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Reducing Environmental Footprint of Disability Sports Events: Challenges and Strategies of Solid Waste Management

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Abstract

As the participation of individuals with disabilities in sports continues to grow, the environmental impact on fauna and flora has come under increasing scrutiny. However, while celebrating athletic achievement and inclusion, it often generates significant amounts of solid waste. This solid waste can have detrimental impacts on the environment, including pollution, resource depletion, and greenhouse gas emissions. Moreover, addressing environmental footprint of sports events is crucial for promoting sustainability and ensuring positive legacy for future generations. This paper therefore, using evaluative and prescriptive methodology, examines challenges associated with solid waste management in disability sports events and propose effective strategies to reduce their environmental impact on fauna and flora. To draw meaningful conclusions, the paper relies on both primary source—observed experience—and secondary source—a literature review of relevant publications from PubMed and Google Scholar. The keywords used in the search were: disabilities sports events, challenges and strategies, solid waste management, sustainable event management, inclusive environmental practices, and waste reduction techniques. Nevertheless, the findings indicate that the challenges are multifaceted, including the logistical complexities of handling large volumes of waste, diversity of waste, limited infrastructure, accessibility and behavioural challenges, public perception and accountability, and inadequate awareness on environmental sustainability of disposal methods. Nonetheless, the paper found out that strategies for addressing these challenges involve combination of innovative approaches and best practices. Key among these is the development of comprehensive waste management plans that prioritize recycling, composting, waste reduction at the source, the use of biodegradable and recyclable materials in sports equipment and event supplies, raising awareness and engaging participants, organizers, and spectators and collaboration between event organizers, waste management companies, and local governments; to make the future of disability sports to be both inclusive and environmentally responsible for the sustenance and survival of humanity.

Keywords: Disabilities Sports Events, Challenges and Strategies, Solid Waste Management, Sustainable Event Management, Inclusive Environmental Practices, Waste Reduction Techniques.

Introduction

Solid waste management has become a growing concern at sports events, including disability sports events, where increased waste generation can lead to significant environmental impacts. Disability sports, due to their specific logistical requirements, face unique challenges in managing solid waste. This position paper evaluates these challenges and proposes strategies to reduce the environmental impact on fauna and flora using evaluative and prescriptive methodologies.

Statement of the Problem

Disability sports events often generate substantial amounts of waste from single-use plastics, food containers, and packaging. The accumulation of this waste poses a threat to local ecosystems, particularly affecting flora and fauna in areas surrounding event venues. The complexity of managing this waste is compounded by accessibility requirements, which can limit the availability of eco-friendly alternatives. Furthermore, inadequate solid waste management systems at many venues exacerbate the problem, leading to the degradation of natural habitats and an increase in pollution.

Research Objectives

This paper examines challenges in disposing waste during sports competitions, the specific waste management challenges posed by disability sports events and proposes solutions to address them in a sustainable manner. Nonetheless, the objectives of this research are:

i. To evaluate the specific challenges associated with solid waste management in disability sports events.
ii. To assess the environmental impacts of waste generated at these events on local flora and fauna.
iii. To propose strategies that ensure the environmental sustainability of these events while maintaining accessibility for participants with disabilities.
iv. To explore potential collaborations with event organizers, waste management companies, and environmental organizations to implement these strategies effectively.

Conceptual Framework

The conceptual framework for this paper revolves around the intersection of accessibility, environmental sustainability, and event logistics. Disability sports events must ensure inclusivity while addressing the waste management challenges that arise from their unique operational demands. This duality creates the need for innovative solutions that balance these competing needs. The conceptual framework for understanding the environmental footprint of disability sports events through the lens of solid waste management involves three key dimensions: environmental sustainability, accessibility, and logistical management. These dimensions interact in complex ways, creating challenges and

opportunities for reducing waste without compromising the inclusivity and accessibility of events for people with disabilities and are discussed as follows:

1. **Environmental sustainability**: This dimension focuses on the principles of reducing, reusing, and recycling waste to minimize the negative environmental impact of sports events. Disability sports events produce a range of waste, from packaging to single-use items. Environmental sustainability in this context involves adopting practices that lower the carbon footprint, reduce resource consumption, and ensure the proper disposal of waste materials to protect local ecosystems.
2. **Accessibility**: Accessibility encompasses ensuring that individuals with disabilities have full and equal access to all aspects of the event, including facilities, services, and waste management systems. This introduces unique challenges, as traditional eco-friendly alternatives, such as reusable containers or complex waste separation systems, may not be easily usable for all participants or attendees. A key aspect of the conceptual framework is ensuring that sustainable practices do not hinder accessibility for disabled athletes and spectators.
3. **Logistical management**: Effective solid waste management requires thorough planning, from the design and placement of accessible recycling bins to the supply of environmentally friendly materials that meet accessibility standards. This dimension also covers collaboration between event organizers, waste management companies, and environmental advocates to ensure that eco-friendly practices are feasible and implemented smoothly.

The interaction of these three dimensions forms the core of the framework, as the goal is to balance the environmental sustainability of events with the need for inclusive design and efficient waste management practices.

Theoretical Framework

From a theoretical perspective, this paper draws on the principles of sustainability and environmental justice. Sustainability emphasizes the importance of balancing human needs with environmental protection, while environmental justice highlights the need for equitable access to clean, healthy environments. In the context of disability sports events, these frameworks underline the necessity of creating environmentally sustainable practices without compromising accessibility for individuals with disabilities. The theoretical underpinning of this research rests on two main theories: sustainable event management and universal design which are discussed as follows:

1. **Sustainable Event Management (SEM)**: SEM theory emphasizes the importance of reducing the environmental impact of large gatherings, including sports events, by adopting sustainable practices throughout the event lifecycle. It encourages event planners to think holistically about waste generation, resource usage, energy consumption, and overall environmental footprint. The SEM model also encourages collaboration with stakeholders, such as vendors, sponsors, and waste

management providers, to achieve environmentally friendly outcomes (Getz, 2009).

2. **Universal Design**: Universal design is the idea that environments and products should be designed to be usable by all people, to the greatest extent possible, without the need for adaptation. In the context of disability sports events, this theory emphasizes the need to make waste disposal systems and sustainability initiatives accessible to people with varying physical and cognitive abilities (Center for Universal Design, 1997). This theory integrates inclusivity into the sustainability efforts, ensuring that eco-friendly practices accommodate individuals with disabilities.

Together, these theories provide a foundation for understanding how to reduce the environmental footprint of disability sports events through solid waste management while maintaining accessibility.

Methodology

The paper adopts an evaluative and prescriptive methodology to achieve its objectives and arrive at meaningful conclusion of findings. The evaluative component assesses the current state of solid waste management in disability sports events, including waste generation rates, disposal methods, and environmental impacts. This assessment is based on a review of existing data from similar events, interviews with event organizers, and site visits to venues hosting disability sports events. The prescriptive component draws on the evaluation to propose actionable strategies aimed at reducing waste and mitigating environmental harm. These strategies are developed in consultation with waste management professionals, environmental organizations, and accessibility experts. The methodology also incorporates a comparative analysis of best practices from other sports events that have successfully reduced their environmental footprint.

