Peri-urbanization and Waste Dynamics: Navigating Challenges in Peri-Urban Waste Management

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Abstract. The research analyzes waste management practices in peri-urban areas of Denpasar City. The study utilized qualitative data, particularly key informant interviews, and secondary sources, which were analyzed thematically. Results show increased waste generation, changing types of waste, and insufficient waste management systems, leading to inappropriate disposal. The study points to the gaps in the provision of proper waste handling and disposal techniques, including community initiatives and appropriate policy responses. The findings indicate issues related to sustainable waste management and suggest ideas for further studies.

Keywords: Peri-urban Areas; Waste Management, Peri-urbanization

1 Introduction

The recent trend of urban growth worldwide has changed the morphology of many urban areas and their outer zones, leading to the close integration of urban centers with their peri-urban zones [1], [2], [3]. This trend has far-reaching consequences in several areas, including waste management. With urbanization, cities are also incurring into the peri-urban zones, predisposing developmental pattern challenges to infrastructure provision and service delivery, including solid waste management. In many developing regions, including Indonesia, the peri-urban interface presents peculiar issues regarding waste generation, waste collection, and disposal processes. Bali province in Indonesia, especially Denpasar City, is a case in point where urbanization tendencies soar up the complex nature of waste generated in the peri-urban zones.

Denpasar City is a center that is developing very fast, with the adjoining hinterland regions registering tremendous growth in population and land use [4] The expansion of housing areas, propelled by migration and even more by the growth of the local population, has resulted in increased waste volumes and more varied wastes. A community's waste management system is more or less on the same level as its population, and since most of the communities are outside rural areas, traditional waste management methods are no longer effective. Further, as people move from agriculture-dependent activities to urban economic activities, waste management conditions worsen even more in these areas [5].

The waste management problem in peri-urban areas, particularly in Denpasar City, must be handled as soon as possible for various reasons. First, the most important problem that can never be highlighted too much is the health and environmental damage attributable to ineffective

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waste disposal strategies. If the waste is disregarded, the soil and water will be polluted, and that will affect the environment and human health negatively. In Denpasar City's peri-urban areas, where farming activities tend to co-exist with heavy infrastructure development, contamination of the soil and water resources can jeopardize the safety of the populace and the nation's food supply. Moreover, the current practice of burning waste to keep these areas clean, which is done in most places with no waste collection services, also causes pollution. These areas often lack formal waste collection and disposal systems, leading to an accumulation of waste [6].

Second, the socio-economic transformation of peri-urban areas is another complicating factor. When the rural districts surrounding Denpasar City become suburban and urban, the type of waste generated also changes due to maturing populations and changing structures of livelihoods. Consumers' spending on goods increases, producing and consuming plastics, electrical appliances, and other nonbiodegradable wastes, which most waste management systems do not accommodate. For instance, the increasing use of single-use plastics and electronic waste is a significant challenge [1], [3]. Such a situation calls for an immediate change of approach to waste management in peri-urban districts; without such changes, such areas are likely to experience further environmental degradation, leading to public health concerns.

There is also increasing awareness that municipalities should be more prominent in urban areas. However, while the center of cities is often given more attention and resources regarding waste management, peri-urban regions tend to be neglected [7], [8]. This is because even though they are one of the areas with some of the highest population growth rates, land-use changes are a burden to waste management [9], [10]. In Denpasar City, the peri-urban areas are urbanizing at a high pace, but usually, such areas lie outside the formal net of waste collection and disposal, causing an accumulation of waste. Due to urbanization, population growth, and changes in livelihood patterns, private waste management efforts in Denpasar's peri-urban regions have faced the challenge of increased waste. In particular, there are increasing volumes of waste acts in many countries, addiction to different waste forms, inappropriate systems, and ill effects on the environment and health. These increasing volumes of waste lead to environmental degradation and public health concerns, making addressing the waste management issue in peri-urban areas imperative.

