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First national survey of medicine waste-minimizing ın Brunei Darussalam

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ABSTRACT: Medicine wastage has become a concern to the nation due to the detrimental impacts that it brings to the economy and environment. Therefore, this study aims to provide an overview of the various waste-minimizing activities performed by government pharmacists and pharmacy technicians A descriptive, cross-sectional survey was conducted from February 2022 until April 2022. The data was collected through the snowball sampling method from the respondents via online platforms. A self-administered questionnaire consisting of 4 segments was used. A total of 76 pharmacy personnel participated in this study. More than half of the participants carried out a variety of activities to reduce medicine waste throughout the stages of the medicine supply chain. 40.8% of the participants reported that prescribers could adjust and optimize the prescribed doses for patients, and 30.3% reported pharmacists would counsel the physicians on efficient prescribing practice. The respondents considered activities in the dispensing stage, particularly those associated with the pharmacy organization, the most attainable to be executed as a regular practice, whereas approaches in the prescribing phase are the most important in minimizing medication waste. Conclusion: Overall, pharmacists and pharmacy technicians have carried out a variety of activities to reduce medicine waste throughout the stages of the medicine supply chain, though other potential activities have yet to be undertaken in government pharmacies. The participants acknowledged the importance of the activities to reduce wastage; however, the feasibility of the interventions for implementation as a standard practice is still questioned.

KEYWORDS: Wastage; pharmacy; medicine; online questionnaire; sustainability; supply chain

1. INTRODUCTION

Medication wastages can take place at any stage of the medicine supply chain, from manufacturers to prescribers, pharmacists, and even the end-users: patients. Several factors contribute to this matter. For example, drugs dispensed to patients may not be fully consumed due to reasons such as patients' mortality, prescribers switching one medicine to another, and discontinuing therapy [1]. The treatment discontinuation may occur after patients experience intolerable adverse effects, lack of drugs' effectiveness, or even resolution of the disease conditions [2]. Not only that, but it is also possible that non-compliant patients stop taking their medications on their own. Furthermore, in low-income countries primarily, the main cause of medical waste, despite not being well-documented, emanates from poor management systems throughout the supply chain, thus leading to overstocking or understocking of inventories [3, 4].

Medication wastage obstructs the therapeutic advantages that the drugs offer. Furthermore, it imposes a substantial economic burden, which can be supported objectively through the following statistics. Each country spends around 25% of its overall healthcare budget solely on medicines [3]. However, 70% of the medicines-invested funds are wasted in a conventional supply system [5]. Notably, countries such as the United States, United Kingdom, and the Netherlands estimated annual losses of up to US$5.4 billion [6], approximately £300 million [7], and at least €100 million [8], respectively. In Brunei Darussalam,

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unfortunately, there are inadequate data on the annual expenses of drug wastage. However, a ten-year retrospective analysis found a total of 1,290,254 unused medication units, worth BND $3,703,170, were returned to the inpatient pharmacy. Around 41.5% (BND $1,538,021.6) of the returned medications did not fulfill the standards or criteria to be reused, hence discarded [9].

Aside from negatively influencing financial resources, medicine wastage was also linked to environmental issues, especially when medications are discarded or disposed of inappropriately, for instance, via environmentally unfriendly routes. These include disposing of any residual drugs in the garbage bin or flushing them down the toilet or sink [10]. As a result, pharmaceuticals can accumulate in the ecosystems, posing a risk to humans, wildlife, and the environment as a whole.

Since medication wastage causes financial burdens and environmental hazards, it is crucial to mitigate this problem by exploring and implementing effective waste-reduction strategies. However, research in this area is unfortunately limited, leaving a significant gap in our understanding of interventions that can effectively curb medicine waste.

