which is in use for sports venues since more than 100 years, resulting in a fair sustainability level.

In comparison with the selected three venues of the Olympic Games 2000 in Sydney two stadiums, Sydney Olympic Stadium and Sydney Indoor Stadium, are new buildings resulting in a comparatively poor sustainability. The third stadium, Canberra Football Stadium (built 1974-1977), is an existing building resulting in a very good level of sustainability. In further comparison with the selected three

venues of the Olympic Games 2008 in Beijing two stadiums, Beijing Olympic Stadium and Beijing Indoor Stadium, are both new buildings resulting in a comparatively poor sustainability level. The third stadium, Beijing Football Stadium (built 1990 and redeveloped 2006), is an existing building resulting in a good sustainability level.

7.2.2 Discussion results A Urban Category

Sub-category A.2 Urban Context

In sub-category 'A.2 Urban Context' consisting of two parameters 'A.2.1 Proximity'ⁱ and 'A.2.2 Connectivity'ⁱⁱ venues of the Olympic Games 2000 in Sydney, Olympic Games 2004 in Athens and Olympic Games 2008 in Beijing are all rated in average with 20 points out of maximum 30 points.

Parameter A.2.1 Proximity

With regard to parameter 'A.2.1 Proximity' venues of the Olympic Games 2000 in Sydney are rated with the highest score because two stadiums, Sydney Olympic Stadium and Sydney Indoor Stadium, are considered as integrated venue locations and part of a community centre resulting in a very good level of Proximity. The third stadium, Canberra Football Stadium, is considered as an isolated venue location at the outskirts of Canberra resulting in a comparatively very poor level of Proximity.

In comparison with the selected three venues of the Olympic Games 2004 in Athens two stadiums, Athens Olympic Stadium and Athens Indoor Stadium, are considered as adjoining venue locations without direct Proximity to catchment areas, but with mainly residential surroundings and only very few commercial elements resulting in a comparatively poor level of Proximity. The third stadium, Athens Football Stadium, is considered as an integrated venue location resulting in a very good level of Proximity. In further comparison with the selected three venues of the Olympic Games 2008 in Beijing the locations of all three stadiums are considered as adjoining venue locations with a linear distance of 500-800m between the venues.

ⁱ 6.1.3 Evaluation A Urban Category, Sub-category A.2, Urban Context, Parameter A.2.1 Proximity, page 128-130

ⁱⁱ 6.1.4 Evaluation A Urban Category, Sub-category A.2, Urban Context, Parameter A.2.2, Connectivity, pages 131-133

Beijing Olympic Stadium and Beijing Indoor Stadium have indirect Proximity to mixed-use commercial, retail, recreational as well as residential areas resulting in a fair level of Proximity. Beijing Football Stadium is not in direct Proximity to catchment areas resulting in a comparatively poor level of Proximity.

Parameter A.2.2 Connectivity

With regard to parameter 'A.2.2 Connectivity' venues of the Olympic Games 2008 in Beijing are rated with the highest score because all three stadiums, Beijing Olympic Stadium, Beijing Indoor Stadium and Beijing Football Stadium, have a good connection with a linear distance of 500m, 350m and 320m to the next metro station resulting in a good level of Connectivity.

In comparison with the selected three venues of the Olympic Games 2004 in Athens for two stadiums, Athens Olympic Stadium and Athens Indoor Stadium, the linear distance to the next metro station is 800m and 520m resulting in a fair level of Connectivity. The third stadium, Athens Football Stadium, has a very good connection within a linear distance of 62m to the next metro station resulting in a very good level of Connectivity.

In further comparison with the selected three venues of the Olympic Games 2000 in Sydney, Sydney Olympic Stadium has a good connection with a linear distance of 320m to the next metro station resulting in a good level of Connectivity. Sydney Indoor Stadium has a fair connection with a linear distance of 560m to the next metro station resulting in a fair level of Connectivity. Canberra Football Stadium has a comparatively poor connection only by bus service resulting in a comparatively poor level of Connectivity.

7.3 Discussion results B Environmental Category

In denomination 'B Environmental Category' consisting of sub-categories 'B.1 Building'^{lii} and B.2 'Building Services'^{liii} further described below, venues of the Olympic Games 2000 in Sydney are rated with the highest score of 43 points, followed by venues of the Olympic Games 2008 in Beijing with 27 points and venues of the Olympic Games in Athens 2004 with 24 points out of maximum 60 points.

^{lii} 6.2.1-6.2.2 Evaluation B Environmental Category, Sub-category B.1, Building, Parameter B.1.1 Overlay and Parameter B.1.2 Adaptability/Flexibility, page 133-140

^{liii} 6.2.3-6.2.4 Evaluation B Environmental Category, Sub-category B.2, Building Services, Parameter B.2.1 Energy Efficiency and Parameter B.2.2 Water Conservation, page 141-147

7.3.1 Discussion results B Environmental Category

Sub-category B.1 Building

In sub-category 'B.1 Building' consisting of two parameters 'B.1.1 Overlay'^{liv} and 'B.1.2 Adaptability/Flexibility'^{lv} venues of the Olympic Games 2000 in Sydney are rated with the highest score of 18 points followed by venues of the Olympic Games 2004 in Athens with 16 points and venues of the Olympic Games 2008 in Beijing with 6 points out of maximum 30 points.

Parameter B.1.1 Overlay

With regard to parameter 'B.1.1 Overlay' venues of the Olympic Games 2000 in Sydney are rated with the highest score because the first of the three stadiums, Sydney Olympic Stadium, has a tailor-made Overlay planning with post- Games removal of the running tracks and new retractable spectator stands resulting in a very good sustainability level. The second stadium, Sydney Indoor Stadium, has only a non-significant Overlay and no post- Games modifications which would enhance operations, resulting in a comparatively poor sustainability level. The third stadium, Canberra Football Stadium, has an Overlay with lowering and conversion of the playing field, which is a disadvantage for post- Games use resulting in a comparatively very poor sustainability level.

In comparison with the selected three venues of the Olympic Games 2004 in Athens the first of the three stadiums, Athens Football Stadium, has been constructed as per the requirements of the IOC, but at the same time in full consideration of the requirements for post- Games use by the home team as well as day-to-day use with integration of other usages resulting in a very good sustainability level. The second stadium, Athens Olympic Stadium, has a roof structure as a permanent Overlay enhancing post- Games utilization of the stadium resulting in a fair sustainability level. The third stadium, Athens Indoor Stadium, has no Overlay and no post- Games modifications resulting in a comparatively very poor sustainability level. In further comparison with the selected three venues of the Olympic Games 2008 in Beijing all three stadiums, Beijing Olympic Stadium, Beijing Indoor Stadium and Beijing Football Stadium do not have an Overlay or post- Games modifications resulting in a comparatively very poor sustainability level.

^{liv} 6.2.1 Evaluation B Environmental Category, Sub-category B.1, Building, Parameter B.1.1 Overlay, page 133-137

^{lv} 6.2.2 Evaluation B Environmental Category, Sub-category B.1, Building, Parameter B.1.2 Adaptability/Flexibility, page 137-140

Parameter B.1.2 Adaptability/Flexibility

With regard to parameter 'B.1.2 Adaptability/Flexibility' venues of the Olympic Games 2000 in Sydney are rated with the highest score because the first of the three stadiums, Sydney Olympic Stadium, provides retractable seating for reconfiguration of the playing field and also modular turf resulting in a very good level of Adaptability/Flexibility. The second stadium, Sydney Indoor Stadium, provides retractable seating for reconfiguration of the playing field resulting in a good level of Adaptability/Flexibility. The third stadium, Canberra Football Stadium, provides no options for reconfiguration of the playing field resulting in a comparatively very poor level of Adaptability/Flexibility.

In comparison with the selected three venues of the Olympic Games 2004 in Athens the first of the three stadiums, Athens Indoor Stadium, provides retractable seating as well as removable flooring (limitation due to extremely time consuming process) resulting in a fair level of Adaptability/Flexibility. The second stadium, Athens Football Stadium, provides removable flooring resulting in a fair level of Adaptability/Flexibility. The third stadium, Athens Olympic Stadium, provides removable flooring, but most of the time not in use, resulting in a comparatively very poor level of Adaptability/Flexibility. In further comparison with the selected three venues of the Olympic Games 2008 in Beijing all three stadiums Beijing Olympic Stadium, Beijing Indoor Stadium and Beijing Football Stadium do not have provisions for reconfiguration of the playing field or retractable spectator stands resulting in a comparatively very poor level of Adaptability/Flexibility.

7.3.2 Discussion results B Environmental Category

Sub-category B.2 Building Services

In sub-category 'B.2 Building Services' consisting of two parameters 'B.2.1 Energy Efficiency'^{lvi} and 'B.2.2 Water Conservation'^{lvii} venues of the Olympic Games 2000 in Sydney are rated with the highest score of 25 points followed by venues of the Olympic Games 2008 in Beijing with 21 points and venues of the Olympic Games 2004 in Athens with 8 points out of maximum 30 points.

^{lvi} 6.2.3 Evaluation B Environmental Category, Sub-category B.2, Building Services, Parameter B.2.1 Energy Efficiency, page 141-144

^{lvii} 6.2.4 Evaluation B Environmental Category, Sub-category B.2, Building Services, Parameter B.2.2 Water Conservation, page 144-147

Parameter B.2.1 Energy Efficiency

With regard to parameter 'B.2.1 Energy Efficiency' venues of the Olympic Games 2000 in Sydney are rated with the highest score because two stadiums, Sydney Olympic Stadium and Sydney Indoor Stadium, have renewable energy usage, energy efficient air-conditioning, energy efficient lighting and environmentally friendly building materials resulting in a very good level of Energy Efficiency. The third stadium, Canberra Football Stadium, has renewable energy usage resulting in a fair level of Energy Efficiency.

In comparison with the selected three venues of the Olympic Games 2008 in Beijing one stadium, Beijing Olympic Stadium, has renewable energy usage, energy efficient air-conditioning, energy efficient lighting and environmentally friendly building materials resulting in a very good level of Energy Efficiency. The other two stadiums, Beijing Indoor Stadium and Beijing Football Stadium, have renewable energy usage and environmentally friendly building materials resulting in a fair level of Energy Efficiency. In further comparison with the selected three venues of the Olympic Games 2004 in Athens one stadium, Athens Football Stadium, has energy efficient provisions for power control of air-conditioning and lighting in specific units resulting in a fair level of Energy Efficiency. The other two stadiums, Athens Olympic Stadium and Athens Indoor Stadium, have no provisions for energy efficiency systems or environmentally friendly materials resulting in a comparatively very poor level of Energy Efficiency.

Parameter B.2.2 Water Conservation

With regard to parameter 'B.2.2 Water Conservation' venues of the Olympic Games 2000 in Sydney are rated with the highest score because two stadiums, Sydney Olympic Stadium and Sydney Indoor Stadium, have rainwater harvesting and water recycling as well as water-efficient appliances resulting in a very good level of Water Conservation. The third stadium, Canberra Football Stadium, has only water-efficient appliances resulting in a poor level of Water Conservation.

In comparison with the selected three venues of the Olympic Games 2008 in Beijing one stadium, Beijing Olympic Stadium, has rainwater harvesting and water recycling resulting in a good level of Water Conservation. The other two stadiums, Beijing Indoor Stadium and Beijing Football Stadium, have water recycling resulting in a fair level of Water Conservation. In further comparison with the selected three venues of the Olympic Games 2004 in Athens all three stadiums Athens Olympic Stadium,

Athens Indoor Stadium and Athens Football Stadium, have no provisions for water conservation resulting in a comparatively very poor level of Water Conservation.

7.4 Discussion results C Social Category

In denomination 'C Social Category' consisting of sub-category 'C.1 Usage Mix'^{lviii} and 'C.2 Utilization'^{lix} further described below, venues of the Olympic Games 2000 in Sydney and venues of the Olympic Games 2004 in Athens are rated with the highest score of 34 points followed by venues of the Olympic Games in Beijing 2008 with 22 points out of maximum 60 points.

7.4.1 Discussion results C Social Category

Sub-category C.1 Usage Mix

In sub-category 'C.1 Usage Mix' consisting of two parameters 'C.1.1 Sport Usage'^{lx} and 'C.1.2 Other Usages'^{lxi} venues of the Olympic Games 2004 in Athens are rated with the highest score of 14 points followed by venues of the Olympic Games 2000 in Sydney with 13 points and venues of the Olympic Games 2008 in Beijing with 10 points out of maximum 30 points.

Parameter C.1.1 Sport Usage

With regard to parameter 'C.1.1 Sport Usage' venues of the Olympic Games 2000 in Sydney are rated with the highest score because the first stadium, Sydney Olympic Stadium, is used by nine home teams for three different sports types resulting in a very good level of Sport Usage. The second stadium, Canberra Football Stadium, is used by two home teams for the same sports type resulting in a fair level of Sport Usage. The third stadium, Sydney Indoor Stadium, has no home team and therefore rarely sports events are held, resulting in a comparatively very poor level of Sport Usage.

^{lviii} 6.3.1-6.3.2 Evaluation C Social Category, Sub-category C.1, Usage Mix, Parameter C.1.1 Sport Usage and Parameter C.1.2 Other Usages, page 147-153

^{lix} 6.3.3-6.3.4 Evaluation C Social Category, Sub-category C.2, Utilization, Parameter C.2.1 Average number of events, Parameter C.2.2 Diversity events, page 153-162

^{lx} 6.3.1 Evaluation C Social Category, Sub-category C.1, Usage Mix, Parameter C.1.1 Sport Usage, page 147-149

^{lxi} 6.3.2 Evaluation C Social Category, Sub-category C.1, Usage Mix, Parameter C.1.2 Other Usages, page 149-153

In comparison with the selected three venues of the Olympic Games 2004 in Athens one stadium, Athens Olympic Stadium, is used by two home teams for the same sports type resulting in a fair level of Sport Usage. The other two stadiums, Athens Indoor Stadium and Athens Football Stadium, are used by one home team each for one sports type resulting in a comparatively poor level of Sport Usage.

In further comparison with the selected three venues of the Olympic Games 2008 in Beijing two stadiums, Beijing Indoor Stadium and Beijing Football Stadium, do not have a home team and therefore no regular sports events are held, resulting in a comparatively very poor level of Sport Usage. The third stadium, Beijing Olympic Stadium, has no home team and therefore no regular sports events are staged. However, it is noted that there are regular annual Snow & Ice Festivals held at the Beijing Olympic Stadium for a duration of two months. These events can be considered as sports events for public participation in the broader sense and therefore points are allocated in sub-category C.2 Utilization. Nevertheless the result is still a comparatively very poor level of Sport Usage.

Parameter C.1.2 Other Usages

With regard to parameter 'C.1.2 Other Usages' venues of the Olympic Games 2004 in Athens and venues of the Olympic Games 2008 in Beijing are rated with the highest score. Venues of the Olympic Games 2004 in Athens have one stadium, Athens Football Stadium, which integrates eight retail/commercial facilities as well as various other temporary attractions like a cinema, children's playing field and a permanent museum resulting in a very good level of Other Usages. The two other stadiums, Athens Olympic Stadium and Athens Indoor Stadium, provide no additional attractions resulting in a comparatively very poor level of Other Usages. Venues of the Olympic Games 2008 in Beijing have one stadium, Beijing Olympic Stadium, which integrates 14 retail/commercial facilities and an Olympic Museum as a tourist attraction resulting in a very good level of Other Usages. The two other stadiums, Beijing Indoor Stadium and Beijing Football Stadium, provide no additional attractions resulting in a comparatively very poor level of Other Usages. In further comparison with the selected three venues of the Olympic Games 2000 in Sydney one stadium, Sydney Olympic Stadium, has one retail/commercial facility and guided tours as a tourist attraction resulting in a comparatively poor level of Other Usages. The other two stadiums, Sydney Indoor Stadium and Canberra Football Stadium, provide no additional attractions resulting in a comparatively very poor level of Other Usages.

7.4.2 Discussion results C Social Category

Sub-category C.2 Utilization

In sub-category 'C.2 Utilization' consisting of two parameters 'C.2.1 Average number of events'^{lxii} and 'C.2.2 Diversity of events'^{lxiii} venues of the Olympic Games 2000 in Sydney are rated with the highest score of 21 points followed by venues of the Olympic Games 2004 in Athens with 20 points and venues of the Olympic Games 2008 in Beijing with 12 points out of maximum 30 points.

Parameter C.2.1 Average number of events

With regard to parameter 'C.2.1 Average number of events' venues of the Olympic Games 2000 in Sydney are rated with the highest score because the first stadium, Sydney Indoor Stadium, hosts six events per month resulting in a very good level of Average number of events. The second stadium, Sydney Olympic Stadium, hosts three events per month resulting in a good level of Average number of events and the third stadium, Canberra Football Stadium, hosts 2 events per month resulting in a fair level of Average number of events.

In comparison with the selected three venues of the Olympic Games 2004 in Athens two stadiums, Athens Olympic Stadium and Athens Football Stadium, host three events per month resulting in a good level of Average number of events. The third stadium, Athens Indoor Stadium, hosts two events per month resulting in a fair level of Average number of events. In further comparison with the selected three venues of the Olympic Games 2008 in Beijing one stadium, Beijing Olympic Stadium, hosts three events per month resulting in a good level of Average number of events. The other two stadiums, Beijing Olympic Stadium and Beijing Indoor Stadium, have no regular events resulting in a comparatively very poor level of Average number of events. However, it is noted that Beijing Olympic Stadium attracted approximately 15 million people between October 2008 and February 2011 creating a major tourist destination.

^{lxii} 6.3.3 Evaluation C Social Category, Sub-category C.2, Utilization, Parameter C.2.1 Average number of events, page 153-157

^{lxiii} 6.3.4 Evaluation C Social Category, Sub-category C.2, Utilization, Parameter C.2.2 Diversity of events, page 158-162

Parameter C.2.2 Diversity of events

With regard to parameter 'C.2.2 Diversity of events' venues of the Olympic Games 2000 in Sydney and venues of the Olympic Games in Athens are rated with the highest score. Venues of the Olympic Games in Sydney have one stadium, Sydney Indoor Stadium, which hosts 93% non-sports events resulting in a very good level of Diversity of events. The other two stadiums, Sydney Olympic Stadium and Canberra Football Stadium, host 3% non-sports events resulting in a comparatively poor level of Diversity of events. Venues of the Olympic Games 2004 in Athens have one stadium, Athens Football Stadium, which hosts 23% non-sports events resulting in a good level of Diversity of events. The second stadium, Athens Indoor Stadium, hosts 6% non-sports events resulting in a fair level of Diversity of events and the third stadium, Athens Olympic Stadium, hosts 3% non-sports events resulting in a comparatively poor level of Diversity of events.

In comparison with the selected three venues of the Olympic Games 2008 in Beijing the first stadium, Beijing Olympic Stadium, hosts 39% non-sports events resulting in a good level of Diversity of events. The other two stadiums, Beijing Indoor Stadium and Beijing Football Stadium, have no regular non-sports events resulting in a comparatively very poor level of Diversity of events.

7.5 Summary chapter discussion

The results of the discussion with the respective ratings for each Category, Sub-category and Parameter are summarized below.

In denomination 'A Urban Category', consisting of sub-categories 'A.1 Urban Integration'^{lxiv} and 'A.2 Urban Context'^{lxv}, venues of the Olympic Games 2004 in Athens are rated with the highest score of 43 points followed by venues of the Olympic Games 2000 in Sydney with 39 points and venues of the Olympic Games in Beijing 2008 with 34 points out of maximum 60 points.

^{lxiv} 6.1.1-6.1.2 Evaluation A Urban Category, Sub-category A.1, Urban Integration, Parameter A.1.1 Location Type and Parameter A.1.2 Building Type, page 122-128

^{lxv} 6.1.3-6.1.4 Evaluation A Urban Category, Sub-category A.2 Urban Context, Parameter A.2.1 Proximity, Parameter A.2.2 Connectivity, page 128-133

In sub-category 'A.1 Urban Integration' consisting of two parameters 'A.1.1 Location Type'^{lxvi} and 'A.1.2 Building Type'^{lxvii} venues of the Olympic Games 2004 in Athens are rated with the highest score of 23 points followed by venues of the Olympic Games 2000 in Sydney with 19 points and venues of the Olympic Games 2008 in Beijing with 14 points out of maximum 30 points.

In sub-category 'A.2 Urban Context' consisting of two parameters 'A.2.1 Proximity'^{lxviii} and 'A.2.2 Connectivity'^{lxix} venues of the Olympic Games 2000 in Sydney, Olympic Games 2004 in Athens and Olympic Games 2008 in Beijing are all rated with 20 points out of maximum 30 points.

In denomination 'B Environmental Category', consisting of sub-categories 'B.1 Building'^{lxx} and B.2 'Building Services'^{lxxi}, venues of the Olympic Games 2000 in Sydney are rated with the highest score of 43 points followed by venues of the Olympic Games 2008 in Beijing with 27 points and venues of the Olympic Games in Athens 2008 with 24 points out of maximum 60 points.

In sub-category 'B.1 Building', consisting of two parameters 'B.1.1 Overlay'^{lxxii} and 'B.1.2 Adaptability/Flexibility'^{lxxiii}, venues of the Olympic Games 2000 in Sydney are rated with the highest score of 18 points followed by venues of the Olympic Games 2004 in Athens with 16 points and venues of the Olympic Games 2008 in Beijing with 6 points out of maximum 30 points.

In sub-category 'B.2 Building Services', consisting of two parameters 'B.2.1 Energy Efficiency'^{lxxiv} and 'B.2.2 Water Conservation'^{lxxv}, venues of the Olympic Games

^{lxvi} 6.1.1 Evaluation A Urban Category, Sub-category A.1, Urban Integration, Parameter A.1.1 Location Type, page 122-125

^{lxvii} 6.1.2 Evaluation A Urban Category, Sub-category A.1, Urban Integration, Parameter A.1.2, Building Type, page 125-128

^{lxviii} 6.1.3 Evaluation A Urban Category, Sub-category A.2, Urban Context, Parameter A.2.1 Proximity, page 128-130

^{lxix} 6.1.4 Evaluation A Urban Category, Sub-category A.2, Urban Context, Parameter A.2.2, Connectivity, page 131-133

^{lxx} 6.2.1-6.2.2 Evaluation B Environmental Category, Sub-category B.1, Building, Parameter B.1.1 Overlay and Parameter B.1.2 Adaptability/Flexibility, page 133-140

^{lxxi} 6.2.3-6.2.4 Evaluation B Environmental Category, Sub-category B.2, Building Services, Parameter B.2.1 Energy Efficiency and Parameter B.2.2 Water Conservation, page 141-147

^{lxxii} 6.2.1 Evaluation B Environmental Category, Sub-category B.1, Building, Parameter B.1.1 Overlay, page 133-137

^{lxxiii} 6.2.2 Evaluation B Environmental Category, Sub-category B.1, Building, Parameter B.1.2 Adaptability/Flexibility, page 137-140

^{lxxiv} 6.2.3 Evaluation B Environmental Category, Sub-category B.2, Building Services, Parameter B.2.1 Energy Efficiency, page 141-144

2000 in Sydney are rated with the highest score of 25 points followed by venues of the Olympic Games 2008 in Beijing with 21 points and venues of the Olympic Games 2004 in Athens with 8 points out of maximum 30 points.

In denomination 'C Social Category', consisting of sub-category 'C.1 Usage Mix'^{lxxvi} and 'C.2 Utilization'^{lxxvii}, venues of the Olympic Games 2000 in Sydney and venues of the Olympic Games 2004 in Athens are rated with the highest score of 34 points followed by venues of the Olympic Games in Beijing 2008 with 22 points out of maximum 60 points. However, it is noted that Beijing Olympic Stadium attracted approximately 15 million people between October 2008 and February 2011 creating a major tourist destination. Nevertheless the Sport Usage and utilization of Beijing Olympic Stadium could be further enhanced.

In sub-category 'C.1 Usage Mix', consisting of two parameters 'C.1.1 Sport Usage'^{lxxviii} and 'C.1.2 Other Usages'^{lxxix}, venues of the Olympic Games 2004 in Athens are rated with the highest score of 14 points followed by venues of the Olympic Games 2000 in Sydney with 13 points and venues of the Olympic Games 2008 in Beijing with 10 points out of maximum 30 points.

In sub-category 'C.2 Utilization', consisting of two parameters 'C.2.1 Average number of events'^{lxxx} and 'C.2.2 Diversity of events'^{lxxxi}, venues of the Olympic Games 2000 in Sydney are rated with the highest score of 21 points followed by venues of the Olympic Games 2004 in Athens with 20 points and venues of the Olympic Games 2008 in Beijing with 12 points out of maximum 30 points.

The findings discussed in this chapter are further elaborated based on a comparative assessment of each parameter in the following chapter.

^{lxxv} 6.2.4 Evaluation B Environmental Category, Sub-category B.2, Building Services, Parameter B.2.2 Water Conservation, page 144-147

^{lxxvi} 6.3.1-6.3.2 Evaluation C Social Category, Sub-category C.1, Usage Mix, Parameter C.1.1 Sport Usage and Parameter C.1.2 Other Usages, page 147-153

^{lxxvii} 6.3.3-6.3.4 Evaluation C Social Category, Sub-category C.2, Utilization, Parameter C.2.1 Average number of events and Parameter C.2.2 Diversity events, page 153-162

^{lxxviii} 6.3.1 Evaluation C Social Category, Sub-category C.1, Usage Mix, Parameter C.1.1 Sport Usage, pages 147-149

^{lxxix} 6.3.2 Evaluation C Social Category, Sub-category C.1, Usage Mix, Parameter C.1.2 Other Usages, page 149-153

^{lxxx} 6.3.3 Evaluation C Social Category, Sub-category C.2, Utilization, Parameter C.2.1 Average number of events, page 153-157

^{lxxxi} 6.3.4 Evaluation C Social Category, Sub-category C.2, Utilization, Parameter C.2.2 Diversity of events, page 158-162

8 COMPARATIVE ASSESSMENT

8.1 Comparative assessment case study results

The comparative assessment is developed for each of the three denominations A Urban Category, B Environmental Category and C Social Category. The summary of the comparative assessment is stated at the beginning for each category and the results are illustrated in a metric graph. Subsequently the comparative assessment is shown for each of the four parameters in the correspondent category and summarized concluding with a 'Statement'. Special emphasis is on the findings for those stadiums rated with the highest score for the respective parameter providing important conclusions for the sustainable design of sports stadiums.

In section 8.5 the results of the comparative assessment are summarized separately for each sports stadium type (Olympic Stadium, Indoor Stadium, Football Stadium) which are also illustrated with metric graphs.

8.2 Comparative assessment A Urban Category

Athens Football Stadium is rated with the highest score in denomination 'A Urban Category'.^{lxxxii} For three out of four parameters, 'Location Type', 'Proximity' and 'Connectivity', the stadium is allocated the maximum of 5 points and for one parameter 'Building Type' it is allocated 3 points. Although Athens Football Stadium is a new building, it is constructed on an Existing Site which has been used for sports venues for more than 100 years. Therefore the site is fully integrated into the Urban Context. Due to additional facilities and provisions within the Football Stadium an independent usage is created. Accordingly the Connectivity of the stadium is excellent as the connection between the metro station and the stadium is convenient with two pedestrian bridges and direct entry to the upper concourse for access to the spectator stands is provided.