The growth of residential suburbs has significantly increased waste generation in the peri-urban areas of Denpasar. The waste management systems integration that is in place was, and still is, suitable except for the rapidly growing urban populations who are now switching from rural to urban migration. Where employment patterns changed notably from farming to urban-oriented jobs, more waste varieties emerged [10], [11]. Adding more trouble to the waste management efforts, the traditional biodegradable residues from agricultural activities have received high volumes of nonbiodegradable and toxic plastics, electronic wastes, and packaging materials, which interfere with the recycling efforts and waste management. Consequently, open burning of waste and dumping has been employed outside the peri-urban areas of Denpasar, thus compromising public health and pollution levels in the ecosystem and the surroundings.

The originality of this research work rests with its concentration on waste management practices in the peri-urban region of Denpasar City, an area that has not received much attention

in scholarly works. Most of the current literature concerning the link between urbanization and waste management tends to concentrate only on either the urban core or the rural areas [12], [13], [14], which makes the peri-urban areas, which are rather complex, largely ignored. In this respect, this study seeks to address that shortcoming by exploring the factors of urbanization, population increase, changing occupations on waste typology, and management in these transitional zones. Further, this research provides an innovative perspective by combining spatial statistics and maps with stakeholders' qualitative input, for example, local residents, governmental bodies' representatives, or waste collectors. This combination of methods provides a valuable perspective on waste management issues in the peri-urban areas of Denpasar City. The study thus enriches urban studies by addressing the more complex relationship between urbanization and waste management in the peri-urban areas, focusing on the spatiotemporal pattern of waste generation and management within peri-urbanization contexts. The main aim of this study is to assess the effect of urbanization, demography, and livelihoods on waste management in the peri-urban areas of Denpasar City. In order to reach this goal, the study will target the following specific aims. The first one targets the analysis of waste generation in the peri-urban areas of Denpasar City in terms of different designations and quantities. This includes gathering and analyzing information on the types of waste generated within these regions and the different factors contributing to their generation, including economic activities, population density, and land use. Secondly, the goal is to analyze the current waste disposal methods practiced in the peri-urban areas of Denpasar City. This also includes the processes of waste collection, segregation, waste transport, and waste disposal, as well as other relevant information regarding the gaps in the waste management system. To propose possible ways to improve waste management in peri-urban regions.

The study's findings are intended to be accompanied by several recommendations about the organization of waste management functioning in the peri-urban areas of Denpasar City. All those strategies will also address the needs of the ever-changing economy and geography of the area and the demand for more integrated and flexible waste management strategies. Focusing on the advancing peri-urban ring of Denpasar City enhances knowledge of the rapid urbanization of the city with regard to waste production and management and addresses the problem practically by making specific suggestions on how environmental sustainability can be improved in such regions.

2 Methods

This study follows a qualitative research approach to understand the situation of waste management in the outskirts of Denpasar City, considering urbanization, population growth, and changing livelihoods. Ethnographic research is especially appropriate for grasping the multifaceted social and environmental dynamics of waste creation and management and the stakeholders' opinions within the study area [15]. The data is first collected through Key Informant Interviews, and to support it, secondary data on waste generated within each study

area is also collected. In this way, a broad picture of waste management in the peri-urban area of Denpasar City is presented.

2.1 Data Collection

Key Informant Interviews

The key informant interview, a crucial data collection method in this study, plays a pivotal role in gaining a comprehensive understanding of waste management in peri-urban areas of Denpasar. It provides a platform for individuals with stakeholder roles or extensive knowledge in waste management to share their insights. The qualitative results from these interviews shed light on the constraints, attitudes, and activities related to waste management in urban settings.

Key informants were sought for purposive sampling as they were expected to have relevant knowledge and experience. The informants consist of: (1) Government Officials (Representatives of the UPT Department of Sanitation and environment of the city of Denpasar where waste management policies and services are concentrated to the peri-urban), (2) Community Leaders (Chiefs of the hamlets or heads of the community-based organizations who can provide information regarding the community waste management system), and (3) Waste Collectors (People involved in the activities of collecting and disposing of waste who understand the daily activities concerning waste in the peri-urban location).

