THE FUTURE OF SUSTAINABLE BADMINTON: BALANCING ENVIRONMENTAL IMPACT WITH ECONOMIC GROWTH

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ABSTRACT

With the spread of badminton all over the world, under the supervision of the Badminton World Federation, its ecological imprint is projected to the construction of the energy-consuming court, synthetic flooring, the manufacture of shuttlecocks, the manufacture of rackets, and the management of large tournaments. Although the sport is known to create jobs, boost local economies, and enhance sporting networks across borders, unregulated development of infrastructures and the use of equipment are some of the factors that have led to depletion of resources and carbon emission. The paper explores the way the badminton industry can balance economy growth and environmental responsibility. It appraises critically sustainable materials in court design, greener shuttlecock and racquet products manufacture, adopting renewable energy in the stadiums, and the green event management practices. Policy gaps, financial constraints, and stakeholder resistance are also considered to be significant challenges in the study. The research provides feasible solutions to the challenges of ensuring future development of badminton in the way which will be environmentally sustainable and at the same time economically viable by proposing models of the circular economy, sustainable systems of certification, and collaborative governance.

Keywords: Sustainable badminton, sports economics, environmental impact, green infrastructure, circular economy, eco-friendly manufacturing, event sustainability, sports governance.

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INTRODUCTION

Badminton is a sport with millions of players in the world that is increasingly becoming a major aspect of the global sporting industry. The development of the sport, nonetheless, involves issues going beyond the physical aspect of the game and into the environmental aspects. Badminton construction and upkeep, manufacturing of shuttlecocks and rackets, and the organization of tournaments are all activities contributing to environmental degradation that could be carbon emission, over-production of waste. At the same time, one must not overlook economic gains related to the sport, which include tourism because of big matches or the creation of jobs in the production sphere. The key question is on how to balance between the economic benefits of badminton and to reduce its impact on the environment. This paper will discuss these dynamic and provide the information how the badminton industry can be developed in order to achieve both the environmental and economic objectives.

1. THE BADMINTON ENVIRONMENTAL IMPACT

High globalization of badminton by various institutions including the Badminton World Federation, has made the sport become a major economic and cultural business. This growth has however increased its environmental footprint as well. Since the creation of raw materials to be used in infrastructures up to the bulk production of equipments and arrangement of international tournaments, every step of the badminton ecosystem is involved in carbon emissions, resource depletion, and wastes. Though the sport is regularly viewed as environmental friendly because of the indoor nature of the sport and its relatively small playing field, its overall environmental expenses are high when evaluated at a local, national and global level. It is important to understand these effects in order to come up with sustainable approaches that can support the growth of sporting activities and also ensure that the environment is taken care of.

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1.1. Construction and Maintenance of Courts

Wood, concrete, synthetic flooring, and adhesives are some of the materials that are commonly used in the construction of badminton courts, which have different sustainability concerns:

Wood: Most of the indoor badminton courts have wooden floors, usually obtained using hardwood species such as maple or oak.[2] Such wood may cause deforestation, loss of biodiversity, and habitat destruction because of unsustainable logging.

Concrete: Badminton courts are normally built on concrete. It is very energy-consuming in production and makes a significant contribution to carbon emission through the use of cement.

Synthetic Flooring: Court flooring made of PVC and other synthetic products are petrochemical-based and in most cases non-biodegradable, and thus will result in many waste management problems.[3] Moreover, the manufacturing of the same materials is characterised by toxic chemicals that are hazardous to the workers and environment.

Adhesives and Paints: Adhesives and paints that are used to construct court and to make marks on them tend to have volatile organic compounds (VOCs), which release dangerous emissions to the atmosphere, thereby polluting the air.

Frequent cleaning of synthetic flooring on badminton courts usually uses chemical based cleaners which when poorly disposed may contaminate water systems, affect aquatic life adversely and negatively affect the environment. Also, waste produced during maintenance and renovation of courts is substantial waste materials such as old flooring and adhesive and equipment, most of which cannot be recycled, and thus ends up in the landfill, which means slow accumulation of waste and eventual destruction of the environment. Moreover, the paints and glues applied in the constructions and markings of the courts are usually volatile organic compounds (VOCs) that

[2] Food & Agric. Org. of the U.N. (FAO), *The State of the World's Forests 2022: Forest Pathways for Green Recovery and Building Inclusive, Resilient and Sustainable Economies* 18–25 (2022).
[3] European Chemicals Agency (ECHA), *PVC and PVC Additives in Products* 5–12 (2023); United Nations Env't Programme, *Turning Off the Tap: How the World Can End Plastic Pollution and Create a Circular Economy* 24–29 (2023).

release harmful emissions to the air, which aggravates and worsens the situation with environmental pollution.