A high sustainability level is achieved with 'Location Type' ideally being an Existing Site, with 'Building Type' ideally being an Existing Building, which correlates with a very good 'Proximity' within the Urban Context and excellent 'Connectivity'. This

^{lxxxii} 6.4 Summary chapter analysis, page 162-164

result can be explained with synergetic effects due to already existing infrastructure and utilities of a site which is already integrated into the Urban Context.

The graph in Illustration 66 below shows a metric to quantify evaluation results in the sub-category A.1 Urban Integration against the respective parameters A.1.1 Location Type and A.1.2 Building Type as well as in the sub-category A.2 Urban Context with the parameters A.2.1 Proximity and A.2.2 Connectivity.

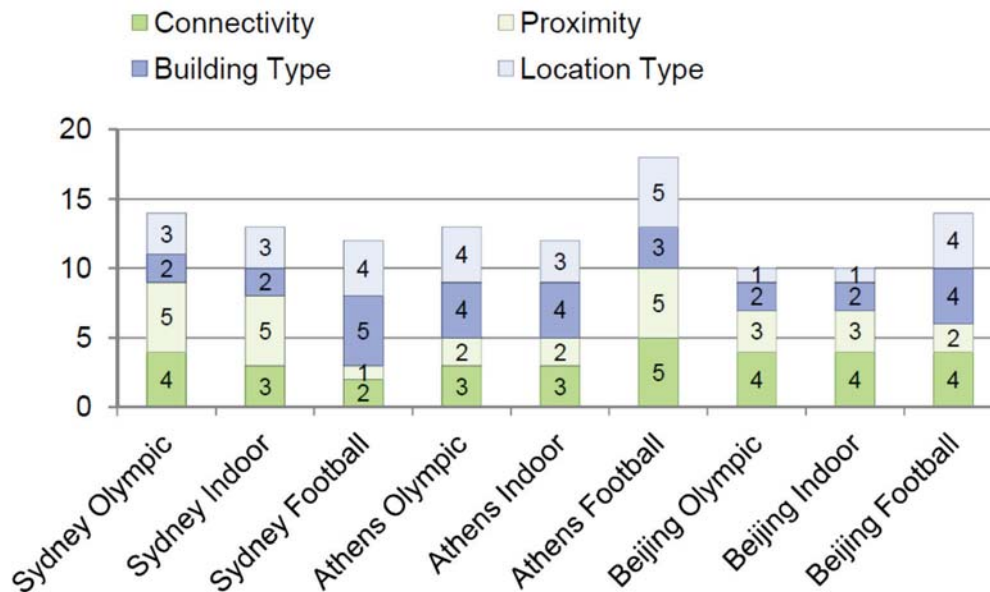


Illustration 66: Evaluation results sub-categories Urban Integration and Urban Context based on 6.4 ‘Summary chapter analysis’

8.2.1 Comparative assessment Sub-category A.1 Urban Integration

Parameter A.1.1 Location Type

With reference to parameter ‘Location Type’^{lxxxiii} it is noted that Athens Football Stadium^{lxxxiv} is rated with the highest score as the stadium is built on an Existing Site which has been used for sports venues for more than 100 years. The original stadium was constructed in 1895-1896 on this site. The stadium was used as a velodrome for the world’s 1st Olympic Games of the modern area in 1896.^{lxxxv}

^{lxxxiii} 4.5.1 Classification A Urban Category, Sub-category A.1, Urban Integration, Parameter A.1.1 Location Type, page 76-78

^{lxxxiv} 6.1.1 Evaluation A Urban Category, Sub-category A.1, Urban Integration, Evaluation Parameter A.1.1 Location Type, page 122-125 (125)

^{lxxxv} 2.2 Historic background of the Olympic Games, page 23-24

In 1952-1954 the original stadium was demolished and a new stadium with track and field was constructed. In preparation for the Olympic Games 2004 the existing stadium was demolished and in 2003-2004 the new Athens Football Stadium was constructed.³⁶³

Statement: Utilization of an Existing Site with existing infrastructure for access and egress such as public transport, road network and existing utilities like electricity, water, sewage, gas, etc. results in a higher sustainability level compared to a Brownfield or Greenfield Site. The longer venues are operated at an Existing Site the higher the actual level of integration into the Urban Context. With reference to the case studies of Athens Football Stadium and Athens Olympic Stadium it was noted that the longer an existing site is used for sports venues the better Urban Integration is achieved.

These findings are in accordance with Agenda 21 which suggests that the “Sports activities, facilities and events must be so arranged as to ensure the protection of conservation areas, the countryside, the cultural heritage and natural resources as a whole.”³⁶⁴

8.2.2 Comparative assessment Sub-category A.1 Urban Integration

Parameter A.1.2 Building Type

With reference to parameter ‘Building Type’³⁶⁵ it is noted that Canberra Football Stadium^{lxxxvi} is rated with the highest score because the existing stadium was constructed more than 30 years ago, upgraded and redeveloped in 1997-1999 in order to meet the requirements of the International Olympic Committee (IOC) for the Olympic Games. The redevelopment included lowering of the playing field to build additional spectator seats closer to the playing field with conversion from an oval to a rectangular shape. In addition a new spectator stand opposite the existing Grand Stand was constructed. Other works included the upgrading of the existing Grand Stand. The total costs were approximately 47 million Australian Dollars (approximately 36 Million EUR).³⁶⁶

Statement: Upgrade and redevelopment of an existing sports facility is performed to meet the requirements of the Olympic Games. Accordingly modifications and/or

^{lxxxvi} 6.1.2 Evaluation A Urban Category, Sub-category A.1, Urban Integration, Evaluation Parameter A.1.2 Building Type, page 125-128 (127)

additional elements like a new roof structure, hospitality facilities, athlete's areas, etc. are needful. Depending on the specific conditions of the existing building the refurbishment/renovation of an existing sports facility is generally considered to result in a higher sustainability level compared to construction of a new sports facility which consumes significantly more resources.

These findings are in accordance with Agenda 21 which suggests "Special effort shall be undertaken for best possible use of existing sports facilities including to keep them in good condition and to improve them by increasing safety and reducing their environmental impact. The creation of new sports facilities must be confined to cases in which demand cannot be satisfied by using or renovating existing facilities."³⁶⁷

8.2.3 Comparative assessment Sub-category A.2 Urban Context

Parameter A.2.1 Proximity

With reference to parameter 'Proximity'^{lxxxvii} it is noted that Sydney Olympic Stadium^{lxxxviii}, Sydney Indoor Stadium^{lxxxix} and Athens Football Stadium^{xc} are rated with the highest score because their location is within the immediate urban context of mixed-use areas e.g. commercial, retail, recreational and residential areas in a linear distance of approximately 0-2 km.

The linear distance between Sydney Olympic Stadium as well as Sydney Indoor Stadium and the City Centre e.g. Central Station is considerably long with approximately 14 km and the distance to Sydney Opera House is approximately 17 km. However, the stadiums are fully integrated within the Olympic Park, an area of 640 acres, which is providing a significant number of different options for recreation and entertainment. The Olympic Park is surrounded by residential areas which have been developed in parallel and also subsequent completion of the Olympic Games. The linear distance between Athens Football Stadium and the City Centre e.g. Central Station is approximately 12 km and the distance to Acropolis is approximately 8 km. The additional facilities and provisions integrated within the

^{lxxxvii} 4.5.1 Classification A Urban Category, Sub-category A.2, Urban Context, Parameter A.2.1 Proximity, page 79-82

^{lxxxviii} 6.1.3 Evaluation A Urban Category, Sub-category A.1, Urban Context, Evaluation Parameter A.2.1 Proximity, page 128-130 (128-129)

^{lxxxix} 6.1.3 Evaluation A Urban Category, Sub-category A.1, Urban Context, Evaluation Parameter A.2.1 Proximity, page 128-130 (128-129)

^{xc} 6.1.3 Evaluation A Urban Category, Sub-category A.1, Urban Context, Evaluation Parameter A.2.1 Proximity, page 128-130 (130)

Football Stadium are creating an independent usage area. Residents of the surrounding areas use the integrated supermarket and gym on a daily basis. The visitors of the adjacent Velodrome regularly use the bars, cafés, and restaurants of the Athens Football Stadium before and after events.³⁶⁸ Residential areas are located adjacent and the Metropolitan Hospital is in the vicinity of the sports facility.

Statement: Commercial areas like the city centre with mixed-use, residential areas or other points of attraction are catchment areas where potential users are positively affecting the operation of the sports facility. These areas act as a catalyst to attract more visitors to the stadium and, vice versa, visitors of the stadium could utilize the areas before or after the event for shopping, recreation, etc. resulting in a higher sustainability level. Proximity to residential areas results in positive effects allowing the users convenient access, but could also lead to negative effects due to traffic congestions, parking issues, noise and other disturbance during events.

8.2.4 Comparative assessment Sub-category A.2 Urban Context

Parameter A.2.2 Connectivity

With reference to parameter 'Connectivity'^{xcii} Athens Football Stadium^{xcii} is rated with the highest score because of the outstanding Connectivity of Athens Football Stadium via metro system and linear distance of 62m to the metro station.

The access to Athens Football Stadium is very good as it is connected via metro system and bus. The connection between the metro station and the stadium is convenient with two pedestrian bridges and direct exit to the upper concourse for access to the spectator stands. Almost all circulation areas on ground floor have been allocated as public areas. This system has the benefit that they can be used by the public during non operation of the stadium. Although many security check points are required (35 entrances) to access the spectator stands, this is considered to be an efficient design allowing maximum usage of the circulation areas during non-events. There are approximately 1,600 parking spaces available close to the stadium.

^{xcii} 4.5.1 Classification A Urban Category, Sub-category A.2, Urban Context, Parameter A.2.2 Connectivity, page 80-82

^{xcii} 6.1.4 Evaluation A Urban Category, Sub-category A.1, Urban Context, Evaluation Parameter A.2.2 Connectivity, page 131-133 (133)

Statement: Sufficient public transport systems, e.g. metro stations close to the stadium within a linear distance of less than 500m, result in a higher sustainability level compared to transportation by bus, car or other modes of transportation. In addition the usage of public transport systems is more environmentally friendly compared to cars.

These findings are in accordance with Agenda 21 which emphasizes that “Non-polluting means of transport and public transport shall be promoted as it contributes beneficially to various environmental problems, including air pollution, the consumption of non-renewable energy and excessive use of land for highways and parking areas.”³⁶⁹

The operator of Sydney Olympic Park confirmed as a lesson learned that “A development of finer grain and hierarchy of public spaces shall be considered. In addition master planning and phasing for development of the stadium precinct should become more important during bidding and execution stage.”

8.2.5 Summary comparative assessment Urban Category

The level of sustainability of sports facilities built on a site previously used for sports venues (A.1.1 Athens Football Stadium) or adjacent to other existing venues is significantly higher because already existing infrastructure (e.g. roads, public transport, utilities, etc.) can be utilized and further developed.

Utilization, redevelopment and modernization of an existing sports facility (A.1.2 Canberra Football Stadium) are generally more sustainable because it preserves resources and reduces material consumption. Existing sites of sports facilities are more sustainable because the site is already integrated into the urban context, therefore in close Proximity to mixed-use areas (e.g. retail, commercial, recreation, etc.) resulting in synergy effects and extended catchment areas (A.2.1 Athens Football Stadium). The level of Connectivity of an existing site and the City Centre as well as other mixed-use areas is higher compared to a new site -unless the new site is part of a city redevelopment like Sydney Olympic Park where the urban context and infrastructure are created as part of an overall masterplan.

8.3 Comparative assessment B Environmental Category

Sydney Olympic Stadium is rated with the highest score in denomination 'B Environmental Category'^{xciii}. For all four parameters, 'Overlay', 'Adaptability/Flexibility', 'Energy Efficiency' and 'Water Conservation' the stadium is allocated the maximum of 5 points. The Overlay was removed after the Olympic Games in order to meet the requirements of the nine home teams for the day-to-day use and reduce consumption of energy. The stadium was well planned with regard to Adaptability/Flexibility and allows for reconfiguration of the playing field as well as provides retractable seating and removable turf. Sydney Olympic Stadium has state-of-the-art renewable energy usage, energy efficient air-conditioning, energy efficient lighting and environmentally friendly building materials. Furthermore Sydney Olympic Stadium provides systems for rainwater harvesting, water recycling as well as water-efficient appliances. Due to the existing environmental characteristics of Australia it is noted, that the general awareness in the society with regard to shortage and preciousness of resources is considerably high and subsequently a co-factor for such an outstanding achievement.

An Overlay which ideally is removed after the Olympic Games in order to meet the requirements of home teams and of the respective day-to-day use or venues which have been originally constructed as a perfect match for post- Games use are an important coefficient for sustainability. At the same time in terms of Adaptability/Flexibility venues ideally shall have provisions for reconfiguration of the playing field, retractable seating and removable flooring/modular turf resulting in a more frequent usage of the sports facility for different event types. These factors combined with a state-of-the-art technologically advanced concept relating to 'Energy Efficiency' and 'Water Conservation' which preferably include usage of energy-efficient systems for power generation and conservation, environmentally friendly building materials and systems for water conservation as well as reduction of wastage of water through water recycling and water-efficient appliances result in a higher sustainability level.

The graph in Illustration 67 below shows a metric to quantify evaluation results in the sub-category B.1 Building against the respective parameters B.1.1 Overlay and B.1.2 Adaptability/Flexibility as well as in the sub-category B.2 Building Services with the parameters B.2.1 Energy Efficiency and B.2.2 Water Conservation.

^{xciii} 6.4 Summary chapter analysis, pages 162-164

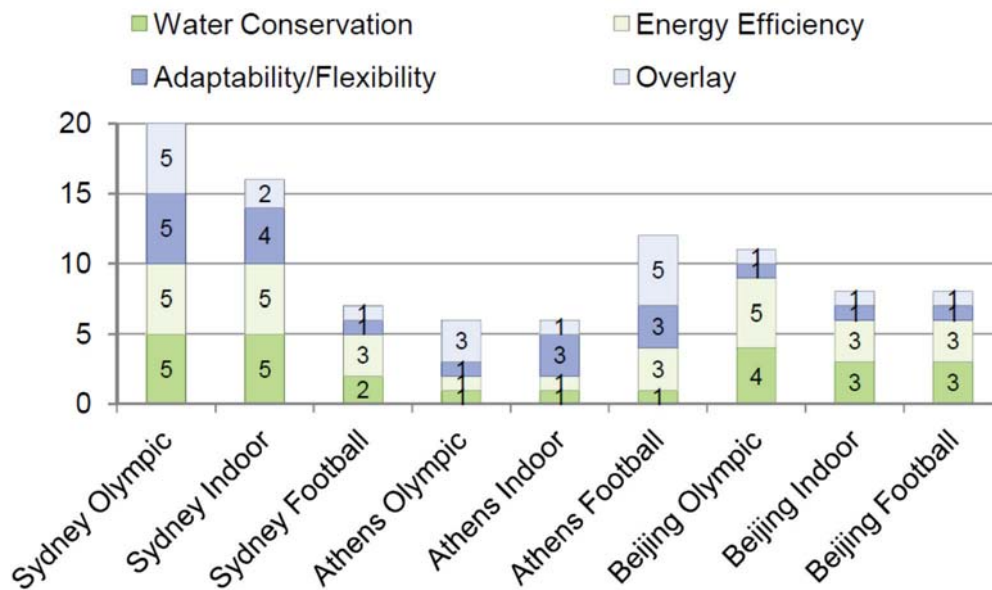


Illustration 67: Evaluation results sub-categories Building and Building Services based on 6.4 ‘Summary chapter analysis’

8.3.1 Comparative assessment Sub-category B.1 Building

Parameter B.1.1 Overlay

With reference to parameter ‘Overlay’^{xciv} it is noted that Sydney Olympic Stadium^{xcv} and Athens Football Stadium^{xcvi} are both rated with the highest score, however for different reasons.

In consideration of the operational requirements of Sydney Olympic Stadium after the Olympic Games it was decided at an early design stage that as part of Overlay the running tracks should be removed. Another component of Overlay was the reduction of the spectator capacity from 115,600³⁷⁰ to 83,500 spectators (82,500 in oval mode) after the Games. For this purpose the north and south spectator stands (seating capacity 15,000 spectators each) were constructed as temporary seating without roof. These 30,000 temporary seats were only leased from the contractor and after removal from Sydney Olympic Stadium in October 2001 the seats were reinstalled at another stadium in New Zealand. Subsequently the roof structures (steel members covered with polycarbonate panels with UV-protection) were

^{xciv} 4.5.2 Classification B Environmental Category, Sub-category B.1, Building, Parameter B.1.1 Overlay, page 82-83

^{xcv} 6.2.1 Evaluation B Environmental Category, Sub-category B.1, Building, Evaluation Parameter B.1.1 Overlay, page 133-137 (133-134)

^{xcvi} 6.2.1 Evaluation B Environmental Category, Sub-category B.1, Building, Evaluation Parameter B.1.1 Overlay, page 133-137 (137)

constructed to cover the remaining seats on the north and south spectator stands. After removal of the running tracks the lower tiers of all spectators stands were extended and partially converted into retractable seating, significantly reducing the distance to the playing field to approximately 15 metres.³⁷¹ The Overlay was removed after the Olympic Games over a period of approximately 2.5 years and completed in 2003 with an estimated overall cost of approximately 80 million Australian Dollars (approximately 62 million EUR).³⁷²

During the bidding stage the consortium for the ANZ Stadium consisted of the architect, consultants, investors and operators (Octagon). Accordingly, the operation of the stadium after the Olympic Games was the main focus. The consortium was selected to design, build and operate the stadium on a 30-year-lease basis. The agreement with the operator Octagon was limited to 10 years and after 9 years the personnel of the operator was taken over by the government.

One of the key factors for the successful conversion of Sydney Olympic Stadium after the Games was this long term approach of an expert bidding team and direct legitimate interest of the operator.

Athens Football Stadium has been constructed as per the requirements of the IOC but at the same time in full consideration of post- Games use for football by the home team as well as day-to-day use by integration of other usages. There has been no temporary Overlay considered and hence Athens Football Stadium remained generally unchanged after the Olympic Games in 2004. Olympiacos CFP undertook in April 2003 the responsibility to build a new football-only ground for the 2004 Olympic Games. In return, Olympiacos was granted exclusive use of the stadium until 2052. The club has to cover all maintenance costs and also pay 15% of revenue to the State.³⁷³ For the design, construction and operation of the new stadium a private consortium was appointed. This was the first stadium project in Greece financed, designed, built and operated by a private consortium.

Statement: Venues with an Overlay which is removed after the Olympic Games in order to meet the requirements of home teams and of the respective day-to-day use or venues which are constructed as a perfect match for post- Games use have a higher sustainability level compared to venues with a permanent Overlay for limited post- Games utilization or venues with Overlay resulting in disadvantages for post-Games utilization.

8.3.2 Comparative assessment Sub-category B.1 Building

Parameter B.1.2 Adaptability/Flexibility

With reference to parameter 'Adaptability/Flexibility'^{xcvii} it is noted that Sydney Olympic Stadium^{xcviii} is rated with the highest score because the differing and partially contradicting requirements of nine home teams Qantas Wallabies (rugby), HSBC Warathas (rugby), NWS State of Origin Blues (rugby), Sydney Swans (rugby), Bulldogs (rugby), South Sydney Rabbitohs (rugby), Pirtek Parramatta Eels (rugby), Qantas Socceroos (football) and Sydney Thunder (cricket) have been considered. Therefore the lower spectator stands are retractable in order to meet the requirements of five different professional sporting codes played at Sydney Olympic Stadium: rugby league, rugby union, Australian rules football, football and cricket. For rugby league and football played as per FIFA standards a rectangular playing field is required. Contrary to this AFL, rugby and cricket require an oval shaped playing field. In order to meet these variable requirements the east and west spectator stands are retractable.

Statement: Provisions for reconfiguration of the playing field, retractable seating and removable flooring/modular turf result in a more frequent usage accommodating different requirements and therefore in a higher sustainability level.

The operator of Sydney Olympic Park confirmed as lessons learned regarding Sydney Olympic Stadium that "Focus in the design should be more on the operation after the Olympic Games rather than on the requirements for the Olympic Games. Costs for modification of the stadium for operation after the Olympic Games should be more intensively considered at bidding stage."

The operator of Sydney Olympic Indoor Stadium confirmed as lessons learned regarding Sydney Indoor Stadium that "Interiors of the indoor hall including ceiling, walls and seating should be in black to create a better ambient. Catwalks should have connection points for lighting (in the original design for the Olympic Games no power was available for the catwalks). Furthermore no curtain-system and mother grid should be installed."

^{xcvii} 4.5.2 Classification B Environmental Category, Sub-category B.1, Building, Parameter B.1.2 Adaptability/Flexibility, page 83-84

^{xcviii} 6.2.2 Evaluation B Environmental Category, Sub-category B.1, Building, Evaluation Parameter B.1.2 Adaptability/Flexibility, page 137-140 (137-138)

8.3.3 Comparative assessment Sub-category B.2 Building Services

Parameter B.2.1 Energy Efficiency

With reference to parameter 'Energy Efficiency'^{xcix} it is noted that Sydney Olympic Stadium^c, Sydney Indoor Stadium^{ci} and Beijing Olympic Stadium^{cii} are rated with the highest score. At Sydney Olympic Stadium "air-conditioning and passive ventilation has been integrated into the design of the stadium. By minimising the extent of air-conditioning provided, valuable energy is conserved."³⁷⁴ "Natural ventilation was maximised by the use of over-sized lift shafts, stairwells and escalator voids. The use of air-conditioning was minimised by about 40 percent."³⁷⁵ With regard to "lighting, a computerised Clipsal C-BUS lighting system with programmable timing is used throughout ANZ Stadium (Sydney Olympic Stadium)- lighting in rooms with no motion or programmed activities automatically switches off after a set period. The need for artificial lighting has been reduced, as the design of the stadium allows maximum intake of daylight through specially constructed light voids. Overall, natural lighting reduced energy needs by 20 percent."³⁷⁶ With regard to "power, environmentally friendly gas fired co-generators serve as a backup to the main supply of electricity."³⁷⁷ "The two gas co-generation units achieved an estimated saving of 5,000 tonnes of carbon dioxide emissions each year from when the venue was completed in 1999. With regard to building materials no PCBs (Polychlorinated Biphenyl) were used in the developments and the use of PCA was minimised and at the same time extensive use of recycled building materials was introduced. These initiatives have resulted in major environmental achievements such as a reduction in greenhouse gas emissions by about 10,000 tonnes a year compared to similar facilities."³⁷⁸

"Sydney Indoor Stadium was awarded the prestigious national Banksia Award for Construction Practices in 1999."³⁷⁹ With regard to "air-conditioning, the system has been designed to cool only the air immediately surrounding the spectators, not the entire airspace in the venue, resulting in lower energy use for cooling. With regard to power, the stadium featured Australia's largest rooftop solar power system. Photovoltaic solar cells were installed on the 19 Olympic Plaza lighting towers on

^{xcix} 4.5.2 Classification B Environmental Category, Sub-category B.2, Building Services, Parameter B.2.1 Energy Efficiency, page 84-85

^c 6.2.3 Evaluation B Environmental Category, Sub-category B.1, Building Services, Evaluation Parameter B.2.1 Energy Efficiency, page 141-144 (141)

^{ci} 6.2.3 Evaluation B Environmental Category, Sub-category B.1, Building Services, Evaluation Parameter B.2.1 Energy Efficiency, page 141-144 (142-143)

^{cii} 6.2.3 Evaluation B Environmental Category, Sub-category B.1, Building Services, Evaluation Parameter B.2.1 Energy Efficiency, page 141-144 (142)

the Olympic Boulevard, providing light for major events at the Olympic Stadium and Sydney Indoor Stadium, both in the lead up to, and during, the Sydney 2000 Games and a permanent clean energy legacy for the site. With regard to building materials, no PCBs (Polychlorinated Biphenyl) were used in the developments and the use of PCA was minimised. At the same time extensive use of recycled building materials was introduced as well as maximum use of natural light and natural ventilation in the building design was implemented. These initiatives have resulted in major environmental achievements such as a reduction in greenhouse gas emissions by about 10,000 tonnes a year compared to similar facilities.”³⁸⁰

Beijing Olympic Stadium “was constructed with regard to air-conditioning, lighting and power in accordance with an advanced energy-saving design and such environment-friendly features as natural ventilation and lighting, utilization of renewable geothermal energy resources and application of solar photovoltaic power generation technologies. Under the football field of Bird's Nest there are 312 GSHP (ground source heat pump) wells, which heat the stadium in winters by absorbing thermal energy from the soil through embedded heat exchange pipes, and cool the place in summers by absorbing cold energy from the soil, saving considerable amount of electric power.”³⁸¹ “Waste water recycling was achieved in all the venues, and the goal of cutting energy consumption by 50% was realised.”³⁸²

Statement: Usage of energy efficient systems for power generation and conservation (e.g. solar power, photovoltaic power, heating system with heat recovery, heat pumps, heat storage), AC/Ventilation (e.g. natural ventilation), lighting (e.g. natural lighting, automatic control for lighting devices, light fittings, etc.) and environmentally friendly building materials (recycled, technically advanced) results in a higher sustainability level.

These findings are in accordance with Agenda 21 which recommends “Reducing energy consumption and use of renewable non-polluting sources shall be promoted as access to energy is a motor of development, but its excessive, pollutive or uncontrolled use mortgages the long term future of that development and is contrary to the principles of sustainable development.”³⁸³

8.3.4 Comparative assessment Sub-category B.2 Building Services

Parameter B.2.2 Water Conservation

With reference to parameter 'Water Conservation'^{ciii} it is noted that Sydney Olympic Stadium^{civ} and Sydney Indoor Stadium^{cv} are rated with the highest score. At Sydney Olympic Stadium and Sydney Indoor Stadium "water is conserved throughout Homebush Bay through the use of water conservation and recycling practices. The most important water conservation initiative is the Water Reclamation and Management Scheme (WRAMS). Sewage generated from Olympic venues and facilities is collected, treated and cleansed for non-potable reuse. Reclaimed water is used for toilet flushing in venues and facilities as well as in the Olympic Village and for irrigation across Sydney Olympic Park. WRAMS is designed to save 850 million litres of water annually that would otherwise be drawn from Sydney's main water supply, providing a permanent environmental and economic benefit and a useful model for other developments. As well, Olympic venues conserve water through water-efficient appliances, including water flow reduction valves and shower roses, roof-fed rainwater tanks and drip irrigation systems."³⁸⁴ "At Sydney Olympic Stadium rain water from the roof is collected in 4 tanks. The total capacity of rainwater harvesting is 3.2 million litres."³⁸⁵ "Australian native trees and shrubs have been planted across Sydney Olympic Park to reduce water needs."³⁸⁶

Statement: Usage of systems for Water Conservation (e.g. rainwater harvesting) and reduction of water wastage (e.g. water recycling, separate systems for potable water and grey water supply for toilet flushing, usage of grey water for irrigation of the landscape) as well as water-efficient appliances result in a higher sustainability level. These findings are in accordance with Agenda 21 which emphasizes the importance of "Careful water management and encouraging and supporting world-wide and local activities intended to protect water reserves and preserve the quality of natural waters as water reserves are limited and form part of a closed system. They are essential for farming activities, drinking and hygiene. In an increasing number of regions of the world, the quantity and quality of water reserves are under threat."³⁸⁷

^{ciii} 4.5.2 Classification B Environmental Category, Sub-category B.2, Building Services, Parameter B.2.2 Water Conservation, page 85-86

^{civ} 6.2.4 Evaluation B Environmental Category, Sub-category B.2, Building Services, Evaluation Parameter B.2.2 Water Conservation, page 144-147 (144-145)

^{cv} 6.2.4 Evaluation B Environmental Category, Sub-category B.2, Building Services, Evaluation Parameter B.2.2 Water Conservation, page 144-147 (145-146)

8.3.5 Summary comparative assessment Environmental Category

The level of sustainability is higher when specific requirements for operation of a sports facility after the Olympic Games are considered in the design at the beginning of the project. Dismantle of the Overlay (temporary structures, elements and equipments to fulfil requirements for staging special events) after the Olympic Games reduces consumption of energy and water in subsequent operation of the stadium. Major structures for the Overlay like a new roof structure designed for permanent usage (B.1.1 Athens Olympic Stadium) or reuse at a different venue (B.1.1 Sydney Olympic Stadium) increase the level of sustainability. Adaptability/Flexibility maximises utilization of the venue (B.1.2 Sydney Olympic Stadium) reducing the need to use new resources for construction of additional sports facilities.