Pharmacists, in particular, have a significant role in the pharmaceutical supply chain and, hence, can contribute to the efforts to reduce medicine waste. They can, for instance, consult and engage with prescribers to alter the prescribed dosages of the medications to be more appropriate in terms of minimizing wastage. Not only that, but they are also responsible for the management of drug inventories in the pharmacy, which includes handling the in-stock medications (on hand) and exchanging drugs with other pharmacies when necessary. Pharmacy technicians play a significant role by assisting the pharmacists in this process. The pharmacy sector in Brunei has shown notable developments in recent years. As of 2022, there were 87 registered pharmacists in Brunei across various sectors. However, the pharmacist-to-population ratio of 1:5771 remains lower than developed countries. Workforce issues continue to present challenges in the Bruneian pharmacy sector, which remains underemployed and reliant on foreign workers. In 2017, a total of 73 pharmacists were hired, including a combination of local and foreign pharmacists, in both public and private sectors. The scarcity of pharmacists is partly due to a deficit in pharmacy education before 2016. However, with the BHSc Pharmacy course now established at PAPRSB Institute of Health Sciences, UBD, local pharmacists are increasingly graduating from domestic institutions [11].

There have been no published studies conducted in Brunei Darussalam that explore activities practised by pharmacists in reducing pharmaceutical waste. Therefore, this study aims to identify and provide an overview of the various waste-minimizing activities performed by government pharmacists and pharmacy technicians, as well as to assess the extent to which the activities are carried out and their importance and feasibility in being broadly implemented as a standard practice in pharmacies. This is the first national survey of medicine waste-minimizing in Brunei Darussalam that serves as baseline to capture the snapshot of this activity.

2. RESULTS

2.1 Survey Response and Demographic Data

A total of 76 pharmacy personnel completed online survey questionnaire. The majority of the respondents were female (77.6%) and were working at hospital pharmacies (84.2%) as opposed to private community pharmacies (15.8%). The majority were within the age group of 30 to 39 years old (38.2%) and had more than ten years of experience (42.1%) working as a pharmacist or a pharmacy technician. The characteristics of the participants are summarized in Table 1.

Table 1: Demographic characteristics of participants recruited in the study (n = 76)

Variable	*n* (%)
Gender	
Male	17 (22.4)
Female	59 (77.6)
Age, years	
18-29	25 (32. 9)
30-39	29 (38.2)
40-49	18 (23.7)
≥ 50	4 (5.3)
Education level	
High School	4 (5.3)
Certificate (HNTec/ NTec/ skill certificate)	20 (26.3)
Diploma	20 (26.3)
Undergraduate	12 (15.8)
Master	20 (26.3)
Occupation	
Hospital Pharmacy	64 (84.2)
Community Pharmacy	12 (15.8)
Location	
Belait	14 (18.4)
Tutong	15 (19.7)
Brunei Muara	44 (57. 9)
Temburong	3 (3.9)
Year of service	
< 5 years	22 (28.9)
5-10 years	22 (28.9)
>10 years	32 (42.1)

2.2 The Prescribing Stage

There were two waste-minimizing activities associated with the prescribing stage incorporated in the survey questionnaire. As shown in Table 2, 40.8% of the participants reported that prescribers could adjust and optimize the prescribed doses for patients, and 30.3% reported pharmacists would counsel the physicians on efficient prescribing practice. In general, the activities were perceived as very important (median rank 5) but were ranked neutral (median rank 3) in terms of feasibility to be implemented as a standard practice in pharmacies (Figure 1).

Table 2. Participants' responses concerning the implementation of each waste-minimizing activity in their respective pharmacies

Activity	Responses, *n* (%)		
	Yes	No	Don't Know
The prescribing stage			
Prescribers tailor prescription amounts	31 (40.8)	23 (30.3)	22 (28.9)
Counsel prescribers on efficient prescribing	23 (30.3)	40 (52.6)	13 (17.1)
The dispensing stage			
Pharmacy related			
Pharmacists adjust prescribed amounts	71 (93.4)	5 (6.6)	
Dispense opened medication package	75 (98.7)	1 (1.3)	
Use (unit) dose dispensing system	53 (69.7)	20 (26.3)	3 (3.9)
Limit medication inventories	57 (75.0)	17 (22.4)	2 (2.6)
Collaborate with other pharmacies to exchange medications	74 (97.4)	2 (2.6)	
Pooling of patients	18 (23.7)	20 (26.3)	38 (50.0)
Patient related			
Review patients' medications	64 (84.2)	9 (11.8)	3 (3.9)
Discuss needed quantity with patients	38 (50.0)	33 (43.4)	5 (6.6)
Use home medications during hospitalization	63 (82.9)	3 (3.9)	10 (13.2)
The leftover stage			
Collect unused medications	61 (80.3)	12 (15.8)	3 (3.9)
Donate unused medications	4 (5.3)	51 (67.1)	21 (27.6)
Re-dispense unused medications	75 (98.7)	1 (1.3)	

