THE REHABILITATION AND PHYSICAL INDUSTRY IN THE CIRCULAR ECONOMY SYSTEM IN BULGARIA

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Abstract: *The rehabilitation and physical industry in the circular economy model is extremely relevant, especially in the context of sustainable development and resource optimization in healthcare. The circular economy is an economic model that strives to minimize waste and optimally use resources through reuse, recycling, repair, and extension of the product life cycle. Instead of the traditional linear „take-produce-dispose" model, the circular economy promotes sustainability and environmental responsibility. Benefits of recycling and reuse.*
1. Economic benefits: reducing the cost of purchasing new equipment; easier access to assistive devices for socially vulnerable groups.
2. Environmental benefits: reducing waste and the carbon footprint; saving resources when producing new products.
3. Social benefits: increasing accessibility to rehabilitation services; – improving the quality of life of disadvantaged patients.
The use of sustainable materials in the rehabilitation and physical industry not only protects the environment but also enhances accessibility, efficiency, and ethics in medical services. To realize this potential, cooperation between manufacturers, healthcare institutions and regulatory authorities is necessary, as well as increased awareness among patients and specialists. In the conditions of a circular economy, a basic principle is the maximum use of resources by extending the life cycle of products. This particularly applies to rehabilitation equipment, which is often costly, specialized, and difficult to replace. Innovations offer new solutions for repair, modernization and intelligent management of devices, thus saving resources, reducing waste and ensuring sustainability.

Keywords: *circular economy, rehabilitation industry, physical industry, recycling.*

Introduction

The rehabilitation and physical industry in the circular economy model is extremely relevant, especially in the context of sustainable development and resource optimization in healthcare. The circular economy is an economic model that strives to minimize waste and optimally use resources through reuse, recycling, repair, and extension of the product life cycle. Instead of the traditional linear „take-produce-dispose" model, the circular economy promotes sustainability and environmental responsibility [1].

Although healthcare is not a core component of the circular economy, the rehabilitation sector has significant potential to fit into this model.

I. Recycling and reuse of medical equipment

A variety of equipment is used in rehabilitation and physical medicine – from small aids to specialized therapy devices. Traditionally, when they wear out or fall out of use, this equipment is discarded, which leads to the accumulation of waste and inefficient use of resources.

The circular economy seeks to extend the life cycle of these devices through repair, recycling and reuse [2].

1. Types of equipment that can be reused.

A large part of the aids, such as crutches, walkers, wheelchairs, anti-decubitus pillows, are reusable. Therapeutic equipment, such as electrostimulators, ultrasound devices, magnetic therapy devices and mechanical exercise equipment: exercise bikes, passive exercise benches, coordination and balance devices, are all reusable. Many orthoses and splints can be adapted for reuse after sterilization [3].

2. Benefits of recycling and reuse.

2.1. Economic benefits:
– reducing the cost of purchasing new equipment;
– easier access to assistive devices for socially vulnerable groups.
2.2. Environmental benefits:
– reducing waste and the carbon footprint;
– saving resources when producing new products.
2.3. Social benefits:
– increasing accessibility to rehabilitation services;
– improving the quality of life of disadvantaged patients [4].

3. Practical mechanisms for implementing the recycling and reuse of medical equipment and aids.

3.1. Establishment of recycling and reuse centers.

Organizations or healthcare institutions can collect used devices for repair, sterilization and re-distribution.

3.2. Establishment of „aid banks”:

„Aide bank” is an organization or service that collects, stores, repairs and re-rents medical and rehabilitation devices and appliances such as wheelchairs, crutches, walkers, orthoses, hospital beds, therapeutic devices and others. These devices are provided temporarily or free of charge to patients in need – especially to people with low incomes or in crisis situations [5].

The creation of such „banks” reflects the basic principles of the circular economy:
– reuse of resources;
– repair and maintenance of existing devices;
– reduction of waste;
– optimization of available equipment.

The „Assistive Devices Bank” operates by:
– collecting donations from hospitals, private individuals, NGOs and manufacturers;
– purchasing new or used devices from social projects;
– assessment and repair;
– technical inspection, disinfection and, if necessary, repair;
– technical documentation and traceability

The distribution of assistive devices and medical equipment is done by:
– requests from patients, social workers or doctors;
– through platforms (website/mobile application) or on site.
– return and reuse is done through a temporary loan – after the patient recovers, the device is returned and used by another patient.

4. Advantages of the connection between the rehabilitation and physical industry and the circular economy model.

4.1. Social:

– gives access to necessary equipment to people in disadvantaged situations, thus reducing economic inequality in access to rehabilitation.