The level of sustainability is significantly enhanced by usage of systems for Energy Efficiency (e.g. natural ventilation, natural lighting, etc.), systems for power generation (photovoltaic, heat pumps, etc.) as well as environmentally friendly building materials (B.2.1 Sydney Indoor Stadium) and systems for Water Conservation (e.g. rainwater harvesting, water recycling, etc.).

8.4 Comparative assessment C Social Category

Athens Football Stadium is rated with the highest score in denomination 'C Social Category'.^{cvi} For the parameter 'Other Usages', the stadium is allocated the maximum of 5 points, for two further parameters 'Average number of events' and 'Diversity of events' each 4 points and for the parameter 'Sport Usage' 2 points. Athens Football Stadium is used by two home teams for the same sports type. The stadium integrates eight retail/commercial facilities and various other temporary attractions like a cinema, children's playing field as well as a permanent museum resulting in a very good level of Other Usages. Furthermore it hosts three events per month and has 23% non-sports events.

Statement: A higher sustainability level is achieved at sports facilities which are ideally used by different home teams resulting in regular sports events. The integration of retail/commercial concepts enhances the utilization of the sports

^{cvi} 6.4 Summary chapter analysis, pages 162-164

facility during non-events significantly. Incorporation of tourism and cultural aspects e.g. with sightseeing tours is adding value by creating an independent attraction. Furthermore it is noted that the higher the number of events hosted at a venue the better post- Games usage is achieved. Ideally the events shall have a high percentage of non-sports functions, which is allowing more variety for usage options and different utilization alternatives especially for venues with less sports events.

The graph in Illustration 68 shows a metric to quantify evaluation results in the sub-category C.1 Usage Mix against the respective parameters C.1.1 Sport Usage and C.1.2 Other Usages as well as in the sub-category C.2 Utilization with the parameters C.2.1 Average number of events and C.2.2 Diversity of events.

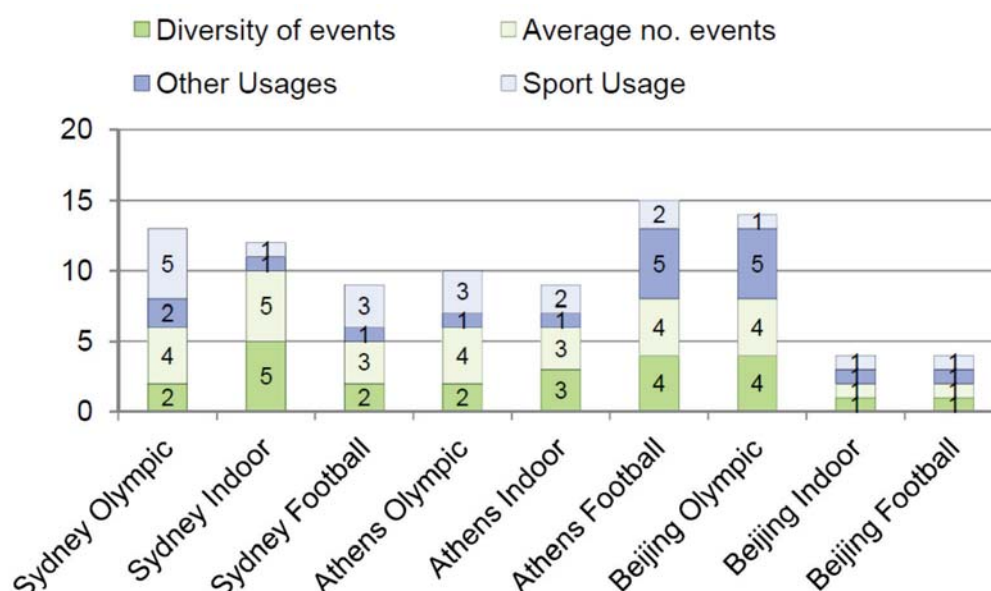


Illustration 68: Evaluation results sub-categories Usage Mix and Utilization based on 6.4 ‘Summary chapter analysis’

8.4.1 Comparative assessment Sub-category C.1 Usage Mix

Parameter C.1.1 Sport Usage

With reference to parameter ‘Sport Usage^{cvi}’ it is noted that Sydney Olympic Stadium^{cvi} is rated with the highest score. Sydney Olympic Stadium has nine

^{cvi} 4.5.3 Classification C Social Category, Sub-category C.1, Usage Mix, Parameter C.1.1 Sport Usage, page 86-87

^{cvi} 6.3.1 Evaluation C Social Category, Sub-category C.1, Usage Mix, Evaluation Parameter C.1.1 Sport Usage, page 147-149

different home teams which use the stadium for three different sports types: Qantas Wallabies (rugby), HSBC Warathas (rugby), NWS State of Origin Blues (rugby), Sydney Swans (rugby), Bulldogs (rugby), South Sydney Rabbitohs (rugby), Pirtek Parramatta Eels (rugby), Qantas Socceroos (football) and Sydney Thunder (cricket).

Statement: Sports facilities which are used by different home teams have more regular sports events. Options for different sports types result in a higher number of events and therefore a higher sustainability level.

8.4.2 Comparative assessment Sub-category C.1 Usage Mix

Parameter C.1.2 Other Usages

With reference to parameter 'Other Usages'^{cix} it is noted that Beijing Olympic Stadium^{cx} and Athens Football Stadium^{cx} are rated with the highest score.

At Beijing Olympic Stadium the following facilities are provided: one restaurant, four Food & Beverage stores, three shops, four souvenir shops, one Walt Disney Shop and one money exchange. Regarding the day-to-day use by citizens it was noted that the precinct of the Olympic Stadium is utilized by the local community e.g. for Taijiquan, skating as well as kite flying. The stadium itself is only accessible with payment of entrance fees and therefore not utilized on a daily basis by the local community. The exhibition area was added after the Olympic Games. The operator mentioned that the museum should be extended soon. During the survey it was noted that the exhibition itself is relatively basic. The operator stated that feasibility studies are undertaken to integrate a hotel within Beijing Olympic Stadium in future. At Athens Football Stadium the following facilities are provided: fan shop, three coffee shops, two bars, one supermarket and one gymnasium, which are located below the spectator stands and are open as well as fully accessible seven days per week for the public. In average there are 2,000 visitors for sightseeing purposes per year, therefore the revenue generated by guided tours is limited. Accordingly the operator is not promoting guided tours. The museum³⁸⁸ of the local team Olympiacos is located below the spectator stands and is accessible for the public. It

^{cix} 4.5.3 Classification C Social Category, Sub-category C.1, Usage Mix, Parameter C.1.2 Other Usages, page 87

^{cx} 6.3.2 Evaluation C Social Category, Sub-category C.1, Usage Mix, Evaluation Parameter C.1.2 Other Usages, pages 149-153

^{cx} 6.3.2 Evaluation C Social Category, Sub-category C.1, Usage Mix, Evaluation Parameter C.1.2 Other Usages, pages 149-153

is open six days per week (except Mondays) with approximately 5,000 visitors per year for an entrance fee of 2 EUR. It was noted that the museum is mainly relating to the local football club Olympiacos. Accordingly schools are not fully utilising the museum since the level of general information about the sports history and stadium history is limited.³⁸⁹. In 2010 the operator converted certain parking areas adjacent to the stadium into a playing field for children. The permission for conversion of the land usage is pending.

Statement: Integration of retail/commercial concepts (e.g. fan shop, tourist shop, church, coffee shop, restaurants, offices, hotel, spa, etc.) enhances the utilization of the sports facility during non-events significantly. Also the incorporation of tourism as well as of cultural aspects resulting in a transfer of knowledge and insights about local culture through the sports facility (e.g. Olympic Museum, Sports Museum) with provisions for sightseeing tours for national and international tourists is considered to add value and result in a higher sustainability level. The operator at Athens Football Stadium confirmed as lessons learned that “Additional VIP boxes and areas for VIP services as well as independent access to the restaurant should be considered. A revised approach for fencing of the stadium and a Building Management System to control individual areas would be of great value.”

8.4.3 Comparative assessment Sub-category C.2 Utilization

Parameter C.2.1 Average number of events

With reference to parameter ‘Average number of events’^{cxii} it is noted that Sydney Indoor Stadium^{cxiii} is rated with the highest score. The operator stated that currently in average 85 to 110 events are held at Sydney Indoor Stadium. The exact number is confidential. Subsequently the operator mentioned that in previous years approximately 75 events per year were held. This would accumulate to 6 events per month.

Statement: The higher the number of events hosted at a venue the better post-Games usage is achieved resulting in a high sustainability level.

^{cxii} 4.5.3 Classification C Social Category, Sub-category C.2, Utilization, Parameter C.2.1 Average number of events, page 88-89

^{cxiii} 6.3.3 Evaluation C Social Category, Sub-category C.2, Utilization, Evaluation Parameter C.2.1 Average number of events, pages 153-157 (155)

8.4.4 Comparative assessment Sub-category C.2 Utilization

Parameter C.2.2 Diversity of events

With reference to parameter ‘Diversity of events’^{cxiv} it is noted that Sydney Indoor Stadium^{cxv} is rated with the highest score. The operator stated the in previous years approx. 75 events per year with 5 sports events out of those were held resulting in 93% non-sports events and 7% sports events. Sydney Indoor Stadium is primarily used for non-sports events. Mainly concerts and music award functions are held. Traditionally the ‘Hillsong’ Conference is an annually repeated event since 2001. “Disney on Ice” was staged once.

Statement: A balanced percentage of sports events and non-sports events is indicating more variety with regard to usage mix ensuring different utilization alternatives especially for venues with less sports events, resulting in a higher sustainability level. The operator of Sydney Olympic Park confirmed as lessons learned that “Sports culture should be enhanced for diverse cultural understanding. Extraordinary events should be included for more variety but mostly ordinary daily events should be considered and single-use of facilities should be converted to multi-use.”

These findings are in accordance with the Olympic Charter which states that “Olympism is a philosophy of life, exalting and combining in a balanced whole the qualities of body, will and mind. Blending sports with culture and education, Olympism seeks to create a way of life based on the joy found in effort, the educational value of good example and respect for universal fundamental ethical principles. The practice of sport is a human right. Every individual must have the right of practising sport without discrimination in any kind and in the Olympic spirit, which requires mutual understanding with a spirit of friendship, solidarity and fair play. The goal of Olympism is to place sport at the service of the harmonious development of humankind, with a view to promoting a peaceful society concerned with the preservation of human dignity.”³⁹⁰

^{cxiv} 4.5.3 Classification C Social Category, Sub-category C.2, Utilization, Parameter C.2.2 Diversity of events, page 88-89

^{cxv} 6.3.4 Evaluation C Social Category, Sub-category C.2, Utilization, Evaluation Parameter C.2.2 Diversity of events, pages 158-162 (159-160)

8.4.5 Summary comparative assessment Social Category

Sustainability results from a balanced Usage Mix consisting of Sport Usage and Other Usages which provide a broad mix of activities for the community and the public. Sports facilities utilized by more than one home team and integration of various other usages (e.g. retail, commercial and recreation) achieve a significantly higher level of sustainability (C.1.2 Athens Football Stadium). Exception is Beijing Olympic Stadium where the usage is mainly resulting from sightseeing rather than sports events or other events.

Utilization of a sports facility correlates with the level of Urban Integration (Location Type, Building Type), Urban Context (Proximity, Connectivity), Building (Overlay, Adaptability/Flexibility) and Usage Mix (Sport Usage, Other Usages). A high rating in these sub-categories results in a high Average number of events and high Diversity of event types. Sports facilities where a private operator was involved at the beginning of the project and specific operational requirements have been already integrated in the project brief and design (C.2.1 Sydney Indoor Stadium) achieved a significantly higher sustainability.

8.5 Comparative assessment stadium types

In consideration of the specific aspects relating to the particular sports stadium type a separate comparative assessment of the parameters is carried out in this section.

8.5.1 Comparative assessment Olympic Stadiums

The evaluation results for the building type Olympic Stadium for each sub-category are shown in the graph as Illustration 69. Sydney Olympic Stadium is rated with the highest total score of 47 points followed by Beijing Olympic Stadium with 35 points and Athens Olympic Stadium with 29 points.

The Olympic Stadium is usually the centre piece of the Olympic Park and therefore an integral part of the case study analysis. Lessons learned for both, the Olympic Park and the Olympic Stadium, are summarized separately for Sydney, Athens and Beijing. These insights are derived from site inspections and surveys as well as from personal interviews with the operators.

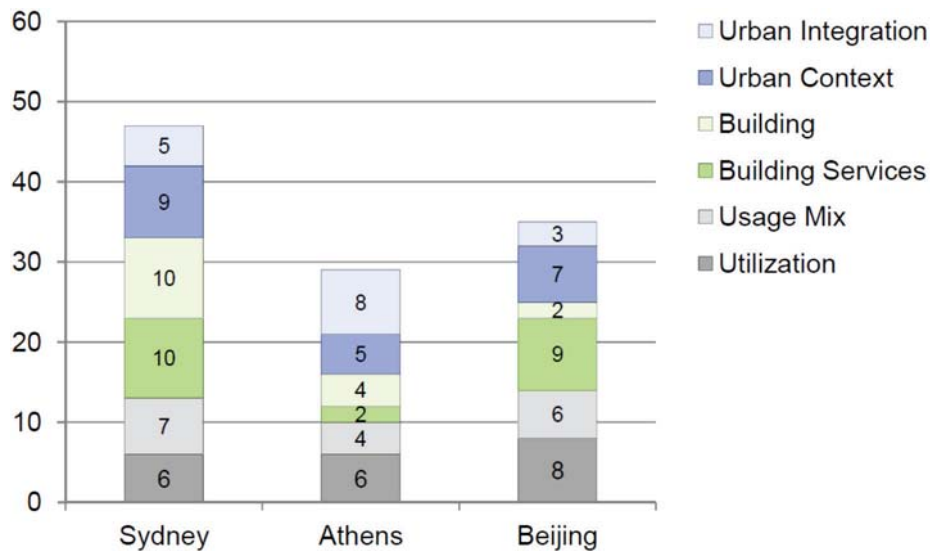


Illustration 69: Evaluation results for the building type Olympic Stadium in sub-categories Urban Integration, Urban Context, Building, Building Services, Usage Mix and Utilization based on 6.4 ‘Summary chapter analysis’^{cxvi}

For Sydney Olympic Park the operator stated that the focus for future development is extended from a sports culture to a more diverse culture with an emphasis on ordinary daily events rather than extraordinary events and the intent to enhance the usage mix for utilization. Facilities for single-use are converted into multi-use facilities with development of finer grain and hierarchy of public spaces rather than the existing large public areas. Sydney Olympic Stadium was modified after the Olympic Games^{cxvii}. However, the costs allocated for modification of the stadium for operation after the Games were underestimated. One operational requirement which was not considered at design stage was the provision of permanent cabling for the media to reduce time for installation. Another important aspect which is resulting in comparatively high operational costs is the manpower of 50 workers required for modifying the spectator stands.^{cxviii}

The Olympic Park in Athens is rarely utilized, neither for sports nor for non-sports activities. One of the key reasons is the lack of integrated masterplanning for utilization of the precinct after the Olympic Games. The absence of suitable landscaped areas in the precinct of the Olympic Stadium and Indoor Stadium does

^{cxvi} 6.4 Summary chapter analysis, page 162-164

^{cxvii} 6.2.1 Evaluation B Environmental Category, Sub-Category B.1, Building, Evaluation Parameter B.1.1 Overlay, page 133-137 (133-134)

^{cxviii} 6.2.2 Evaluation B Environmental Category, Sub-Category B.1, Building, Evaluation Parameter B.1.2 Adaptability/Flexibility, page 137-140 (137-138)

not provide space for recreation. Furthermore no restaurants or coffee shops were allocated anywhere in the precinct. 'Event Areas' for usage before and after games are not considered in the masterplanning for the Olympic Park. During the visit to an event, it was also noted that motorbikes use the entire precinct including pedestrian paths to access the stadium which is a safety concern.

For the Beijing Olympic Stadium the operator stated that it would have been beneficial to integrate more VIP boxes and meeting rooms which could have been used on a daily basis. Lastly, it was recommended to generally consider a retractable roof in order to maximize utilization for events such as concerts.

8.5.2 Comparative assessment Indoor Stadiums

The evaluation results for the building type Indoor Stadium in each sub-category are shown in the graph as Illustration 70. Sydney Indoor Stadium is rated with the highest total score of 41 points followed by Athens Indoor Stadium with 27 points and Beijing Indoor Stadium with 22 points.

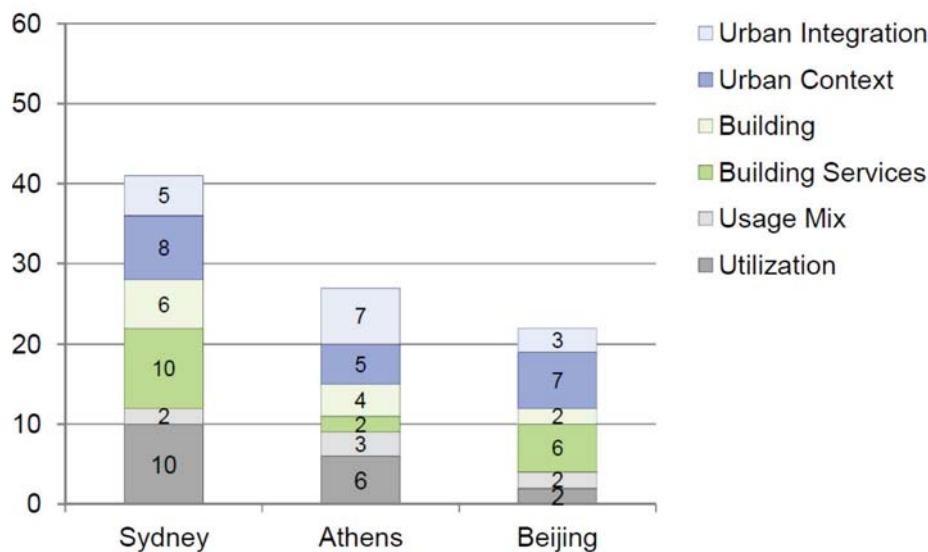


Illustration 70: Evaluation results for the building type Indoor Stadium in sub-categories Urban Integration, Urban Context, Building, Building Services, Usage Mix and Utilization based on 6.4 'Summary chapter analysis'.^{cxix}

^{cxix} 6.4 Summary of chapter analysis, pages 162-164

Lessons learned for Sydney Indoor Stadium are mainly relating to operational requirements which have not been considered at the design stage. The operator recommended that all interiors of the Indoor Stadium (including ceiling, walls and seating) should be in black colour to create a better ambient for concerts. In addition it was observed that loading docks for trucks should be without slope in order to avoid a gradient of the floor in the truck. In the original design for the Olympic Games no separate power grid was available for the catwalks without connection points for lighting used for operations. Furthermore it was suggested that the venue should be equipped with curtain systems. For Athens Indoor Stadium one of the most important operational limitations relates to the removable flooring system. Though designed to be removed for non-sports events, the reassembly was found to be too complicated. Therefore, events where the existing sports flooring system would have to be removed are not preferred. Another improvement which may be considered for future projects is to increase the number of retractable seating in order to maximize the flexibility of the playing field. There was no data available for the Beijing Indoor Stadium and an interview with the operator could not be arranged despite of various attempts. At the site inspection it was observed that the venue has not been used for an extended period of time. Therefore no information on potential lessons learned is available.

8.5.3 Comparative assessment Football Stadiums

The evaluation results for the building type Football Stadium in each sub-category are shown in the graph below as Illustration 71. Athens Football Stadium is rated with the highest total score of 45 points followed by Sydney Football Stadium with 28 points and Beijing Football Stadium with 26 points.

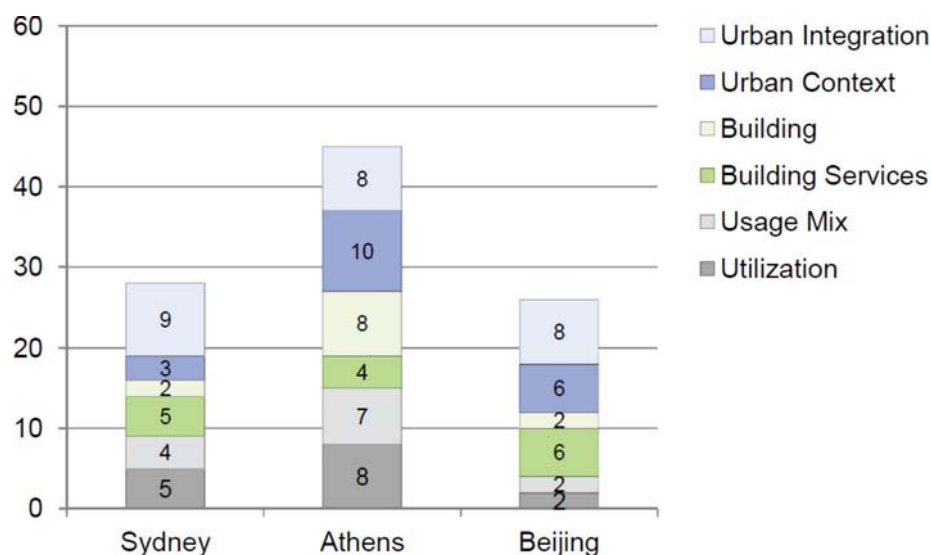


Illustration 71: Evaluation results for the building type Football Stadium in the sub-categories Urban Integration, Urban Context, Building, Building Services, Usage Mix and Utilization based on 6.4 'Summary of chapter analysis'^{cxx}

Lessons learned for Athens Football Stadium are mainly relating to provision of additional VIP Boxes and additional areas for VIP Services. In order to minimize security a separate independent access to the restaurant is preferred. For improvement of the energy efficiency and water conservation a Building Management System was implemented after the Olympic Games.

8.6 Summary chapter comparative assessment

In this chapter the high level findings are summarized separately for each of the three denominations A Urban Category, B Environmental Category and C Social Category. In addition the insights of the comparative assessment for each specific sports stadium type (e.g. Olympic Stadium, Indoor Stadium and Football Stadium) are described. It was noted that the overall ratings for the Sydney Olympic Stadium, Sydney Indoor Stadium and Athens Football Stadium are higher compared to the other venues. Lessons learned from the operator's point of view as well as observations during the site visits for the respective stadiums are presented. In summary, the lessons learned are relating either to specific operational requirements (e.g. additional areas to generate higher revenue with VIP boxes) or to limitations of options for future development of the sports stadiums (e.g. enhancement of usage mix and diversity of events).

Before drawing conclusions based on the comparative assessment in this chapter the general applicability of the Evaluation Matrix for other sports stadiums is verified^{cxxi}. For this purpose, one additional case study of the London Olympic Games in 2012 is conducted in the following chapter. The evaluation of Wembley Stadium in London is carried out based on a desk study using the same Evaluation Matrix described in Chapter 4.5 with reference to the categories and sub-categories defined in Chapter 4.5.1, 4.5.2 and 4.5.3. However, it is important to note that no site survey or interview with the operator was conducted.

^{cxx} 6.4 Summary of chapter analysis, pages 162-164

^{cxxi} 4.3 Methodology development of research tool, page 70-72

9 EXAMPLE OLYMPIC GAMES 2012

9.1 Introduction Wembley Stadium

The sustainability indicators and research tool developed in this thesis for the Urban Category, Environmental Category and Social Category shall be applied for an exemplary evaluation of a stadium used for the most recent Olympic Games in 2012. The results shall be summarized accordingly at the end of this chapter. At Wembley Stadium in London, shown in Illustration 72, eight football matches during the London 2012 Olympics³⁹¹ were hosted and it was chosen as an additional example to the three case studies Sydney 2000, Athens 2004 and Beijing 2008. Purpose of this independent assessment is to verify the general applicability of the selected indicators for other sports stadiums beyond the case studies.

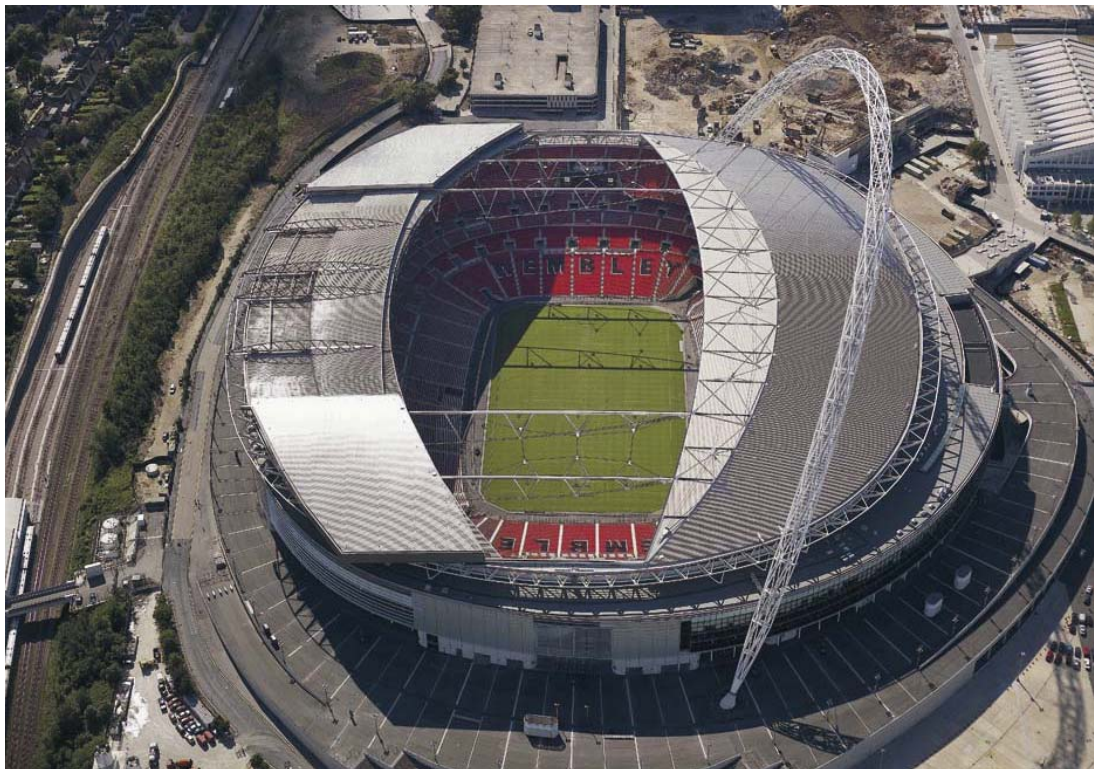


Illustration 72: Wembley Stadium, London³⁹²

9.2 Application sustainability indicators on Wembley Stadium

The evaluation of Wembley Stadium in London is carried out based on a desk study using the same Evaluation Matrix described in Chapter 4.5 with reference to the categories and sub-categories defined in Chapter 4.5.1, 4.5.2 and 4.5.3. However, it

is important to note that no site survey or interview with the operator was conducted. It can be assumed that the comparative assessment in Chapter 9 'Example Olympic Games 2012' demonstrates the general applicability of the sustainability indicators developed in this thesis independently of venue location.