Using such a flexible guiding instrument, the semi-structured interviews were executed as a free discussion of subjects as they emerged. The following issues were focused on during the interviews: (1) the evolution of the rate of waste production while increasing urbanization and populace; (2) whether the existing waste systems and facilities are enough; (3) what methods are used in the local setting to dispose of waste including illegal practices such as dumping and burning; (4) the health and environmental consequences of poor waste management and (5) the possible answers and suggestions regarding the waste management practices in the peri-urban setting. The interviews, which were approximately 45 minutes to one hour long, were audiotaped (with the permission of the interviewees) in order to facilitate inorganic listening during transcription and analysis. The interviews were all in person or via phone based on the informant's convenience and socio-geographic factors of the fieldwork.

Secondary Data Collection

Besides primary data from interviews, this study also attempts to establish a background and a rationale for growth and waste issues through secondary data on waste generation. These secondary data include (1) Waste Generation Statistics, which contain the amount and composition of waste generation per study area consisting of waste area data that has been obtained from Denpasar City Department of Sanitation and Environment, (2) Demographic Data, containing the population growth and land cover conditions in the peri-urban area, information from the City Planning Office of Denpasar and National Statistical, and (3) Peri-urbanization Trends, report & publications which include facts and figures as well as literature

on the extent of urban development and its effect on the periphery of urban centers covering Denpasar.

These help to both provide quantitative data about the scale of the problem of waste management and strengthen the results of the analysis of interviews. It further provides the basis for predicting waste caused by different stages of urbanization, such as the expansion of housing and changes in economic activities.

2.2 Data Analysis

Transcription and Coding

All the interviews were directly transcribed to ensure the complete reliability of the data collected. These transcripts were then brought into NVivo, a qualitative data analysis software for coding, and this was systematically done through three stages: open coding, axial, and selective coding.

The first stage of open coding, where transcripts of the interviews were read, and points or statements relevant to waste management were picked, was undertaken. This produces a long list of codes, each of which relates to some aspect of the research question, for example, "changes regarding waste composition," "infrastructure aspects," and "community participation." The first-order codes were further collapsed in the second analysis stage into broader categories or themes. So, the codes' waste composition' and 'peri-urbanization impacts' will come under one broad theme: 'urbanization and waste dynamics.' This process contributes to organizing the data into more coherent themes that reflect the research goals. Within this last stage of coding and categorization, the last techniques used consisted of selecting the main topics from which the analysis will be built. This concerns major interrelated concepts such as urbanization and infrastructure gaps, community waste management practices, and environmental and health impacts.

Thematic Analysis

After the main themes were identified, the data underwent a comprehensive thematic analysis. The study focused on the issue of urbanization and its associated population growth trends in the peri-urban regions of Denpasar City, examining its implications for waste generation and management practices. This included a thorough investigation of the changes and challenges in waste management practices.

In particular, they sought to comprehend the tendency of categorization of waste types that emerged relatively more recently due to changes in consumption and economic activities in the peri-urban areas. Additionally, it will examine informers' views about waste management systems and services in place, including their effectiveness and shortfalls. In addition, it evaluated the perceived consequences of unsound waste disposal practices on the environment and health of the community, focusing on issues raised by informers concerning pollution of water and soil resources. The analysis was further enriched by the rigorous validation process,

which involved triangulating primary data against secondary data. For instance, if informants claimed there was an increase in the amount of plastic waste, this was supported via statistics about waste composition in the area.

Narrative Synthesis

To present the findings, the thematic analysis results were combined into a narrative regarding the management of waste in peri-urban areas of Denpasar CIty. Such a narrative approach underscores the interrelated themes and the processes of urbanization, population increase, and livelihood changes and how all these factors interact with waste in a growing city. The narrative also captures various actors' voices and the challenges and solutions to such challenges.

3 Results and Discussions

The information that forms the basis of this research stems from secondary data and interviews conducted with several waste management stakeholders in the peri-urban areas of Denpasar. The results from secondary show that waste generation in Denpasar City's peri-urban areas growth 50.30% from 2019 to 2023 , as seen in Figure 1.