2.3. The Dispensing Stage

2.3.1.Pharmacy-Related Activities

Overall, almost all of the activities were regularly implemented in the pharmacies except the pooling of patients with iv drugs treatment. For this particular activity, only 23.7% reported that the patients would be scheduled on the same day so that the parenteral medications could be prepared simultaneously; half of the respondents were unsure or not aware of the activity implementation in their pharmacies (Table 2). The three most frequently reported approaches practised in this stage were dispensing opened medication packages (98.7%), followed by collaborating with other pharmacies for drug exchange, especially those that were rarely used and nearing expiration date (97.4%), and adjusting the prescribed doses to suit the course of treatment (93.4%).

Out of all phases, the activities practised by pharmacists and pharmacy technicians in the dispensing stage were generally ranked the highest in terms of feasibility (median rank 4) and were regarded as important (median rank 4) in reducing medication waste (Figure 1). According to the study participants, modifying prescribed medication doses by the pharmacy personnel and collaborating with other pharmacies to swap or trade medications were viewed as very important in limiting pharmaceutical waste (median rank 5) (Figure 2). On the other hand, dispensing opened medication packages was the most feasible activity to be broadly

implemented as a regular practice (median rank > 4), whereas pooling of patients was considered the least practical (median rank 3).

Based on the data collected from the open-ended question, a few approaches that were not listed in the survey were reported to be executed in hospitals and community pharmacies. These include dispensing non-compliant patients with only a limited one-month supply and practising FEFO (First Expired, First Out) to ensure medications with the earliest expiration date were used first. Not only that, but the pharmacy personnel would also check patients' balance medications before dispensing a new supply; the pharmacist and pharmacy technicians were advised not to provide the patients with the medicines if there were still at least 3 weeks or enough stock at home. In addition, pharmacy technicians working in hospital pharmacies further addressed the significance of communicating with ward nurses concerning ward stock and medication supply for discharged patients.

2.3.2. Patient-Related Activities

Patient-related activities in the dispensing stage, for the most part, were implemented in government pharmacies in Brunei Darussalam. Out of all participants that were taking part in the research study, 84.2% of the participants responded that medication reviews were carried out in their pharmacies as one of the initiatives to reduce medication waste, and 82.9% allowed patients to use home medications during hospital admission, especially those obtained from the private sector (Table 2). Only half of the respondents reported that a patient-centered discussion was conducted to increase awareness about wastage while addressing the needed medication quantity for treatment optimization and ensuring minimal drug waste. All of the three activities were considered important for medicine waste reduction (median rank 4) and feasible to be implemented (median rank 4), except for performing discussions with patients that scored lower in terms of practicality (median rank 3) (Figures 1 and 2).

Moreover, the participants suggested a few other waste-reducing activities that were not on the survey's list. The activities mainly focused on communicating with patients, including advising them to take medications as instructed and return any extra, unused, or discontinued medicines to the pharmacy. During dispensing, the pharmacists and pharmacy technicians would also inquire about which medications the patients would like to collect, especially PRN drugs.

2.4. The Leftover Stage

Almost all (98.7%) participants from the study agreed on the implementation of re-dispensing unused medications to patients in their pharmacies. This particular activity scored the highest compared to other activities throughout the stages, both in terms of importance and feasibility, with a median rank of 5 for each category (Table 2, Figure 2). 80.3% of the respondents reported that unused or unwanted medications from patients were collected for safe disposal. In contrast, only 5.3% indicated that unwanted medications were allowed to be donated to other countries or individuals in need.

The pharmacists and pharmacy technicians involved in the research study emphasized that the unused medications could only be re-dispensed to patients if the criteria for a safe supply of medicines were met. The products should be in an unopened bottle or blister pack, and the batch number and expiry date should still be visible. The items would first be inspected visually before being dispensed to patients; there should be no observable changes in the medicines' appearance, colour, and shape. All temperature-sensitive items were disposed of and would not be reused as the condition in which the medications were stored was unknown. Not only that but any open liquid bottles, creams, inhalers and loose tablets would also be discarded accordingly.