9.3 Evaluation A Urban Category

9.3.1 A Urban Category

Sub-category A.1 Urban Integration

Evaluation Parameter A.1.1 Location Type

"Originally built for the British Empire Exhibition of 1924, and in turn the site of the Olympic Games in 1948 and the football World Cup Final in 1966, the old Wembley Stadium was the most important sports and entertainment venue in Britain. The challenge in reinventing it for a new century was to build on its extraordinary heritage and yet create a venue that would be memorable and magical in its own right. With 90,000 seats, standing almost four times the height and covering twice the area of the original, the new stadium is the largest covered arena in the world."³⁹³

Evaluation result: Considering that an Existing Site used for sports venues for 83 years has been redeveloped for Wembley Stadium the maximum of 5 points out of 5 points is allocated.

9.3.2 A Urban Category

Sub-category A.1 Urban Integration

Evaluation Parameter A.1.2 Building Type

Demolition of the existing stadium (built 1924) and construction of Wembley Stadium as a new stadium on an Existing Site. Constructed in 2002-2007 with a seating capacity of 90,000.

Evaluation result: Considering that Wembley Stadium is a new structure as a perfect match without necessity for major changes after the Olympic Games a total of 3 points out of 5 points is allocated.

9.3.3 A Urban Category

Sub-category A.2 Urban Context

Evaluation Parameter A.2.1 Proximity

The linear distance between Wembley Stadium and City Centre e.g. Central Station in London is approximately 14 km. The distance to a major tourist destination e.g. Big Ben is approximately 14 km. In June 2004 the Brent Council and the private developer Quintain both unveiled plans for the area that is supposed to deliver thousands of jobs and homes with improved local facilities. "Planning permission was granted for an ambitious mixed-use development proposal covering some 50 acres of land surrounding the stadium. Quintain Estates and Development has started work on site to develop the land around the stadium and their plans look set to create a vibrant development that will provide new jobs, homes, leisure facilities, shops, bars, restaurants, offices, a hotel and major new public spaces."³⁹⁴ Now 70 shops, 9 cafes, a cinema, a square, a hotel, an activity centre and a library as well as new residences surround the Stadium.³⁹⁵

Evaluation result: Considering that Wembley Stadium can be described as an Integrated venue location with mixed-use areas e.g. retail, commercial, recreational and residential areas within the immediate urban context of the stadium in a linear distance of approximately 0-2 km the maximum of 5 points out of 5 points is allocated.

9.3.4 A Urban Category

Sub-category A.2 Urban Context

Evaluation Parameter A.2.2 Connectivity

The access via underground and overground to Wembley Stadium is good. There are three stations servicing Wembley Stadium. The distance to the closest public transport station e.g. metro is approximately 600m. Additionally there is a regular bus connection, bus shuttle from the station to the stadium on event days as well as a "dial-a-ride" option for disabled visitors and car parking provisions for blue badge holders.³⁹⁶

Evaluation result: Considering the connectivity of Sydney Olympic Stadium via metro system and linear distance of approximately 600m to the next metro station a total of 3 points out of 5 points is allocated.

9.4 Evaluation B Environmental Category

9.4.1 B Environmental Category

Sub-category B.1 Building

Evaluation Parameter B.1.1 Overlay

At Wembley Stadium the following Overlay was constructed in preparation of the Olympic Games. "Erection of temporary structures including warm up courts, compound areas, a temporary retractable walkway and cable bridge across Engineers Way, vehicle and pedestrian access areas and a temporary secure perimeter fencing for the purposes of hosting the Badminton and Rhythmic Gymnastics at Wembley Arena and the Football Competition at Wembley Stadium. Civil Engineering works to level the surface of the land to the north of Engineers Way. The only overlay that is required for Wembley Stadium is for vehicle access areas. This will comprise of one vehicle access tent to the east of the stadium and a second access tent to the west of the stadium."³⁹⁷

Evaluation result: Considering that till now there was no necessity of conversion or modification of Wembley Stadium and that the Overlay is not directly applying to the existing venues it can be considered as a perfect match and therefore the maximum of 5 points out of 5 points is allocated. However, it is important to note that there was no detailed information provided by the operator.

9.4.2 B Environmental Category

Sub-category B.1 Building

Evaluation Parameter B.1.2 Adaptability/Flexibility

"The stadium's facilities are designed to maximise spectator enjoyment. The seats are larger than before, with much more leg-room, the highest tiers are easily accessed via escalators, and the concourse that wraps around the building can provide catering for 40,000 spectators at any one time. One of the things that make the stadium special is the retractable roof, which ensures that the spectator experience is comfortable in all weathers. When the roof is open it ensures that the turf receives sufficient sunlight and air to keep it in perfect condition, while in poor weather it can be closed to cover the entire seating bowl. The roof is supported structurally by a 133-metre-high arch that soars above the stadium. An iconic replacement for the old building's twin towers, floodlit at night it is a strong symbol

for Wembley and an instantly recognisable London landmark. The venue for the 2012 Olympics football finals, the stadium is designed to be ideal for the sport. Its geometry and steeply raked seating tiers ensure that everyone has an unobstructed view of the game. To recreate the intimate atmosphere and the distinctive 'Wembley roar' for which the old stadium was famous, the seats are located as close to the pitch as possible. Yet the building has also been consciously future proofed, with the ability to be adapted to host a variety of events, including international track and field events up to Olympic standard if required.”³⁹⁸ “A ‘platform system’ has also been designed to convert the stadium for athletics use; however installation of the platform decreases the stadium's capacity to approximately 60,000.”³⁹⁹

Evaluation result: Considering that Wembley Stadium has an option for adaptation to host a variety of events (in 2013 Football, American Football, Rugby, Conferences, Concerts and Balls), including international track and field activities, which can be rated as reconfiguration of the playing field the maximum of 5 points out of 5 points is allocated.

9.4.3 B Environmental Category

Sub-category B.2 Building Services

Evaluation Parameter B.2.1 Energy Efficiency

“Wembley Stadium faces the challenge of being a large venue with correspondingly high energy demands. Despite this the energy consumption was reduced by 28% to date and a purchase of 100% of the electricity is from the supplier’s green tariff.

Wembley Stadium is a ‘zero waste to landfill’ venue with around 60% of waste being recycled. The remainder is sent to a ‘waste to energy’ plant where energy produced is returned to the national grid. As a result of the environmental activity so far, Wembley Stadium is proud to have won a Platinum Award from the Mayor of London’s Green500 Programme, achieved the Carbon Trust Standard and the Industry Green standard for venues.”⁴⁰⁰ Furthermore with regard to lighting “the vast majority of the lighting at Wembley Stadium is fully controlled by a centrally operated lighting control system. By creating stricter guidelines for lighting requests by internal and external stakeholders, electricity has been saved in the following ways:

1. Placing a requirement on the cleaning contractor to issue a schedule of cleaning around the Stadium in advance so the lighting is scheduled to be switched on in certain areas for a set length of time.

2. The catering contractor has to submit lighting requests with start and finish time for many of the areas required across the Stadium.
3. The lighting requirements for the Stadium Tours have been refined.
4. PIR3 occupancy detection has been installed in all main office areas across the Stadium.
5. Working with Brent Council, emergency lighting has been reduced on event-day egress staircases on non-event days.
6. Lighting controls for the Stadium are monitored from offsite locations allowing unnecessary lights to be switched off at any time.
7. The security team have received training on the lighting control system and have been briefed on how to action lighting requests.
8. Lighting in 25 lift cars has been upgraded from 20 Watt Halogen lamps to 9 Watt LED lamps. These lights are on 24 hours a day so the change of lamp has had maximum effect; 19,272 kWh per year have been saved through this initiative.”⁴⁰¹

“Wembley has become one of the first national stadiums to be certified to ISO 14001, the international standard for the implementation of Environmental Management Systems. The work carried out by the stadium’s ‘Green Team’ has helped recycling rates on event days reach highs of 82%. Electricity consumption was reduced by 32% from 2007-2012. Including reductions in gas consumption, total energy savings for the Stadium is close to £4m. Building on its environmental certification, Wembley Stadium is committing to implementing ISO 20121, the international standard for event sustainability management systems by the end of 2015.”⁴⁰²

Evaluation result: Considering that Wembley Stadium has an energy efficient lighting system as well as an option of ‘waste to energy’ for renewable energy and many environmental certifications the maximum of 5 points out of 5 points is allocated.

9.4.4 B Environmental Category

Sub-category B.2 Building Services

Evaluation Parameter B.2.1 Water conservation

“At Wembley the main water challenge is the consumption of potable water. 600,000 litres of water are stored and processed on site. The stadium’s water consumption is, unsurprisingly, greatest on event days when up to 90,000 people use the”⁴⁰³

"facilities. On non-event days, maintenance activities such as cleaning, jet-washing and watering the pitch consume a significant amount of non-potable water. The Green Team continues to trial a number of water-saving initiatives around the Stadium."⁴⁰⁴

Evaluation result: Considering that Wembley Stadium has a provision for water storage and processing most probably collected through rain harvesting a total of 3 points out of 5 points is allocated. However, it is important to note that there was no detailed information provided by the operator.

9.5 Evaluation C Social Category

9.5.1 C Social Category

Sub- category C.1 Usage Mix

Evaluation Parameter C.1.1 Sport Usage

Wembley Stadium is used by five different Event holders. "The Football Association (FA) runs the England Teams, the FA Cup, the FA Community Shield, Women's Football, the FA Youth Cup and a range of other competitions. Every year the stadium hosts all home, senior England International games, the FA Cup final and semi-finals, the FA Community Shield and the FA Vase and Trophy Finals. Wembley National Stadium Limited, the company that operates Wembley Stadium, is a fully owned subsidiary of the Football Association. The Rugby Football League administers the Superleague, Rugby League Division 1, the National Conference and the Challenge Cup. The Challenge Cup Final, traditionally held in August has been held at Wembley Stadium since 1929. It returned to the new stadium in August 2007. The Football League stages its five showpiece finals at Wembley Stadium: The Capital One Cup Final, the Johnstone's Paint Trophy Final and the three Play-Off finals. The National Football League (NFL) is a professional American football league composed of 32 teams. The NFL has been staging regular season International Series games every year at Wembley since 2007 and will continue to do so until at least 2016. Saracens are a professional rugby union team based in London. Saracens usually play home games at the Allianz Park in Hendon but have played two home games at Wembley every season since 2009."⁴⁰⁵

Evaluation result: Considering that Wembley Stadium is used by five Event holder teams with three different sports types the maximum of 5 points is allocated.

9.5.2 C Social Category

Sub-category C.1 Usage Mix

Evaluation Parameter C.1.2 Other Usages

Wembley Stadium offers a tour daily between 10am to 4pm and tickets cost 9-45 GBP.⁴⁰⁶ The Stadium has 5 restaurants, box catering, 8 F&B outlets, coffee kiosks, 5 bars and a store.⁴⁰⁷ Furthermore there is an educational/cultural initiative, the 'Learning Zone', "which offers a range of fun day activities, six-week courses and bespoke programmes, as well as being a venue for workshops, conferences and celebrations. Equipped with a multitude of desktop computers, laptops, digital cameras, camcorders, Lego Mindstorms (robotics), Lego mechanics and renewable energy kits, scratching desks, arts and crafts materials, STIXX machines and a kitchen the Learning Zone tailors every experience to the specific needs of individual groups. With direct access to the inner workings of the stadium, each visit is a mixture of educational activities and inspirational walks inside this iconic landmark."⁴⁰⁸

Evaluation result: Considering that Wembley Stadium integrates 5 restaurants, 8 food outlets, coffee kiosks, 5 bars and a store as well as daily guided tours and an educational/ cultural programme the maximum of 5 points out of 5 points is allocated.

9.5.3 C Social Category

Sub-category C.2 Utilization

Evaluation Parameter C.2.1 Average number of events

Since the Olympic Games in 2012 Wembley Stadium hosted in average 3 events per month (35 events in 12 months equals to 3 events per month). As per the documentation made available by the operator the following events were held.

2013 28x sports events, 7x non-sports events⁴⁰⁹

Evaluation result: Considering that Wembley Stadium hosts in average three events per month a total of 4 points out of 5 points is allocated.

9.5.4 C Social Category

Sub-category C.2 Utilization

Evaluation Parameter C.2.2 Diversity of events

Wembley Stadium is mainly used for football matches. Other sports events are occasionally rugby and American football matches. As non-sports events concerts are the main functions. A ball and Poker event were held once.

24x	Football 2013
2x	Rugby 2013
2x	American Football 2013
5x	Concert 2013
1x	Ball 2013
1x	Poker event 2013

Evaluation result: Considering that Wembley Stadium hosts 80% sports events and 20% non-sports events (total 35 events, 28 sports events, 7 non-sports events) a total of 3 points out of 5 points is allocated.

9.6 Summary chapter example Olympic Games 2012

The sustainability indicators developed in this thesis for the Urban Category, Environmental Category and Social Category have been applied for an exemplary evaluation of a stadium used for the most recent Olympic Games in 2012.⁴¹⁰ This additional case study was conducted in order to verify the general applicability of the Evaluation Matrix for other sports stadiums.

For the additional case study the London Wembley Stadium, which hosted eight football matches including the finals during the London 2012 Olympics, was chosen as an independent example to the three case studies Sydney 2000, Athens 2004 and Beijing 2008. The result of this independent assessment shows that the Evaluation Matrix is generally applicable for other sports stadiums beyond the case studies. Following the verification of the method and Evaluation Matrix in this chapter the conclusions for the case studies are drawn based on the comparative assessment and presented in the following chapter 10.

The London Wembley Stadium was evaluated as a primary desk study. The respective findings are obtained through an indirect and therefore different approach which is considered sufficient to verify the general applicability of the Evaluation Matrix. The accurateness, depth and precision of the insights of the inspected venues and personally conducted case studies represent a different level of assessment and therefore cannot be directly compared with the results of the desk study. Accordingly the London Wembley is presented separately in this chapter. The results are briefly summarized below.

The Wembley example furthermore shows that the highlighted key factors for a good post-Games legacy were reconfirmed through the approach of creating a multi-purpose stadium with options for adaptability and reconfiguration leading to a satisfactory usage by five event holder teams with three different sports types.

The fact that Wembley has become one of the first national stadiums to be certified to ISO 14001, the international standard for the implementation of Environmental Management Systems, proves that the environmentally friendly approach is applied to enhance the level of sustainability.

In denomination 'A Urban Category', consisting of sub-categories 'A.1 Urban Integration' and 'A.2 Urban Context', Wembley Stadium is rated with a score of 16 points out of 20 points.

In sub-category 'A.1 Urban Integration' consisting of two parameters 'A.1.1 Location Type' and 'A.1.2 Building Type' Wembley Stadium is rated with a score of 8 points out of 10 points.

In sub-category 'A.2 Urban Context' consisting of two parameters 'A.2.1 Proximity' and 'A.2.2 Connectivity' Wembley Stadium is rated with 8 points out of 10 points.

In denomination 'B Environmental Category' consisting of sub-categories 'B.1 Building' and B.2 'Building Services' Wembley Stadium is rated with a score of 18 points out of 20 points.

In sub-category 'B.1 Building' consisting of two parameters 'B.1.1 Overlay' and 'B.1.2 Adaptability/Flexibility' Wembley Stadium is rated with a score of 10 points out of 10 points.

In sub-category 'B.2 Building Services', consisting of two parameters 'B.2.1 Energy Efficiency' and 'B.2.2 Water Conservation' Wembley Stadium is rated with a score of 8 points out of 10 points.

In denomination 'C Social Category', consisting of sub-category 'C.1 Usage Mix' and 'C.2 Utilization' Wembley Stadium is rated with a score of 17 points out of 20 points.

In sub-category 'C.1 Usage Mix', consisting of two parameters 'C.1.1 Sport Usage' and 'C.1.2 Other Usages' Wembley Stadium is rated with a score of 10 points out of 10 points.

In sub-category 'C.2 Utilization' consisting of two parameters 'C.2.1 Average number of events' and 'C.2.2 Diversity of events' Wembley Stadium is rated with a score of 7 points out of 10 points.

10 CONCLUSIONS

In response to the aims and objectives of this research the final conclusions are drawn and presented in this chapter. For the comparative assessment of the case studies the research tool was developed. The indicators influencing the level of sustainability in the Urban Category, Environmental Category and Social Category were selected in consideration of existing certification systems such as BREEAM, LEED and DGNB. On this basis the key differences between the selected venues for the Olympic Games in Sydney, Athens and Beijing with respect to the three categories were identified for the comparative assessment. Before drawing conclusions based on the comparative assessment the general applicability of the Evaluation Matrix for other sports stadiums was verified with one additional case study (desk study) of the London Olympic Games 2012 in the previous chapter. The result of this independent assessment shows that the Evaluation Matrix is generally applicable for other sports stadiums beyond the case studies.

The conclusions for the case studies of the Olympic Summer Games in Sydney (2000), Athens (2004) and Beijing (2008) are described in this chapter with recommendations for sustainable stadium design in the Olympic context.

10.1 General conclusions

In the Urban Category, existing sites previously used for sports venues or adjacent to other existing venues are more sustainable because these sites are already integrated into the Urban Context with existing infrastructure, Connectivity and Proximity to existing mixed-use areas resulting in synergy effects and extended catchment areas.

In the Environmental Category, the level of sustainability is higher when specific requirements for long-term operation of the sports stadium after the Olympic Games are defined in the project brief. Unless the Overlay is required for permanent usage, dismantling the Overlay after the Olympic Games reduces energy consumption in subsequent operations of the stadium. The implementation of energy efficient systems, power generation, water conservation and environmentally friendly building materials further enhances the level of sustainability and significantly reduces operational costs.

In the Social Category, a balanced, diversified usage consisting of regular sports events, cultural events and other usages/functions provides a broad mix of activities for the community/public, resulting in a higher utilization of the sports stadium. The utilization of a sports stadium correlates positively with a high rating of the indicators: Urban Integration, Urban Context, Building and Usage Mix.

Thus, the development strategy for utilization of future sports stadiums should not only consider sport-related activities, but also the implementation of a diverse Usage Mix with integration of other functions for long-term operation. Emphasis should be on day-to-day utilization with ordinary daily activities/events in addition to the weekly events of the home team rather than on potential extraordinary events. This type of mixed usage allows the community and public to benefit continuously from sports stadiums built for Olympic Games creating a positive and long-lasting legacy.

10.2 Conclusions comparative assessment case studies

In the Urban Category, the level of sustainability of sports stadiums built on a site previously used for sports venues (e.g. Athens Football Stadium) or adjacent to other existing venues is significantly higher because already existing infrastructure (e.g. roads, public transport, utilities, etc.) can be utilized and further developed. Utilization, redevelopment, and modernization of an existing sports stadium (e.g. Canberra Football Stadium) are generally more sustainable because resources are preserved and material consumption reduced. Existing sites of sports stadiums are also more sustainable because the sites are usually already integrated into the Urban Context and therefore in close Proximity to existing mixed-use areas (e.g. retail, commercial, recreation, residential, etc.) resulting in synergy effects and extended catchment areas (e.g. Athens Football Stadium). The level of Connectivity between an existing site and the city centre as well as other mixed-use areas is better compared to a new site- unless the new site is part of a city redevelopment project, like Sydney Olympic Park, where the Urban Context and infrastructure were created as part of an overall masterplan.

In the Environmental Category, the level of sustainability is higher if specific requirements for the long-term operation of the sports stadiums after the Olympic Games are considered. Dismantle of the Overlay (temporary structures, elements, and equipments necessary to fulfil the requirements for staging special events) after

the Olympic Games reduces consumption of energy, water and other resources in the subsequent operation of the stadium. Major structures for the Overlay like a new roof structure designed for permanent usage (e.g. Athens Olympic Stadium) or an Overlay which is reused at a different venue (e.g. Sydney Olympic Stadium) increase the level of sustainability. Adaptability and Flexibility of the sports stadium maximize utilization of the venue (e.g. Sydney Olympic Stadium) and avoid usage of new resources for construction of additional sports facilities. The level of sustainability is significantly enhanced by usage of energy efficient systems (e.g. natural ventilation, natural lighting, etc.), power generation (e.g. photovoltaic, heat pumps, etc.), water conservation (e.g. rainwater harvesting, water recycling, etc.) and environmentally friendly building materials (e.g. Sydney Indoor Stadium).

In the Social Category, the long-term utilization of sports stadiums results from a good balance consisting of Sport Usage and Other Usages, thus providing a broad Usage Mix of different activities for athletes and the public. Sports stadiums utilized by more than one home team with integration of various other usages (e.g. retail, commercial, recreation, etc.) achieve a significantly higher level of sustainability (e.g. Athens Football Stadium). The exception is Beijing Olympic Stadium, which is mainly used as a tourist attraction for sightseeing purposes rather than for sports activities. Utilization of a sports stadium correlates with the level of sustainability regarding Urban Integration (Location, Building), Urban Context (Proximity, Connectivity), Building (Overlay, Adaptability/Flexibility) and Usage Mix (Sport Usage, Other Usages). A high rating in these sub-categories results in a comparatively higher Number of events and a higher Diversity of event types. The results of the case study for Athens Football Stadium prove that Other Usages can be successfully integrated to utilize the venue on a daily basis.

Sports stadiums where a (private) operator was involved at the inception of the project achieved a significantly higher level of sustainability because specific operational requirements were already integrated during the design stage (e.g. Sydney Olympic Stadium).

10.3 Recommendations stadium design in the Olympic context

During the election process of the host city for the Olympic Games the impact of permanent sports stadiums on the urban, environmental and social context tends to

be underestimated, while the opportunities for utilization of the venues after the Olympic Games seem to be overestimated by the applicant/candidate cities. Therefore, it is recommended that the International Olympic Committee (IOC) establishes more specific guidelines for preparation of the project brief and feasibility studies in order to verify and assess the proposed level of sustainability of each sports stadium in the Urban Category, Environmental Category and Social Category.

In addition to the feasibility study, it is suggested that applicant/candidate cities develop a business plan with dedicated reserve funds for maintenance and modernisation of the stadium and entire precinct in order to meet the evolving requirements for the long-term operation of the facilities. Considering the diverse operational requirements for each of the sports stadiums, it is recommended that applicant/candidate cities involve an operator for preparation of the project brief and feasibility studies. This is to ensure that the focus is not only on the fulfilment of short-term requirements for staging the Olympic Games, but more importantly, on the long-term utilization of each sports stadium after the Olympic Games.

With reference to the bidding documents for the Olympic Games 2008 it was noted that the candidate city Beijing did not fully address the long-term utilization of the built legacy for the Olympic Games. The bidding documents did not include a long-term concept for operating each of the sports stadiums (e.g. Beijing Indoor Stadium) after the Olympic Games. Apart from the significant success as a tourist attraction Beijing Olympic Stadium was used for only 23 sports events (including the regular annual Beijing Ice and Snow Festival with a duration of 63 days) since the Olympic Games between 2008 and 2012.^{cxix} Therefore it is recommended that the long-term operation of each sports stadium shall become an integral part of the bidding document for an independent assessment of its feasibility including the Usage Mix and Utilization. This approach could ensure a satisfactory post- Games utilization of the sports stadium and ultimately a positive legacy of the Olympic Games in the long-term.

During the field research for the case studies it was further noted that only limited information was made available to monitor the implementation of commitments of the candidate city at bidding stage. Data for the actual analysis and assessment

^{cxix} 6.3.4 Evaluation C Social Category, Sub-category C.2, Utilization, Evaluation Parameter C 2.2 Diversity of events, page 158-162 (159)

regarding sustainability indicators such as electricity and water consumption as well as accurate numbers of events and spectators per year were only available in fragments for selected sports stadiums. For further information on this topic the data collected in this research is compiled in Chapter 11.

In order to enhance the existing knowledge base it is recommended that the International Olympic Committee (IOC) shall carry out surveys of venues used for the Olympic Games and make the accessibility of data compulsory for the hosting cities. These data should also allow a verification of other important sustainability indicators (e.g. water consumption, energy consumption, waste generation, recycling, etc.) in the long-term operation of the sports stadiums. Based on the findings of previous Olympic Games a detailed guideline for future hosts of the Olympic Games could be provided.

Other indicators relating to design efficiency such as average construction area per seat and average dead loads of spectator stands and roof structures could be added to the Evaluation Matrix. A comparative assessment of these parameters could provide important benchmarks to verify the efficiency of the structural elements for an even more sustainable design of sports stadiums.

11 APPENDIX

11.1 Template for comparative evaluation matrix

The Evaluation Matrix developed as a research tool for this thesis is shown in Illustration 73 below. The Rating matrix for the comparative assessment is presented in Illustration 74.

	A			B			C			Max. points
	Venue Type 1	Venue Type 2	Venue Type 3	Venue Type 1	Venue Type 2	Venue Type 3	Venue Type 1	Venue Type 2	Venue Type 3	
A Urban Category										
A.1 Urban Integration (Σ)										10
A.1.1 Location Type										5
A.1.2 Building Type										5
A.2 Urban Context (Σ)										10
A.2.1 Proximity										5
A.2.2 Connectivity										5
Sub-total										20
B Environmental Cat.										
B.1 Building (Σ)										10
B.1.1 Overlay										5
B.1.2 Adaptability/Flexibility										5
B.2 Building Services (Σ)										10
B.2.1 Energy Efficiency										5
B.2.2 Water Conservation										5
Sub-total										20
C Social Category										
C.1 Usage Mix (Σ)										10
C.1.1 Sport Usage										5
C.1.2 Other Usages										5
C.2 Utilization(Σ)										10
C.2.1 Average no. events										5
C.2.2 Diversity of events										5
Sub-total										20
Total each Venue Type										60

Illustration 73: Template Evaluation Matrix

This template could be used for independent assessment of sports venues or potential sites where an evaluation with a more complex certification system such as BREEAM, LEED or DGNB is either not intended or where detailed data is not available. Where additional data is available, other important parameters such as usage of low energy and low carbon materials or average energy and water consumption per seat could be included in the Evaluation Matrix. Other indicators relating to design efficiency such as average construction area per seat and average dead loads of spectator stands and roof structures could be added to the Evaluation Matrix. A comparison of these parameters could provide benchmarks to verify the efficiency of different designs.

11.2 Rating matrix for comparative assessment

For a simplified assessment of different project sites during feasibility stage the Evaluation Matrix has been modified. The table shown in Illustration 74 below could be used where no sufficient data is available for a more detailed assessment.