4.2. Economic:
– save money for health institutions and patients;
– reduces the need to constantly buy new equipment.
4.3. Environmental:
– reduces the production and accumulation of waste;
– supports a longer life cycle of the devices [6], [7].

5. Challenges for the rehabilitation and physical industry in the circular economy model *[8], [9], [10].*

There are certain challenges for the rehabilitation and physical industry, such as:
– hygiene and safety – especially important for equipment that comes into contact with the skin or body fluids of patients;
– legislative restrictions – many countries have strict rules for the reuse of medical equipment;
– lack of infrastructure – lack of logistical and technical resources for collection and recycling;
– stereotypes and distrust – some patients and specialists prefer „new” equipment.

6. Successful examples of the rehabilitation and physical industry in the circular economy model.

Scandinavian countries – well-developed system for the reuse of assistive devices through municipal services.

Netherlands – companies that collect and repair wheelchairs and resell them.

Bulgaria (in the initial stage) – non-governmental organizations and donation campaigns for the provision of assistive devices.

Recycling and reuse of medical equipment in the rehabilitation sector is a key step towards sustainable and accessible healthcare. With properly structured policies, technical support and public awareness, this practice can become the norm, not the exception. This would benefit not only the environment, but also the healthcare system and patients. Equipment such as walkers, wheelchairs, physiotherapy equipment and others can be: recycled, refurbished, donated or re-provided, instead of being replaced with new ones.

II. Using secondary raw materials to produce new assistive devices

The rehabilitation industry relies on a variety of assistive devices - from wheelchairs and crutches to orthoses, splints and therapeutic devices. Most of them are made of plastic, aluminum, steel and textiles, which often remain unused, damaged or thrown away, although they could be restored or recycled. This is where secondary raw materials come into play - recycled materials that are used to create new, functional assistive devices. Secondary raw materials are materials extracted from already used products that have undergone a recycling, processing or restoration process, such as:
– metal – aluminum and steel from old wheelchairs and structures;
– plastic – recycled polymers from packaging or old devices;
– textiles and rubber – used in handles, seats, guards, etc.

The use of secondary raw materials in the production of assistive devices supports the basic principles of the circular economy such as: [12]
– reducing waste - using existing resources instead of extracting new ones;
– extended life cycle of materials;
– closed production cycle - old device → raw material → new product.

Many companies offer buyback and recycling of their products. This is a model in which manufacturers buy back used products from their customers, repair, recycle or refurbish them and either put them back on the market or use the parts for new production. This is a key part of the circular economy, as it extends the life of products and reduces waste.

This leads to sustainable use of resources, a reduction in carbon footprint and production costs, more affordable products for customers (including refurbished ones at a lower price), and incentives for returning old equipment (cash, discounts or donations).

III. Modular design – creating devices that can be disassembled and reused

Modular design is an engineering and design concept in which products are created from separate, interchangeable parts (modules) [14] that:

– can be easily disassembled, repaired, replaced or reused;

– allow adaptation and upgrading without requiring a completely new device.

In rehabilitation, this means that assistive devices – such as wheelchairs, crutches, prostheses and orthoses – can be adapted and updated over the years, without the need for disposal.

The modular approach is key to implementing the „design for reuse“ model and its connection to the circular economy [15] by:

– extending the life cycle of devices;

– allowing easier recycling of parts;

– reducing production and waste volume;

– facilitating local repair and maintenance.

1. Examples of modular design in the rehabilitation industry.

Wheelchairs – the frame, wheels, armrests and backrests can be replaced individually, allowing adaptation as a child grows, needs change or damage occurs

Prostheses and orthoses – replaceable modules: ankle joints, legs, knee mechanisms. This facilitates adaptation to different levels of amputation and motor activity.

Electronic therapy devices – control, sensor and power modules are replaceable or compatible, allowing upgrades without replacing the entire device.

2. Benefits of the modular approach.

Economic – saves costs for replacing the entire device; possibility of partial repair. Environmental – less waste, easier recycling of parts, reduced carbon footprint. Social – more affordable solutions through upgrades instead of replacement; support for decentralized services. Technological - the ability to integrate innovations without the need for a new device.

Conclusion

The use of sustainable materials in the rehabilitation and physical industry not only protects the environment but also enhances accessibility, efficiency, and ethics in medical services. To realize this potential, cooperation between manufacturers, healthcare institutions and regulatory authorities is necessary, as well as increased awareness among patients and specialists. In the conditions of a circular economy, a basic principle is the maximum use of resources by extending the life cycle of products. This particularly applies to rehabilitation equipment, which is often costly, specialized, and difficult to replace. Innovations offer new solutions for repair, modernization and intelligent management of devices, thus saving resources, reducing waste and ensuring sustainability.

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