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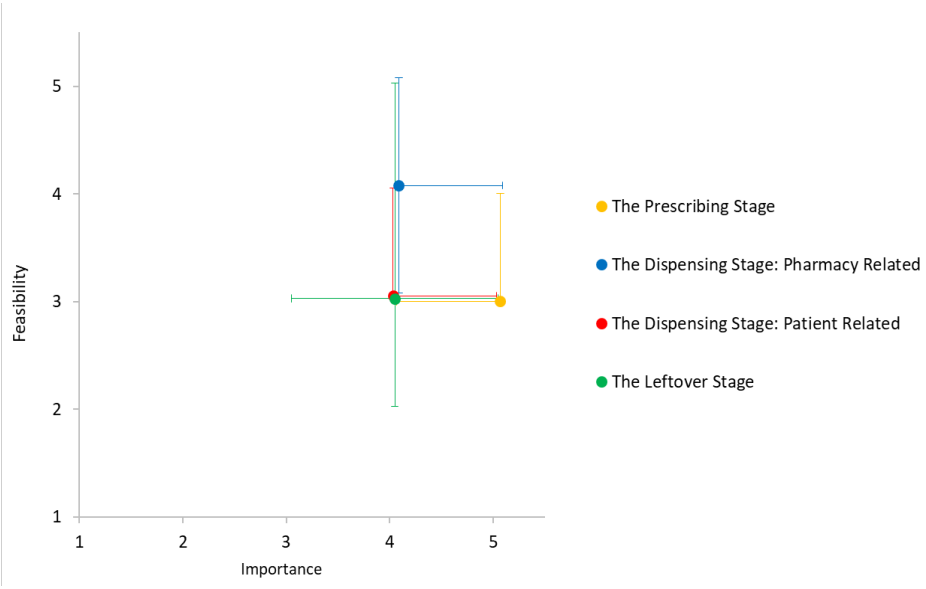

Figure 1: The median importance and feasibility rankings (with upper and lower quartiles) for each stage of the pharmaceutical chain