A	Urban Category	
A.1	Urban Integration (Σ)	Max. 10
A.1.1	Location Type	Max. 5
	Existing Site	4-5
	Brownfield Site	2-3
	Greenfield Site	1-2
A.1.2	Building Type	Max. 5
	Existing Building	4-5
	New Building	2-3
	Temporary Structure	1-5
A.2	Urban Context (Σ)	Max. 10
A.2.1	Proximity	Max. 5
	Integrated venue location	4-5
	Adjoining venue location	2-3
	Isolated venue location	1
A.2.2	Connectivity	Max. 5
	Metro station in less than 100m	5
	Metro station in less than 500m	4
	Metro station in less than 800m	3
	No metro connection but bus connection	2
	No public transport provided on a daily basis	1
	Sub-total	Max. 20

Illustration 74: Rating matrix Urban Category

B Environmental Category		
B.1	Building (Σ)	Max. 10
B.1.1	Overlay	Max. 5
	Tailor-made Overlay with post- Games removal or perfect match	4-5
	Permanent Overlay with post- Games utilization	2-3
	No post- Games modif. or Overlay to disadvantage	1-2
B.1.2	Adaptability/Flexibility	Max. 5
	Reconfig. playing field, retractable seating, remov. flooring/turf	5
	Retractable seating, removable flooring/turf	4
	Removable flooring/turf	3
	Option for modifications but out of use	2
	No options for modifications	1
B.2	Building Services (Σ)	Max. 10
B.2.1	Energy Efficiency	Max. 5
	Renew. energy, energy eff. a/c, lighting, env. friendly materials	5
	Energy efficient a/c, lighting, env. friendly materials	4
	Energy efficient lighting, env. friendly materials	3
	Environmentally friendly building materials	2
	No provisions for energy efficiency or env. friendly materials	1
B.2.2	Water Conservation	Max. 5
	Rainwater harvesting, water recycling, water-efficient appliances	5
	Rainwater harvesting, water recycling	4
	Rainwater harvesting	3
	Water-efficient appliances	2
	No provisions for water conservation	1
Sub-total		Max. 20

Illustration 75: Rating matrix Environmental Category

C Social Category		
C.1	Usage Mix (Σ)	Max. 10
C.1.1	Sport Usage	Max. 5
	Minimum 4 home teams, 3 sports types	5
	Minimum 3 home teams, 2 sports types	4
	Minimum 2 home teams, 1 sports type	3
	Minimum 1 home team, 1 sports type	2
	No home team, rarely used for sports events	1
C.1.2	Other Usages	Max. 5
	Minimum 4 retail/commercial facilities and tourist attraction	5
	Minimum 3 retail/commercial facilities and tourist attraction	4
	Minimum 2 retail/commercial facilities and tourist attraction	3
	Minimum 1 retail/commercial facility and tourist attraction	2
	No additional attractions	1

C.2	Utilization(Σ)	Max. 10
C.2.1	Average no. events	Max. 5
	Minimum 4 events per month	5
	Minimum 3 events per month	4
	Minimum 2 events per month	3
	Minimum 1 event per month	2
	Less than 1 event per month	1
C.2.2	Diversity of events	Max. 5
	Minimum 50% non-sports events	5
	Minimum 25% non-sports events	4
	Minimum 5% non-sports events	3
	Minimum 3% non-sports events	2
	No non-sports events	1
	Sub-total	Max. 20
	Total	Max. 60

Illustration 76: Rating matrix Social Category

The ratings are proposed as following:

1 point = very poor

2 points = poor

3 points = fair

4 points = good

5 points = very good

11.3 Sydney 2000, Games of the XXVII Olympiad

11.3.1 Sydney Olympic Stadium event schedules

The following sports events of the home teams Qantas Wallabies⁴¹¹, HSBC Waratahs⁴¹², Qantas Socceroos⁴¹³, NSW State of Origin Blues⁴¹⁴, Sydney Swans⁴¹⁵, Bulldogs⁴¹⁶, South Sydney Rabbitohs⁴¹⁷, Pirtek Parramatta Eels⁴¹⁸ and non-sports events⁴¹⁹ were held at Sydney Olympic Stadium between 18.02.2006-31.12.2010. The event schedules are based on publicly available data from the operator, respective home teams, event managers and other sources.

Summary of events at Sydney Olympic Stadium 2006-2010

No.	Type of events	Spectators
1x	Motorcar Race 2010	No data
2x	Cricket 2010	56,149
8x	Concert 2006, 2008, 2010	347,037
1x	Audition 2010	1,000
6x	Rugby AFL 2009, 2010	220,007
5x	Rugby 2009, 2010	274,992
3x	Football 2008, 2009, 2010	150,040
167x	Rugby NRL 2006, 2007, 2008, 2009,2010	4,261,452

Events per year at Sydney Olympic Stadium 2006-2010

Year	Type of events	Spectators
2010	35x sports events, 8x non-sports events	1,277,314
2009	25x sports events	758,273
2008	48x sports events, 2x non-sports events	1,263,934
2007	40x sports events	1,105,726
2006	34x sports events, 1x non-sports event	914,438

List of events at Sydney Olympic Stadium 2006-2010

Date	Type of events	Spectators
14.12.2010	Concert, U2, '360° Tour'	N/A
13.12.2010	Concert, U2, '360° Tour'	N/A
03.12.2010	Motorcar Race, Sydney Telstra 500 (3 days)	N/A
23.10.2010	Rugby NRL, Sydney Rabbitohs v/s Penrith Panthers	N/A
03.10.2010	Rugby NRL, Illawarra Dragons v/s Sydney Roosters	82,334
25.09.2010	Rugby NRL, Illawarra Dragons v/s Wests Tigers	71,212
11.09.2010	Rugby, Qantas Wallabies v/s All Blacks	70,288
30.08.2010	Rugby NRL, Bulldogs v/s Penrith Panthers	13,794
27.08.2010	Rugby NRL, South Sydney Rabb. v/s Parramatta Eels	19,098
14.08.2010	Rugby NRL, Bulldogs v/s Canberra Raiders	10,116
07.08.2010	Rugby NRL, South Sydney Rabbit. v/s Wests Tigers	23,298
31.07.2010	Rugby AFL, Sydney Swans v/s Geelong Cats	30,710
30.07.2010	Rugby NRL, Bulldogs v/s South Sydney Rabbitohs	15,312
25.07.2010	Rugby NRL, Rabbitohs v/s New Zealand Warriors	13,895
23.07.2010	Rugby NRL, Bulldogs v/s Pirtek Parramatta Eels	34,662
16.07.2010	Rugby NRL, Rabbitohs v/s Illawarra Dragons	22,238
10.07.2010	Football, Sydney FC v/s Everton	40,446
07.07.2010	Rugby NRL, Aussie Blues v/s Queensland Maroons	61,259
26.06.2010	Rugby AFL, Sydney Swans v/s Collingwood	43,585
19.06.2010	Rugby, Qantas Wallabies v/s England	48,392
07.06.2010	Rugby NRL, Rabbitohs v/s North Queensl. Cowboys	9,688
04.06.2010	Rugby NRL, Bulldogs v/s Wests Tigers	11,837
30.05.2010	Rugby NRL, Rabbitohs v/s Penrith Panthers	11,108
26.05.2010	Rugby NRL, Aussie Blues v/s Queensland Maroons	68,753
14.05.2010	Rugby NRL, Bulldogs v/s St George Illawarra Dragons	37,773
02.05.2010	Rugby NRL, Rabbitohs v/s Manly Sea Eagles	15,459
30.04.2010	Rugby NRL, Pirtek Parramatta Eels v/s Bulldogs	31,991
23.04.2010	Rugby NRL, Bulldogs v/s Brisbane Broncos	17,014
18.04.2010	Rugby NRL, Pirtek Parramatta Eels v/s Rabbitohs	25,152
10.04.2010	Rugby NRL, Bulldogs v/s New Zealand Warriors	17,095
05.04.2010	Rugby NRL, South Sydney Rabbitohs v/s Bulldogs	30,120
28.03.2010	Rugby NRL, Bulldogs v/s Sydney Roosters	19,738
27.03.2010	Rugby AFL, Sydney Swans v/s St Kilda Saints	31,330

Date	Type of events	Spectators
19.03.2010	Rugby NRL, Rabbitohs v/s Gold Coast Titans	10,943
14.03.2010	Rugby NRL, Rabbitohs v/s Sydney Roosters	23,149
13.03.2010	Rugby NRL, Bulldogs v/s Newcastle Knights	18,110
27.02.2010	Rugby NRL, Rabbit. v/s St George Illawarra Dragons	27,221
22.02.2010	Concert, AC/DC, 'Black Ice World Tour'	66,896
20.02.2010	Concert, AC/DC, 'Black Ice World Tour'	75,867
18.02.2010	Concert, AC/DC, 'Black Ice World Tour'	70,282
17.01.2010	Cricket, RTA SpeedBlitz Blues v/s South Australia	26,406
13.01.2010	Cricket, RTA SpeedBlitz Blues v/s Queensland	29,743
04.10.2009	Rugby NRL, Melbourne Storm v/s Parramatta Eels	82,538
12.09.2009	Rugby NRL, Bulldogs v/s Newcastle Knights	21,369
30.08.2009	Rugby NRL, Bulldogs v/s New Zealand Warriors	41,835
29.08.2009	Rugby NRL, South Sydney Rabbitohs v/s St George	19,918
24.08.2009	Rugby NRL, Bulldogs v/s Sydney Roosters	12,298
22.08.2009	Rugby, Qantas Wallabies v/s New Zealand	80,228
15.08.2009	Rugby AFL, Sydney Swans v/s Geelong Cats	40,261
14.08.2009	Rugby NRL, Sydney Rabbitohs v/s Gold Coast Titans	11,977
08.08.2009	Rugby NRL, Bulldogs v/s Canberra Raiders	13,310
02.08.2009	Rugby NRL, South Sydney Rabbitohs v/s Bulldogs	24,217
27.07.2009	Rugby NRL, Sydney Rabbitohs v/s Sydney Roosters	11,031
25.07.2009	Rugby NRL, Bulldogs v/s Parramatta Eels	31,664
10.07.2009	Rugby NRL, Rabbitohs v/s Penrith Panthers	9,017
04.07.2009	Rugby NRL, South Sydney Rabbit. v/s Wests Tigers	14,856
27.06.2009	Rugby, Qantas Wallabies v/s Giteau	43,588
26.06.2009	Rugby NRL, Bulldogs v/s North Queensland Cowboys	13,461
24.06.2009	Rugby NRL, State of Or. II NSW Aussie Blues v/s QLD	80,459
20.06.2009	Rugby AFL, Sydney Swans v/s Collingwood	41,042
19.06.2009	Rugby NRL, Bulldogs v/s Panthers	13,992
10.06.2009	Football, Australia v/s Bahrain	39,540
01.06.2009	Rugby NRL, Raiders v/s Rabbitohs	9,805
22.05.2009	Rugby NRL, Eels v/s Rabbitohs	10,670
16.05.2009	Rugby AFL, Sydney Swans v/s West Coast Eagles	33,079
03.05.2009	Rugby NRL, Bulldogs v/s Wests Tigers	25,622
21.03.2009	Rugby, Waratahs v/s Crusaders	32,496

Date	Type of events	Spectators
27.11.2008	Concert, Andre Rieu, 'World Stadium Tour'	35,402
05.10.2008	Rugby NRL, Telstra Premiership Grand Final	80,388
06.09.2008	Rugby NRL, Swans v/s Nth Melbourne	19,127
31.08.2008	Rugby NRL, Bulldogs v/s Broncos	7,685
30.08.2008	Rugby NRL, Dragons v/s Eels	17,103
24.08.2008	Rugby NRL, Rabbitohs v/s Raiders	10,128
23.08.2008	Rugby NRL, Wests Tigers v/s Sea Eagles	27,564
17.08.2008	Rugby NRL, Rabbitohs v/s Sea Eagles	11,114
16.08.2008	Rugby NRL, Swans v/s Geelong	44,995
03.08.2008	Rugby NRL, Tigers v/s Bulldogs	16,121
02.08.2008	Rugby NRL, Rabbitohs v/s Warriors	9,276
28.07.2008	Rugby NRL, Dragons v/s Bulldogs	7,802
26.07.2008	Rugby NRL, Wallabies v/s All Blacks	78,944
20.07.2008	Rugby NRL, Rabbitohs v/s Tigers	21,818
19.07.2008	Rugby NRL, Bulldogs v/s Warriors	12,973
12.07.2008	Rugby NRL, Rabbitohs v/s Eels	17,897
07.07.2008	Rugby NRL, Bulldogs v/s Rabbitohs	15,562
05.07.2008	Rugby NRL, Sydney Swans v/s Collingwood	59,202
02.07.2008	Rugby NRL, NSW v/s QLD	78,751
28.06.2008	Rugby NRL, Qantas Wallabies v/s France	48,899
23.06.2008	Rugby NRL, Rabbitohs v/s Titans	9,827
22.06.2008	Football, Australia v/s China	70,054
21.06.2008	Rugby NRL, Bulldogs v/s Raiders	9,845
20.06.2008	Rugby NRL, Dragons v/s Panthers	9,032
15.06.2008	Rugby NRL, Wests Tigers v/s Eels	22,107
07.06.2008	Rugby NRL, Knights v/s Bulldogs	9,565
01.06.2008	Rugby NRL, Dragons v/s Rabbitohs	12,978
26.05.2008	Rugby NRL, Bulldogs v/s Sharks	9,289
21.05.2008	Rugby NRL, NSW v/s QLD	67,620
18.05.2008	Rugby NRL, Sydney Swans v/s Essendon	34,604
17.05.2008	Rugby NRL, St. George Illawarra v/s Melbourne	16,313
11.05.2008	Rugby NRL, Parramatta v/s St. George Illawarra	16,313
10.05.2008	Rugby NRL, Penrith v/s Bulldogs	10,257
04.05.2008	Rugby NRL, Rabbitohs v/s Cowboys	9,818

Date	Type of events	Spectators
03.05.2008	Rugby NRL, Broncos v/s Wests Tigers	11,787
30.04.2008	Rugby NRL, Bulldogs v/s Wests Tigers	21,057
25.04.2008	Rugby NRL, Dragons v/s Roosters	21,596
19.04.2008	Rugby NRL, Bulldogs v/s Dragons	14,764
14.04.2008	Rugby NRL, Cronulla v/s Rabbitohs	12,988
12.04.2008	Rugby NRL, Sydney v/s West Coast	44,235
05.04.2008	Rugby NRL, Dragons v/s Sharks	15,318
04.04.2008	Rugby NRL, Roosters v/s Bulldogs	36,526
21.03.2008	Rugby NRL, Bulldogs v/s Rabbitohs	21,839
15.03.2008	Rugby NRL, Eels v/s Bulldogs	25,065
02.03.2008	Rugby NRL, Bulldogs v/s Panthers	6,138
01.03.2008	Rugby NRL, Rabbitohs v/s Dragons	25,127
23.02.2008	Rugby NRL, Swans v/s Port Adelaide	2,500
24.01.2008	Concert, The Police 'Reunion Tour'	40,000
10.01.2008	Rugby NRL, WA v/s SpeedBlitz Blues	12,884
08.01.2008	Rugby NRL, SpeedBlitz Blues v/s Queensland	23,737
27.11.2007	Rugby NRL, Sydney v/s Galaxy	80,295
07.10.2007	Rugby NRL, Storm v/s Sea Eagles	81,392
15.09.2007	Rugby NRL, Parramatta Eels v/s Bulldogs	50,621
01.09.2007	Rugby NRL, Roosters v/s Rabbitohs	32,126
31.08.2007	Rugby NRL, Knights v/s Wests Tigers	13,446
24.08.2007	Rugby NRL, Storm v/s Bulldogs	21,756
20.08.2007	Rugby NRL, Rabbitohs v/s Manly	12,087
12.08.2007	Rugby NRL, Bulldogs v/s Raiders	12,127
11.08.2007	Rugby NRL, Sydney Swans v/s St Kilda	63,369
10.08.2007	Rugby NRL, Roosters v/s Wests Tigers	25,166
03.08.2007	Rugby NRL, Eels v/s Bulldogs	27,201
28.07.2007	Rugby NRL, Rabbitohs v/s Gold Coast Titans	13,351
22.07.2007	Rugby NRL, Rabbitohs v/s Cowboys	10,022
14.07.2007	Rugby NRL, Panthers v/s Bulldogs	12,465
07.07.2007	Rugby NRL, Qantas Wallabies v/s Springboks	51,174
06.07.2007	Rugby NRL, West Tigers v/s Panthers	12,395
02.07.2007	Rugby NRL, Bulldogs v/s Roosters	20,722
24.06.2007	Rugby NRL, Rabbitohs v/s Sharks	9,568

Date	Type of events	Spectators
23.06.2007	Rugby NRL, Collingwood v/s Sydney	64,222
15.06.2007	Rugby NRL, Broncos v/s Bulldogs	10,121
13.06.2007	Rugby NRL, Queensland v/s New South Wales	76,924
08.06.2007	Rugby NRL, Rabbitohs v/s Panthers	5,053
04.06.2007	Rugby NRL, Parramatta Eels v/s Wests Tigers	22,245
02.06.2007	Rugby NRL, Uruguay v/s Australia	61,795
26.05.2007	Rugby NRL, Wallabies v/s Wales	40,872
20.05.2007	Rugby NRL, Sharks v/s Bulldogs	12,384
13.05.2007	Rugby NRL, West Tigers v/s Dragons	13,625
12.05.2007	Rugby NRL, Raiders v/s Rabbitohs	11,088
06.05.2007	Rugby NRL, Bulldogs v/s Newcastle Knights	12,654
29.04.2007	Rugby NRL, Warriors v/s Rabbitohs	13,044
27.04.2007	Rugby NRL, Wests Tigers v/s Bulldogs	18,066
14.04.2007	Rugby NRL, Sea Eagles v/s Bulldogs	20,269
06.04.2007	Rugby NRL, Bulldogs v/s Rabbitohs	34,315
01.04.2007	Rugby NRL, Bulldogs v/s Titans	14,675
31.03.2007	Rugby NRL, West Coast v/s Sydney	62,586
25.03.2007	Rugby NRL, Rabbitohs v/s Eels	15,165
16.03.2007	Rugby NRL, Port Adelaide v/s Sydney Swans	3,013
03.03.2007	Rugby NRL, Illawarra Dragons v/s Rabbitohs	23,053
24.01.2007	Rugby NRL, Tasmanian Tigers v/s SpeedBlitz Blues	2,810
10.01.2007	Rugby NRL, Tasmanian Tigers v/s SpeedBlitz Blues	18,464
01.10.2006	Rugby NRL, Broncos v/s Storm	79,609
23.09.2006	Rugby NRL, Storm v/s Dragons	40,901
22.09.2006	Rugby NRL, Swans v/s Dockers	61,313
09.09.2006	Rugby NRL, Bulldogs v/s Raiders	14,628
27.08.2006	Rugby NRL, Cowboys v/s Rabbitohs	8,914
26.08.2006	Rugby NRL, Swans v/s Lions	37,659
18.08.2006	Rugby NRL, Broncos v/s Bulldogs	26,111
13.08.2006	Rugby NRL, Bulldogs v/s Dragons	31,256
06.08.2006	Rugby NRL, Rabbitohs v/s Panthers	9,126
05.08.2006	Rugby NRL, Wallabies v/s South Africa	60,552
29.07.2006	Rugby NRL, Rabbitohs v/s Raiders	6,152
23.07.2006	Rugby NRL, Eels v/s Tigers	21,456

Date	Type of events	Spectators
22.07.2006	Rugby NRL, Bulldogs v/s Roosters	14,020
15.07.2006	Rugby NRL, Manly v/s Rabbitohs	7,509
09.07.2006	Rugby NRL, Bulldogs v/s Warriors	14,076
02.07.2006	Rugby NRL, Bulldogs v/s Wests Tigers	22,511
25.06.2006	Rugby NRL, Warriors v/s Rabbitohs	6,597
24.06.2006	Rugby NRL, Collingwood v/s Swans	60,307
17.06.2006	Rugby NRL, Wests Tigers v/s Sydney Roosters	19,360
12.06.2006	Rugby NRL, Raiders v/s Bulldogs	12,541
11.06.2006	Rugby NRL, Wallabies v/s England	62,124
10.06.2006	Rugby NRL, Rabbitohs v/s Broncos	6,537
04.06.2006	Rugby NRL, Tigers v/s Cowboys	16,736
14.05.2006	Rugby NRL, Bulldogs v/s Eels	13,159
06.05.2006	Rugby NRL, Storm v/s Rabbitohs	8,083
30.04.2006	Rugby NRL, Knights v/s Rabbitohs	8,649
29.04.2006	Rugby NRL, Sydney v/s Geelong	37,032
23.04.2006	Rugby NRL, Manly v/s Canterbury	13,621
11.04.2006	Concert, Rolling Stones 'A Bigger Bang Tour'	58,590
26.03.2006	Rugby NRL, Dragons v/s Rabbitohs	16,049
17.03.2006	Rugby NRL, Bulldogs v/s Tigers	32,578
12.03.2006	Rugby NRL, Roosters v/s Rabbitohs	16,741
11.03.2006	Rugby NRL, Panthers v/s Bulldogs	17,510
10.03.2006	Rugby NRL, Tigers v/s Dragons	27,865
18.02.2006	Rugby NRL, Rabbitohs v/s Dragons	24,566

11.3.2 Sydney Indoor Stadium event schedules

The following sports events^{420, 421, 422, 423} and non-sports events,^{424, 425, 426, 427, 428, 429, 430} were held at Sydney Indoor Stadium between 01.01.2000-31.12.2012. The event schedules are based on publicly available data from the operator, respective home teams, event managers and other sources. In this particular case the data is incomplete, because schedules of previous events were not made available by the operator. During the personal interview the operator stated that in average 85 to 110 events per year are held. However, the exact number remains confidential.

Summary of events at Sydney Indoor Stadium 2000-2012

No.	Type of events	Spectators
1x	Tennis 2001	17,500
10x	Hillsong Conference 2001-2010	2,20,100
8x	Netball 2003, 2004, 2005, 2006, 2007, 2008, 2012	88,004
10x	Music Awards 2003-2011	14,00,000
1x	Basketball 2004	14,805
2x	Hillsong 'Colour Your World' Women's Conf. 2007,2008	32,000
1x	Boxing 2009	16,000
8x	Concerts 2010, 2012	No data
1x	Football 2012	No data
1x	Bull Riding 2012	No data
1x	Disney on Ice 2012	No data
1x	Roller Skating 2012	No data

Events per year at Sydney Indoor Stadium 2000-2012

Year	Type of events	Spectators
2012	4x sports events, 6x non-sports events	13,640
2011	1x non-sports event	No data
2010	4x non-sports events	21,000
2009	1x sports event, 2x non-sports events	38,000
2008	1x sports event, 3x non-sports events	52,999
2007	1x sports event, 4x non-sports events	50,500
2006	1x sports event, 3x non-sports events	50,482
2005	1x sports event, 2x non-sports events	41,350
2004	3x sports events, 2x non-sports event	14,45,931
2003	1x sports event, 2 non-sports event	28,507
2002	1x non-sports event	16,000
2001	1x sports event, 1x non-sports events	30,000

List of events at Sydney Indoor Stadium 2000-2012

Date	Type of events	Spectators
02.07.2001	Hillsong Conference (5 days)	12,500
12.11.2001	Tennis Masters Cup - ATP World Tour Final	17,500
08.07.2002	Hillsong Conference (5 days)	16,000
07.07.2003	Hillsong Conference (5 days)	18,000
12.09.2003	Netball: Commbank Trophy Grand Final	10,507
21.10.2003	17th Annual 'ARIA Music Awards'	No data
05.07.2004	Hillsong Conference (5 days)	21,600
28.08.2004	Netball: Commonwealth Bank Trophy Grand Final	5,187
17.10.2004	18th Annual 'ARIA Music Awards'	No data
13.11.2004	Netball: Australia v/s New Zealand	14,339
26.11.2004	Basketball: NBL: Razorbacks v/s Kings	14,805
29.06.2005	Netball: Australia v/s New Zealand	12,350
04.07.2005	Hillsong Conference (5 days)	29,000
23.10.2005	19th Annual 'ARIA Music Awards'	No data
12.04.2006	MTV Australia Awards	No data
03.07.2006	Hillsong Conference (5 days)	30,000
25.07.2006	Netball: Australia v/s New Zealand	10,482
29.10.2006	20th Annual 'ARIA Music Awards'	10,000

Date	Type of events	Spectators
15.03.2007	Hillsong 'Colour Your World' Women's Conf. (3 days)	16,000+
29.04.2007	MTV Australia Awards	No data
02.07.2007	Hillsong Conference (5 days)	26,000
19.08.2007	Netball: Commonwealth Bank Trophy Grand Final	8,500
28.10.2007	21st Annual 'ARIA Music Awards'	No data
06.03.2008	Hillsong 'Colour Your World' Women's Conf. (3 days)	+16,000
07.07.2008	Hillsong Conference (5 days)	24,000
28.07.2008	Netball: ANZ Championship Grand Final	12,999
19.10.2008	22nd Annual 'ARIA Music Awards'	No data
07.07.2009	Hillsong Conference (5 days)	22,000
26.11.2009	23rd Annual 'ARIA Music Awards'	No data
02.12.2009	Boxing Danny Green v/s Roy Jones Junior	16,000
05.07.2010	Hillsong Conference (5 days)	21,000
18.09.2010	Concert by Metallica	No data
10.11.2010	Concert by Metallica (2 days)	No data
13.11.2010	Concert by Metallica	No data
27.11.2011	25th Annual 'ARIA Music Awards'	No data
11.05.2012	Concert, Prince's 'Welcome to Australia' (2 days)	No data
22.05.2012	Concert, Prince's 'Welcome to Australia'	No data
09.06.2012	Football: LFL - Lingerie Football League	No data
20.06.2012	Concert, Lady Gaga 'Born This Way Tour' (2 days)	No data
23.06.2012	Concert, Lady Gaga 'Born This Way Tour' (2 days)	No data
11.07.2012	Disney On Ice - Let's Celebrate (6 days)	No data
21.07.2012	Bull Riding: Australian Cup Series (PBR) 2012	No data
21.10.2012	Netball: Australia v/s New Zealand	13,640
18.11.2012	Concert, George Michael	No data
21.12.2012	Roller Skating Roller Derby Xtreme (RDX)	No data

11.3.3 Canberra Football Stadium event schedules

The following sports events^{431, 432, 433, 434} of the home teams Canberra Raiders⁴³⁵, ACT Brumbies⁴³⁶ and non-sports events^{437, 438, 439} were held at Canberra Football Stadium between 04.10.2000-31.12.2012. The event schedules are based on publicly available data from the operator, respective home teams, event managers and other sources.

