Benefits of Using Information and Communication Technology in the Control of Residues in Medicine Production Within Public Organizations: A Sustainability Practice

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This case study aims to elucidate the advantages of employing communication and information technology tools for disposing of pharmaceutical residues in a public production laboratory, highlighting its significance as a sustainable practice. The study employs a qualitative approach, incorporating applied methodology, technical procedures, bibliographic document research, and a case study with an exploratory objective. The primary outcomes reveal enhancements in optimization processes, reflecting paradigm shifts and technologies within laboratory operations. The study concludes that substantial impacts have occurred in work processes, fostering the dissemination of sustainability practices within the organization.

Keywords: Residues Management. Sustainability. Pharmaceutical Industry. Information and Communication Technology. Public Laboratory.

Introduction

The evolution of industrial processes in the pharmaceutical industry has led to the development of new technologies and health inputs, impacting the environment through the increased generation of residues often disposed of inadequately [1]. A Syndicate of Pharmaceutical Industries study in Brazil reported that the pharmaceutical industry moved approximately BRL 76.98 billion in 2020, creating 90,025 thousand direct jobs at the beginning of the same year in companies manufacturing drugs for human use [2].

While this intense production benefits the economy by creating jobs and enhancing access to medicines, it poses a significant environmental challenge. Despite economic, labor, and social advances, the environmental impact must be transparently discussed with society [1]. Environmental preservation has been a subject of discussion in Brazil since the 1990s, with sustainability gaining traction in technical, scientific, and political spheres [3].

The Sustainable Development Goals (ODS) urge governments to devise strategies for socio-environmental action [4]. Waste disposal in the pharmaceutical industry becomes a focal point in aligning actions with these goals. The industry, representing a substantial portion of the global health-productive market, generates waste through the production of medicines. The complexities of the drug production process result in various wastes, necessitating proper treatment and disposal [5].

We emphasize that specific rules and procedures governed by applicable laws manage industry residues. Addressing SDG objectives, particularly Objective 6, which emphasizes ensuring the availability and sustainable management of water and sanitation for all, and Objective 9, promoting resilient infrastructures, inclusive and sustainable industrialization, and fostering innovation [4], becomes imperative for the pharmaceutical industry. Improving internal processes to reinforce the sustainability cycle aligns with these objectives, aiming to minimize adverse environmental impacts and achieve the indicators of the 2030 agenda.

The industry's commitment to social responsibility is paramount in managing residues,

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necessitating innovative management practices [6]. The pharmaceutical industry has explored adopting information and communication technology tools (ICT) to enhance process controls, especially in managing residues [7-9]. This work presents a case study highlighting the benefits of ICT in controlling waste generated during drug production. It emphasizes its role as a sustainability practice through a systemic solution for managing pharmaceutical residues within a public laboratory warehouse.

Materials and Methods

Sample Case Study

The study was conducted in a public Pharmaceutical Laboratory, a technical-scientific unit linked to Brazil's Ministry of Health (MS). Established in 1976, the laboratory serves as a market regulator in the pharmaceutical sector, occupying a 40,000 m² facility in Jacarepaguá, Rio de Janeiro, Brazil. The laboratory, certified with ISO 14001 (Environmental Management System) since 2015, operates under the pillars of socio-environmental sustainability, adhering to the 5R concept – Rethink, Reduce, Refuse, Reuse, and Recycle [4].

Results and Discussion

Warehouse Waste Disposal Process

In 2014, the laboratory acquired the SAP® integrated Information and Management System to optimize and integrate its processes. This system addressed data security concerns, complied with sanitary regulatory requirements, and ensured traceability throughout the production flow and product life cycle. The Logistics Department managed warehouses storing raw materials, packaging materials, and medicines. The department handled inventory control, storage conditions defined by the manufacturer, internal expeditions for production and research, and distribution to State and Municipal Health Secretariats based on the Ministry of Health's strategic programs. Responsibilities also included collecting medicines from customer complaints, managing deviations in quality, and disposing of expired, disapproved, and returned items from customers.