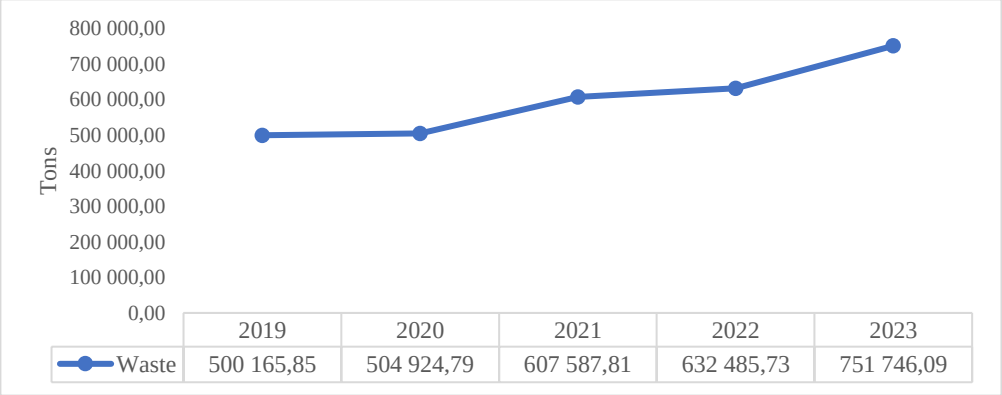

Figure 1. The Growth of Waste Generation in Denpasar City's Peri-urban Areas

(Source: https://sipsn.menlhk.go.id/sipsn)

Thus, the thematic analysis led to several critical areas that pertain to waste generation, waste management issues, environmental concerns, and community participation. These areas were arrived at through codes and categorization of the interview data, which helped dig deeper into the forces behind the existing waste management system in the region under study.

The analysis of the interview data undertook identified areas where predominant themes emerged as follows: the impact of urbanization on waste generation; infrastructure and institutional barriers; environmental and health dimensions of the waste problem; and waste management and community engagement practices. For each theme, a wide range of specific categories were developed, representing the diverse aspects of waste management topics from the point of view of the informants, which are summarized in Table 1.

Table 1. Matrix of Themes, Categories, and Key Statements

Themes	Categories	Key Informant Statements
Urbanization and Waste Generation	Increased waste volume	*"The population has increased while the amount of waste the society generates has also increased. No one has even tried to slow down the increase of the waste".*
	Changes in waste composition	*"In earlier days, little waste was generated composed of non-biodegradable substances like plastic, but recently, waste has included packaging materials plastic and much more".*
Infrastructure and Institutional Challenges	Inadequate waste collection services	*"The collection trucks do not come there regularly, and there are certain areas which are completely ignored as far as the services are concerned".*
	Lack of waste processing facilities	*"The reason is that there are no recycling or composting facilities, which is why all the waste is directed to the landfill".*
Environmental and Health Impacts	Soil and water contamination	*"The people leave their rubbish in the open land and soon after this it has an adverse impact on the crops".*
	Air pollution from burning	*"Plastics are mostly burned which in turn gives rise to a number of respiratory diseases."*
Community Involvement and Waste Management Practices	Informal waste disposal	*"Some of the people still prefer burning their waste materials since they do not know how else to handle the matter."*
	Potential for community-based solutions	*"Unlike most non-governmental organizations from other countries rather than saturating the population with social or health awareness campaigns, only some of the residents are willing to do this after the government helps the locals in some ways".*

The informants repeatedly raised the issue of increasing waste due to urbanization and population growth. They stated that as people move from villages to urban cities, there has been a significant rise in waste that does not rot, such as plastics and e-waste, unlike before. Increased consumerism and the adoption of urban consumption patterns in peri-urban spaces are to blame for this change in waste characterization.

Informants from peri-urban areas stressed the inadequate integration of waste management services, which poses significant challenges for residents. They pointed out that waste collection services frequently overlook certain areas, resulting in unrestricted open

dumping and waste burning. Furthermore, the lack of infrastructure for waste treatment and recycling exacerbates the waste management challenge in these regions. Institutional hurdles, such as ineffective government oversight, were also identified as barriers to efficient waste management.