Summary of events at Canberra Football Stadium 2000-2012

No.	Type of events	Spectators
153x	Rugby League 2001 - 2012	1,546,883
95x	Rugby Union 2001 - 2012	1,336,221
20x	Football Games 2000 - 2010	31,915
4x	RWC 2003 - 2006 (2003, 2004, 2005, 2006)	83,248
1x	Motor Cross X 2010	No data
3x	Opening Ceremony 2003 - 2006 (except 2004)	6,807
1x	Function 2007	1,000
1x	Dance Show 2003	13,680
2x	Concert 2002, 2012	14,501

Events per year at Canberra Football Stadium 2000-2012

Year	Type of events	Spectators
2012	22x sports events, 1x non-sports event	2,23,071
2011	22x sports events	2,64,000
2010	25x sports events	284,935
2009	22x sports events	234,489
2008	19x sports events	226,520
2007	19x sports events, 1x non-sports event	246,929
2006	22x sports events, 1x non-sports event	274,719
2005	21x sports events, 1x non-sports event	292,353
2004	8x sports events	90,005
2003	37x sports events, 2x non-sports events	622,977
2002	20x sports events, 1x non-sports event	256,715
2001	31x sports events	
2000	5x sports. events	

List of events at Canberra Football Stadium 2000-2012

Date	Type of events	Spectators
14.11.2012	Elton John, Concert	12,000
09.09.2012	Rugby League, Canberra Raiders v/s Sharks	24,450
24.08.2012	Rugby League, Canberra Raiders v/s. Bulldogs	13,158
18.08.2012	Rugby League, Canberra Raiders v/s Roosters	No data
05.08.2012	Rugby League, Canberra Raiders v/s Broncos	9,850
29.07.2012	Rugby League, Canberra Raiders v/s Knights	10,260
15.07.2012	Rugby League, Canberra Raiders v/s Titans	8,240
14.07.2012	Rugby Union, Brumbies v/s Blues	No data
02.07.2012	Rugby League, Canberra Raiders v/s Dragons	10,462
12.06.2012	Rugby Union, Brumbies v/s Wales	No data
02.06.2012	Rugby League, Canberra Raiders v/s Wests Tigers	9,210
26.05.2012	Rugby Union, Brumbies v/s Reds	16,123
13.05.2012	Rugby League, Canberra Raiders v/s Eels	9,210
05.05.2012	Rugby Union, Brumbies v/s Waratahs	No data
29.04.2012	Rugby League, Canberra Raiders v/s Sharks	12,227
14.04.2012	Rugby Union, Brumbies v/s Rebels	14,011
08.04.2012	Rugby League, Canberra Raiders v/s Warriors	10,800
02.04.2012	Rugby League, Canberra Raiders v/s Cowboys	12,135
31.03.2012	Rugby Union, Brumbies v/s Sharks	No data
24.03.2012	Rugby Union, Brumbies v/s Highlanders	12,269
10.03.2012	Rugby Union, Brumbies v/s Cheetahs	16,593
03.03.2012	Rugby League, Canberra Raiders v/s Storm	7,862
24.02.2012	Rugby Union, Brumbies v/s Force	14,211
07.10.2011	Football, Qantas Socceroos v/s Malaysia	10,041
14.08.2011	Rugby League, Canberra Raiders v/s Rabbitohs	12,150
25.07.2011	Rugby League, Canberra Raiders v/s Dragons	10,425
17.07.2011	Rugby League, Canberra Raiders v/s Storm	11,853
27.08.2011	Rugby League, Canberra Raiders v/s Panthers	10,085
04.07.2011	Rugby League, Canberra Raiders v/s Storm	No data
25.06.2011	Rugby League, Canberra Raiders v/s Eels	13,457
10.06.2011	Rugby Union, Brumbies v/s Rebels	11,777
05.06.2011	Rugby League, Canberra Raiders v/s Cowboys	11,128
28.05.2011	Rugby Union, Brumbies v/s Stormers	10,311

Date	Type of events	Spectators
20.05.2011	Rugby League, Canberra Raiders v/s Bulldogs	12,865
14.05.2011	Rugby Union, Brumbies v/s Lions	10,122
01.05.2011	Rugby League, Canberra Raiders v/s Wests Tigers	13,425
24.04.2011	Rugby League, Canberra Raiders v/s Knights	11,879
17.04.2011	Rugby Union, Brumbies v/s Force	13,123
09.04.2011	Rugby Union, Brumbies v/s Hurricanes	12,333
02.04.2011	Rugby League, Canberra Raiders v/s Titans	12,165
26.03.2011	Rugby Union, Brumbies v/s Waratahs	18,011
18.03.2011	Rugby League, Canberra Raiders v/s Broncos	16,146
13.03.2011	Rugby League, Canberra Raiders v/s Sharks	13,450
05.03.2011	Rugby Union, Brumbies v/s Reds	16,027
19.02.2011	Rugby Union, Brumbies v/s Chiefs	13,227
23.10.2010	Motor Cross, Super X	7,064
20.09.2010	Rugby League, ACT Junior Rugby League Finals	2,983
19.09.2010	Rugby League, ACT Junior Rugby League Finals	2,421
17.09.2010	Rugby League, Canberra Raiders v/s Tigers	21,965
04.09.2010	Rugby Union, ACT Junior Rugby Union Finals	2,889
28.08.2010	Rugby League, Canberra Raiders v/s Cowboys	10,434
22.08.2010	Rugby League, Canberra Raiders v/s Dragons	19,722
09.08.2010	Rugby League, Canberra Raiders v/s Panthers	7,185
24.07.2010	Rugby League, Canberra Raiders v/s Sharks	8,304
18.07.2010	Rugby League, Canberra Raiders v/s Knights	8,469
04.07.2010	Rugby League, Canberra Raiders v/s Roosters	9,742
28.06.2010	Rugby League, Canberra Raiders v/s Bulldogs	10,050
06.06.2010	Rugby League, Canberra Raiders v/s Titans	9,301
05.06.2010	Football, Australia v/s Fiji	13,901
15.05.2010	Rugby League, Canberra Raiders v/s Storm	10,693
08.05.2010	Rugby Union, Brumbies v/s Highlanders	15,168
01.05.2010	Rugby Union, Brumbies v/s Reds	16,482
25.04.2010	Rugby League, Canberra Raiders v/s Rabbitohs	12,772
16.04.2010	Rugby Union, Brumbies v/s Hurricanes	13,763
10.04.2010	Rugby Union, Brumbies v/s Cheetahs	13,143
04.04.2010	Rugby League, Canberra Raiders v/s Tigers	16,328
26.03.2010	Rugby Union, Brumbies v/s Chiefs	13,640

Date	Type of events	Spectators
22.03.2010	Rugby League, Canberra Raiders v/s Broncos	12,894
13.03.2010	Rugby Union, Brumbies v/s Sharks	14,739
05.03.2010	Rugby Union, Brumbies v/s Lions	10,883
31.10.2009	Football, Central Coast Mariners v/s Adelaide Unit.(AL)	4,843
19.09.2009	Rugby League, ACT Jun. Rugby League Final (2 days)	2,900
05.09.2009	Rugby Union, ACT Junior Rugby Union Finals (2 days)	2,507
04.09.2009	Football, Central Coast Mariners v/s Perth Glory (AL)	4,089
31.08.2009	Rugby League, Canberra Raiders v/s Knights	8,530
15.08.2009	Rugby League, Canberra Raiders v/s Dragons	18,749
01.08.2009	Rugby League, Canberra Raiders v/s Broncos	8,785
26.07.2009	Rugby League, Canberra Raiders v/s Tigers	10,743
05.07.2009	Rugby League, Canberra Raiders v/s Titans	8,704
28.06.2009	Rugby League, Canberra Raiders v/s Storm	8,651
14.06.2009	Rugby League, Canberra Raiders v/s Sharks	8,704
13.06.2009	Rugby Union, Wallabies v/s Italy	20,743
24.05.2009	Rugby League, Canberra Raiders v/s Warriors	7,383
09.05.2009	Rugby Union, Brumbies v/s Blues	15,258
02.05.2009	Rugby League, Canberra Raiders v/s Panthers	7,900
26.04.2009	Rugby League, Canberra Raiders v/s Bulldogs	11,204
17.04.2009	Rugby Union, Brumbies v/s Bulls	12,392
11.04.2009	Rugby Union, Brumbies v/s Stormers	13,320
14.03.2009	Rugby Union, Brumbies v/s Waratahs	21,094
28.02.2009	Rugby Union, Brumbies v/s Force	15,173
21.02.2009	Rugby Union, Brumbies v/s Crusaders	17,501
30.01.2009	Rugby Union, Brumbies v/s Hurricanes	5,316
07.09.2008	Rugby League, Canberra Raid. v/s Canterb. Bulldogs	14,396
17.08.2008	Rugby League, Canberra Raid. v/s Newcastle Knights	11,206
10.08.2008	Rugby League, Canberra Raiders v/s Penrith Panthers	5,880
26.07.2008	Rugby League, Canberra Raid. v/s Gold Coast Titans	8,700
20.07.2008	Rugby League, Canberra Raiders v/s Roosters	11,174
30.06.2008	Rugby League, Canberra Raiders v/s Cronulla Sharks	9,136
15.06.2008	Rugby League, Canberra Raid. v/s Brisbane Broncos	10,157
30.05.2008	Rugby League, Canberra Raid. v/s Manly Sea Eagles	11,486
19.05.2008	Rugby League, Canberra Raiders v/s Rabbitohs	10,155

Date	Type of events	Spectators
25.04.2008	Rugby Union, Brumbies v/s Lions	13,708
21.04.2008	Rugby League, Canberra Raiders v/s Melbourne Storm	14,113
19.04.2008	Rugby Union, Brumbies v/s SA Sharks	12,830
13.04.2008	Rugby League, Canberra Raiders v/s Wests Tigers	11,619
04.04.2008	Rugby Union, Brumbies v/s Chiefs	13,313
29.03.2008	Rugby League, Canberra Raiders v/s St George	13,721
21.03.2008	Rugby Union, Brumbies v/s Cheetahs	13,157
14.03.2008	Rugby Union, Brumbies v/s Highlanders	13,359
01.03.2008	Rugby Union, Brumbies v/s Queensland Reds	14,929
23.02.2008	Rugby Union, Brumbies v/s Highlanders	13,481
01.09.2007	Rugby League, Canberra Raiders v/s Cronulla Sharks	10,440
18.08.2007	Rugby League, Canberra Raiders v/s NZ Warriors	7,334
27.07.2007	Rugby League, Canberra Raiders v/s Penrith Panthers	6,783
15.07.2007	Rugby League, Canberra Raid. v/s Gold Coast Titans	7,973
01.07.2007	Rugby League, Canberra Raiders v/s Wests Tigers	11,798
23.06.2007	Rugby League, Canberra Raiders v/s Cowboys	11,263
09.06.2007	Rugby League, Canberra Raiders v/s Parramatta Eels	11,232
25.05.2007	Rugby League, Canberra Raiders v/s St George	13,187
06.05.2007	Rugby League, Canberra Raid. v/s Manly Sea Eagles	14,387
28.04.2007	Rugby Union, Brumbies v/s Canterbury Crusaders	20,127
20.04.2007	Rugby Union, Brumbies v/s Western Force	18,021
16.04.2007	Rugby League, Canberra Raiders v/s Roosters	15,862
08.04.2007	Rugby Union, Brumbies v/s Waratahs	23,097
02.04.2007	Rugby League, Canberra Raid. v/s Newcastle Knights	13,109
24.03.2007	Rugby League, Canberra Raiders v/s Melbourne Storm	9,556
18.03.2007	Function, Australian Idol Auditions	1,000
09.03.2007	Rugby Union, Brumbies v/s Stormers	14,410
03.03.2007	Rugby Union, Brumbies v/s SA Bulls	15,101
10.02.2007	Rugby Union, Brumbies v/s Blues	16,127
26.01.2007	Rugby Union, Brumbies v/s Hurricanes	6,122
23.09.2006	Rugby League, ACT Jun. Rugby League Final (2 days)	4,979
15.09.2006	Rugby Union, ACT Junior Rugby Union Finals (3 days)	9,277
26.08.2006	Rugby League, Canberra Raiders v/s Melbourne Storm	21,255
06.08.2006	Rugby League, Canberra Raid. v/s Brisbane Broncos	13,137

Date	Type of events	Spectators
23.07.2006	Rugby League, Canberra Raiders v/s St George	13,904
22.07.2006	Football, Sydney FC v/s Newcastle Jets	6,881
16.07.2006	Rugby League, Canberra Raiders v/s Wests Tigers	9,125
09.07.2006	Kanga Cup Opening Ceremony	2,234
01.07.2006	Rugby League, Canberra Raiders v/s Parramatta Eels	8,824
25.06.2006	Rugby League, Canberra Raiders v/s Sydney Roosters	11,000
03.06.2006	Rugby League, Canberra Raid. v/s Sydney Rabbitohs	9,298
14.05.2006	Rugby League, Canberra Raiders v/s Cronulla Sharks	8,895
06.05.2006	Rugby Union, Brumbies v/s Highlanders	18,862
29.04.2006	Rugby Union, Brumbies v/s Queensland Reds	17,041
22.04.2006	Rugby Union, Brumbies v/s Hurricanes	16,751
15.04.2006	Rugby League, Canberra Raiders v/s NZ Warriors	6,174
09.04.2006	Rugby League, Canberra Raid. v/s Canterb. Bulldogs	11,425
08.04.2006	Rugby Union, Brumbies v/s Cheetahs	15,927
01.04.2006	Rugby League, Canberra Raiders v/s Penrith Panthers	8,399
19.03.2006	Rugby League, Canberra Raid. v/s Newcastle Knights	10,193
15.03.2006	Rugby Union, Brumbies v/s Waikato Chiefs	16,953
11.03.2006	Rugby Union, Brumbies v/s SA Sharks	15,134
03.03.2006	Rugby Union, Brumbies v/s SA Cats	19,051
19.09.2005	Rugby League ACT Jun. Rugby League Finals (2 days)	3,176
12.09.2005	Rugby Union, ACT Junior Rugby Union Finals (4 days)	8,031
03.09.2005	Rugby League, Canberra Raiders v/s Manly	9,866
13.08.2005	Rugby League, Canberra Raid. v/s Sydney Rabbitohs	7,905
07.08.2005	Rugby League, Canberra Raiders v/s Wests Tigers	14,695
17.07.2005	Rugby League, Canberra Raiders v/s Parramatta Eels	12,738
09.07.2005	Kanga Cup Opening Ceremony	453
03.07.2005	Rugby League, Canberra Raiders v/s Penrith Panthers	9,206
26.06.2005	Rugby Union, Australia A v/s Junior All Blacks	8,750
25.06.2005	Rugby League, Canb. Raiders v/s Nth Queensl. Cowb.	9,129
11.06.2005	Rugby League, Canberra Raid. v/s Brisbane Broncos	8,609
15.05.2005	Rugby League, Canberra Raiders v/s Cronulla Sharks	13,844
11.05.2005	Rugby Union, Brumbies v/s Stormers	22,316
07.05.2005	Rugby Union, Brumbies v/s Waikato Chiefs	20,077
24.04.2005	Rugby League, Canberra Raiders v/s Melbourne Storm	13,280

Date	Type of events	Spectators
16.04.2005	Rugby Union, Brumbies v/s NSW Waratahs	27,040
10.04.2005	Rugby League, Canberra Raiders v/s Sydney Roosters	19,130
02.04.2005	Rugby League, Canberra Raiders v/s St George	15,614
19.03.2005	Rugby League, Canberra Raid. v/s Newcastle Knights	11,835
04.03.2005	Rugby Union, Brumbies v/s SA Bulls	20,927
26.02.2005	Rugby Union, Brumbies v/s Crusaders	24,115
19.02.2005	Rugby Union, Brumbies v/s Hurricanes	11,617
18.09.2004	Rugby League, ACT Jun. Rugby League Final (2 days)	3,700
04.09.2004	Rugby League, Canberra Raid. v/s S. Sydney Rabbit.	10,839
22.08.2004	Rugby League, Canberra Raiders v/s Sydney Roosters	15,312
15.08.2004	Rugby League, Canberra Raiders v/s Melbourne Storm	9,801
25.07.2004	Rugby League, Canberra Raiders v/s NZ Warriors	8,535
10.07.2004	Rugby League, Canberra Raid. v/s Nth Queensl. Co.	8,771
03.07.2004	Rugby League, Canberra Raiders v/s Wests Tigers	10,792
21.02.2004	Rugby Union, Brumbies v/s Auckland Blues	22,255
01.11.2003	Masters Games Opening Ceremony	4,120
25.10.2003	RWC 2006, Wales v/s Italy	22,641
19.10.2003	RWC 2004, Wales v/s Tonga	19,748
15.10.2003	RWC 2003, Italy v/s Tonga	20,357
03.10.2003	RWC 2005, Italy v/s Canada	20,502
12.09.2003	Rugby League, Canberra Raiders v/s Melbourne Storm	14,049
07.09.2003	Rugby League, Canberra Raiders v/s Sydney Roosters	22,813
29.08.2003	Rugby Union, ACT Junior Rugby Union Finals (3 days)	6,000
25.08.2003	Rugby League, Canberra Raid. v/s Newcastle Knights	8,050
16.08.2003	Rugby League, Canberra Raid. v/s Nth Queensl. Co.	8,074
27.07.2003	Rugby League, Canberra Raiders v/s Cronulla Sharks	9,563
19.07.2003	Rugby League, Canberra Raiders v/s Wests Tigers	10,363
06.07.2003	Rugby League, Canberra Raiders v/s Melbourne Storm	11,689
29.06.2003	Rugby Union, Brumbies v/s Tonga	8,021
22.06.2003	Rugby Union, Brumbies v/s Fiji	10,486
15.06.2003	Rugby League, Canberra Raid. v/s Brisbane Broncos	18,136
12.06.2003	Rugby League, Canberra Raiders v/s Cronulla Sharks	9,922
07.06.2003	Rugby League, Canberra Raiders v/s Parramatta Eels	12,968
29.05.2003	Rugby League, Canberra Raiders v/s Manly	9,229

Date	Type of events	Spectators
22.05.2003	Rugby Union, Brumbies v/s Canterbury Crusaders	28,753
17.05.2003	Rugby League, Canberra Raiders v/s Penrith Panthers	13,140
15.05.2003	Rugby Union, Brumbies v/s Waikato Chiefs	23,191
09.05.2003	Rugby Union, Brumbies v/s Canterbury Crusaders	25,279
09.05.2003	Rugby League, Canberra Raid. v/s Brisbane Broncos	12,319
01.05.2003	Rugby Union, Brumbies v/s Hurricanes	21,474
26.04.2003	Rugby League, Canberra Raid. v/s Canterbury Bulld.	19,372
24.04.2003	Rugby League, Canberra Raid. v/s Newcastle Knights	10,280
18.04.2003	Rugby Union, Brumbies v/s NSW Warathas	25,112
09.04.2003	Rugby Union, Brumbies v/s Highlanders	23,104
06.04.2003	Rugby Union, Brumbies v/s Waikato Chiefs	18,154
03.04.2003	Rugby League, Canberra Raiders v/s Parramatta Eels	13,285
29.03.2003	Rugby League, Canberra Raiders v/s St George	13,744
28.03.2003	Rugby Union, Brumbies v/s Queensland Reds	24,017
22.03.2003	Rugby Union, Brumbies v/s SA Bulls	20,240
19.03.2003	Rugby League, Canberra Raiders v/s Penrith Panthers	14,327
14.03.2003	Rugby Union, Brumbies v/s SA Stormers	18,896
06.03.2003	Rugby Union, Brumbies v/s SA Sharks	18,064
27.02.2003	Rugby Union, Brumbies v/s SA Cats	19,815
11.02.2003	Dance Show, Riverdance (5 days)	13,680
05.10.2002	Concert, Celtic Crossroads	2,501
15.09.2002	Rugby Union, ACT Junior Rugby Union Finals	5,000
07.09.2002	Rugby League, Canberra Raiders v/s Melbourne Storm	9,374
25.08.2002	Rugby League, Canberra Raid. v/s Canterbury Bulld.	13,751
17.08.2002	Rugby League, Canberra Raiders v/s Sydney Roosters	10,526
11.08.2002	Rugby League, Canberra Raiders v/s Wests Tigers	10,081
27.07.2002	Rugby League, Canberra Raid. v/s Auckland Warriors	8,702
24.07.2002	Football, Australian U23 v/s Chilean Colo Colo	2,201
14.07.2002	Rugby League, Canberra Raid. v/s Newcastle Knights	10,082
30.06.2002	Rugby League, Canberra Raiders v/s Penrith Panthers	6,736
01.06.2002	Rugby League, Canberra Raiders v/s Northern Eagles	6,295
26.05.2002	Rugby League, Canberra Raid. v/s North Queensland	6,088
10.05.2002	Rugby Union, Brumbies v/s NZ Blues	23,623
04.05.2002	Rugby League, Canberra Raiders v/s Cronulla Sharks	9,370

Date	Type of events	Spectators
26.04.2002	Rugby Union, Brumbies v/s NZ Highlanders	20,724
14.04.2002	Rugby Union, Brumbies v/s Hurricanes	21,011
13.04.2002	Rugby League, Canberra Raid. v/s Brisbane Broncos	10,929
23.03.2002	Rugby League, Canberra Raiders v/s South Sydney	16,292
08.03.2002	Rugby Union, Brumbies v/s SA Sharks	20,940
02.03.2002	Rugby Union, Brumbies v/s SA Cats	19,518
23.02.2002	Rugby Union, Brumbies v/s Queensland Reds	22,971
10.09.2001	Rugby Union, ACT Junior Rugby Union Finals (3 days)	7,773
01.09.2001	Rugby League, Canberra Raiders v/s Melbourne Storm	6,439
19.08.2001	Rugby League, Canberra Raiders v/s Northern Eagles	6,987
11.08.2001	Rugby League, Canberra Raiders v/s Penrith Panthers	6,189
22.07.2001	Rugby League, Canberra Raiders v/s Wests Tiger	7,259
24.06.2001	Rugby League, Canberra Raiders v/s Roosters	No data
16.06.2001	Rugby League, Canberra Raiders v/s Cronulla Sharks	No data
26.05.2001	Rugby Union, Brumbies v/s SA Sharks	No data
19.05.2001	Rugby Union, Brumbies v/s Queensland Reds	No data
13.05.2001	Rugby League, Canberra Raid. v/s Brisbane Broncos	No data
11.05.2001	Rugby Union, Brumbies v/s Waikato Chiefs	No data
29.04.2001	Football, Canberra Cosmos v/s Perth Glory	No data
25.04.2001	Football, Canberra	No data
21.04.2001	Rugby League, Canberra Cosmos v/s Northern Spirit	No data
15.04.2001	Rugby League, Canberra Raid. v/s North Queensland	No data
13.04.2001	Rugby Union, Brumbies v/s Waratahs	No data
08.04.2001	Rugby League, Canberra Raid. v/s Newcastle Knights	No data
07.04.2001	Rugby League, Canberra Cosmos v/s Eastern Pride	No data
25.03.2001	Rugby League, Canberra Raiders v/s Parramatta	No data
24.03.2001	Rugby Union, Brumbies v/s SA Stormers	No data
23.03.2001	Football, Canberra Cosmos v/s Sydney United	No data
18.03.2001	Rugby League, Canberra Raiders v/s St George	No data
17.03.2001	Rugby Union, Brumbies v/s SA Bulls	No data
10.03.2001	Football, Canberra Cosmos v/s Wollongong Wolves	No data
03.03.2001	Football, Canberra Cosmos v/s Newcastle Breakers	No data
25.02.2001	Rugby League, Canberra Raiders v/s Bulldogs	No data
24.02.2001	Football, Canberra Cosmos v/s Parramatta Power	No data

Date	Type of events	Spectators
23.02.2001	Rugby Union, Brumbies v/s Canterbury	No data
17.02.2001	Football, Canberra Cosmos v/s Brisbane Strikers	No data
03.02.2001	Football, Canberra Cosmos v/s Marconi Stallions	No data
13.01.2001	Football, Canberra Cosmos v/s Adelaide City	No data
30.12.2000	Football, Canberra Cosmos v/s Kings FC	No data
16.12.2000	Football, Canberra Cosmos v/s Sydney Olympic	No data
02.12.2000	Football, Canberra Cosmos v/s South Melbourne	No data
28.10.2000	Football, Canberra Cosmos v/s Melbourne Knights	No data
14.10.2000	Football, Canberra Cosmos v/s Carlton	No data

11.4 Athens 2004, Games of the XXVIII Olympiad

11.4.1 Athens Olympic Stadium event schedules

The following sports events of the home teams Panathinaikos FC⁴⁴⁰ and AEK FC⁴⁴¹ and other non-sports events⁴⁴² were held at Athens Olympic Stadium between 01.01.2004-31.12.2010. The event schedules are based on publicly available data from the operator, respective home teams, event managers and other sources.

Summary of events at Athens Olympic Stadium 2004-2010

No.	Type of events	Spectators
270x	Football Games 2004-2010	No data
5x	Concerts 2004-2010 (2006, 2007, 2008, 2009, 2010)	No data
3x	Athletics 2004-2010 (2006, 2007, 2008)	No data
2x	Functions 2004-2010 (2005)	No data
2x	Rally 2004-2010 (2005, 2006)	No data
1x	Party 2007	No data
1x	Conference 2004-2010 (2006)	No data

Events per year Athens Olympic Stadium 2004-2010

Year	Type of events	Spectators
2010	40x sports events, 1x non-sports event	No data
2009	39x sports events, 1x non-sports event	No data
2008	42x sports events, 1x non-sports event	No data
2007	40x sports events, 2x non-sports events	No data
2006	39x sports events, 2x non-sports events	No data
2005	39x sports events, 2x non-sports events	No data
2004	37x sports events	No data

The following sports and non-sports events⁴⁴³ were held at 'Common Domain' of the Olympic Park in Athens between 01.01.2004-31.12.2010. The event schedules are based on publicly available data from the operator, respective home teams, event managers and other sources.