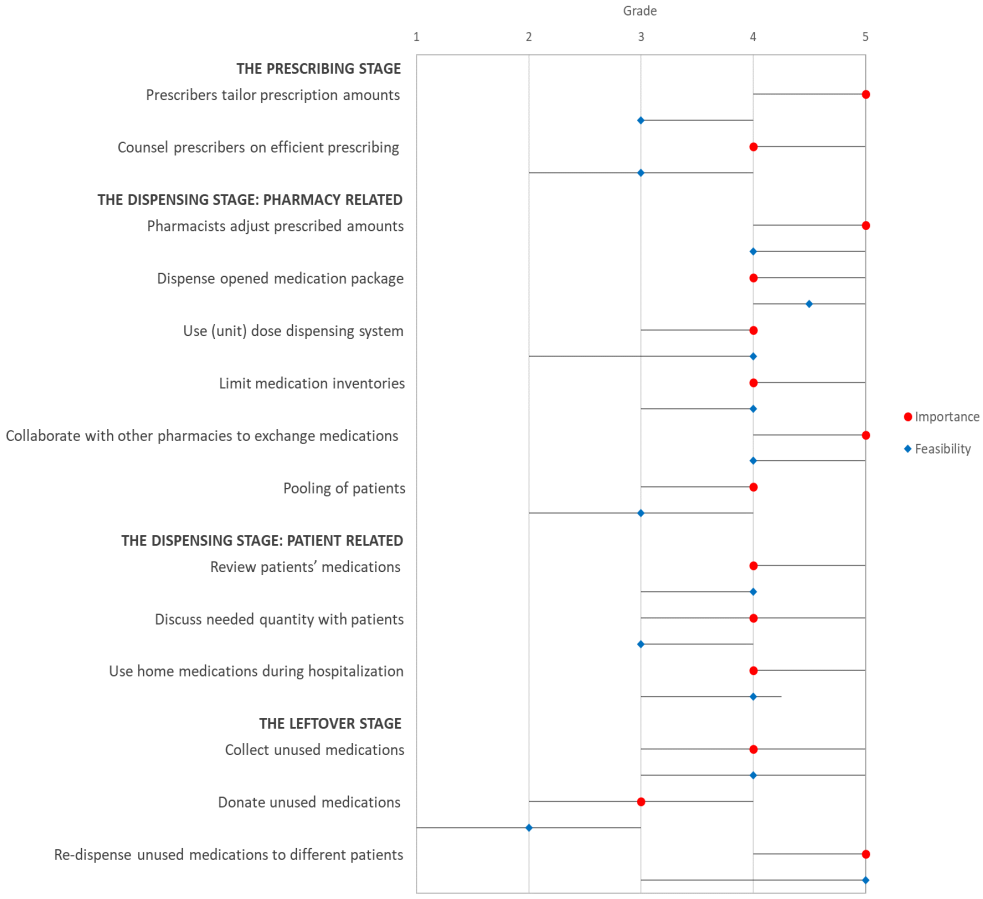

Figure 2: The median importance and feasibility rankings (with upper and lower quartiles) for each waste-minimizing activity

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3. DISCUSSION

As far as is known, this is the first research conducted in Brunei Darussalam that explores the implementation of various waste-minimizing activities undertaken by pharmacists and pharmacy technicians in government pharmacies. This study also assesses the importance and feasibility of the identified interventions as a standard practice in the country. Almost all of the suggested activities for medicine waste re-duction are practised by more than half of the participants, except pooling patients so that their IV medications can be prepared at the same time, discussing the needed medicine quantity with patients, and donating unused drugs to other country or individuals in need, as well as the two activities in the prescribing stage.

The respondents acknowledged the importance and necessity of performing interventions targeting the issue of pharmaceutical waste. Reviewing the available information on potential measures, one of the interventions to reduce medicine waste in the pre-scribing stage is to tailor and supply patients' medications in a smaller, limited quantity, especially for new therapeutic regimen prescriptions, which are subjected to frequent changes and costly drugs like oral anticancer medications [2, 12].

Restricting the first-time supply of new medication to two weeks, and then providing a one-month supply to repeat prescription patients can help decrease the likelihood of unused drugs and unnecessary wastage. According to a study conducted in 2014, it has been discovered that patients receiving a supply of more than 30 days have a higher probability of having medicines that are unused [13]. Other studies support these findings [14, 15]. Additionally, medication waste can be reduced considerably by ensuring that prescriptions are appropriately utilized and prescribed only if necessary. Therefore, discontinuing patients from unnecessary treatment and providing patients with limited doses of PRN drugs can prevent excessive prescribing by practitioners, which may contribute to medication wastage [16-18].

In the dispensing stage, there are various approaches that pharmacists and pharmacy technicians can undertake to help minimize drug waste. Collaborating with other pharmacies by exchanging slow-moving medications and those nearing expiration can aid in the prevention of unused medicines being discarded [2]. In Brunei Darussalam, government pharmacies can place orders for demanded medicines that are not available in stock through the national healthcare management platform, Bru-HIMS, as the system enables the monitoring and tracking of pharmaceutical inventory.

Not only prescribers and pharmacy personnel but also patients need to play their part as medication end-users in preventing and reducing medical waste. The citizens in Brunei Darussalam receive free healthcare and medications, and it is still considered a common perception that patients must be given prescription drugs following visits to hospitals or clinics [19]. Therefore, it can be beneficial in combating the issue of medication waste reduction by increasing patients' awareness concerning waste. Allowing patients to recognize and acknowledge the medication expenditures funded by the government is one method to promote awareness of pharmaceutical waste. This can be accomplished by attaching price tags to the items [20].

Medication waste can also be reduced by implementing collaborative decision-making between practitioners and patients, and carrying out periodical medication reviews, as these activities can reduce polypharmacy and optimize drug doses that cater to patients' specific needs [21]. During the consultation, the prescribers can have a patient-centered discussion addressing the number of medicines dispensed to patients, which can help limit the supply of unnecessary drugs and, perhaps, wastage. Moreover, by performing medication reviews, the patients' medications can be evaluated, allowing non-adhered medicines to be identified and unneeded therapies to be discontinued, thus, facilitating waste minimizations [16, 17]. On top of that, bringing patients' own medications from home when being hospitalized can aid in wastage reduction; the financial value of inpatient pharmaceutical waste can be effectively lowered [22].