Other pertinent concerns of the informants included the environmental and health hazards associated with inadequate refuse management. Many reported that the indiscriminate dumping and burning of waste materials has resulted in air, soil, and water pollution, which can be harmful to the environment and human health. Air pollution due to the incineration of plastic waste, a common practice in waste management, was indicated as a severe health threat to children and the elderly.

In regions lacking formal waste disposal options, informal practices have become common. However, our sources view this gap as an opportunity for greater public engagement in waste management. They believe that communities can take a more active role in waste reduction and management with adequate resources and education. Advocates of this policy change express a desire to address these limitations through community involvement, such as local composting and waste sorting initiatives, to alleviate pressure on the official waste disposal system.

This study's results indicate that urbanization has significantly altered the waste dynamics in the peri-urban areas of Denpasar, increasing waste and changes in its composition. Conventional methods that were in place and worked efficiently in small rural settings cannot be sustained any longer owing to the increase in the population and consequent consumption patterns. Nonbiodegradable waste, such as plastics, has become a menace in these areas, with no facilities to dispose of and recycle available materials. Such a lack of infrastructure is a recurrent theme in the data bore. The respondents also complained about the problem of irregular waste collection and the absence of waste processing plants. These shortcomings have compelled people to use unhealthy practices such as open dumping and burning waste, which pose a risk to the environment and human health. Pollution is not only an environmental concern but also a health concern to the residents, mostly from gaseous substances and waste management deterioration. This notwithstanding, the findings also indicate the potential for the community to use waste to develop community waste management measures. They argued that a considerable involvement of the local population in waste disposal can also be done if they are adequately trained, educated, and supported. Such observational findings point towards a possible avenue through which waste management in peri-urban areas may be enhanced by elevating the capacity of communities and embracing them as part of waste management efforts. These results inform the detailed waste management practices in situ in the peri-urban area of Denpasar.

This study echoes Borrelle et al. Borrelle et al. (2020) assertion that urbanization leads to increased waste production and strain on waste management systems. In many developing cities, the expansion of metropolitan areas outpaces the waste management capabilities of local authorities, leading to pollution and health risks [7]. This trend is similar in the peri-urban areas of Denpasar City, where demographic growth and urbanization have strained existing recycling systems, resulting in increased stray waste disposal practices such as dumping and burning.

Another aspect that has garnered significant attention in the literature is the shift from organic waste to non-biodegradable waste, particularly plastic. Alzamora et al. [1]noted that the availability of packaged goods influences mass consumption in peri-urban areas, leading to increased plastic waste. Similar patterns were observed in the peri-urban areas of Denpasar, where informants reported a surge in the use of plastic and packaging materials. These observations reflect global urban waste management trends. Holmes & Argent [11] stress that urbanization not only increases waste volume, but also alters its composition.

The issues of waste management in peri-urban settings, mainly how it affects the environment and the inhabitants' health, have also received much attention. Subsistence practices of waste management through open dumping and burning could result in soil and water contamination, air pollution, and health problems, including respiratory infections from inhaling fumes from burning plastic waste [16]. Such impacts were also reported in Denpasar, where informants indicated that the burning of plastic waste contributed to soil deterioration, water source degradation, and respiratory tract infections among children. This finding is also in line with global patterns in other areas that are experiencing rapid urbanization [17].

Furthermore, the analysis of this research contributes significantly to the theoretical aspects of delineating waste management in peri-urban environments, particularly within the peri-urbanization context. In contrast, the existing theories of waste management, particularly the Integrated Sustainable Waste Management (ISWM) framework [18], identify the gaping hole without stressing the technical, social, and institutional factors in waste management strategies. This study supports the relevance of the ISWM framework by pointing out the shortcomings of excluding local people from waste management options in peri-urban areas. Along the lines of ISWM, the study's findings confirm that the challenges of peri-urban waste management cannot so much be solved by technological measures (like better waste collection services) as they can invite new policies fostering public involvement and education, as in ISWM.