Literature Review

The existing literature on solid waste management at sports events highlights a series of persistent challenges and solutions for reducing environmental impact. Research focusing specifically on disability sports events is limited. However, this literature review examines general waste management strategies for sports events and explores the specific needs and challenges of managing waste at disability sports events as follows:

Disability

Disability is a worldwide phenomenon that has no boundary and cuts across countries, sex, religion, race, social status, economic and political positions. It's prevalence and then incidence in the contemporary world are high and worrisome. According to the World Health Organization (WHO, 2013), more than a billion people, which is about 15% of the world's population have some form of disability. However, disability is defined depending on the paradigm that is being considered. The medical model of disability is strongly

normative, based on the individual and his or her medical condition and people are considered to be disabled on the basis of being unable to or less able to function as "normal" persons (Mitra, 2006). Moreover, disability is a medical condition in which an individual has a defect—structural and bio-chemical abnormality; a physical pathology or aberration and interference with the normal growth or development or capacity to learn, caused by continuing disability to the body, intellect or personality to such a degree to need extra care or treatment from medical, nursing, social and educational services. "Persons with disabilities include those who have long-term physical, mental, intellectual or sensory impairments which in interaction with various barriers may hinder their full and effective participation on equal basis with others" (Article 11) (United Nations, 2006). They are classified as the visually impaired, hearing impaired, speech impaired, physical and health impaired, intellectually retarded, emotionally disturbed, learning disabled, gifted and talented.

Disability Sports

Disability sports, also referred to as adaptive sports, are designed to accommodate individuals with physical, intellectual, or sensory impairments. This form of sports allows people with disabilities to participate in physical activities that can improve their physical and mental well-being, promote social inclusion, and empower them to achieve greater autonomy. Over the years, disability sports have evolved into a well-organized global movement, fostering international competition, professional development, and social awareness. The history of organized disability sports can be traced back to the aftermath of World War II, when large numbers of soldiers returned with physical impairments. Early initiatives aimed at using sport as a form of rehabilitation began in hospitals and rehabilitation centers. One of the pivotal moments occurred in 1944, when Sir Ludwig Guttmann, a German-born British neurosurgeon, founded the National Spinal Injuries Centre at Stoke Mandeville Hospital in Aylesbury, England. Guttmann strongly believed that sport was a key component of rehabilitation for individuals with spinal cord injuries. However, in 1948, Guttmann organized the first Stoke Mandeville games for disabled veterans, coinciding with the London Olympic games. This event, which featured wheelchair-bound athletes competing in archery, marked the birth of competitive disability sports. The Stoke Mandeville games later evolved into the Paralympic games, which is now the pinnacle of competitive disability sport. The first official Paralympic games were held in Rome in 1960, featuring 400 athletes from 23 countries. These games were a direct outgrowth of Guttmann's vision and represented a formalized platform for athletes with disabilities to compete on an international stage. Since then, the Paralympic games have continued to grow, with the Tokyo 2020 Paralympic games attracting over 4,400 athletes from 162 countries (Brittain, 2012; Gilbert, & Schantz, 2008).

Environmental Impact of Disabilities Sports Waste

However, the global sports industry has long been recognized not only for its social and economic impacts but also for its environmental footprint. Major sporting events, particularly those catering for athletes with disabilities, such as the Paralympic games, have garnered increased attention concerning their environmental sustainability practices (Brown & Jones, 2019). As the participation of individuals with disabilities in sports continues to grow, the environmental impact of these events has come under increasing scrutiny because while celebrating athletic achievement and inclusion, it often generates significant amount of solid waste. Several studies have examined waste generation and management at large-scale sports events. According to Cheng et al. (2021), international sports events like the Olympics generate enormous amounts of waste, primarily from single-use plastics, food containers, and packaging materials. Cheng et al. (2021) noted that despite efforts to promote recycling, a large percentage of waste still ends up in landfills due to improper waste segregation at the source and insufficient recycling infrastructure. This waste can have detrimental impacts on the environment, including pollution, resource depletion, and greenhouse gas emissions which endangers the existence and survival of the fauna and flora.

Moreover, research has also highlighted the environmental consequences of improper waste disposal on local flora and fauna, particularly in areas where sports events are held outdoors. According to Lopez and Richards (2022), poorly managed waste can disrupt local ecosystems by introducing plastics and other harmful materials into the environment. These materials may be ingested by animals or broken down into micro plastics, which contaminate soil and waterways, negatively affecting plant life and animal populations. The study by Singh et al. (2018) explored the specific impact of waste from sports events on nearby wildlife. They found that waste left unattended in outdoor venues poses significant risks to animals, who may consume or become entangled in discarded materials. Their research underscores the need for stricter waste management practices, particularly in venues located near protected or ecologically sensitive areas.

Nevertheless, in another study, Martin and Beck (2020) explored the environmental impacts of waste on local ecosystems during large-scale events. They found that improper disposal of waste near natural habitats leads to contamination, which can disrupt local flora and fauna and threaten biodiversity. This finding is particularly relevant for disability sports events held in or near nature reserves or public parks, where the environmental stakes are high. Nevertheless, these numerous environmental impacts, each contributing to the ecological footprint are due to:

- Energy consumption: Powering stadiums, broadcasting, and related infrastructure require vast amounts of energy. For example, the energy demand for lighting, cooling and heating during events can be immense. According to a study by Eaton (2020), stadiums have peak energy usage, with demand increasing four to five fold on match days compared to non-event days. This high energy consumption often relies on non-renewable sources, contributing significantly to carbon emissions. For

instance, the 2020 Tokyo Olympics had a total carbon footprint of 1.96 Million tCO2e (IOC, 2020) with a significant portion attributed to energy use (Ukpanah, 2024).

- Increased waste generation: Large crowds produce substantial waste, often improperly managed. Events like the FIFA World Cup and the Olympics generate enormous amount of waste, including food packaging, plastic bottles and promotional materials. The 2012 London Olympics generated 61,000 tons of waste (Knowledge-Wharton, 2012). Disabilities sports events, like other large gatherings, produce significant amount of waste. This includes food packaging, promotional materials, single-use plastics, and discarded equipment. Also, disability sports events often involve specialized equipment, accommodations, and medical supplies, leading to increased waste generation compared to traditional sporting events.
- Transport emissions: Athlete and spectator travel contributes heavily to carbon footprints. Major international events attract visitors from around the globe, leading to significant air travel emissions. The International Olympics Committee estimated that travel-related emissions were a major contributor to the carbon footprint of the Tokyo 2020 Olympics.
- Habitat disruption: The construction of new venues for sports can disturb local ecosystems. Building large-scale sports facilities often requires clearing land, which can lead to habitat destruction and biodiversity loss. For example, constructing new stadiums for the FIFA World Cup in Qatar involved significant land development, impacting local wildlife and ecosystems.