1.2. Equipment Manufacturing

They are necessary in the game as the shuttlecocks and rackets are a big challenge to the environment. Rackets frames are mostly constructed using non-biodegradable products such as carbon fiber, aluminum and some plastics.[4] Carbon fiber is manufactured offering lightweight and durable alternatives, but the energy consumption in the production processes is energy-consuming, thereby increasing the emission of greenhouse gasses. Other significant parts of a badminton racket that accompany the frame include the grip and the strings which are very critical in performance and comfort.[5] A good grip will be able to provide a good amount of control, reduce the amount of slipperyness and will help reduce strain on the hand during play. Good strings guarantee the required tension, strength, and accuracy of shots, which has a strong influence on the performance of a player.

Nevertheless, grips and strings of rackets frequently have a synthetic substance, which is extremely harmful to the environment due to its extraction and processing. In order to counter this, they can manufacture them using sustainable materials.[6] The other indispensable constituent of badminton is the traditional shuttlecock. Rackets and shuttlecock are two wheels of a carriage, without one of which, the game cannot be played. Nonetheless, the standard feather shuttlecocks (where the feathers are made of geese or duck feathers) are also a source of animal welfare and sustainability issues. Additionally, they are manufactured with the help of adhesives and plastics, which are also the contributors to the environmental issues.

1.3. Tournament and Event Management

Badminton tournaments, be it locally, district, regional, the state, national or the international ones, will always result in the accumulation of a huge amount of waste, much of which is of disposable

[4] International Olympic Committee, *Carbon Footprint of Sporting Equipment and Materials* 11–16 (2021).
[5] United Nations Env't Programme, *Sustainability and Circularity in the Sports Sector* 37–40 (2023).
[6] United Nations Env't Programme & International Olympic Committee, *Sports for Nature Framework* 18–22 (2023).

nature like plastic bottles and packaging among others. Also, the energy consumption of such events is significant, and lighting, transport, or HVAC systems increase consumption. The total carbon footprint of such events is frequently extremely large as air travel, domestic transit and the energy-intensive aspect of broadcasting are all contributive to an ever-growing tsunami of emissions.

2. The Badminton-led Economic Growth

The increased popularity of badminton as a competitive as well as recreational sport all over the world has played a vital role in the economic development on various levels. Through the international exposure of the Badminton World Federation, the investments in infrastructure, sports technology, tourism and broadcasting of media have been triggered by badminton tournaments, leagues and the grass roots programs.[7] Building of indoor arenas, training academies, and community sports complexes creates jobs and helps the related industries like construction, management of facilities, and retail. Also, the manufacturing and sale of racquets, shuttlecocks, footwear and apparel have produced broad markets, not only to the multinational brands, but also to the local manufacturers. Big events in the world championship attract sponsorship, advertising and sports tourism hence bolster the economy of the region. Besides direct financial benefits, badminton also enhances skills, business opportunities, and global trading patterns; making the sport a dynamic source of sustainable economic growth in both the emerging and developed economies.[8]

2.1. Job Creation

Badminton has a wide range of employment, including production and management of events. In developing countries, the popularity of the sport is associated with the development of employment opportunities in manufacturing of sporting equipment, retailing, and training, coaching and organization of sports events.[9] Also, the spectacle of badminton in significant global sporting

[7] World Trade Organization, *World Trade Report 2023: Re-globalization for a Secure, Inclusive and Sustainable Future* 112–18 (2023).
[8] United Nations, *Sport for Development and Peace: Advancing the Sustainable Development Goals* 7–15 (2022).
[9] United Nations Educ., Sci. & Cultural Org. (UNESCO), *Fit for Life: Sport, Social Inclusion and Economic Development* 32–38 (2023).

events, including the Olympics, has a multiplier effect, which enhances local economies due to tourism and other services.

