



Pathways to sustainable peri-urban waste management

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ABSTRACT

Background: This research evaluates sustainable waste management in the peri-urban areas of Denpasar City, which has experienced significant waste problems due to fast urbanization. The study reveals significant issues with household waste segregation, poor infrastructure, and little community involvement using key informant interviews and thematic analysis. However, the study also provides a hopeful vision for better waste management powered by sustainability. **Methods:** This model combines the piety of segregation of organic, inorganic, and residual waste with measures like composting and much fancy implementation of waste-to-energy systems. **Findings:** The study highlights the need to enhance policy enforcement and infrastructure investment and integrate informal waste collectors into formal systems. **Conclusion:** The implications of the preceding findings are considered, policy and practice implications are delineated, and recommendations for future research are proposed, particularly concerning the evaluation of the long-term effects of technological interventions on the utilization of these methods. They offer a pragmatic solution to the challenge of environmental sanitation for other urbanizing regions encountering similar waste management issues, thereby promoting a transition towards sustainability. **Novelty/Originality of this article:** This study introduces a novel approach by integrating informal waste collectors into formal systems and emphasizing the long-term evaluation of technological interventions in sustainable waste management in peri-urban areas.

KEYWORDS: community engagement; informal waste collectors; peri-urban dynamics; sustainable waste management.

1. Introduction

Urbanization on a global scale is genomically altering the spatial structures of cities and their hinterlands, gradually making the pattern emerging out of direct economic and social links between urban centers and peri-urban areas more complex (Satterthwaite et al., 2010; Woltjer, 2014). This process leads to a lot of negative impacts on lots of sectors, including one of the major issues these days, which is waste generation. As cities redraw their city limits, the immediate peri-urban zones are also witnessing an urban sprawling phenomenon that, in turn, puts excessive stress on services like solid waste management. Different from the method in developed countries, many developing countries, including Indonesia, still handle waste, which is severe waste management in peri-urban areas.

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Denpasar is an emerging urban area in which peri-urban regions are increasingly occupied, facing the frontier of population growth and threatened with land use transformation (Christiawan, 2019). Rapid residential expansion due to in-migration and population growth is associated with increased levels of waste generation and a greater diversity of waste types. This is frequently a problem because peri-urban communities generate waste volumes and complexities that traditional (more rural) small-scale waste solutions cannot effectively process. Moreover, the relationship to a maintainable lifeform in a vast city honorably increased the amount of waste management in this place.

Several reasons underline the urgency of waste management in peri-urban regions, such as those at Denpasar's peri-urban areas. Poor waste management's effects on health and the environment are catastrophic (Thanh et al., 2010). Improper waste management results in soil and water pollution, badly affecting local ecosystems and human health (Evode et al., 2021). In the peri-urban areas of Denpasar, where agricultural activities tend to reside alongside urban development, ground and surface-water source contamination lies at the interface of food security and public health. It can also contribute to air pollution — burning is a standard solution in places with scarce waste removal services.

These dichotomies are further complicated through peri-urbanization by their socio-economic transformation as well. Slumberous villages around Denpasar, for example, provide are replaced by different species of waste as the landscape is transformed into a peri-urban interface. Consumerism is rising due to higher incomes and lifestyle changes, which produce non-biodegradable waste, such as plastics and e-waste, that traditional waste management systems are ill-equipped to handle (Borrelle et al., 2020; Evode et al., 2021). This problem, however, needs to be taken as an alarming sign for reviewing waste management practices in peri-urban areas, and not adapting to it will result in aggravating environmental degradation, leading to public health crises.

Peri-urban areas are increasingly being recognized as the grey blind spot in urban planning processes (Fielke & Bardsley, 2015; Gonçalves et al., 2017). Urban areas, on the other hand, have sometimes seen more investment in waste management solutions while peri-urban locations struggle. This is despite the fact that they have some of the fastest population growth and land use change rates in this country, which puts lots of pressure on waste management systems. In Denpasar, both slum areas and peri-urban areas are expanding steadily, yet much is located away from formal waste collection. This situation could lead to a potential health crisis due to the presence of unmanaged garbage in the urban area.