Challenges in Disposing Waste during Sports Competitions

Solid waste management emerges as a critical component of environmental sustainability, given its direct impact on landfills, pollution, and resource conservation. Effective waste management in sports competitions is also critical not only for environmental sustainability but also for the health and safety of participants and spectators. However, waste disposal during these setting presents significant challenges, exacerbated by the scale and diversity of waste generated Moreover, "the urgency of addressing environmental concerns has been propelled by the rising awareness of climate change, resource depletion, and waste generation" (Smith & Thompson, 2020). Nevertheless, the following are challenges in disposing waste during sports competitions:

- Lack of waste segregation infrastructure: Disability sports events often lack appropriate waste segregation infrastructure, leading to a mix of recyclable and non-recyclable materials being discarded together. This lack of segregation reduces the effectiveness of recycling efforts.
- Over-reliance on single-use plastics: Single-use plastic items such as water bottles, food packaging, and straws are commonly used at disability sports events. These

materials contribute significantly to the overall waste burden and are difficult to replace without compromising accessibility.

- Environmental impact on flora and fauna: Improper disposal of solid waste, especially in outdoor venues, has a direct negative impact on local ecosystems. Wildlife can ingest plastics or become entangled in waste, while toxic substances from decomposing waste can seep into the soil and waterways, harming plant life.
- Limited access to eco-friendly alternatives: While there is growing interest in sustainable materials, many disability sports events find it difficult to source eco-friendly alternatives that meet the specific accessibility needs of participants.
- Volume of waste: One of the primary challenges is the sheer volume of waste generated during large-scale sports events. These events can attract tens of thousands of spectators, athletes, and staff, all of whom contribute to waste streams that include plastic bottles, food packaging, and other disposables. Managing this high volume of waste presents a considerable challenge, especially in venues not designed for such large-scale events. According to Sánchez-Lozano et al. (2021) waste generation at sports events is often underestimated, leading to inadequate planning and facilities, which can result in overflowing bins and littering.
- Diversity of waste: The waste generated at these events is diverse, ranging from organic waste to hazardous materials like batteries and medical supplies. This diversity complicates waste management efforts, as different types of waste require different handling, treatment, and disposal methods. For instance, marathon events may generate large amounts of single-use plastic from water stations, while football matches might produce significant food packaging waste. As noted by Kim and Walker (2022) this variability requires tailored waste management strategies for each event type, which can be resource-intensive and challenging to implement effectively.
- Limited infrastructure: Many sports venues, particularly in developing regions, lack adequate waste management infrastructure. This includes insufficient waste bins, lack of recycling facilities, and inadequate waste collection services. The absence of proper infrastructure often leads to the improper disposal of waste, contributing to environmental pollution. The availability of recycling facilities is often insufficient at sports venues, leading to a higher percentage of waste being directed to landfills. A study by Corradini et al. (2020) highlights that many sports venues are not equipped with adequate recycling bins, or if they are, these bins are not always clearly labelled or strategically placed to encourage proper disposal. Additionally, the study found that contamination of recyclable materials is common due to improper sorting by attendees. Perera et al. (2021) examined the waste generated at international sporting events and noted that disability sports often require specialized packaging and assistive devices, many of which are not recyclable. The

lack of facilities capable of handling this waste further compounds the issue. Similarly, Jones et al. (2019) found that sports venues are often ill-equipped to manage large-scale waste disposal in an environmentally friendly manner, particularly when the events require significant logistical adaptations for disability access.

- Accessibility of waste disposal facilities: Waste management facilities are not accessible to all participants, including those with disabilities. There is slack of accessible waste bins and clear signage in formats that can be easily understood by individuals with different disabilities. Traditional waste bins may be inaccessible to individuals who use wheelchairs, crutches, or have limited mobility. Moreover, individuals with visual impairments may face difficulty locating bins, especially if the event venue is crowded or lacks tactile or auditory guidance systems.
- Behavioural challenges: Spectator behaviour plays a significant role in waste management outcomes. Research by Martin et al. (2019) indicates that many attendees are not motivated to recycle or dispose of waste responsibly, especially when under the influence of alcohol or when experiencing the excitement of the event. The social atmosphere of sports competitions can lead to negligence regarding waste disposal, with littering becoming a prevalent issue.
- Logistical and operational challenges: Managing waste disposal logistics in the context of sports event can be complex. The need to maintain clean and accessible facilities throughout the event requires continuous waste collection and monitoring. However, as highlighted by Porter and Shaw (2023), staffing and resource allocation for waste management can be inconsistent, leading to lapses in service and an accumulation of waste in public areas.
- Sustainability goals and practical implementation: Many sports organizations and event organizers have adopted sustainability goals, including commitments to zero waste. However, achieving these goals in practice can be challenging due to budget constraints, lack of expertise, and the need for collaboration with multiple stakeholders. The gap between sustainability aspirations and actual implementation remains a significant barrier, with many events falling short of their waste reduction targets.
- Public perception and accountability*:* The visibility of waste management practices during sports events can affect public perception and the reputation of the event organizers. Poorly managed waste disposal can lead to negative media coverage and damage the image of both the event and its sponsors.
- Inadequate awareness and education: Both event participants and attendees may lack awareness about the environmental impacts of waste and the importance of proper disposal practices. Without adequate education and awareness campaigns, efforts to promote waste segregation and recycling can be ineffective.

- Specialized equipment and medical waste: One of the most significant waste management challenges at disability sports events involves the handling of medical waste. Disability sports events pose unique challenges for waste management due to the specific requirements of the participants. Athletes with disabilities may require medical assistance during events, which leads to the generation of biohazardous waste, including bandages, gloves, catheters, syringes, and other medical supplies. Managing this type of waste is critical for public health and safety, as improper disposal of medical waste can pose risks to event staff, volunteers, and other attendees. Many athletes with disabilities rely on assistive devices and specialized packaging that often include non-recyclable materials (Perera et al., 2021). This reliance on customized equipment leads to higher levels of waste generation, as these materials are not typically designed with environmental sustainability in mind. Moreover, disability sports events often involve the use of specialized equipment such as prosthetics, orthotic devices, wheelchairs, and assistive technology. Managing waste associated with the repair, maintenance, and replacement of such equipment presents unique challenges. Unlike regular sporting equipment, these items may be made from complex materials such as carbon fiber, metals, and specialized plastics, which require different recycling or disposal methods.
- Increased use of single-use products: Another unique challenge in disability sports event waste management stems from the necessity of single-use products for many athletes and spectators with disabilities. While many large-scale sports events are moving towards eliminating single-use plastics, disability sports events face unique obstacles in reducing reliance on disposable items. Many athletes and spectators with disabilities rely on single-use products such as straws, gloves, wipes, and sanitary items for personal care. These items are often essential for hygiene and safety reasons and cannot easily be replaced with reusable alternatives. For instance, some individuals with motor impairments may require single-use utensils to consume food, while others may depend on disposable hygiene products for health reasons. Balancing the need for these products with the goal of reducing waste generation is a challenge that requires thoughtful consideration and innovative solutions. According to Meehan et al. (2020), the push to eliminate single-use items at large events often overlooks the needs of people with disabilities, for whom alternatives such as reusable products may not be feasible or safe. Research on sustainable events typically encourages the use of reusable materials and biodegradable alternatives (Jones & Phillips, 2015), but these suggestions are not always applicable to disability sports events. Scholars like Meehan et al. (2020) highlight the tension between sustainability goals and accessibility requirements, particularly when it comes to waste reduction strategies that inadvertently exclude individuals with disabilities.