Item disposal emerged as a crucial activity among defined internal procedures, impacting all process stages. Figure 1 illustrates flaws in the warehouse waste disposal process due to inadequacies in the existing computerized system. Consequently, a new system was acquired, necessitating the definition of new activities and routines in its programming. The entire process was programmed into computerized routines within the purchased software, offering advantages such as greater control of item validity, correct disposal of residues, issuance of reports for control bodies, participation of waste-generating areas, accounting control for accountability to control bodies, and reproducibility of actions in SIAFI, the Financial System of the Brazilian Federal Government.

The pharmaceutical industry's high demand has resulted in substantial consumption, leading to numerous consequences related to the improper disposal of medicines. Globalization and the Third Technological Revolution have exacerbated the disposal of drug waste, impacting citizens' lives [4]. Studies reveal that certain substances in drugs resist treatment processes, negatively affecting the environment for extended periods and causing environmental and socioeconomic problems [12]. Changes were implemented in the waste disposal flow to address disposal challenges (Figure 2). The implementation of ICT introduced opportunities for mitigating disposal challenges.

Sustainability has gained increased attention in the pharmaceutical industry, making residue disposal a prominent subject in academic studies [13]. Environmental sustainability, particularly in terms of cleaner production, green supply chains, green materials, and sustainable human resources management, has become a central

Figure 1. Failures and opportunities in the warehouse waste disposal process.

Failures Diagnosed in the Use of the Own Computerized System	Opportunities Diagnosed in the Use of ICT
a. There was no write-off of discarded items; b. The generating areas did not paricipate in the disposal process, leaving all activity under the responsibility of the Warehouse Manager; c. Lack of accounting control, as the system did not have accounting logic; d. There was no differentiation between the stock of inputs or expired drugs, from the regulated waste classifications; e. The activities were time-consuming, due to the processing of authorizations for disposals being carried out through memorandums, causing an increase in stock in the rejected areas; f. Time-consuming flow, as it contains several steps to be controlled.	a. Creation of Systemic Disposal Flow; b. Disposal Approval Flow by item characteristics; c. Flow initiated and controlled by the Logistics Manager; d. Approval flow, with justification of the reason for disposal, being attached to the system; e. Easy-to-understand flow; f. Paricipation of the Accounting Sector, in the accounting items' classification; g. Systemic action in real time, through the integrated system; h. Information sharig at all stages of the process; i Transformation of items into classified waste in the system; j. Blocking of disapproved stock, preventing movement; k. Control of quantity and final value of the disposal; l. Systemic write-off and automatic transformation into classified waste, according to the waste legislation; m. Issuance of tax documents; n. Projection of annual quantity, for the elaboration of the Term of Reference for contracting a company specialized in the final destination; o. Issuance of reports containing all information from the approval of the disposal to the issuance of the INEA Manifest; p. Elaboration of indicators; q. Search by Transfer Order number, document generated for transfer between virtual stock and waste deposits; r. Search by Waste Manifest number; s. Search by DANFE number, as inserted in the Manifest; t. Search for Original Material Transfer document used in the Disposal Approval Flow; u. Search by Source Material / Batch; v. Name of the disposal approver, resposible for the disposal approval information; w. Annual search criteria for disposal documents; x. Description of the source material; y. Return date of the Manifest, as a Workflow closing step.