In peri-urban areas of Denpasar, waste management had a complexity issue; the increase in urbanization, population growth, and shift in livelihood were attributed to the primary problems. The problems that arise have several differences: the increase in the amount of generated waste, the nature of waste changing cycle by cycle, incomplete waste management infrastructure and pollution caused by environmental damage and harm to health (Alhazmi et al., 2021; Debolini et al., 2015).

Highly intensified and rapidised urbanization has contributed to growing amounts of garbage in the peri-urban area of Denpasar. Today, the existing waste management infrastructure constructed for rural or semi-rural populations has been buffeted by a rapidly growing urban population, causing it to be jam-packed. Livelihoods are transitioning from agricultural work to urbanized jobs, and the variety of waste generated has expanded. Traditional biodegradable waste, such as those from farm activities, is now mixed up with a growing stock of non-biodegradable and hazardous waste like plastics, electronics, and packages, which require additional safeguards for consumer disposal and recycling (Alzamora et al., 2022). Situated on the fringe of Denpasar, most of these peri-urban settlements are not served by formal waste collection. The absence of these has lead to uncontrolled informal waste management activities such as open dumping and burning that could degrade environment and public health. Which means that soil contamination and water pollution and air contamination due to improper waste disposal in peripheral urban areas. These environmental repercussions not only menace with negative impacts on

the local ecology but also undermine the present-day society economically and socially, mainly living on agro-activity.

This research is novel in its particular concern of waste management dynamics in the peri-urban areas of Denpasar that have remained relatively unexplored within existing literature. Urbanization literature on waste management generally concentrates either in urban cores or in rural areas, paying little attention to the peculiar challenges faced by peri-urban zones (Ermawati et al., 2014; Ernawati et al., 2012; Yusari & Purwohandoyo, 2020). This research seeks to fill in this gap, by examining the impact of urbanization, population expansion and shifting livelihoods on waste fractions and management in such transitioning zones. This study explains an innovative methodology in which spatial analysis is linked with qualitative assessment of the views from various stakeholders such as local residents, informants involved in waste management, and their operators. This mixed method approach provides a more complete picture of waste management issues than either survey type alone would have. This paper develops our understanding of urbanization and peri-urban waste management by investigating the spatial patterns of waste generation and social dynamics affecting waste management practices. In addition, this research lot is located at the crossroads between urban and environmental fields of epidemic concern that has intensified debates on sustainable urbanization all over the world. It highlights the necessity for broadened waste management regimes that integrate the local setting of a significantly high number of peri-urban districts still erroneously being neglected in traditional urban planning concepts.

This study aims to evaluate the influence of urbanization on waste management dynamics in peri-urban areas of Denpasar. The first being study on the quantity and composition of waste in peri-urban areas Denpasar. This would include gathering and analyzing data on the composition of waste generated in these areas, generation rates and characteristics, as well as socio-economic parameters such as population density, economic activities, land use etc. Then, to observe the current waste management practices within peri-urban region of Denpasar. This includes study on the waste collection, transportation and disposal mechanism we have individually as well as studying what are loopholes or issues in our current waste management system. Finally, to recommend potential strategies for enhancing waste management in peri-urban areas. The goal of the research is to come up with practical and sustainable recommendations on waste management in the peri-urban areas of Denpasar according to our findings that have been done. These will be contextualized taking into consideration the socio-economic and spatial dynamics of the area, along with providing for more inclusive and adaptable waste management policies. Urbanization: An important and unexplored result of this research is how it plays out for waste management in peri-urban areas. Through insights into the fast-growing peri-urban zones in Denpasar City, this study provides a view on waste generation and management under rapid urbanization process with a set of recommendations for enhancing sustainability in these areas.

2. Methods

The study aims to reveal some dynamics on waste management in peri-urban of Denpasar City, which considers how urbanization, population growth and changing livelihoods influence waste generation; based on its research question the researchers adopted a qualitative research design (Creswell, 2007). The qualitative method is ideally suitable to explain and explore interlinked social and environmental processes in the study area that are associated with waste generation, disposal or treatment; as well as stakeholder perspectives. It is predominantly based on key informant interviews as well as secondary data regarding the amount of solid waste generated in the different study sites. Together, they give a wide-ranging picture of waste dynamics in peri-urban Denpasar.