- Catering and food packaging: Catering for disability sports events often requires adapting food packaging and service to be accessible and easy to use. Pre-packaged meals may be necessary for athletes or attendees with limited dexterity, and these packaging materials, often plastic or non-recyclable, contribute to the event's waste footprint. In addition, providing adaptive eating utensils and containers designed for individuals with impairments can lead to an increase in single-use items.
- Recycling and waste segregation education: Promoting waste segregation and recycling at any large event is a challenge, and this becomes even more complex when the event involves individuals with a variety of disabilities. For instance, waste disposal systems that rely on visual cues (such as colour-coded bins) may not be effective for individuals with visual impairments. Similarly, waste management instructions that are purely written may not be accessible to those with intellectual disabilities or language barriers.
- Poor implementation of environmentally friendly waste management strategies: In a study by Jones et al. (2019), the authors examined waste management practices at disability sports events and found that accessibility concerns often take precedence over environmental goals. For instance, accessible packaging for food and beverages, although essential for some participants, is typically made of non-biodegradable plastics. Jones et al. (2019) argued that while disability sports events have prioritized inclusivity, they lag behind in implementing environmentally friendly waste management strategies.

Overcoming Challenges in Disposing of Waste during Competitive Sports: General Considerations

The challenges associated with waste disposal during competitive sports events are significant but not insurmountable. Effective strategies require a combination of planning, technology, stakeholder collaboration, and public engagement. However, the following are approaches in overcoming these challenges:

- Comprehensive waste management planning*:* Effective waste management begins with meticulous planning tailored to the specific needs of each event. Organizers should conduct a waste audit before the event to estimate the types and volumes of waste that will be generated. According to Corradini et al. (2020), such audits enable the development of customized waste management plans that include the appropriate number and placement of bins, schedules for waste collection, and strategies for handling different waste streams.
- Investment in recycling infrastructure: Recycling is a cornerstone of effective waste management. By turning waste materials into new products, recycling conserves natural resources, reduces greenhouse gas emissions, and minimizes the need for landfill space. From paper and plastics to electronics and metals, almost every type

of waste has the potential to be recycled, given the right technology and processes (Uffizio, 2024). Investing in adequate recycling infrastructure is crucial in reducing the amount of waste sent to landfills. This includes providing clearly labeled recycling bins in convenient locations and ensuring that attendees have easy access to them. A study by Kim and Walker (2022) suggests that the strategic placement of recycling bins, along with clear signage, can significantly increase recycling rates at sports events. Additionally, the use of smart waste management systems, which employ sensors to monitor bin fill levels, can optimize collection schedules and reduce the likelihood of overflow.

- Leveraging advanced software: Advanced waste collection software streamlines the process of waste collection and management. These systems use data analytics to optimize collection routes, reduce operational costs, and improve overall efficiency. They also provide valuable insights into waste generation patterns, helping to design more effective waste reduction and recycling programmes (Uffizio, 2024.
- Smart waste management: Beyond software, other smart waste management systems like sensor-equipped bins and automated sorting technologies are making waste collection more efficient. These technologies can identify and sort recyclables, reducing contamination and improving the quality of materials sent for recycling (Uffizio, 2024).
- Composting: Composting is an eco-friendly solution for managing organic waste. This natural process turns organic materials like food scraps and yard waste into a valuable soil amendment, enriching soil quality and reducing the need for chemical fertilizers. These initiatives not only reduce the volume of waste going to landfills but also engage the community in sustainable practices. For example, some cities provide compost bins to households and offer guidance on composting techniques, making it easier for residents to contribute to waste reduction (Uffizio, 2024). In this method, bulk organic waste is converted into fertilizer by biological action (biological waste treatment). Separated compostable waste is dumped in underground trenches in layers. Minimizing waste generation and recycling reduces human impacts on the environment. With this focus, composting has received a high ranking in the hierarchy of recycling methods and continues to gain importance throughout the world for the conversion of organic by-products to new resources. The wastes are finally converted into humus that has fertilizing value as it contains lots of Nitrogen, phosphates and other minerals which are needed for good growth of plant. Composting can be done in depth compost pit, composting on plain earth surface and anaerobic digestion in a bio digester.
- Incineration: This process is also known as thermal treatment where solid waste materials are converted by incinerators into heat, gas, steam and ash. Incineration of solid waste is suitable if waste contains more hazardous material and organic

content (combustible refuse). Incineration is practiced in countries where landfill space is no longer available, which includes Japan.

- Gasification and pyrolysis: These are two similar methods, both of which decompose organic waste materials by exposing waste to low amounts of oxygen and very high temperature. Pyrolysis uses absolutely no oxygen while gasification allows a very low amount of oxygen in the process. Gasification is considered more advantageous as it allows the burning process recover energy without causing air pollution (Rick, 2016).
- Incorporating technology and innovation: Leveraging technology can streamline waste management processes and improve outcomes. For example, the use of waste sorting robots or automated systems can reduce human error and contamination in recycling streams. Jackson et al. (2021) discuss how technology and data analytics can track waste generation in real time, allowing for dynamic adjustments to waste collection and disposal strategies. Furthermore, implementing mobile apps that guide attendees on proper waste disposal can enhance participation and reduce littering.
- AI and machine learning: Another notable trend is the integration of technology in waste management. Advanced waste collection software, AI-driven sorting systems, and smart bins are becoming more prevalent, offering smarter and more efficient ways to manage waste. The use of artificial intelligence (AI) and machine learning is on the rise in waste management. These technologies can optimize waste collection routes, enhance sorting processes, and even predict waste generation patterns. AI-driven systems are increasingly being integrated with advanced waste collection software to create smarter, and more efficient waste management solutions (Uffizio, 2024).
- Energy recovery from waste: Energy recovery from waste is another innovative approach. Waste-to-energy plants convert non-recyclable waste materials into usable heat, electricity, or fuel through various processes like combustion, gasification, and anaerobic digestion. This not only helps in managing waste but also provides a renewable energy source. The adoption of waste-to-energy technologies can significantly reduce the environmental impact of waste disposal. These technologies are particularly useful in regions with limited landfill space. Additionally, they provide economic benefits by generating energy and creating jobs in the waste management sector (Uffizio, 2024).
- Event-specific waste management strategies: Tailoring waste management strategies to the specific needs of each event type can improve efficiency and effectiveness. For instance, marathon events may benefit from on-site composting stations for organic waste, while football matches could implement deposit-return schemes for beverage containers. According to Sánchez-Lozano et al. (2021)

understanding the unique waste profile of each event allows for the design of more targeted and effective waste management interventions.