2.2. Infrastructure Development

Due to the expansion of the sport, more and more new badminton courts are required, both in the recreational context and as an element of professional facilities. Such infrastructure projects also help in the economic growth as they offer construction employment, improvement in local businesses and an increment in the demand of sports facility related products i.e. lighting, flooring and equipments.[10]

2.3. Tourism and Event Revenue

Major badminton events including international championships or tournaments generate enormous income to hosting cities in terms of tourism, hospitality as well as selling tickets and merchandise. The local economic growth is fueled by the events as it brings global attention, media coverage and corporate sponsorship to the larger tourism and hospitality industries.

3. The Dilemma of the Environment and Economic Development

The major dilemma that the badminton industry is facing is the need to balance between the footprint of the industry in terms of the environment and its contribution to economic growth. On the one hand, the industry may gain a lot when it moves towards the further development, not only in the context of the revenue income but also employment opportunities.[11] Conversely, such an expansion may also lead to the destruction of the environment in case sustainable practices are not emphasized.

3.1. The Sustainability of Practices

To balance it, the stakeholders should practice sustainability at all levels of the sport. Sustainable recycled materials like bamboo, recycled carbon fiber or bio-plastics could be used to make the

[10] Ellen MacArthur Foundation, *Completing the Picture: How the Circular Economy Tackles Climate Change* 45–53 (2019).
[11] International Olympic Committee, *Sustainability Essentials for Sports Organisations* 24–38 (2022).

racks.[12] The materials are used to assist in minimizing the carbon footprint without compromising performance. For example, Bamboo is also sustainable and strong and is therefore an environmentally friendly substitute of racket frames. One of the most popular brands of badminton equipments, Yonex uses bamboo as part of manufacturing some frames of the rackets.

There are great advantages in the use of recycled carbon fiber, which is available in the form of used products like car parts or discarded rackets. It lowers carbon emissions and wastes that come along with production of raw carbon fiber and a guarantee of making strong and lightweight racket frames. Even some of the most popular badminton brands such as Li-Ning and Carlton have been practicing greener methods with the use of recycled materials in their products.

Natural resin coating on racket frames ensures that plastics that are made using petroleum products are less relied on. These coating surfaces are made of renewable sources and are either biodegradable or easier to recycle than the conventional plastic finishes. Li-Ning has also implemented the use of water-based adhesives to reduce environmental effects of its manufacturing processes.

They should have the sustainable material as the grip and strings of rackets.

Like for Grips:

- Cork is a natural and renewable substance that is produced on the cork of the cork oak tree, provides great cushioning properties and non slip.
- Recycled rubber is a shock-absorbent and durable recycled material that is made of old tires or recycled rubber.
- Bio-degradable and made of renewable crops, organic cotton or hemp can be woven into soft and comfortable grips with high moisture capacity.
- Bamboo fiber wraps are lightweight, durable, and environmentally friendly that has natural antibacterial properties.

[12] Pablo van der Lugt, *Bamboo as a Sustainable Building Material for the Future* 32–41 (2020).

- Biodegradable polyurethane is a sustainable product that can be used in place of synthetic PU grips.

For Strings:

Natural gut strings Natural gut strings are traditionally built out of the intestines of animals and are biodegradable and known to be elastic and performing.

- The recycled nylon is produced using discarded fishing nets or other nylon waste which will decrease the amount of plastic pollution and can retain string tension and durability.
- Plant bioplastics, including polylactic acid (PLA) made out of cornstarch or sugarcane are renewable and biodegradable.
- Silk strings are a natural and sustainable product that is very elastic and strong.

Shuttlecocks can be constructed using bamboo, cork, natural latex, nylon and even plant-based fibers, which are greener and can degrade in a shorter time. An example of that is Yonex who launched the Eco Shuttle, a recyclable synthetic material shuttlecock offering a more sustainable alternative in the sport. On the same note, other sports equipment suppliers such as Li-Ning and Carlton also embrace the use of eco-friendly plastics in their shuttlecocks thereby enhancing environmental sustainability in badminton.

Renewable materials, bamboo and cork, as well as minimal energy usage (through the passive nature of the building design and renewable energy sources) can be used in the construction of court facilities so that fewer harmful effects on the environment occur. Emission can be significantly minimized as electricity consumption can be reduced with the use of energy-efficient lighting provided by LED. Such lights are durable, they need minimum maintenance, and provide excellent light, which makes them suitable to use in an indoor court. Moreover, by incorporating renewable energy sources, e.g., solar panels or wind turbines to ensure lighting systems, one can reduce the use of non-renewable energy, which will further lead to environmental sustainability and cost-saving.