There are a limited number of activities studied concerning the leftover stage, and most research concentrated on the quantity and financial value of the returned medicines [9, 23-27]. One of the interventions that can be conducted in this particular phase is collecting and gathering unused medications following patients' treatment regimen changes, discontinuation, or death. The collected drugs, especially tablets and capsules enclosed in original packaging that are still intact and undamaged, can be reused or re-dispensed to patients after examining the drugs for evidence of damage. Not only that but unused medications from wards can also be returned to pharmacies to be reused, as long as the original unit dose is undamaged and un-changed. It has been discovered that re-dispensing of medicines, primarily for expensive drugs, is cost-effective, with promising outcomes in pilot studies [28, 29].

The re-dispensing of medicines in Brunei Darussalam is a regular practice, as discovered in this research study, where 98.7% of the participants conducted this activity to reduce wastage. A retrospective study revealed that between 2006 and 2016, 29 696 oral solid medications, worth a total of BND $636,749.10, were reused and re-dispensed to patients in the RIPAS Hospital, Brunei Darussalam [9]. However, significant changes or alterations may develop to the medicines as the returned items may not be stored appropriately, as instructed by the manufacturers. Therefore, employing enhanced packaging technologies, such as tamper-evident sealings and 'smart' tags that react to temperature and humidity, will allow the identification of medications that have been poorly stored [25, 30]. Hence, this will ensure that safety and quality standards are fulfilled for re-dispensing.

Increasing public knowledge about proper storage for drugs and urging patients to return unused items to pharmacies will enhance and optimize the reusability of leftover medications. Additionally, addressing the environmental consequences of inappropriate medicine disposal can be a source of encouragement for sending the medications back to pharmacies. Nevertheless, the World Health Organization discourages the donation of unused drugs to other countries due to the substantial challenges encountered, though donations can be considered for short-term resolutions to definite problems [31].

For this particular study, a few limitations can be recognized. Only government pharmacists and pharmacy technicians working in the dispensary participated in the online survey questionnaire. Therefore, further information or activities relating to medical waste reduction from other healthcare professionals, including physicians, regulatory authorities, and personnel working in the storage department, were not explored. Considering all respondents employed in the study were from the government sector, the subsequent outcomes gathered in this research will not be translated to private practice pharmacies. Moreover, not all invited pharmacy personnel submitted the questionnaire; leading to low response rates from other districts. thus, the findings of the study can not be generalised. Last but not least, response bias could arise from employing participants via convenience sampling as well as due to the self-administering nature of the questionnaire

4. CONCLUSION

This research study shows that pharmacists and pharmacy technicians have established and implemented a variety of activities to reduce medicine waste throughout the stages of the medication supply chain. However, several other activities may have promising effects on waste minimization that are yet to be practiced in government pharmacies. Although pharmacy personnel acknowledges the importance and significance of the activities to reduce wastage, the feasibility of the interventions to be generally implemented as a standard pharmacy practice is still uncertain and questioned. Further investigations and studies need to be conducted to precisely determine the quantity and types of medicine wasted in Brunei Darussalam to set the objectives for pharmaceutical waste reduction, medication reuse, and economic advancement.

5. METHODS

5.1. Study Design and Population

A descriptive, cross-sectional survey was carried out online from February 2022 until April 2022 involving government pharmacy personnel in Brunei.

The study population consisted of pharmacists and pharmacy technicians working in Brunei Darussalam. Due to the limited number of pharmacists employed in the public sector, pharmacy technicians were also eligible to participate in the research study to boost the sample size. This decision was reached after noting that waste-reducing activities were not solely restricted to pharmacists; pharmacy technicians or dispensers also have the responsibility to practice and implement a variety of interventions throughout the pharmaceutical supply chain to reduce medication wastage in Brunei Darussalam [16, 17].