- Promoting zero-waste initiatives: Aiming for zero waste is an ambitious but achievable goal for many sports events. This requires a holistic approach that includes reducing waste at the source, maximizing recycling, and minimizing the amount of waste sent to landfills. Zero waste strategy is a focused approach of conserving all resources through responsible production, consumption, reuse and recovery of product, packaging and materials without burning and with the least discharge to air, water or land that cause an adverse effect on our environment and human health (Pant & Joshi, 2022). The zero waste model not only mention cycles but also provides economics business model with zero waste solutions by providing useful steps that can be implemented into every cycle per the requirements. These steps are Reduce, Reuse, Recycle and Recovery to landfill (Korai, Mahar, & Uqaili, 2016). Successful zero-waste initiatives, as described by UNEP (2019) involve comprehensive planning, stakeholder engagement, and robust public participation. These initiatives often include waste reduction targets, detailed monitoring and reporting, and continuous improvement processes.
- Sanitary landfills: Generally, this term means a large piece of land away from living places where all the waste from a town is deposited. Proper landfill management involves sorting out all the waste (waste separation), and sending only the waste that cannot be recycled and composted to the site. Land fill is the oldest form of waste treatment. Historically, landfills have been the most common method of organized waste disposal and remain so in many places around the world. Over 80% of municipal solid waste generated in China is land-filled. Land filling provides the cheapest and most convenient method of waste disposal today when operated efficiently (Krook, et, al., 2012; Morris & Barlaz, 2011). Several million tons of municipal solid waste (MSW) are disposed of in sanitary landfills (controlled landfill) and dump sites (uncontrolled landfills) daily around the world (EPA, 2005). Proper landfills are lined at the bottom to minimize the leakage of soil pollutants and other toxins from getting into the water table.
- Adoption of sustainable materials: The use of sustainable, biodegradable, or recyclable materials can drastically reduce the environmental impact of waste generated at sports events. For instance, replacing single-use plastics with compostable alternatives for food and beverage packaging can make waste disposal more manageable.
- Engaging stakeholders and collaborative efforts: Collaboration among stakeholders, including event organizers, local authorities, waste management companies, and sponsors, is key to effective waste management. Stakeholder engagement can help align goals, share resources, and coordinate efforts. A study by Porter and Shaw (2023) found that partnerships with local waste management

companies allowed for more efficient waste collection and processing during large sports events, leading to higher recycling rates and reduced environmental impact.

- Incentivizing responsible behaviour*:* Providing incentives for responsible waste disposal can motivate attendees to participate in recycling and waste reduction efforts. For example, offering discounts or rewards for returning used containers or participating in recycling programmes can encourage more sustainable behaviour. As noted by Martin et al. (2019), gamification of waste management, where attendees can earn points or rewards for proper disposal, has proven effective in increasing waste management engagement.
- Public education and awareness campaigns: Educating attendees about proper waste disposal practices is essential for improving compliance. This can be achieved through pre-event communications, in-venue announcements, and the use of digital platforms such as event apps. As highlighted by Martin et al. (2019), engaging the public through interactive campaigns, such as rewarding those who recycle correctly, can foster a culture of responsibility. Additionally, involving local schools and community groups in these efforts can extend the impact of these educational initiatives beyond the event itself.
- Monitoring and evaluation of waste management efforts: Monitoring and evaluating the effectiveness of waste management strategies is crucial for continuous improvement. This can involve tracking the amount of waste generated, recycled, and disposed of, as well as gathering feedback from participants and attendees. The data collected can be used to identify areas for improvement and to set targets for reducing waste in future events.
- Utilizing post-event waste audits: Conducting a waste audit after the event can provide valuable insights into the effectiveness of waste management strategies and identify areas for improvement. This feedback loop allows organizers to refine their approaches for future events. Kim and Walker (2022) recommend that post-event audits be used to measure success against sustainability goals and to inform future planning efforts.

Overcoming challenges in Disposing of Waste during Competitive Sports: Specific Considerations

Several strategies have been proposed to reduce the environmental impact of solid waste at sports events, but few have been specifically tailored to disability sports. To address the challenges posed by disability sports events, organizers should implement adaptive and inclusive waste management strategies. However, the following solutions can help mitigate the environmental impact while ensuring accessibility for all attendees:

- Collaboration with environmental and accessibility experts: Partnerships with environmental organizations and accessibility advocates are key to designing waste management systems that serve both environmental and accessibility goals.

Collaborative efforts can lead to the development of innovative products and solutions that meet the diverse needs of participants in disability sports events (Perera et al., 2021). According to the International Paralympic Committee (IPC), organizers of disability sports events should work closely with environmental experts and waste management companies to develop solutions that cater to both environmental sustainability and accessibility (IPC, 2020). This could include offering eco-friendly products that are also accessible, such as compostable food containers with easy-to-use openings. Event organizers should work closely with waste management companies, environmental NGOs, and accessibility advocates to ensure that sustainable practices are effectively integrated into event logistics.

- Inclusive design of waste management systems: Organizers of disability sports events should ensure that waste segregation systems are inclusive. This can include providing auditory or tactile cues, employing volunteers to assist with waste disposal, and developing simple, accessible educational materials about waste management. Implementing designated waste disposal bins for recyclable, compostable, and non-recyclable waste can improve recycling rates and reduce environmental impact. Accessible waste segregation stations, designed with the needs of individuals with disabilities in mind, should be installed at all disability sports events.
- Adaptability: Recycling systems at sports events are often designed to encourage attendees to separate their waste into distinct streams (e.g., plastics, paper, organic waste). However, disability sports events should adapt these systems to accommodate individuals with cognitive or sensory impairments. According to Carter and Groves (2017), recycling programmes at large events are only effective if they are simple and user-friendly, but these systems often fail to account for the diversity of cognitive and physical abilities in the population. At disability sports events, clear signage alone may not be sufficient. Studies on inclusive design in public spaces suggest that multiple communication methods (such as visual, auditory, and tactile cues) are necessary to ensure that individuals with a wide range of abilities can participate in recycling programmes (Greenhalgh & Worpole, 2016). Additionally, the need for on-site assistance is greater at disability sports events, as some individuals with disabilities may require help in navigating waste segregation systems. Research on volunteer programes at sports events (Houlihan, 2018) suggests that volunteers can play a key role in guiding attendees through the recycling process, but this practice is not always the standard at disability sports competitions. Further research is needed to assess how effective volunteer programmes and accessible recycling systems can improve waste segregation outcomes at these events. Waste disposal facilities should be designed with universal accessibility in mind. This includes providing bins that are at wheelchair-accessible heights, using large and clearly marked openings, and offering tactile or auditory indicators for individuals with visual impairments. Recycling and waste

stations should also be equipped with accessible signage, including Braille or contrasting colours for individuals with limited vision.