2.1 Data collection

Key informant interviews are this research's primary data collection method. It seeks to learn from those that either have hands-on or first-hand experience in the matter of waste management in Denpasar peri-urban area. Qualitative data on the problems, perspectives and practices by urbanization garbage disposal were obtained through these interviews. Purposive sampling was used to select key informants based on their relevant expertise and experience. The informants consisted of: (1) Government Officials from Denpasar City Department of Sanitation and Environment (responsible for local policy on waste management as well as service provision in the peri-urban areas), (2) Community Leaders, such as village heads or neighbourhood association representatives (offering insight into communities' role in waste management), and (3) Waste Collectors (working directly with collection services and disposal, providing information on challenges at the ground). Interviews were semi-structured, with a broad range of questions that could be asked and probed to explore themes as they emerged. Interview questions focused (1) changes in waste generation patterns with urbanization and population growth, (2) adequacy of current waste management infrastructure and services in the peri-urban context, (3) local waste disposal practice including open dumping and burning in informal sectors, (4) environmental and health consequences of waste mismanagement among all stakeholders; and suggestions on how to improve solid waste management system suitable for rapid urban expansion while taking international evidence from developed countries into consideration. Every interview took 45 minutes to one hour in time, which was tape-recorded (statements after the interest of informed consent) for accurate transcription. Informants were interviewed by in-person or telephone interviews, whichever was more convenient for the informant and practical for fieldwork.

Complementing primary data from interviews, the research leverages secondary data on waste generation to addurance casework and reinforce qualitative findings. These are (1) Waste Generation Statistics, a secondary data by on the types and amounts of waste generated in each case study area also from the Department of Sanitation & Environment Denpasar City, and (2) Peri-urbanization Trends provides a literature review of statistics related to urban expansion affecting in peri-urban areas Denpasar city. This data serves to provide quantitative information on the extent of waste management and also substantiates stories from responses collected during FGDs. It helps to reveal spatio-temporal patterns of kinds of waste that correlate with different forms of urbanization (e.g. residential growth) and economic activity changes.

2.2 Data analysis

We conducted thematic analysis that included survey responses and key informant interviews to analyze the qualitative data. The approach lends itself to the exploration of key underpinning dynamics and discourses regarding waste management practices, particularly within the contexts of larger peri-urban socio-economic transitions. Although thematic analysis avoid simplistic distortions of data, key themes were identified and thematic analysis was used to make sense of the data. The study analysed the impact of urbanisation and population growth on waste generation and management in peri-urban areas in Denpasar. This focused on studying the changing trends and issues of waste management. Especially in the different representations of waste production according to changes in consumption patterns and economic activities on urban fringes. Secondly, there was a need to process informants' understandings of current waste management infrastructure and services, which in turn identified areas not covered by these. In addition, the paper will investigate the reported effects of waste mismanagement on local eco-systems and human health to further our understanding of this development challenge, including specific informants concerns about water and soil contamination. Triangulation was made with secondary data to ensure the validity of the findings in addition to all detailed other analysis. This was compared to official waste composition data at the area to

check for an increase in plastic waste — and so on. The secondary data also enabled the qualitative findings to be understood against wider urbanization trends and hence further contribute towards a more comprehensive understanding of the issue.

3. Results and Discussion

The study results are completely learning form recorded documentation and key informant interviews research from the various stakeholders who engage in waste management from periphery area–Denpasar. The thematic analysis identifies a number of key themes regarding waste production, difficulties in handling waste, environmental effects and community participation. The results are key themes identified by coding and categorizing the interview data, which provide a richer insight into the underling factors that drive waste management in this region.

Results: The thematic analysis of the interview data generated four main themes which were summarily written as; Theme 1: Urbanization, Population and Waste Generation, Theme 3: Infrastructure and Institutional Challenges, Theme 4: Environmental Damage & Health Impact) and; theme 5: Community Participation in Solid Waste Management. These themes were further supported by a set of categories already manifest from the interview data which, at this stage demonstrate a range of reasons for adopting or not adopting waste management practices by sample selection (see Table 1).