In addition, the study enforces theories on the ‘urban-rural continuum’, a concept that states that the peri-urban interface acts as a bridge between rural and urban zones but sometimes with different social economic and environmental attributes [19]. The Alua Area in Denpasar adopts a hybrid approach to waste management in which urban-rural waste practices in this area utilizes formal municipal services alongside the informal waste disposal. The duality depicts the transitional character of peri urban areas and emphasizes the necessity to develop waste management oriented to the local context of these areas instead of applied urban approach. These results also add to the discussions of environmental justice including the spatial equity of environmental risk assessment. Peri-urban areas and their communities are the most affected due to poor waste management, which subjects them to contaminated water and air pollution [20]. In Denpasar City, the study brings out that peri-urban residents experience environmental injustices in waste management where pollution risks from poor waste facilities are enhanced. Such conclusions are argued against and suggest that the environmental justice frameworks can however bear sociological principles in the peripheral setting in the negative aspect of urbanization. This study demonstrates the implications for waste management policy and practice in peri-urban regions, especially in fast-growing cities like Denpasar city, including but

not limited to better waste collection and infrastructure, improving community-based waste management approaches, mitigating environmental hazards and health effects, and incorporating peri-urban areas into the regional planning management.

This study emphasizes the feasibility of using a community-centered approach to waste management practices within peri-urban settings. To this end, local authorities, hand in hand with NGOs, must develop programs that seek to enhance the waste management practices of the communities. The dangers posed by poor waste management in the peri-urban setting, not only from environmental and health perspectives, are high and must be addressed urgently. It is thus recommended that guidelines be put in place to address the problems of open dumping and open burning of waste, which include policies aimed at efficient solid waste disposal and improvement of environmental surveillance in peri-urban areas. These may include communication about health and access to health facilities and equipment for those handling waste. The study also discusses the integration of peri-urban interface areas into the broader frame of urban planning and waste management systems. Especially such peri-urban regions, which are rapidly urbanizing and have escalating waste management problems, remain neglected in municipal plans for the management of waste. Legislative authorities should take into consideration the specifics of peri-urban territories, and formulate reasonable waste management policies that are responsive to the variances of the surrounding socio-economic and environmental conditions. Such incorporation might be more difficult and necessitate more integration between the municipal government and the peri-urban residents. It also underscores the need for specialized funding for peri-urban waste management programs.

4 Conclusion

This paper has focused on waste management practices in Denpasar City's peri-urban region, which has experienced rapid urban growth, increased population, and changes in economic activities, resulting in changes in the generation and handling of waste. The study shows that urban sprawl naturally increased the amount of waste produced as well as the types of waste, which mainly include plastics that are not biodegradable. People have poor facilities and services, such as irregular garbage collection and poor waste management, and there are few treatment options for the collected waste. Hence, open burning and dumping of wastes and other similar methods are common and pose massive health and environmental hazards. The study suggests several practice-related recommendations. First, there is an urgent need for local authorities to enhance the waste collection services and initiate the construction and establishment of waste resource processing plants, including but not limited to compost and recycling plants, to control the ever-increasing threat of waste in the suburban population. Second, community efforts could be essential in bringing about many improvements in waste management systems. Support and encouragement should be given to the type of waste reduction, sorting, and recycling campaigns in which the community takes part, and these can be facilitated by education and financial benefits. Lastly, the resolution of poorly disposed waste

management problems cannot be accomplished without building regulation and enforcement systems and interventions to mitigate the downside exposures associated with informal waste dumping. Regarding the suggestions for further research, it would be better to address the issues in the peri-urban areas, which tend to be under-researched since they are between the urban and rural categories. Cross-sectional studies of transitional countries that are both developing and grappling with the challenge of waste management would give a better understanding of how urbanization impacts waste management issues in the long run. Moreover, more studies on the determinants of community involvement in waste management, especially in developing countries, are necessary to bring about better policies and practices towards waste management in densely populated cities like Denpasar.

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