- Innovative recycling programmes for specialized equipment: Event organizers can establish specialized recycling programmes for the equipment used by athletes with disabilities. For example, prosthetics, wheelchairs, and other assistive devices that are damaged during competition can be recycled or donated for repurposing. Partnering with manufacturers or specialized recycling companies can help ensure that materials such as metals, plastics, and carbon fibers are properly managed.
- Labelling: waste segregation systems that are clearly labeled and designed to accommodate people with disabilities can enhance recycling rates.
- Responsible management of medical waste: Organizers should work with certified medical waste disposal companies to manage the collection, transportation, and disposal of medical and biohazard waste. Dedicated medical waste bins should be placed throughout the event venue to allow athletes and medical personnel to dispose of items such as gloves, bandages, and hygiene products safely.
- Sustainable catering solutions: Vendors at disability sports events should be encouraged to use eco-friendly, accessible food packaging solutions, such as biodegradable materials. Event organizers can also reduce waste by offering refillable drink stations, minimizing the use of single-use cups and bottles. Importantly, reusable utensils and packaging should be designed for ease of use by individuals with disabilities, and alternatives should be available for those who require single-use products. Event organizers should find ways to balance the provision of accessible food options with sustainable waste management practices. One solution is to work with vendors who use biodegradable or compostable packaging while ensuring that the packaging is easy to handle for individuals with physical impairments.
- Education and awareness programmes: Raising awareness among participants, volunteers, and spectators about the importance of proper waste disposal can lead to more responsible behavior. Organizers can partner with environmental organizations to run educational campaigns during events. To promote effective waste management, educational programmes should be tailored to the needs of individuals with disabilities. Accessible materials, including videos with sign language interpretation, easy-to-read guides, and on-site volunteers, can help ensure that all attendees understand how to segregate waste properly. These programmes should focus on inclusivity and provide alternative communication methods for those with sensory or intellectual impairments.
- Accessibility of waste management systems: Accessible waste management infrastructure should be designed to accommodate the needs of people with different abilities Accessibility is a central consideration in any aspect of event management for disability sports, and waste management is no exception. Sports

event venues should ensure that waste disposal systems are designed to be accessible to all, including individuals with physical, sensory, and intellectual disabilities. Researchers such as Greenhalgh and Worpole (2016) argue that public facilities, including waste disposal systems, should be designed inclusively to accommodate individuals with different physical abilities. This includes ensuring that waste bins are at appropriate heights for wheelchair users, and equipped with large openings and contrasting colours to assist people with visual impairments. Clear signage using universal symbols and Braille can also make waste disposal more accessible equipped with tactile markers for the visually impaired, and have large openings for easy use by individuals with limited mobility. However, Martin and Beck (2020) suggested that this tension between accessibility and sustainability can be resolved through innovation and collaboration. They proposed the development of eco-friendly, accessible materials and equipment that cater to the specific needs of athletes with disabilities. They also highlighted the importance of educating event organizers and participants about sustainable practices and waste reduction, which could lead to behavioral changes that benefit both the environment and event operations.

- Waste management systems are easily navigable: Scholars like Houlihan (2018) point out that many event organizers fail to consider the additional waste infrastructure requirements for disability sports. While most general sports events focus on reducing single-use plastics and promoting recycling, disability sports events should also ensure that waste management systems are easily navigable for individuals who might have mobility challenges or rely on assistive devices.
- Specialized medical waste: According to Marsden (2017), medical waste at sports events should be handled by trained personnel to ensure compliance with safety protocols and health regulations. This need becomes even more pronounced at disability sports events, where the frequency of medical interventions might be higher.
- Use of single-use products and materials: According to Meehan et al. (2020), the push to eliminate single-use items at large events often overlooks the needs of people with disabilities, for whom alternatives such as reusable products may not be feasible or safe. However, research on sustainable events typically encourages the use of reusable materials and biodegradable alternatives (Jones & Phillips, 2015).
- Event planning and policy implications: In recent years, event organizers have increasingly focused on making sports events more sustainable, yet there is a lack of clear guidelines addressing waste management challenges specific to disability sports. As noted by Marsden (2017), sustainability efforts at large sports events often prioritize environmental outcomes over accessibility, leading to a disconnect between waste management strategies and the needs of disabled attendees.

Carter and Groves (2017) argue that disability inclusion should be a central consideration in sustainable event planning, particularly in areas such as waste reduction and management. Policies such as those promoted by the International Paralympic Committee (IPC) emphasize the importance of accessibility at sports events, but specific waste management guidelines are largely absent. Meehan et al. (2020) call for greater collaboration between sustainability experts, disability advocates, and event organizers to develop comprehensive waste management strategies that address the needs of all participants. Such collaboration could result in new policies that integrate sustainability with accessibility, ensuring that future disability sports events are both inclusive and environmentally responsible.

- Health and safety regulations compliance: Medical waste generated by athletes, including disposable items such as gloves, bandages, catheter bags, and other personal hygiene products, should be handled carefully. Medical waste poses biohazard risks and cannot be disposed of through regular waste channels. Proper protocols for segregating, collecting, and disposing of medical waste should be in place, ensuring compliance with health and safety regulations.
- Encouraging public transportation: Managing this high volume of waste from motor and automobiles vehicles presents a considerable challenge, especially in venues not designed for such large-scale events. Encouraging public transportation, carpooling, and virtual spectating can help mitigate vehicle emissions.
- Early planning and design phases: Liu and Sanford (2020) emphasized that the success of waste management initiatives at sports events depends largely on the early planning and design phases. They argue that placing clearly marked waste bins, reducing single-use plastics, and educating participants about proper waste disposal can significantly reduce the environmental footprint of such events. Moreover, the adoption of eco-friendly materials and reusable products has proven effective in reducing overall waste generation, as demonstrated in several case studies of "green" sporting events.
- Promotion of zero waste initiatives: One promising strategy is the use of zero waste initiatives, which encourage the use of reusable materials and discourage single-use plastics. For example, reusable water bottles and accessible refill stations can be installed at sports venues to reduce the need for plastic bottles (Jones et al., 2019). Disability sports events can reduce waste by encouraging participants to bring reusable water bottles and providing water refill stations. These stations should be designed for easy use by individuals with mobility impairments
- Use of eco-friendly, accessible packaging: Event organizers should prioritize the use of biodegradable or reusable packaging materials that are also accessible for individuals with disabilities. Collaboration with manufacturers to develop products that meet both accessibility and sustainability criteria is essential.

Results and Discussion

The result from primary source (observed experience) and secondary source (a literature review of relevant publications) in this paper indicate the following as environmental impacts on disability sports and challenges in disposing waste during disabilities sports competitions:

Study report: environmental impacts on disability sports

Sports for individuals with disabilities provide physical, social, and mental health benefits. However, organizing such events, like other large-scale activities, contributes to environmental degradation. This paper focuses on four key environmental factors: energy consumption, waste generation, transport emissions, and habitat disruption. Each factor plays a role in shaping the ecological footprint of disability sports as follows:

1. Energy Consumption: The energy required to host disability sports events is considerable. Facilities such as stadiums, training centers, and adaptive equipment require significant energy, especially if these venues are poorly optimized for sustainability. Lighting, heating, and cooling of indoor arenas, as well as the operation of equipment, contribute to increased carbon emissions and reliance on non-renewable energy sources through:

- **Indoor sports:** Activities such as wheelchair basketball and swimming often take place in temperature-controlled environments, where energy demands are higher.
- **Adaptive equipment**: Power-assisted wheelchairs and other mobility devices require charging, adding to the energy load.
- **Venue accessibility**: Specialized transportation and modifications, such as elevators and ramps, add to the operational energy needs of facilities.