Summary of Events Athens Common Domain 2004-2010

No.	Type of events	Spectators
2x	Function 2005	No data
1x	Party 2007	No data

List of Events Athens Common Domain 2004-2010

Date	Type of events	Spectators
17.07.2007	Party, Fly Beyond Festival (3 days)	No data
29.10.2005	Function, Awards ceremony of LR International Hellas	No data
19.10.2005	Function, Awareness campaign for breast cancer	No data

List of Events Athens Olympic Stadium 2004-2010

Date	Type of events	Spectators
18.12.2010	Football, Panathinaikos v/s Volos (SL)	No data
16.12.2010	Football, AEK Athens v/s Zenit St Peters. (UEFA EL)	No data
12.12.2010	Football, AEK Athens v/s Larissa (SL)	No data
04.12.2010	Football, Panathinaikos v/s Panserraikos (SL)	No data
27.11.2010	Football, AEK Athens v/s Olympiakos (SL)	No data
24.11.2010	Football, Panathinaikos v/s Barcelona (UEFA CL)	No data
20.11.2010	Football, Panathinaikos v/s Iraklis Salonika (SL)	No data
13.11.2010	Football, Panathinaikos v/s Larissa (SL)	No data
08.11.2010	Football, AEK Athens v/s Ergotelis (SL)	No data
04.11.2010	Football, AEK Athens v/s Anderlecht (UEFA EL)	No data
02.11.2010	Football, Panathinaikos v/s Rubin Kazan (UEFA CL)	No data
30.10.2010	Football, Panathinaikos v/s Olympiakos (SL)	No data
24.10.2010	Football, AEK Athens v/s Panathinaikos (SL)	No data
20.10.2010	Football, Panathinaikos v/s Rubin Kazan (UEFA CL)	No data
16.10.2010	Football, Panathinaikos v/s PAOK Salonika (SL)	No data
03.10.2010	Football, AEK Athens v/s Xanthi (SL)	No data
29.09.2010	Football, Panathinaikos v/s FC Copenh. (UEFA CL)	No data
25.09.2010	Football, Panathinaikos v/s Panionios (SL)	No data
19.09.2010	Football, AEK Athens v/s Asteras Tripolis (SL)	No data
16.09.2010	Football, AEK Athens v/s Hajduk Split (UEFA EL)	No data
12.09.2010	Football, AEK Athens v/s Panserraikos (SL)	No data
03.09.2010	Concert, U2, '360° Tour'	No data
27.08.2010	Football, Panathinaikos v/s Xanthi (SL)	No data
26.08.2010	Football, AEK Athens v/s Dundee United (UEFA EL)	No data
18.04.2010	Football, AEK Athens v/s Asteras Tripolis (SL)	No data
11.04.2010	Football, Panathinaikos v/s Iraklis Salonika (SL)	No data
28.03.2010	Football, AEK Athens v/s Panionios (SL)	No data
21.03.2010	Football, Panathinaikos v/s Olympiakos (SL)	No data
13.03.2010	Football, AEK Athens v/s Kavala (SL)	No data
11.03.2010	Football, Panathinaikos v/s Standard Liege (UEFA EL)	No data
07.03.2010	Football, Panathinaikos v/s Levadiakos (SL)	No data
27.02.2010	Football, AEK Athens v/s Ergotelis (SL)	No data
21.02.2010	Football, AEK Athens v/s Aris Salonika (SL)	No data

Date	Type of events	Spectators
18.02.2010	Football, Panathinaikos v/s Roma (UEFA EL)	No data
14.02.2010	Football, Panathinaikos v/s Kavala (SL)	No data
06.02.2010	Football, AEK Athens v/s Xanthi (SL)	No data
31.01.2010	Football, Panathinaikos v/s AEK Athens (SL)	No data
24.01.2010	Football, AEK Athens v/s Giannina (SL)	No data
17.01.2010	Football, Panathinaikos v/s Panthrakikos (SL)	No data
10.01.2010	Football, AEK Athens v/s Atromitos Athens (SL)	No data
06.01.2010	Football, Panathinaikos v/s Ergotelis (SL)	No data
19.12.2009	Football, Panathinaikos v/s Giannina (SL)	No data
16.12.2009	Football, Panathina. v/s Dinamo Bucharest (UEFA EL)	No data
13.12.2009	Football, AEK Athens v/s Levadiakos (SL)	No data
06.12.2009	Football, Panathinaikos v/s Atromitos Athens (SL)	No data
02.12.2009	Football, AEK Athens v/s Everton (UEFA EL)	No data
28.11.2009	Football, AEK Athens v/s PAOK Salonika (SL)	No data
22.11.2009	Football, Panathinaikos v/s Asteras Tripolis (SL)	No data
09.11.2009	Football, AEK Athens v/s Larissa (SL)	No data
05.11.2009	Football, AEK Athens v/s BATE Borisov (UEFA EL)	No data
01.11.2009	Football, Panathinaikos v/s Panionios (SL)	No data
25.10.2009	Football, Panathinaikos v/s PAOK Salonika (SL)	No data
22.10.2009	Football, Panathinaikos v/s Sturm Graz (UEFA EL)	No data
18.10.2009	Football, AEK Athens v/s Panthrakikos (SL)	No data
05.10.2009	Football, Panathinaikos v/s Larissa (SL)	No data
01.10.2009	Football, AEK Athens v/s Benfica (UEFA EL)	No data
27.09.2009	Football, AEK Athens v/s Panathinaikos (SL)	No data
23.09.2009	Football, AEK Athens v/s Olympiakos (SL)	No data
20.09.2009	Football, Panathinaikos v/s Aris Salonika (SL)	No data
17.09.2009	Football, Panathinaikos v/s Galatasaray (UEFA EL)	No data
13.09.2009	Football, AEK Athens v/s Iraklis Salonika (SL)	No data
30.08.2009	Football, Panathinaikos v/s Xanthi (SL)	No data
27.08.2009	Football, AEK Athens v/s Vaslui (UEFA EL)	No data
19.08.2009	Football, Panathinaikos v/s Atletico Madrid (UEFA CL)	No data
04.08.2009	Football, Panathinaikos v/s Sparta Prague (UEFA CL)	No data
28.05.2009	Concert, AC/DC, 'Black Ice World Tour'	60,000
26.04.2009	Football, Panathinaikos v/s OFI Crete (SL)	No data

Date	Type of events	Spectators
12.04.2009	Football, AEK Athens v/s Aris Salonika (SL)	No data
05.04.2009	Football, Panathinaikos v/s Xanthi (SL)	No data
22.03.2009	Football, AEK Athens v/s Levadiakos (SL)	No data
10.03.2009	Football, Panathinaikos v/s Villarreal (UEFA CL)	No data
07.03.2009	Football, Panathinaikos v/s Larissa (SL)	No data
28.02.2009	Football, AEK Athens v/s Xanthi (SL)	No data
21.02.2009	Football, Panathinaikos v/s Panionios (SL)	No data
14.02.2009	Football, AEK Athens v/s Thrasivoulos Fylis (SL)	No data
08.02.2009	Football, Panathinaikos v/s PAOK Salonika (SL)	No data
01.02.2009	Football, AEK Athens v/s Olympiakos (SL)	No data
25.01.2009	Football, AEK Athens v/s Panionios (SL)	No data
18.01.2009	Football, Panathinaikos v/s Aris Salonika (SL)	No data
11.01.2009	Football, AEK Athens v/s PAOK Salonika (SL)	No data
04.01.2009	Football, Panathinaikos v/s AEK Athens (SL)	No data
21.12.2008	Football, AEK Athens v/s Ergotelis (SL)	No data
14.12.2008	Football, Panathinaikos v/s Panserraikos (SL)	No data
09.12.2008	Football, Panathina. v/s Anorthosis Famag. UEFA CL	No data
07.12.2008	Football, AEK Athens v/s Panthrakikos (SL)	No data
29.11.2008	Football, Panathinaikos v/s Asteras Tripolis (SL)	No data
22.11.2008	Football, Panathinaikos v/s Thrasivoulos Fylis (SL)	No data
15.11.2008	Football, AEK Athens v/s Panserraikos (SL)	No data
09.11.2008	Football, Panathinaikos v/s Olympiakos (SL)	No data
02.11.2008	Football, AEK Athens v/s Asteras Tripolis (SL)	No data
29.10.2008	Football, Panathinaikos v/s Ergotelis (SL)	No data
26.10.2008	Football, Panathinaikos v/s Iraklis Salonika (SL)	No data
22.10.2008	Football, Panathina. v/s Werder Bremen (UEFA CL)	No data
19.10.2008	Football, AEK Athens v/s Larissa (SL)	No data
05.10.2008	Football, Panathinaikos v/s Levadiakos (SL)	No data
27.09.2008	Concert, Madonna, 'Sticky and Sweet Tour'	80,000
21.09.2008	Football, AEK Athens v/s Iraklis Salonika (SL)	No data
16.09.2008	Football, Panathinaikos v/s Inter Milan (UEFA CL)	No data
13.09.2008	Football, Panathinaikos v/s Panthrakikos (SL)	No data
31.08.2008	Football, AEK Athens v/s Panathinaikos (SL)	No data
26.08.2008	Football, Panathinaikos v/s Sparta Prague (UEFA CL)	No data

Date	Type of events	Spectators
14.08.2008	Football, AEK Athens v/s Omonia Nicosia (UEFA Cup)	No data
30.07.2008	Football, Panathinaikos v/s Dinamo Tbilisi (UEFA CL)	No data
13.07.2008	Athletics, IAAF Grand Prix 'Tsiklitiria 2008'	No data
20.04.2008	Football, AEK Athens v/s Asteras Tripolis (SL)	No data
13.04.2008	Football, Panathinaikos v/s Aris Salonika (SL)	No data
06.04.2008	Football, AEK Athens v/s Ergotelis (SL)	No data
30.03.2008	Football, Panathinaikos v/s Panionios (SL)	No data
30.03.2008	Football, AEK Athens v/s Olympiakos (SL)	No data
22.03.2008	Football, Panathinaikos v/s Iraklis Salonika (SL)	No data
16.03.2008	Football, AEK Athens v/s Aris Salonika (SL)	No data
09.03.2008	Football, Panathinaikos v/s Larissa (SL)	No data
05.03.2008	Football, AEK Athens v/s Xanthi (SL)	No data
02.03.2008	Football, AEK Athens v/s Panathinaikos (SL)	No data
24.02.2008	Football, Panathinaikos v/s Levadiakos (SL)	No data
21.02.2008	Football, Panathinaikos v/s Rangers (UEFA Cup)	No data
13.02.2008	Football, AEK Athens v/s Getafe (UEFA Cup)	No data
09.02.2008	Football, Panathinaikos v/s Veria (SL)	No data
03.02.2008	Football, Panathinaikos v/s Asteras Tripolis (SL)	No data
03.02.2008	Football, AEK Athens v/s Panionios (SL)	No data
27.01.2008	Football, AEK Athens v/s Levadiakos (SL)	No data
20.01.2008	Football, Panathinaikos v/s Ergotelis (SL)	No data
12.01.2008	Football, AEK Athens v/s Veria (SL)	No data
06.01.2008	Football, Panathinaikos v/s Apollon Kalamaria (SL)	No data
30.12.2007	Football, AEK Athens v/s PAOK Salonika (SL)	No data
23.12.2007	Football, Panathinaikos v/s OFI Crete (SL)	No data
20.12.2007	Football, AEK Athens v/s Villarreal (UEFA Cup)	No data
09.12.2007	Football, AEK Athens v/s Apollon Kalamaria (SL)	No data
05.12.2007	Football, Panathina. v/s Lokomot. Moscow UEFA Cup	No data
01.12.2007	Football, Panathinaikos v/s Xanthi (SL)	No data
29.11.2007	Football, AEK Athens v/s Fiorentina (UEFA Cup)	No data
25.11.2007	Football, AEK Athens v/s OFI Crete (SL)	No data
11.11.2007	Football, Panathinaikos v/s AEK Athens (SL)	No data
04.11.2007	Football, AEK Athens v/s Iraklis Salonika (SL)	No data
28.10.2007	Football, Panathinaikos v/s Atromitos Athens (SL)	No data

Date	Type of events	Spectators
25.10.2007	Football, Panathinaikos v/s Aberdeen (UEFA Cup)	No data
20.10.2007	Football, AEK Athens v/s Larissa (SL)	No data
02.10.2007	Football, Panathina. v/s Artmedia Petrzalka UEFA Cup	No data
29.09.2007	Football, Panathinaikos v/s PAOK Salonika (SL)	No data
23.09.2007	Football, AEK Athens v/s Atromitos Athens (SL)	No data
20.09.2007	Football, AEK Athens v/s Salzburg (UEFA Cup)	No data
03.09.2007	Football, AEK Athens v/s Seville (UEFA CL)	No data
02.09.2007	Football, Panathinaikos v/s Olympiakos (SL)	No data
26.07.2007	Concert, George Michael, '25 Live Tour	40,000 ⁴⁴⁴
02.07.2007	Athletics, IAAF Grand Prix 'Tsiklitiria 2007'	30,000
28.05.2007	Football, Goal in our heart	No data
23.05.2007	Football, UEFA Champions League Athens Final 2007	74,000
13.05.2007	Football, Panathinaikos v/s Kerkyra (SL)	No data
29.04.2007	Football, AEK Athens v/s Xanthi (SL)	No data
22.04.2007	Football, Panathinaikos v/s Aris Salonika (SL)	No data
15.04.2007	Football, AEK Athens v/s Aigaleo (SL)	No data
18.03.2007	Football, Panathinaikos v/s Atromitos Athens (SL)	No data
11.03.2007	Football, Panathinaikos v/s Ergotelis (SL)	No data
03.03.2007	Football, AEK Athens v/s Aris Salonika (SL)	No data
25.02.2007	Football, Panathinaikos v/s Iraklis Salonika (SL)	No data
22.02.2007	Football, Panathinaikos v/s Lens (UEFA Cup)	No data
18.02.2007	Football, AEK Athens v/s Panathinaikos (SL)	No data
14.02.2007	Football, AEK v/s Paris St-Germain (UEFA Cup)	No data
11.02.2007	Football, Panathinaikos v/s OFI Crete (SL)	No data
04.02.2007	Football, AEK Athens v/s Olympiakos (SL)	No data
26.01.2007	Football, Panathinaikos v/s Panionios (SL)	No data
21.01.2007	Football, AEK Athens v/s Atromitos Athens (SL)	No data
14.01.2007	Football, AEK Athens v/s OFI Crete (SL)	No data
07.01.2007	Football, Panathinaikos v/s Aigaleo (SL)	No data
17.12.2006	Football, AEK Athens v/s Panionios (SL)	No data
09.12.2006	Football, Panathinaikos v/s Larissa (SL)	No data
02.12.2006	Football, AEK Athens v/s Ionikos (SL)	No data
30.11.2006	Football, Panathina. v/s Rapid Bucharest (UEFA Cup)	No data
26.11.2006	Football, Panathinaikos v/s Apollon Kalamaria (SL)	No data

Date	Type of events	Spectators
21.11.2006	Football, AEK Athens v/s AC Milan (UEFA CL)	No data
18.11.2006	Football, AEK Athens v/s Kerkyra (SL)	No data
12.11.2006	Football, AEK Athens v/s Larissa (SL)	No data
05.11.2006	Football, Panathinaikos v/s Olympiakos (SL)	No data
01.11.2006	Football, AEK Athens v/s Lille (UEFA CL)	No data
28.10.2006	Football, AEK Athens v/s Apollon Kalamaria (SL)	No data
23.10.2006	Football, Panathinaikos v/s AEK Athens (SL)	No data
19.10.2006	Football, Panathina. v/s Hapoel Tel-Aviv (UEFA Cup)	No data
30.09.2006	Football, AEK Athens v/s Ergotelis (SL)	No data
26.09.2006	Football, AEK Athens v/s Anderlecht (UEFA CL)	No data
24.09.2006	Football, Panathinaikos v/s PAOK Salonika (SL)	No data
18.09.2006	Football, AEK Athens v/s Iraklis Salonika (SL)	No data
14.09.2006	Football, Panathina v/s Metalurg Zaporiz' (UEFA Cup)	No data
09.09.2006	Football, Panathinaikos v/s Xanthi (SL)	No data
26.08.2006	Football, Panathinaikos v/s Ionikos (SL)	No data
23.08.2006	Football, AEK Athens v/s Heart Midlothian (UEFA CL)	No data
19.08.2006	Football, AEK Athens v/s PAOK Salonika (SL)	No data
20.07.2006	Concert, Shakira, 'Oral Fixation Tour'	No data
03.07.2006	Athletics, IAAF Grand Prix 'Tsiklitiria 2006'	No data
01.06.2006	Rally, Acropolis SuperStage (4 days)	65,000 ⁴⁴⁵
14.05.2006	Football, AEK Athens v/s Xanthi (SL)	No data
30.04.2006	Football, Panathinaikos v/s Aigaleo (SL)	No data
16.04.2006	Football, AEK Athens v/s OFI Crete (SL)	No data
09.04.2006	Football, Panathinaikos v/s Atromitos Athens (SL)	No data
02.04.2006	Football, AEK Athens v/s Levadiakos (SL)	No data
26.03.2006	Football, AEK Athens v/s Akrotitos (SL)	No data
19.03.2006	Football, Panathinaikos v/s OFI Crete (SL)	No data
12.03.2006	Football, AEK Athens v/s Panionios (SL)	No data
05.03.2006	Football, Panathinaikos v/s AEK Athens (SL)	No data
26.02.2006	Football, AEK Athens v/s Ionikos (SL)	No data
19.02.2006	Football, Panathinaikos v/s Kallithea (SL)	No data
12.02.2006	Football, AEK Athens v/s Larissa (SL)	No data
04.02.2006	Football, Panathinaikos v/s Levadiakos (SL)	No data
29.01.2006	Football, Panathinaikos v/s Ionikos (SL)	No data

Date	Type of events	Spectators
14.01.2006	Football, AEK Athens v/s Atromitos Athens (SL)	No data
07.01.2006	Football, Panathinaikos v/s Larissa (SL)	No data
2006	Conference, Herbalife's annual conference	No data
19.12.2005	Function, PANATHAS Power, Christmas for children	No data
17.12.2005	Football, AEK Athens v/s Apollon Kalamaria (SL)	No data
11.12.2005	Football, Panathinaikos v/s Iraklis Salonika (SL)	No data
04.12.2005	Football, AEK Athens v/s PAOK Salonika (SL)	No data
26.11.2005	Football, Panathinaikos v/s Xanthi (SL)	No data
22.11.2005	Football, Panathinaikos v/s Udinese (UEFA CL)	No data
19.11.2005	Football, Panathinaikos v/s Apollon Kalamaria (SL)	No data
05.11.2005	Football, AEK Athens v/s Kallithea (SL)	No data
03.11.2005	Function, Ramadan End, Muslim Uni. Greece (2 days)	No data
30.10.2005	Football, Panathinaikos v/s PAOK Salonika (SL)	No data
23.10.2005	Football, AEK Athens v/s Panathinaikos (SL)	No data
18.10.2005	Football, Panathinaikos v/s Barcelona (UEFA CL)	No data
15.10.2005	Football, Panathinaikos v/s Akrotiris (SL)	No data
02.10.2005	Football, AEK Athens v/s Olympiakos (SL)	No data
29.09.2005	Football, AEK v/s Zenit St Petersburg (UEFA Cup)	No data
27.09.2005	Football, Panathina. v/s Werder Bremen (UEFA CL)	No data
24.09.2005	Football, Panathinaikos v/s Panionios (SL)	No data
18.09.2005	Football, AEK Athens v/s Aigaleo (SL)	No data
11.09.2005	Football, AEK Athens v/s Iraklis Salonika (SL)	No data
28.08.2005	Football, Panathinaikos v/s Olympiakos (SL)	No data
23.08.2005	Football, Panathinaikos v/s Wisla Krakow (UEFA CL)	No data
23.06.2005	Rally, Acropolis SuperStage (4 days)	60,000 ⁴⁴⁶
25.05.2005	Football, AEK Athens v/s Apollon Kalamaria (SL)	No data
15.05.2005	Football, Panathinaikos v/s AEK Athens (SL)	No data
08.05.2005	Football, AEK Athens v/s Ionikos (SL)	No data
24.04.2005	Football, Panathinaikos v/s Atromitos Athens (SL)	No data
17.04.2005	Football, AEK Athens v/s Xanthi (SL)	No data
10.04.2005	Football, Panathinaikos v/s Olympiakos (SL)	No data
10.04.2005	Football, AEK Athens v/s PAOK Salonika (SL)	No data
03.04.2005	Football, Panathinaikos v/s Aris Salonika (SL)	No data
20.03.2005	Football, AEK Athens v/s Ergotelis (SL)	No data

Date	Type of events	Spectators
12.03.2005	Football, Panathinaikos v/s Iraklis Salonika (SL)	No data
06.03.2005	Football, AEK Athens v/s Aris Salonika (SL)	No data
27.02.2005	Football, Panathinaikos v/s Kerkyra (SL)	No data
19.02.2005	Football, AEK Athens v/s Iraklis Salonika (SL)	No data
16.02.2005	Football, Panathinaikos v/s Seville (UEFA Cup)	No data
12.02.2005	Football, Panathinaikos v/s Apollon Kalamaria (SL)	No data
23.01.2005	Football, AEK Athens v/s Aigaleo (SL)	No data
16.01.2005	Football, Panathinaikos v/s OFI Crete (SL)	No data
09.01.2005	Football, AEK Athens v/s Panathinaikos (SL)	No data
29.12.2004	Football, Panathinaikos v/s PAOK Salonika (SL)	No data
19.12.2004	Football, AEK Athens v/s OFI Crete (SL)	No data
15.12.2004	Football, AEK v/s Alemania Aachen (UEFA Cup)	No data
12.12.2004	Football, Panathinaikos v/s Ergotelis (SL)	No data
07.12.2004	Football, Pana. v/s PSV Eindhoven (UEFA CL)	No data
02.12.2004	Football, AEK Athens v/s Seville (UEFA Cup)	No data
28.11.2004	Football, AEK Athens v/s Atromitos Athens (SL)	No data
25.11.2004	Football, AEK Athens v/s Lille (UEFA Cup)	No data
20.11.2004	Football, Panathinaikos v/s Kallithea (SL)	No data
07.11.2004	Football, AEK Athens v/s Olympiakos (SL)	No data
30.10.2004	Football, Panathinaikos v/s Panionios (SL)	No data
24.10.2004	Football, AEK Athens v/s Kallithea (SL)	No data
21.10.2004	Football, AEK v/s Zenit St Petersburg (UEFA Cup)	No data
20.10.2004	Football, Panathinaikos v/s Arsenal (UEFA CL)	No data
16.10.2004	Football, Panathinaikos v/s Aigaleo (SL)	No data
03.10.2004	Football, AEK Athens v/s Panionios (SL)	No data
30.09.2004	Football, AEK Athens v/s HIT Gorica (UEFA Cup)	No data
26.09.2004	Football, AEK Athens v/s Kerkyra (SL)	No data
25.09.2004	Football, Panathinaikos v/s Xanthi (SL)	No data
19.09.2004	Football, Panathinaikos v/s Ionikos (SL)	No data
14.09.2004	Football, Panathinaikos v/s Rosenborg (UEFA CL)	No data
16.05.2004	Football, AEK Athens v/s OFI Crete (SL)	No data
02.05.2004	Football, Panathinaikos v/s Akratitos (SL)	No data
24.04.2004	Football, AEK Athens v/s Paniliakos (SL)	No data
18.04.2004	Football, Panathinaikos v/s Olympiakos (SL)	No data

Date	Type of events	Spectators
04.04.2004	Football, AEK Athens v/s Akrotiros (SL)	No data
21.03.2004	Football, Panathinaikos v/s Atromitos Athens (SL)	No data
03.03.2004	Football, Panathinaikos v/s Auxerre (UEFA Cup)	No data
29.02.2004	Football, Panathinaikos v/s Aigaleo (SL)	No data
28.02.2004	Football, AEK Athens v/s Aris Salonika (SL)	No data
22.02.2004	Football, Panathinaikos v/s Iraklis Salonika (SL)	No data
07.02.2004	Football, AEK Athens v/s Panionios (SL)	No data
01.02.2004	Football, Panathinaikos v/s AEK Athens (SL)	No data
25.01.2004	Football, AEK Athens v/s Iraklis Salonika (SL)	No data
18.01.2004	Football, Panathinaikos v/s OFI Crete (SL)	No data
18.01.2004	Football, AEK Athens v/s Ionikos (SL)	No data

Abbreviations

SL: Greek Super League

UEFA CL: UEFA Champions League

UEFA EL: UEFA Europe League

11.4.2 Athens Indoor Stadium event schedules

The following sports events⁴⁴⁷ of the home team Panathinaikos BC⁴⁴⁸ and non-sports events⁴⁴⁹ were held at Athens Indoor Stadium between 01.01.2004-31.12.2010. The event schedules are based on publicly available data from the operator, respective home teams, event managers and other sources.

Summary of Events at Athens Indoor Stadium 2004-2010

No.	Type of events	Spectators
136x	Basketball 2004-2010	No data
3x	Concert 2004-2010 (2005, 2006)	No data
3x	Function 2004-2010 (2005, 2006)	No data
2x	Conference 2004-2010 (2005, 2006)	No data
1x	Sport 2004-2010 (2006)	No data
1x	Fair 2004-2010 (2006)	No data

Events per year at Athens Indoor Stadium 2004-2010

Year	Type of events	Spectators
2010	19x sports events	No data
2009	16x sports events	No data
2008	21x sports events	No data
2007	22x sports events	No data
2006	21x sports events, 5x non-sports events	No data
2005	22x sports events, 4x non-sports events	No data
2004	17x sports events	No data

List of Events at Athens Indoor Stadium 2004-2010

Date	Type of events	Spectators
11.12.2010	Basketball, Athens Panathinaikos v/s Aris	No data
28.11.2010	Basketball, Athens Panathina. v/s Maroussi Athens	No data
21.11.2010	Basketball, Athens Panathinaikos v/s Kavala	No data
06.11.2010	Basketball, Athens Panathina. v/s Peristeri Athens	No data
23.10.2010	Basketball, Athens Panathinaikos v/s PAOK	No data
02.06.2010	Basketball, Athens Panathinaikos v/s Olympiakos	No data
26.05.2010	Basketball, Athens Panathinaikos v/s Olympiakos	No data
23.05.2010	Basketball, Athens Panathina. v/s Panellinios Athens	No data
15.05.2010	Basketball, Athens Panathina. v/s Panellinios Athens	No data
01.05.2010	Basketball, Athens Panathinaikos v/s Panionios	No data
25.04.2010	Basketball, Athens Panathinaikos v/s AEK	No data
10.04.2010	Basketball, Athens Panathinaikos v/s Panionios	No data
20.03.2010	Basketball, Athens Panathina. v/s Ilisiakos Athens	No data
17.03.2010	Basketball, Athens Panathinaikos v/s Kavala	No data
28.02.2010	Basketball, Athens Panathinaikos v/s Olympiakos	No data
14.02.2010	Basketball, Athens Panathinaikos v/s Aris	No data
30.01.2010	Basketball, Athens Panathina. v/s Olympia Larissa	No data
23.01.2010	Basketball, Athens Panathina. v/s Kolossos Rodou	No data
09.01.2010	Basketball, Athens Panathina. v/s Peristeri Athens	No data
29.12.2009	Basketball, Athens Panathinaikos v/s Trikala AS	No data
06.12.2009	Basketball, Athens Panathinaikos v/s PAOK	No data
22.11.2009	Basketball, Athens Panathina. v/s Maroussi Athens	No data
01.11.2009	Basketball, Athens Panathina. v/s Panellinios Athens	No data
01.06.2009	Basketball, Athens Panathinaikos v/s Olympiakos	No data
25.05.2009	Basketball, Athens Panathinaikos v/s Olympiakos	No data
16.05.2009	Basketball, Athens Panathinaikos v/s Aris	No data
09.05.2009	Basketball, Athens Panathinaikos v/s Aris	No data
25.04.2009	Basketball, Athens Panathinaikos v/s PAOK	No data
15.04.2009	Basketball, Athens Panathinaikos v/s Kavala	No data
05.04.2009	Basketball, Athens Panathina. v/s Olympia Larissa	No data
08.03.2009	Basketball, Athens Panathinaikos v/s Egaleo AO	No data
18.02.2009	Basketball, Athens Panathinaikos v/s Panellinios At.	No data
08.02.2009	Basketball, Athens Panathinaikos v/s Panionios	No data

Date	Type of events	Spectators
21.01.2009	Basketball, Athens Panathina. v/s Kolossos Rodou	No data
11.01.2009	Basketball, Athens Panathinaikos v/s AEK	No data
20.12.2008	Basketball, Athens Panathinaikos v/s PAOK	No data
07.12.2008	Basketball, Athens Panathinaikos v/s Aris	No data
23.11.2008	Basketball, Athens Panathinaikos v/s Olympiakos	No data
08.11.2008	Basketball, Athens Panathinaikos v/s Trikala AS	No data
25.10.2008	Basketball, Athens Panathina. v/s Larissis Adamou	No data
12.10.2008	Basketball, Athens Panathina. v/s Maroussi Athens	No data
14.07.2008	Basketball, Pre-Olympic Tournament (7 days)	No data
07.07.2008	Basketball, 22 nd Intl. Tourn. Acropolis (3 days)	No data
04.06.2008	Basketball, Athens Panathinaikos v/s Olympiakos	No data
29.05.2008	Basketball, Athens Panathinaikos v/s Olympiakos	No data
24.05.2008	Basketball, Athens Panathinaikos v/s Olympiakos	No data
15.05.2008	Basketball, Athens Panathinaikos v/s Panionios	No data
10.05.2008	Basketball, Athens Panathinaikos v/s Panionios	No data
03.05.2008	Basketball, Athens Panathina. v/s Olympia Larissa	No data
23.04.2008	Basketball, Athens Panathina. v/s Panellinios Athens	No data
16.04.2008	Basketball, Athens Panathinaikos v/s Panionios	No data
29.03.2008	Basketball, Athens Panathina. v/s Olimpiada Patron	No data
15.03.2008	Basketball, Athens Panathina. v/s Kolossos Rodou	No data
01.03.2008	Basketball, Athens Panathina. v/s Maroussi Athens	No data
09.02.2008	Basketball, Athens Panathinaikos v/s PAOK	No data
13.01.2008	Basketball, Athens Panathina. v/s Larissis Adamou	No data
29.12.2007	Basketball, Athens Panathinaikos v/s AEK	No data
08.12.2007	Basketball, Athens Panathinaikos v/s Egaleo AO	No data
24.11.2007	Basketball, Athens Panathina. v/s Olympia Larissa	No data
10.11.2007	Basketball, Athens Panathinaikos v/s Aris	No data
04.11.2007	Basketball, Athens Panathinaikos v/s Olympiakos	No data
21.10.2007	Basketball, Athens Panathinaikos v/s Rethimno AGO	No data
20.08.2007	Basketball, 21 st Intl. Tourn. Acropolis (3 days)	No data
20.06.2007	Basketball, Athens Panathinaikos v/s Olympiakos	No data
13.06.2007	Basketball, Athens Panathinaikos v/s Olympiakos	No data
06.06.2007	Basketball, Athens Panathinaikos v/s Olympiakos	No data
27.05.2007	Basketball, Athens Panathinaikos v/s Panionios	No data