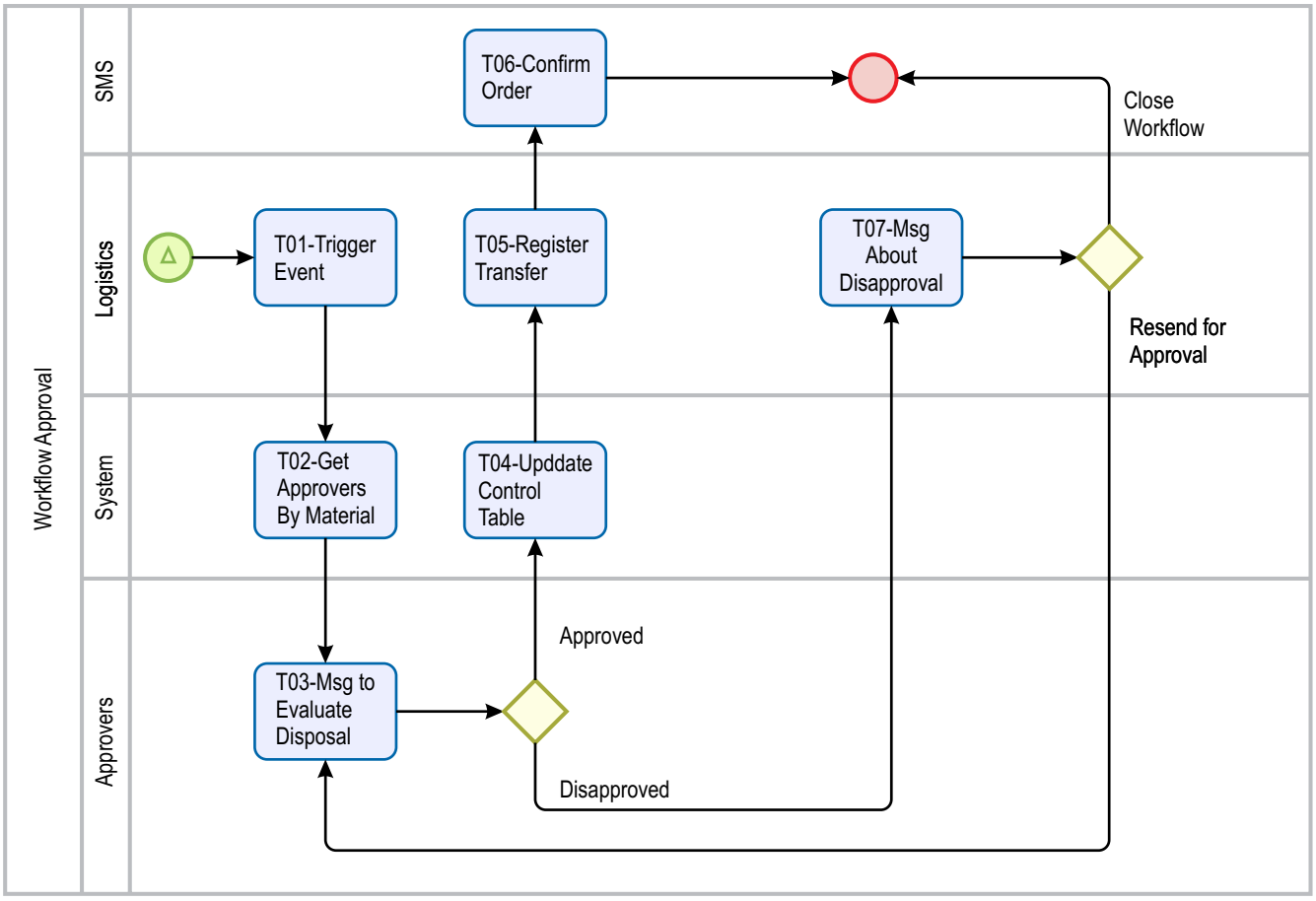
Source: Authors by internal management report (2012).

focus of management studies [3]. The regulation of waste management in the pharmaceutical industry underwent multiple changes from 1981 to 2022, reflecting legislative efforts to address environmental concerns (Figure 3).

Conclusion

ICT has significantly advanced responsible waste disposal in the pharmaceutical laboratory studied. The impacts on work processes were notable, including a reduction in the storage time of disapproved or expired items, the transformation of manual processes to computerized systems, faster processes, enhanced reliability of records with control bodies, real-time traceability, provision of disposal indicators, issuance of reports by waste classification/quantity/sector, reduced use of paper and office materials, and the introduction of recyclable disposal bins. ICT provided these advantages and facilitated better management and integration between

Figure 2. Warehouse disposal approval flow.