2. Increased waste generation: Disability sports events often lead to the production of large quantities of waste. Disposable plastics, food packaging, and medical waste (such as used prosthetics components or assistive devices) are common at events. Additionally, disposable paper and promotional materials contribute to the environmental burden through:

- **Single-use equipment**: Athletes with disabilities may require customized gear, some of which is disposable after an event.
- **Health and hygiene**: Due to medical needs, the use of single-use products like gloves or sanitary items is necessary, leading to higher waste production.
- **Food and beverage packaging**: Like any other large-scale sporting event, food vendors produce packaging waste, which must be managed effectively.

3. Transport Emissions: Transportation is a significant contributor to carbon emissions, and disability sports events often involve participants traveling long distances. Accessible transport options, such as wheelchair-accessible buses or vans, are crucial but often run on fossil fuels, increasing carbon output through:

- **Increased accessibility needs:** Specialized vehicles, often powered by diesel or gasoline, are required for the transportation of athletes, spectators, and support staff with disabilities.
- **Air travel**: International events, such as the Paralympic Games, involve air travel for athletes and their equipment, significantly increasing the carbon footprint.
- **Public transport**: Public transportation systems may not always be accessible, pushing event organizers to rely on individualized or private transport options, exacerbating emissions.

4. Habitat Disruption: The construction of accessible sports venues or the adaptation of existing ones may lead to habitat disruption. Building facilities often involves clearing natural land, altering ecosystems, and increasing local pollution levels through*:*

- **Construction and development**: The need for fully accessible venues, including ramps, elevators, and parking spaces, may require the modification of existing habitats or the creation of new structures.
- **Temporary disruption**: Large-scale disability sports events might lead to the temporary setup of facilities, affecting local flora and fauna in the surrounding areas.
- **Urbanization**: Hosting events in previously underdeveloped areas can lead to increased urban sprawl, further disrupting natural habitats.

Study report: challenges in disposing waste during disabilities sports competitions

Sports competitions, while fostering athleticism and community engagement, generate significant amounts of waste. Effective waste disposal at such events is crucial to minimizing environmental impact, but various challenges hinder the proper management of waste. This study outlines key challenges in waste disposal at sports events, including infrastructural, logistical, behavioral, and operational issues. These challenges contribute to inefficiencies in waste management and environmental degradation and are as follows:

1. **Lack of waste segregation infrastructure:** One of the primary challenges is the absence of waste segregation systems at sports events. Without the necessary infrastructure for sorting recyclable and non-recyclable waste, much of the waste generated is sent to landfills, contributing to environmental pollution with the following impact: non-recyclable and recyclable materials are mixed, making waste treatment more difficult and inefficient and missed opportunities for recycling materials such as plastics, metals, and paper.

2. **Over-reliance on single-use plastics:** Many sports competitions rely heavily on single-use plastics, particularly in catering, packaging, and other event supplies. This creates large volumes of plastic waste that are challenging to recycle and often end up polluting ecosystems with the following impact: single-use plastics contribute to long-term pollution due to their non-biodegradable nature and plastic waste often finds its way into waterways, posing threats to marine life and ecosystems.

3. **Environmental impact on flora and fauna:** Improper disposal of waste, particularly in outdoor sporting events, can have a detrimental effect on local flora and fauna. Littering and waste accumulation can damage habitats and disrupt wildlife with the following impact: wildlife may ingest or become entangled in plastic and other waste and toxic substances from improperly disposed waste can contaminate soil and water, affecting plant life and ecosystems.

4. **Limited access to eco-friendly alternatives:** While sustainable alternatives to single-use plastics and other waste-producing materials exist, their availability is often limited at sports events. Eco-friendly products are typically more expensive or less accessible to event organizers with the following impact: event organizers may opt for cheaper, non-sustainable materials due to budget constraints and lack of awareness or access to alternatives leads to the continued use of environmentally harmful materials.

5. **Volume and diversity of waste:** The large scale of sports competitions generates a vast quantity of diverse waste, ranging from food packaging and plastic bottles to medical waste and specialized equipment. Managing such a high volume and variety of waste can overwhelm existing disposal systems with the following impact events produce mixed waste streams that are challenging to manage efficiently and higher waste volumes increase the burden on local waste management facilities, leading to overfilled landfills.

6. **Limited infrastructure and accessibility of waste disposal facilities:** Many sports venues lack sufficient infrastructure for managing waste. In addition, accessible waste disposal points may not be adequately positioned for spectators, athletes, and staff, leading to improper disposal practices with the following impact: inaccessible or insufficient disposal bins lead to littering or improper waste disposal and limited waste disposal infrastructure can cause event venues to become cluttered with trash.

7. **Behavioral challenges:** Audience and participant behavior play a significant role in the success of waste management strategies. Without proper education and engagement, spectators and athletes may be unaware of proper disposal practices or simply choose convenience over environmental responsibility with the following impact: people may fail to use recycling or composting bins correctly, exacerbating waste segregation problems and littering becomes prevalent when proper waste disposal methods are not emphasized or enforced.

8. **Logistical and operational challenges:** Organizing large sports competitions involves complex logistics, and waste management can be deprioritized in favor of other operational needs. Staff shortages, inadequate equipment, and the complexity of managing waste disposal for large crowds add to the logistical challenges with the following impact: inconsistent waste collection schedules or inadequate staff reduce the effectiveness of waste management efforts and large crowds make waste collection and disposal more difficult to manage in real-time.

9. **Sustainability goals and practical implementation:** Many sports organizations set ambitious sustainability goals, but translating these goals into actionable waste management practices can be difficult. In practice, sustainability initiatives may fall short

due to a lack of resources, infrastructure, or commitment from stakeholders with the following impact: sustainability goals may be more symbolic than actionable, leading to poor execution and a gap often exists between setting environmental targets and the ability to meet them due to practical constraints.

10. **Public perception and accountability:** Public perception and expectations around environmental responsibility are growing, putting pressure on event organizers to manage waste sustainably. However, without strong accountability measures, these expectations may not be met with the following impact: failure to meet public expectations for sustainability can damage the reputation of event organizers and a lack of transparency regarding waste management practices may lead to skepticism about an event's environmental impact.

11. **Inadequate awareness and education:** One of the underlying issues in waste management is the lack of adequate education and awareness around proper disposal methods. Both spectators and athletes may not be aware of how to correctly dispose of waste, contributing to improper practices with the following impact: inefficient waste management due to lack of awareness around recycling and waste segregation and missed opportunities to educate the public about sustainable waste practices during sports events.

12. **Specialized equipment and medical waste:** Sports competitions, particularly for athletes with disabilities, can generate specialized equipment and medical waste. This type of waste requires careful handling and disposal, often involving special protocols that are not always available at general sporting events with the following impact: improper disposal of medical waste can pose health hazards to people and the environment and specialized equipment may be difficult to recycle or reuse, leading to increased waste production.

13. **Increased use of single-use products in catering and food packaging:** Catering services at sports events are often responsible for generating large amounts of waste, particularly single-use food packaging and disposable utensils. These materials are often non-recyclable, adding to the overall waste burden with the following impact: high levels of non-recyclable waste contribute to increased landfill use and packaging waste can be difficult to segregate and recycle effectively.