The inclusion or eligibility criteria were: 1) pharmacists and pharmacy technicians presently employed in public community health centers and hospitals, 2) pharmacists registered with the Brunei Darussalam Pharmacy Board, and 3) those who provided consent for participation in the research study. On the other hand, the exclusion criteria for the survey were as follows: 1) unregistered pharmacists, including those that were still in the pre-registration training program, 2) pharmacy personnel working in private sectors, and 3) those who were unwilling to participate in the research study.

5.2. Sampling Method and Sampling Size

Data was collected using convenience sampling and snowball sampling. Email invitations for survey participation were developed and disseminated by the researcher to relevant heads of pharmacies.

The Raosoft sample size calculator was used due to the high accuracy and reliability of the software [32]. The sample size was estimated with a 95% confidence interval and a 5% margin of error. Additionally, the response distribution was set at 50%, which gave the largest number of participants. A total of 117 pharmacy personnel were employed in government hospitals and health centers; therefore, a sample size of at least 90 participants was expected to respond to the online survey.

5.3. Study Tool

The questionnaire tool of this particular study was adapted and appropriately modified based on a research survey developed by a number of researchers from The Netherlands, which was previously disseminated to numerous developed countries in Europe [17]. The online questionnaire was conveyed in English as it was deemed most appropriate for the study population; furthermore, the language held a preeminent rank as the 'Lingua Franca' in global scientific communication, as reported in several former research [33, 34].

The final questionnaire for the research data collection used both open and closed-ended questions. The self-administered online survey consisted of four segments. The majority of the questions were about activities or interventions that the participants could or had practised in their pharmacies to reduce medication wastage – categorized into the prescribing, dispensing (pharmacy-related and patient-related activities), and left-over stages. For each activity, the participants were to answer whether or not they implemented the activity in their respective pharmacies, rate the importance of the waste-minimizing activities, and the feasibility of the interventions for the implementation of the medication waste reduction. The rating system used to measure the participants' opinions on the importance and feasibility of the activities was a 5-point Likert scale: ranging from 1, signifying that the intervention was "not important" or "not feasible," to 5, "very important" or "very feasible." The respondents could also add other activities practised in their pharmacies if not stated in the questionnaire.

Other than that, some socio-demographic questions were also generated for characteristics analysis, including but not limited to the participant's age, gender, education level, years of work experience, and work setting (community/hospital pharmacy). Two pharmacists (i.e., a hospital and academic pharmacists) comprehensively re-viewed the questionnaire to ensure its validity in terms of clarity, pertinence, and readability and achieve the standard for distribution of the survey to all pharmacy personnel of Brunei Darussalam's government. The questionnaire was then pretested with five pharmacists and modified accordingly. The information acquired was not included in the actual study sample.

5.4. Validation of Questionnaire and Pilot Study

For content validation, the questionnaire was evaluated by five experts comprising researchers, physicians, academicians, and pharmacists. These professionals reviewed the questionnaire based on content relevance, clarity, simplicity, and ambiguity. To ensure the reliability of the questionnaire a pilot study was carried out between the 30 participants Cronbach's alpha coefficient was used to calculate the internal consistency.

5.5. Ethical Consideration

This study successfully attained full approval from the Institute of Health Sciences Research Ethics Committee (IHSREC) of University Brunei Darussalam (Reference Number: UBD/PAPRSBIHSREC/2021/109). Also, informed consent from the participants was the first requisite to answering the questionnaire survey as participation in the study worked on a voluntary basis. The confidentiality and anonymity of the data acquired from the questionnaire survey were strictly maintained and protected. Besides, no identifiable participants' information was collected throughout the study.

5.6. Data Analysis

Once the survey was closed, all of the data obtained from the online survey platform used, Qualtrics, were collected. The information was then downloaded directly from the website and exported to the

computer, where the data were subsequently checked, arranged, and coded manually. R software version 4.0.4 and Microsoft Excel 2019 were used to conduct data analysis [35, 36].

Descriptive statistics were utilized via the R statistical software: the categorical variables were described using counts (n) and percentages, whereas the importance and feasibility ranking scales were evaluated using median and interquartile ranges. The outcomes from the analyzed data would also be presented in particular table and graph formats.

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