The application of energy-efficient HVAC systems can be used to make temperature and humidity regulation in the badminton indoor courts more sustainable. They can have a major effect in the

reduction of their environmental impact by integrating these systems with renewable energy sources (solar or wind power). Moreover, modern construction techniques with appropriate insulation and natural ventilation can also be used to keep the best indoor climate level and, accordingly, minimise the high level of HVAC use and minimize the total energy consumption.

In order to keep the badminton courts in a sustainable manner, it is important to embrace environmentally friendly practices. There are water saving cleaning techniques like dry cleaning or installation of water recycling system which would save a lot of water, unnecessary wasting. Moreover, the adhesives and paints used should be low-VOC to reduce air pollution, which will contribute to the improvement of air quality among the workers and the players. The recycling of used floor materials or recycling of the material and instead using it in other applications are not only effective in helping to cut down on land-fills but also in promoting the practice of sustainable production. In addition, the development of programs to gather and recycle old equipment also contributes to the management of waste, which is to maintain a more environmentally friendly attitude to maintaining the courts.

3.2. Cooperation among the Stakeholders

To attain sustainability in badminton, there must be cooperation between the different stakeholders like the governing bodies, badminton manufacturers, sports organizations and the consumers. As an illustration, the collaboration between sporting federations and environmental organizations could be used to promote the creation of environmentally friendly equipment and environmentally certified events. In addition, the environmental responsibility cycle can be inspired by consumer demand of products that are sustainable compelling manufacturers to implement more environmentally-friendly production methods.

3.3. Investment and Technological Innovations

There are exciting possibilities of cutting down emission on the environment of the sport through technological advancements that include the invention of biodegradable shuttlecocks, energy efficient court lighting and water saving cleaning systems among others. In addition, the environmental performance of badminton-related services and products can be made better

through investment in more sustainable material and technologies through research and development, so as to help to cut the costs and enhance the environmental performance.

4. Balancing the Impact of the Environment and Economic Growth

The Swedish badminton is of prime importance in the sustainable future of badminton by balancing the environmental and economics. Through considerate measures, the sport will be able to reduce its environmental impact as it expands economically. The following are some of the strategies that can be used to establish this balance:

4.1. Green Infrastructure/ Energy Saving.

The use of green infrastructure and energy efficient technologies are one of the most successful measures which can be taken to make badminton events and facilities less harmful to nature. They can also streamline lighting and HVAC systems that comprise a large percentage of the energy used in indoor facilities by switching to energy-efficient LED lighting and install a smart HVAC system that will increase or decrease energy usage according to the current demand. Furthermore, renewable energy like solar panels and wind turbines will help relieve the carbon footprint of the badminton venues to a large extent. Using the natural resources, these projects not only save energy, but also become a part of the further strategy of environment sustainability, producing sports environment which is environmentally friendly and self-sufficient.

4.2. Circular Economy Models

The idea of a circular economy, where all resources are reused, recycled, and retained as long as possible, has provided an effective way to minimize the waste in the industry of badminton. This may start with designing of machineries like rackets and shuttlecocks whereby emphasis is laid on developing products that are durable, repairable and recycleable. Use of old products like old rackets, court flooring or shuttlecock helps to avoid the use of new raw material and helps in recycling wastes that get to the landfills. Moreover, the consumption of single-use plastic items at the events, including water bottles, packaging, and promo items, can be lowered to eliminate as much waste as it is possible. Reusable bottles, reusable materials and encouraging the re-upcycling of used equipment will further decrease the environmental impact of the sport.

4.3. Sponsorships and Partnerships are environmentally friendly

Sponsorships and partnerships targeting environmental friendliness can assist badminton events and organizations to sensitize the people on the issue of sustainability as well as fund environmentally friendly projects. Brands that value sustainability can work in cooperation with the organizers of the event, so the partnership will be in line with the values of environmental friendliness. As an example, sponsors may be interested in subsidizing the carbon emissions, subsidizing renewable energy set-ups or sponsoring the usage of environmentally friendly materials. Through a relationship with sustainable brands, badminton is able to make a positive contribution to the environment and to gain some benefit in the economy. Such collaborations may develop a stronger bond between sports fans and brands and support sustainable practices among more people.