Source: Disposal Workflow Project Elaboration Report (2016).

involved areas, enhancing the reliability of generated data. On the other hand, it allows for more qualified analyses by managers during decision-making processes, contributing to disseminating a culture of sustainability practices within the organization.

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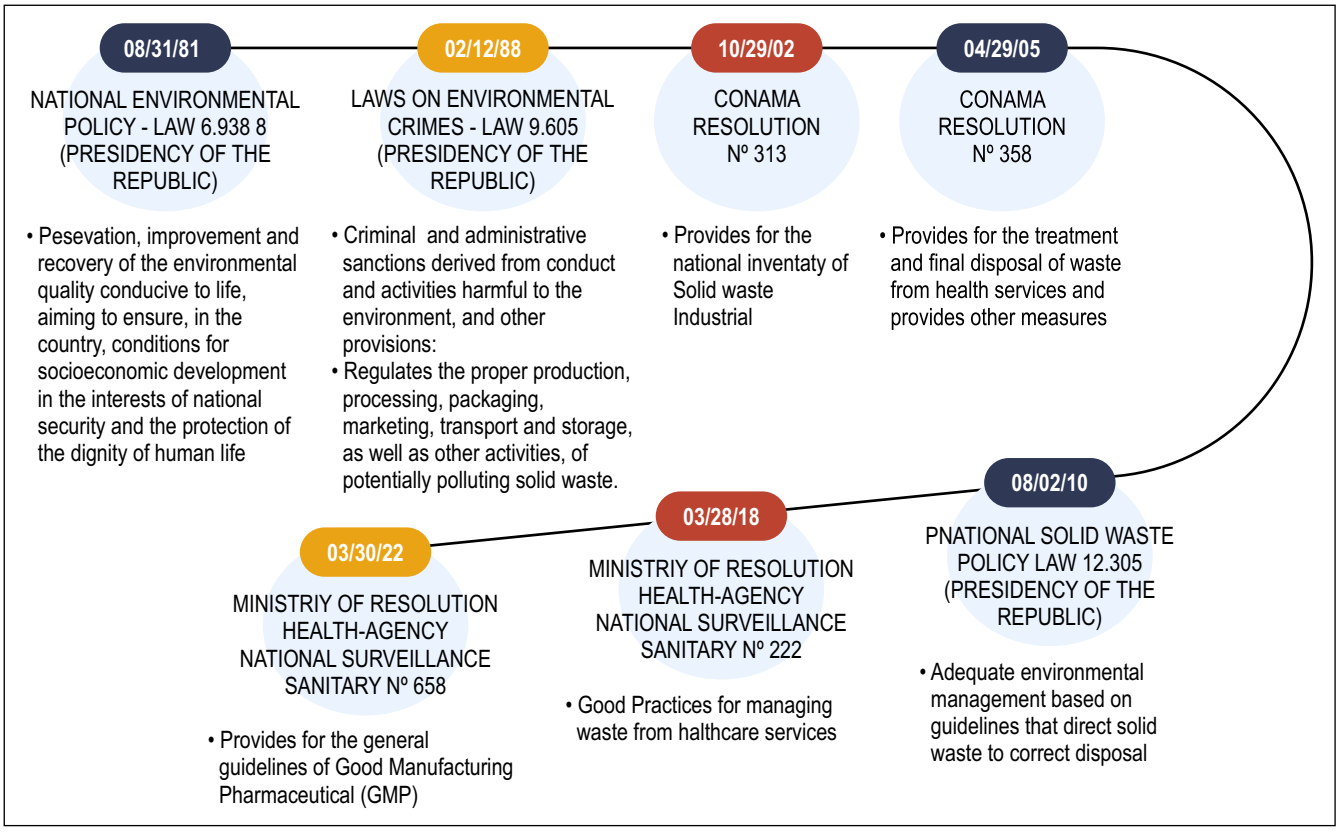
Figure 3. Regulation of waste management in the pharmaceutical industry.



Source: Authors.

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