Date	Type of events	Spectators
20.05.2007	Basketball, Athens Panathinaikos v/s Panionios	No data
13.05.2007	Basketball, Athens Panathina. v/s Maroussi Athens	No data
04.05.2007	Basketball, Euroleague Basketball Final (3 days)	No data
28.04.2007	Basketball, Athens Panathina. v/s Olympia Larissa	No data
21.04.2007	Basketball, Athens Panathina. v/s Maroussi Athens	No data
21.04.2007	Basketball, Apollon Achaia v/s Makedonikos	No data
18.03.2007	Basketball, Athens Panathina. v/s Panellinios Athens	No data
03.03.2007	Basketball, Athens Panathinaikos v/s PAOK	No data
17.02.2007	Basketball, Athens Panathinaikos v/s Olympiakos	No data
27.01.2007	Basketball, Athens Panathina. v/s Olimpiada Patron	No data
06.01.2007	Basketball, Athens Panathinaikos v/s Makedonikos	No data
10.12.2006	Basketball, Athens Panathinaikos v/s Panionios	No data
03.12.2006	Basketball, Athens Panathinaikos v/s Apollon Achaia	No data
18.11.2006	Basketball, Athens Panathina. v/s Larissis Adamou	No data
04.11.2006	Basketball, Athens Panathinaikos v/s Egaleo AO	No data
21.10.2006	Basketball, Athens Panathinaikos v/s AEK	No data
12.10.2006	Basketball, Athens Panathinaikos v/s Aris	No data
30.09.2006	Concert, Pearl Jam, '2006 World Tour'	15,000 ⁴⁵⁰
26.06.2006	Sport, 13 th World High School Games (8 days)	No data
24.06.2006	Fair, Ecolife	No data
07.06.2006	Basketball, Athens Panathinaikos v/s Olympiakos	No data
31.05.2006	Basketball, Athens Panathinaikos v/s Olympiakos	No data
21.05.2006	Basketball, Athens Panathinaikos v/s Aris	No data
15.05.2006	Basketball, Athens Panathinaikos v/s Aris	No data
08.05.2006	Basketball, Athens Panathinaikos v/s Panionios	No data
03.05.2006	Basketball, Athens Panathinaikos v/s Makedonikos	No data
19.04.2006	Basketball, Athens Panathina. v/s Maroussi Athens	No data
09.04.2006	Basketball, Athens Panathinaikos v/s Olympiakos	No data
25.03.2006	Basketball, Athens Panathina. v/s Kolossos Rodou	No data
04.03.2006	Basketball, Athens Panathinaikos v/s Aris	No data
11.02.2006	Basketball, Athens Panathinaikos v/s AEK	No data
27.01.2006	Concert, Vanessa Mae, 'Choreography Tour'	No data
22.01.2006	Basketball, Athens Panathinaikos v/s Iraklis	No data
10.01.2006	Function, Muslim Union of Greece	No data

Date	Type of events	Spectators
07.01.2006	Basketball, Athens Panathinaikos v/s Apollon Achaia	No data
2006	Conference, Herbalife's annual conference	No data
2006	Basketball, Basketopolis – Papaloukamp	200
23.12.2005	Basketball, Hellenic B., EFG Eurobank (children)	No data
10.12.2005	Basketball, Athens Panathina. v/s Olympia Larissa	No data
02.12.2005	Function, Love Three-Pointer	No data
01.12.2005	Function, World March Roche Empl. for AIDS 2005	No data
01.12.2005	Conference, International AIDS Day	No data
27.11.2005	Basketball, Athens Panathinaikos v/s Panionios	No data
12.11.2005	Basketball, Athens Panathina. v/s Panellinios Athens	No data
05.11.2005	Basketball, Athens Panathinaikos v/s PAOK	No data
22.10.2005	Basketball, Athens Panathina. v/s Larissis Adamou	No data
30.09.2005	Basketball, AEK's large celebration	15,000
24.09.2005	Concert, Sakis Rouvas, Charity purpose	18,000 ⁴⁵¹
15.06.2005	Basketball, Athens Panathinaikos v/s AEK	No data
09.06.2005	Basketball, Athens Panathinaikos v/s AEK	No data
05.06.2005	Basketball, Athens Panathinaikos v/s Panionios	No data
29.05.2005	Basketball, Athens Panathinaikos v/s Panionios	No data
22.05.2005	Basketball, Athens Panathinaikos v/s Panionios	No data
17.05.2005	Basketball, Athens Panathinaikos v/s Olympiakos	No data
27.04.2005	Basketball, Athens Panathinaikos v/s AEK	No data
02.04.2005	Basketball, Athens Panathinaikos v/s Makedonikos	No data
19.03.2005	Basketball, Athens Panathina. v/s Olympia Larissa	No data
05.03.2005	Basketball, Athens Panathinaikos v/s PAOK	No data
26.02.2005	Basketball, Athens Panathina. v/s Ionikos Saloniki	No data
13.02.2005	Basketball, Athens Panathinaikos v/s Olympiakos	No data
29.01.2005	Basketball, Athens Panathinaikos v/s Aris	No data
22.01.2005	Basketball, Athens Panathina. v/s Panellinios Athens	No data
08.01.2005	Basketball, Athens Panathina. v/s MENT Vassilakis	No data
11.12.2004	Basketball, Athens Panathina. v/s Maroussi Athens	No data
27.11.2004	Basketball, Athens Panathinaikos v/s Panionios	No data
06.11.2004	Basketball, Athens Panathinaikos v/s Iraklis	No data
23.10.2004	Basketball, Athens Panathinaikos v/s Apollon Achaia	No data
02.06.2004	Basketball, Athens Panathina. v/s Maroussi Athens	No data

Date	Type of events	Spectators
26.05.2004	Basketball, Athens Panathina. v/s Maroussi Athens	No data
22.05.2004	Basketball, Athens Panathinaikos v/s Iraklis	No data
16.05.2004	Basketball, Athens Panathinaikos v/s Iraklis	No data
06.05.2004	Basketball, Athens Panathinaikos v/s Olympiakos	No data
24.04.2004	Basketball, Athens Panathinaikos v/s AEK	No data
04.04.2004	Basketball, Athens Panathinaikos v/s Panionios	No data
14.03.2004	Basketball, Athens Panathinaikos v/s PAOK	No data
07.02.2004	Basketball, Athens Panathinaikos v/s Apollon Achaia	No data
31.01.2004	Basketball, Athens Panathina. v/s Ilisiakos Athens	No data
17.01.2004	Basketball, Athens Panathina. v/s Maroussi Athens	No data
04.01.2004	Basketball, Athens Panathinaikos v/s Iraklis	No data

11.4.3 Athens Football Stadium event schedules

The following sports events⁴⁵² of the home team Olympiakos FC⁴⁵³ and non-sports events⁴⁵⁴ were held at Athens Football Stadium between 01.01.2004-31.12.2010. The event schedules are based on publicly available data from the operator, respective home teams, event managers and other sources.

Summary of Events at Athens Football Stadium 2004-2010

No.	Type of events	Spectators
146 x	Football 2004, 2005, 2006, 2007, 2008, 2009, 2010	3,138,910
12 x	Concert 2005, 2006, 2007, 2008, 2009, 2010	146,000
33 x	Cinema 2005	23,100

Events per year at Athens Football Stadium 2004-2010

Year	Type of events	Spectators
2010	22x sports events, 2x non-sports events	410,263
2009	19x sports events, 1x non-sports event	499,686
2008	23x sports events, 3x non-sports events	610,172
2007	19x sports events, 2x non-sports events	465,453
2006	20x sports events, 3x non-sports events	531,091
2005	24x sports events, 34x non-sports events	441,585
2004	19x sports events	349,760

List of events Athens Football Stadium 2004-2010

Date	Type of events	Spectators
19.12.2010	Football, Olympiakos v/s Larissa (SL)	Away
12.12.2010	Football, Olympiakos v/s Atromitos Athens (SL)	20,015
21.11.2010	Football, Olympiakos v/s PAOK Salonika (SL)	30,275
06.11.2010	Football, Olympiakos v/s Panionios (SL)	22,312
24.10.2010	Football, Olympiakos v/s Aris Salonika (SL)	30,099
12.10.2010	Football, Greece v/s Israel (NT)	16,170
08.10.2010	Football, Greece v/s Turkey (NT)	12,700
02.10.2010	Football, Olympiakos v/s Volos (SL)	27,605
25.09.2010	Football, Olympiakos v/s Asteras Tripolis (SL)	25,090
11.09.2010	Football, Olympiakos v/s Kerkyra (SL)	Banned
03.09.2010	Football, Greece v/s Georgia (NT)	14,919
29.07.2010	Football, Olympiakos v/s Maccabi Tel-Aviv (UEFA EL)	Banned
22.07.2010	Football, Olympiakos v/s Besa Kavaje (UEFA EL)	Banned
20.06.2010	Concert, Aerosmith, 'Cocked, Locked, Ready to ...'	18,000
01.06.2010	Concert, Rihanna, 'Last Girl on the Earth Tour'	20,000
18.04.2010	Football, Olympiakos v/s Aris Salonika (SL)	14,217
28.03.2010	Football, Olympiakos v/s Xanthi (SL)	18,010
13.03.2010	Football, Olympiakos v/s Giannina (SL)	15,969
28.02.2010	Football, Olympiakos v/s Atromitos Athens (SL)	21,866
23.02.2010	Football, Olympiakos v/s Bordeaux (UEFA CL)	29,763
07.02.2010	Football, Olympiakos v/s Levadiakos (SL)	Banned
24.01.2010	Football, Olympiakos v/s PAOK Salonika (SL)	26,137
10.01.2010	Football, Olympiakos v/s Larissa (SL)	19,327
06.01.2010	Football, Olympiakos v/s AEK Athens (SL)	27,789
13.12.2009	Football, Olympiakos v/s Panthrakikos (SL)	18,041
09.12.2009	Football, Olympiakos v/s Arsenal (UEFA CL)	30,272
29.11.2009	Football, Olympiakos v/s Panathinaikos (SL)	31,059
07.11.2009	Football, Olympiakos v/s Iraklis Salonika (SL)	20,415
24.10.2009	Football, Olympiakos v/s Ergotelis (SL)	21,254
20.10.2009	Football, Olympiakos v/s Standard Liege (UEFA CL)	29,891
17.10.2009	Football, Olympiakos v/s Asteras Tripolis (SL)	20,398
26.09.2009	Football, Olympiakos v/s Panionios (SL)	22,163
16.09.2009	Football, Olympiakos v/s AZ Alkmaar (UEFA CL)	29,018

Date	Type of events	Spectators
12.09.2009	Football, Olympiakos v/s Kavala (SL)	16,056
26.08.2009	Football, Olympiakos v/s Sheriff Tiraspol (UEFA CL)	27,631
05.08.2009	Football, Olympiakos v/s Slov. Bratislava (UEFA CL)	26,137
06.07.2009	Concert, The Scorpions, 'Festival 2009'	22,000
12.04.2009	Football, Olympiakos v/s Larissa (SL)	24,801
15.03.2009	Football, Olympiakos v/s Iraklis Salonika (SL)	25,182
01.03.2009	Football, Olympiakos v/s Panathinaikos (SL)	28,775
18.02.2009	Football, Olympiakos v/s Saint-Etienne (UEFA Cup)	29,609
14.02.2009	Football, Olympiakos v/s Aris Salonika (SL)	25,867
24.01.2009	Football, Olympiakos v/s OFI Crete (SL)	25,633
10.01.2009	Football, Olympiakos v/s Xanthi (SL)	25,484
21.12.2008	Football, Olympiakos v/s Thrasivoulos Fylis (SL)	20,033
18.12.2008	Football, Olympiakos v/s Hertha Berlin (UEFA Cup)	30,003
07.12.2008	Football, Olympiakos v/s Levadiakos (SL)	22,337
30.11.2008	Football, Olympiakos v/s Panionios (SL)	27,487
27.11.2008	Football, Olympiakos v/s Benfica (UEFA Cup)	30,178
16.11.2008	Football, Olympiakos v/s PAOK Salonika (SL)	29,458
02.11.2008	Football, Olympiakos v/s Ergotelis (SL)	26,058
19.10.2008	Football, Olympiakos v/s Panthrakikos (SL)	23,693
15.10.2008	Football, Greece v/s Switzerland (NT)	28,566
11.10.2008	Football, Greece v/s Moldova (NT)	14,894
05.10.2008	Football, Olympiakos v/s AEK Athens (SL)	30,074
02.10.2008	Football, Olympiakos v/s Nordsjaelland (UEFA Cup)	24,513
21.09.2008	Football, Olympiakos v/s Panserraikos (SL)	25,234
30.08.2008	Football, Olympiakos v/s Asteras Tripolis (SL)	20,392
27.08.2008	Football, Olympiakos v/s Famagusta (UEFA CL)	27,898
15.07.2008	Concert, 'Athens Fly Beyond Festival'	8,000
10.07.2008	Concert, Patti Smith	6,000
01.07.2008	Concert, Def Leppard and Whitesnake	10,000
20.04.2008	Football, Olympiakos v/s Iraklis Salonika (SL)	29,084
06.04.2008	Football, Olympiakos v/s Larissa (SL)	24,318
15.03.2008	Football, Olympiakos v/s Atromitos Athens (SL)	20,343
01.03.2008	Football, Olympiakos v/s Asteras Tripolis (SL)	24,503
19.02.2008	Football, Olympiakos v/s Chelsea (UEFA CL)	31,238

Date	Type of events	Spectators
16.02.2008	Football, Olympiakos v/s Ergotelis (SL)	14,544
27.01.2008	Football, Olympiakos v/s Aris Salonika (SL)	30,014
13.01.2008	Football, Olympiakos v/s Panathinaikos (SL)	31,310
29.12.2007	Football, Olympiakos v/s Xanthi (SL)	23,164
16.12.2007	Football, Olympiakos v/s AEK Athens (SL)	30,229
11.12.2007	Football, Olympiakos v/s Werder Bremen (UEFA CL)	30,623
08.12.2007	Football, Olympiakos v/s Levadiakos (SL)	17,096
24.11.2007	Football, Olympiakos v/s Veria (SL)	18,070
06.11.2007	Football, Olympiakos v/s Real Madrid (UEFA CL)	30,355
03.11.2007	Football, Olympiakos v/s PAOK Salonika (SL)	28,013
20.10.2007	Football, Olympiakos v/s Panionios (SL)	20,104
06.10.2007	Football, Olympiakos v/s Apollon Kalamaria (SL)	27,029
23.09.2007	Football, Olympiakos v/s OFI Crete (SL)	24,824
18.09.2007	Football, Olympiakos v/s Lazio (UEFA CL)	Banned
23.06.2007	Concert, Evanescence	8,000
18.06.2007	Concert, The Scorpions, 'Humanity Tour'	15,000
22.04.2007	Football, Olympiakos v/s Kerkyra (SL)	23,655
24.03.2007	Football, Greece v/s Turkey (NT)	31,405
18.03.2007	Football, Olympiakos v/s Aris Salonika (SL)	26,087
04.03.2007	Football, Olympiakos v/s Panathinaikos (SL)	30,598
18.02.2007	Football, Olympiakos v/s Atromitos Athens (SL)	15,026
11.02.2007	Football, Olympiakos v/s Iraklis Salonika (SL)	15,501
27.01.2007	Football, Olympiakos v/s OFI Crete (SL)	25,517
14.01.2007	Football, Olympiakos v/s Panionios (SL)	25,157
16.12.2006	Football, Olympiakos v/s Ionikos (SL)	17,192
10.12.2006	Football, Olympiakos v/s Aigaleo (SL)	16,245
05.12.2006	Football, Olympiakos v/s Shak. Donetsk (UEFA CL)	30,805
26.11.2006	Football, Olympiakos v/s Larissa (SL)	22,156
12.11.2006	Football, Olympiakos v/s Apollon Kalamaria (SL)	19,254
28.10.2006	Football, Olympiakos v/s Ergotelis (SL)	20,455
18.10.2006	Football, Olympiakos v/s Roma (UEFA CL)	31,009
07.10.2006	Football, Greece v/s Norway (NT)	20,939
23.09.2006	Football, Olympiakos v/s AEK Athens (SL)	29,100
12.09.2006	Football, Olympiakos v/s Valencia (UEFA CL)	31,488

Date	Type of events	Spectators
09.09.2006	Football, Olympiakos v/s PAOK Salonika (SL)	29,140
19.08.2006	Football, Olympiakos v/s Xanthi (SL)	21,100
13.07.2006	Concert, Archive	5,000
13.06.2006	Concert, 50 Cent ,‘European Tour‘	10,000
09.06.2006	Concert, Massive Attack	12,000
14.05.2006	Football, Olympiakos v/s Ionikos (SL)	31,178
08.04.2006	Football, Olympiakos v/s Aigaleo (SL)	28,228
27.03.2006	Football, Olympiakos v/s Atromitos Athens (SL)	22,200
12.03.2006	Football, Olympiakos v/s Apollon Kalamaria (SL)	28,560
05.03.2006	Football, Olympiakos v/s OFI Crete (SL)	25,489
19.02.2006	Football, Olympiakos v/s AEK Athens (SL)	31,115
06.02.2006	Football, Olympiakos v/s Kallithea (SL)	16,955
15.01.2006	Football, Olympiakos v/s Panathinaikos (SL)	31,483
17.12.2005	Football, Olympiakos v/s Levadiakos (SL)	25,525
12.12.2005	Football, Olympiakos v/s Larissa (SL)	Banned
06.12.2005	Football, Olympiakos v/s Real Madrid (UEFA CL)	30,496
28.11.2005	Football, Olympiakos v/s Iraklis Salonika (SL)	Banned
06.11.2005	Football, Olympiakos v/s Xanthi (SL)	Banned
01.11.2005	Football, Olympiakos v/s Lyon (UEFA CL)	30,843
16.10.2005	Football, Olympiakos v/s PAOK Salonika (SL)	Banned
12.10.2005	Football, Greece v/s Georgia (NT)	28,222
24.09.2005	Football, Olympiakos v/s Akratitos (SL)	Banned
13.09.2005	Football, Olympiakos v/s Rosenborg (UEFA CL)	31,572
10.09.2005	Football, Olympiakos v/s Panionios (SL)	Banned
18.07.2005	Concert, The Scorpions, ‘Unbreakable Tour‘	12,000
15.06- 31.07.2005	Cinema, daily 2 shows (except 11.07-24.07.2005), capacity per cinema event approx. 300-400	Approx. 350
08.06.2005	Football, Greece v/s Ukraine (NT)	31,392
15.05.2005	Football, Olympiakos v/s Panionios (SL)	31,081
24.04.2005	Football, Olympiakos v/s Aigaleo (SL)	29,894
03.04.2005	Football, Olympiakos v/s Ionikos (SL)	27,958
30.03.2005	Football, Greece v/s Albania (NT)	31,313
13.03.2005	Football, Olympiakos v/s AEK Athens (SL)	Banned
10.03.2005	Football, Olympiakos v/s Newcastle (UEFA Cup)	30,595

Date	Type of events	Spectators
27.02.2005	Football, Olympiakos v/s Atromitos Athens (SL)	Banned
17.02.2005	Football, Olympiakos v/s Sochaux (UEFA Cup)	24,634
12.02.2005	Football, Olympiakos v/s Xanthi (SL)	Banned
09.02.2005	Football, Greece v/s Denmark (NT)	29,823
30.01.2005	Football, Olympiakos v/s Aris Salonika (SL)	Banned
16.01.2005	Football, Olympiakos v/s Iraklis Salonika (SL)	23,137
29.12.2004	Football, Olympiakos v/s Kerkyra (SL)	29,059
12.12.2004	Football, Olympiakos v/s Apollon Kalamaria (SL)	24,053
04.12.2004	Football, Olympiakos v/s Panathinaikos (SL)	30,856
23.11.2004	Football, Olympiakos v/s Deport. Coruna (UEFA CL)	31,349
20.11.2004	Football, Olympiakos v/s OFI Crete (SL)	25,315
17.11.2004	Football, Greece v/s Kazakhstan (NT)	31,837
03.11.2004	Football, Olympiakos v/s Monaco (UEFA CL)	31,320
30.10.2004	Football, Olympiakos v/s PAOK Salonika (SL)	26,972
16.10.2004	Football, Olympiakos v/s Ergotelis (SL)	26,141
28.09.2004	Football, Olympiakos v/s Liverpool (UEFA CL)	31,300
19.09.2004	Football, Olympiakos v/s Kallithea (SL)	30,043
08.09.2004	Football, Greece v/s Turkey (NT)	31,515
22.05.2004	Football, Olympiakos v/s Aigaleo (SL)	Away
16.05.2004	Football, Olympiakos v/s Aris Salonika (SL)	Away
25.04.2004	Football, Olympiakos v/s Panionios (SL)	Away
04.04.2004	Football, Olympiakos v/s Iraklis Salonika (SL)	Away
14.03.2004	Football, Olympiakos v/s AEK Athens (SL)	Away
08.02.2004	Football, Olympiakos v/s Xanthi (SL)	Away
25.01.2004	Football, Olympiakos v/s Proodeftiki (SL)	Away

Abbreviations

SL: Greek Super League

UEFA CL: UEFA Champions League

UEFA EL: UEFA Europa League

NT: National Team

11.5 Beijing 2008, Games of the XXIX Olympiad

11.5.1 Beijing Olympic Stadium event schedules

The following sports and non-sports events were held at Beijing Olympic Stadium between 01.01.2008-31.12.2012.⁴⁵⁵ The event schedules are based on publicly available data from the operator, respective home teams, event managers and other sources.

Summary of Events at Beijing Olympic Stadium 2008-2012

No.	Type of events	Spectators
10x	Concert 2009, 2010, 2011, 2012	1,58,961
10x	Football, 2009, 2010, 2011, 2012	2,15,666
1x	Race of Champions, 2009	No data
4x	Ice & Snow Festival, 2009, 2010, 2011,2012	No data
4x	Sports Meeting, 2010	No data
1x	Photo Contest, 2010	No data
1x	Olympic Cultural Festival, 2010	No data
1x	Photo Exhibition, 2010	No data
1x	Celebration, Returning to Bird's Nest, 2010	No data
1x	Track & Field Sports, Bird's Nest Cup, 2010	No data
1x	Beijing International Equestrian Show, 2011	No data
1x	Feast Patriotic Songs, 2011	No data
1x	Youth Sports Mind Games, Bird's Nest Cup, 2011	No data
1x	China X Open, 2011	No data
1x	World Snow Board Tour, 2011	No data

Events per year at Beijing Olympic Stadium 2008-2012

Year	Type of events	Spectators
2012	2x sports events, 2x non-sports events	1,65,000
2011	6x sports events, 4x non-sports events	80,000
2010	11x sports events, 8x non-sports events	No data
2009	4x sports events, 2x non-sports events	1,29,627

List of events at Beijing Olympic Stadium 2008-2012

Date	Type of events	Spectators
22.12.2012	Beijing Ice and Snow Festival ⁴⁵⁶ (64 days)	No data
27.07.2012	Football, Arsenal v/s Manchester United	No data
11.08.2012	Football, Supercoppa Italiana, Juventus v/s Napoli	75,000
14.04.2012	Concert, Leehom Wang ⁴⁵⁷	90,000
18.12.2011	Beijing Ice and Snow Festival ⁴⁵⁸ (12 days)	No data
03.12.2011	World Snow Board Tour	No data
27.10.2011	China X Open (3 days)	No data
06.08.2011	Football, Supercoppa Italiana, Milan v/s Internazionale	80,000
20.07.2011	Youth Sports Mind Games, Bird's Nest Cup	No data
12.06.2011	Feast, Patriotic Songs	No data
21.05.2011	Concert, Andrea Bocelli	No data
20.05.2011	Concert, Andrea Bocelli	No data
19.05.2011	Beijing International Equestrian Show (3 days)	No data
01.05.2011	Concert, Rock 30	No data
21.12.2010	Beijing Ice and Snow Festival ⁴⁵⁹ (64 days)	No data
03.10.2010	Concert, Central Opera Theatre	No data
23.10.2010	Track & Field Sports, Bird's Nest Cup (2 days)	No data
03.10.2010	Concert, drum corps	No data
23.08.2010	Football Match, Baidui Cup	No data
20.08.2010	Football Tournament, Aocheng	No data
08.08.2010	Football Match, Beijing Guo v/s FC Barcelona	No data
06.08.2010	Celebration, Returning to Bird's Nest	No data
06.08.2010	Photo exhibition (5 days)	No data
02.08.2010	Olympic cultural festival (15 days)	No data
27.07.2010	Charity sports meeting, Passing on love	No data
25.07.2010	Football Tournament, Bird's Nest Cup (6 days)	No data
21.07.2010	Football Match, Philanthropy China Tour	No data
18.07.2010	Concert, New Age	No data
26.07.2010	Sports meeting, Urban Construction	No data
07.06.2010	Sports meeting, Schlumberger	No data
04.05.2010	Football Tournament, Bird's Nest Cup (10 days)	No data
27.04.2010	Photo contest, Charm Bird's Nest (157 days)	No data
23.04.2010	Sports meeting, Yumin Primary School	No data

Date	Type of events	Spectators
19.12.2009	Beijing Ice and Snow Festival ⁴⁶⁰ (63 days)	No data
03.11.2009	Race of Champions	No data
06.10.2009	Turandot, Opera ⁴⁶¹	68,961
08.08.2009	Football, Supercoppa Italiana, Internazionale v/s Lazio	60,666
30.06.2009	Concert, Charm China	No data
01.05.2009	Concert, Jackie Chan and his friends	No data

11.5.2 Beijing Indoor Stadium event schedules

No data was made available by the operator despite of elaborate research and enquiries regarding sports and non-sports events held at Beijing Indoor Stadium between 01.01.2008-31.12.2012.

Summary of events at Beijing Indoor Stadium 2008-2012

Date	Type of event	Spectators
17.12.2011	Concert, Boeey Lehou ⁴⁶²	No data

11.5.3 Beijing Football Stadium event schedules

No data was made available by the operator despite of elaborate research and enquiries regarding sports and non-sports events sports and non-sports events held at Beijing Football Stadium between 01.01.2008-31.12.2012.

Summary of events at Beijing Football Stadium 2008-2012

Date	Type of event	Spectators
No data	No data	No data

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