14. **Recycling and waste segregation education:** Many waste management issues stem from a lack of education on proper recycling and segregation practices. Without clear signage and education campaigns, spectators may not know how to properly dispose of their waste with the following impact: improper use of recycling bins leads to contamination, reducing the efficiency of recycling efforts and missed opportunities to engage and educate the public on sustainable waste practices.

15. **Poor implementation of environmentally friendly waste management strategies:** Even when environmentally friendly waste management strategies are in place, poor implementation can render them ineffective. Inadequate planning, resource allocation, and enforcement often undermine sustainability initiatives with the following impact:

ineffective implementation leads to continued environmental degradation and events fail to meet their sustainability goals, contributing to negative environmental outcomes.

Recommendations

This paper has shown that "disability sports events, characterized by their unique infrastructural and logistical requirements, pose distinct challenges in implementing effective solid waste management strategies. These challenges range from accommodating accessibility needs, ensuring inclusive facilities, to managing specialized equipment and materials tailored for athletes with disabilities" (Williams & Patel (2021) including behavioural and logistical difficulties. But with careful planning and inclusive strategies, these challenges can be overcome. However, to be specific and effectively reduce the environmental footprint of disability sports events, particularly in the domain of solid waste management, a multifaceted approach that integrates planning, education, technology, and collaboration is essential. Moreover, to minimize the environmental impact of these events, stakeholders must invest in better waste segregation systems, raise awareness, promote eco-friendly alternatives, and ensure the proper disposal of specialized and medical waste. Organizers should consider adopting more sustainable practices, such as using renewable energy sources, promoting waste reduction initiatives, facilitating green transportation, and minimizing habitat disruption during event planning. As the demand for sustainable practices continues to grow, the sports industry should innovate and adapt its waste management practices to meet the expectations of both attendees and the global community. By adopting comprehensive waste management strategies, investing in recycling infrastructure, and engaging stakeholders and the public; event organizers can significantly reduce the environmental impact of these events. Organizers should consider adopting more sustainable practices, such as using renewable energy sources, promoting waste reduction initiatives, facilitating green transportation, and minimizing habitat disruption during event planning. Efforts to reduce their environmental impact should focus on innovative solutions that maintain accessibility while promoting sustainability. Nonetheless, the following recommendations aim to address the unique challenges faced by these events, while leveraging innovative strategies to promote sustainability should be considered:

1. Implement inclusive and comprehensive waste management plans: A robust waste management plan should be tailored to the specific needs of disability sports events.
2. Adopt technology-driven solutions: Incorporating technology into waste management processes should be adopted as it can enhance efficiency and reduce the overall environmental impact.
3. Enhance stakeholder engagement: Effective waste management at disability sports events requires the active participation of all stakeholders, including event organizers, athletes, volunteers, and spectators. Therefore, stakeholders should be properly engaged in disability sports waste management.

4. Design events with sustainability in mind: Incorporating sustainability into the design and planning of disability sports events should be made a priority as it can significantly reduce waste generation.
5. Develop partnerships with specialized waste management services: Given the unique nature of waste generated at disability sports events, partnerships with specialized waste management should be encouraged as such services are crucial in tackling the menace of waste disposal at disability sports events.
6. Educate and promote waste management awareness: Learn about waste management practices and share this knowledge within your community. Launch educational campaigns to improve public knowledge about waste management and recycling practices.
7. Adopt sustainable practices: Reduce, reuse, and recycle whenever possible.
8. Support technological innovations: Advocate for the adoption of advanced waste management technologies, including smart waste collection software, in your local area.
9. Influence policy: Engage with local authorities and policymakers to implement effective waste management policies.
10. Transits to renewable energy: Transition to renewable energy for venue operation and improvement on energy efficiency in indoor facilities should be undertaken.
11. Waste reduction: Implement recycling programmes and encourage the use of reusable equipment and materials where possible.
12. Sustainable transport: Promote the use of electric or hybrid vehicles for athlete transport and incentivize the use of public transport where accessible.
13. Minimizing habitat disruption: Integrate environmental planning into venue development, focusing on eco-friendly construction and minimizing damage to local ecosystems.
14. Emulate countries that have excelled in solid waste management: Countries with good track record of effective waste management should be emulated. Imitating strategies used by countries such as Sweden, Japan and USA will go a long way to "tackle the solid waste management problems that face our planet make a difference, one step at a time, for a cleaner, more sustainable world" Uffizio, 2024).
15. Invest in waste segregation infrastructure: Implement comprehensive waste segregation systems, with clearly labeled bins and recycling stations.
16. Reduce single-use plastics: Encourage the use of reusable or biodegradable materials in catering and event supplies.
17. Incorporate sustainable alternatives: Increase access to eco-friendly alternatives for event organizers and vendors.
18. Enhance logistics and operations: Improve the operational capacity of waste management teams to ensure timely collection and disposal.

Conclusion

Disability sports events, while vital for inclusivity and social cohesion, contribute significantly to the ecological footprint. The environmental impact of disability sports is multifaceted and can be seen in the energy consumed, the waste generated, the emissions produced, and the disruption of natural habitats. However, despite these concerns, it is essential to balance the environmental footprint with the social, health, and cultural benefits that these events offer to participants. Moreover, "the transient nature of such events, combined with the influx of spectators, athletes, and support staff, exacerbates waste generation, necessitating robust and adaptive waste management solutions" (Chen & Lee, 2022). Nevertheless, "the challenges of solid waste management are multifaceted and demand a range of solutions. From recycling and waste reduction strategies to the adoption of advanced technologies like waste collection software, each approach plays a crucial role in building a sustainable future. The case studies from around the world demonstrate that effective waste management is not only possible but also beneficial for both the environment and society" (Uffizio, 2024). By addressing the issues of energy consumption, waste generation, transport emissions, and habitat disruption, stakeholders can enhance the sustainability of these important sporting activities without compromising their inclusivity; by prioritizing these sustainable practices, disability sports can continue to thrive while contributing to global efforts to reduce environmental degradation and; by designing accessible waste management systems, promoting the recycling of specialized equipment, and managing medical waste responsibly, event organizers can minimize the environmental impact while meeting the needs of athletes, spectators, and staff with disabilities. In doing so, disability sports events can serve as models for inclusive and sustainable event planning, paving the way for future advancements in waste management across the sporting world. In the same vein, overcoming these challenges will help sports competitions align with broader sustainability goals while maintaining public accountability. Nonetheless, "It is clear that tackling solid waste management problems is not just the responsibility of governments or waste management companies; it involves every one of us. Consumers, businesses, and communities all have a part to play. By making conscious choices, supporting eco-friendly practices, and participating in local waste management programs, we can collectively make a significant impact. The advancement of technology, particularly in the form of advanced waste collection software, offers a beacon of hope in this endeavor. These tools provide smarter, more efficient ways to manage waste, but their success hinges on widespread adoption and integration with other waste management practices. Now is the time to act" (Uffizio, 2024)—yes indeed to make the future of disability sports to be both inclusive and environmentally responsible for the sustenance and survival of humanity.

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