4.4. Education and Advocacy

Advocacy and education play an essential role in the development of a culture of sustainability in the badminton fraternity. Players, fans, coaches and other stakeholders have to be sensitized on the significance of minimizing environmental effects and embracing sustainable practices. Green certifications can be initiated during tournaments and events that satisfy some sustainability standards, including waste management, energy efficiency, and carbon emissions reduction, will be rewarded. The event organizers could also be provided with the necessary tools to organize ecologically friendly tournaments with the help of training programs, which would further facilitate the concepts of environmental responsibility. Through awareness creation and offering to the necessary equipment in practicing sustainability, badminton can motivate more players and spectators to participate in environmental protection as they play the game.

5. Conclusion

The future of badminton is in the harmonious approach to its fast growth and the sustainable management of its effect on nature. The sport has created immense economic gains to the host country, through job creation, infrastructural development and tourism, as the sport expands. These economic benefits however, should be sought with a keen understanding of the environmental issues of nature they bring about. In order to achieve a sustainable existence of badminton, it is

mandatory that the stakeholder in the game, including the governing bodies and event organizers, manufacturers, and fans collaborate to reduce the ecological footprint of the sport and increase its economic potential.

The energy used to build, maintain, and operate badminton facilities, especially indoor facilities that have to be well-lit, heated, ventilated, and air-conditioned facilities is one of the primary environmental issues in badminton. Equally important, the materials in which the courts, shuttlecocks and rackets are made are also highly polluted and the waste produced by tournaments is also hazardous to the environment. Only a few of the examples of how the sport activities can lead to the degradation of the environment are non-renewable resources, chemical-based cleaners, and single-use plastic products. These problems may compromise the long term sustainability of the sport and defy its economic proliferation unless an active attitude towards sustainability is practiced.

Describing the concerns, one can imagine the future when badminton will prosper economically and have a smaller impact on the environment. To begin with, the sport should adopt sustainability in all its operations. As an example, ecofriendly materials can be applied to court building and their maintenance: recycled rubber material can be used as a floor, non-toxic paints and adhesives, and energy saving lights. Putting renewable energy systems, e.g. solar panels can also drastically minimize the carbon footprint in badminton facilities. Furthermore, the implementation of the energy-efficient HVAC systems and water-saving technologies may reduce the use of resources and impact the environment of the event management.

The other major sustainability concern is the manufacture of gear especially the shuttle cocks and rackets. Manufacturers can also switch to the use of sustainable materials, including bio-degradable alternatives of shuttlecock and re-use of metals and fibers that are recycled to make rackets. Subsidiary alterations can be used to overcome environmental issues pertaining to garbage and diminished resources. In addition, environmentally friendly production techniques that can lead to a decrease in emissions and energy consumption might have a ripple effect across the manufacturing industry and contribute to forming a more environmentally friendly supply chain.

The organizers of the tournament have a very important role in influencing the environment of badminton. Big events can bring thousands of fans, and such significant events produce plastic single-use bottles, packaging, and promotional items that create enormous amounts of waste. Nevertheless, as the trend moves to reusable and recyclable materials, waste management can be enhanced and the amounts of waste that are taken to landfills are minimized. Also, the carbon footprint of international tournaments can be minimized with the promotion of sustainable traveling activities, including taking buses or carbon-offset initiatives in air travel.

Notably, the cooperation of diverse stakeholders is essential to the achievement of the sustainable badminton potential. The bodies that control such as Badminton World Federation (BWF) can prescribe sustainability on every level of competition. Manufacturers, event organizers, and sponsors have to follow these principles and be the first in their practises. The fans, in their turn, can help by engaging in environmentally-friendly practices, including cutting plastic consumption and participating in sustainable programs on the occasions.

With the sport being still growing within the global contexts influenced by the Badminton World Federation, it has to go beyond the traditional forms of sport development based on infrastructural development and commercial benefits at the expense of the ecological considerations. To achieve sustainable change, renewable energy source should be considered in stadiums, recyclable and biodegradable equipment need to be encouraged, and green certification criteria should be used in tournaments and training centers. Research and innovation can also minimize the amount of material waste and carbon emissions, whereas policy intervention and working in groups can guarantee compliance and impact in the long run. Development and environmental sustainability should not be opposed as contrary objectives. Rather, responsible consumer awareness, green jobs and new markets can be created by sustainable sports management. Through joint effort on behalf of the ruling bodies, manufacturers, organizers, and players, badminton has a chance to become a prototype of an eco-sensitive sporting progress, as other sports will emulate this approach and base its expansion on the health of the planet.

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