Table 1. Matrix of themes, categories, and key statements

Themes	Categories	Key Informant Statements
Urbanization and Waste Generation	Increased waste volume	"Population has gone up and with it the wastage increased."
	Changes in waste composition	"We used to get mostly organic waste and now we're receiving a lot of plastic and packaging materials."
Infrastructure and Institutional Challenges	Inadequate waste collection services	"The trucks are not collecting in many places and some parts of the colony are totally ignored."
	Lack of waste processing facilities	"This is a landfill where there are no recycling, or composting facilities; everything you throw away will go to the dump."
Environmental and Health Impacts	Soil and water contamination	"Majority of the waste is being thrown in the fields and it's affecting our crops."
	Air pollution from burning	"Plastic waste is running into respiratory issues and being burnt."
Community Involvement and Waste Management Practices	Informal waste disposal	"Most of the people still burn their waste as they don't know what to do with the waste."
	Potential for community-based solutions	"Perhaps if the government would get behind local projects we might be able to make some headway."

All the informants emphasized how as a consequence of urbanization and increasing population, there was mounting waste. They noted that over the past shift from a predominantly rural lifestyle into an urban one, there has been considerable growth in non-biodegradable waste (mostly plastics and e-waste) which was non-existent some time back. This change in waste composition is associated with higher consumerism and rapid urbanization in the peri-urban space. A common bottleneck regarding the waste management infrastructure in the peri-urban areas was also that usually, it was insufficient as mentioned by several informants. They revealed that waste collection services are sporadic and may be entirely absent in communities which have little option other than to dispose of waste via open dumping or burning. Furthermore, as these regions lack a waste processing and recycling industry, the garbage continues to pile up. Answering questions of the legal and regulatory framework, insufficient government oversight and leadership also all played major roles in preventing effective waste management.

Poor waste management leading to increased amount of non degradable and non decomposable items causing harmful environment and health hazards was the second major concern raised from the informants side. A common grievance among these residents is that open dumping and burning of this waste have polluted the soil, which later leads to contamination of water sources — putting the environment and public health at risk. Burning plastic waste leading to air pollution was commonly cited as a major health threat, especially when burning affected vulnerable populations like children and the elderly. While a few simply pointed out that the existence of arid communities with no other way to dispose of waste can have little recourse but to use land, several informants also highlighted a strong tradition for community-based waste management actions. So, if we could only get the support and education needed for communities to look at ways that they might actually reduce waste – some people are talking about waste reduction rather than management. Informants proposed community-based strategies, like composting at a local level or sorting programs that could potentially off-set some of the demand from the formal waste management system.

This research showed that urbanization had significantly altered the dynamics of waste production and the composition of waste in peri-urban areas one of which was in the Denpasar City. These endless practices used to work well with sparse, rural populations but are just not cutting it in allowing for large-scale human growth and advancement with the growing population bases that accompany these changing consumption behaviors. All these surfaces are heavily littered with both biodegradable and non-biodegradable materials but plastics seem to be taking over especially in the absence of recycling plants or facilities for managing such wastes. Infrastructure is another common theme throughout the data. Local residents were disappointed that waste collection was carried out irregularly, and no plants for the processing of garbage in the village there. This creates a significant gap in waste management services and drives communities towards unregulated practices like open dumping and burning, that can be particularly detrimental to the environment and public health. As many local water sources get more and more polluted, and as agricultural land degrades due to bad waste manger, we can see the environmental impact roaming around us in our ecosystem, while confronting different health issues due to air pollution which is so alarming issue nowadays. However, one of the most interesting aspects that this paper reveals is a foot-in-the-door for community-based waste management options. Informants stated that local communities could better manage their waste if properly supported and facilitated with the necessary resources. That presents a pathway to better waste management in peri-urban areas, by strengthening the hands of local populations and folding them into-disposal strategies. The present results expand on this and provide greater detail in terms of the waste management dynamics of Denpasar's peri-urban area.

The findings of this study show that the total waste generation in the peri-urban areas has experienced a fairly consistent increase (Fig. 1).

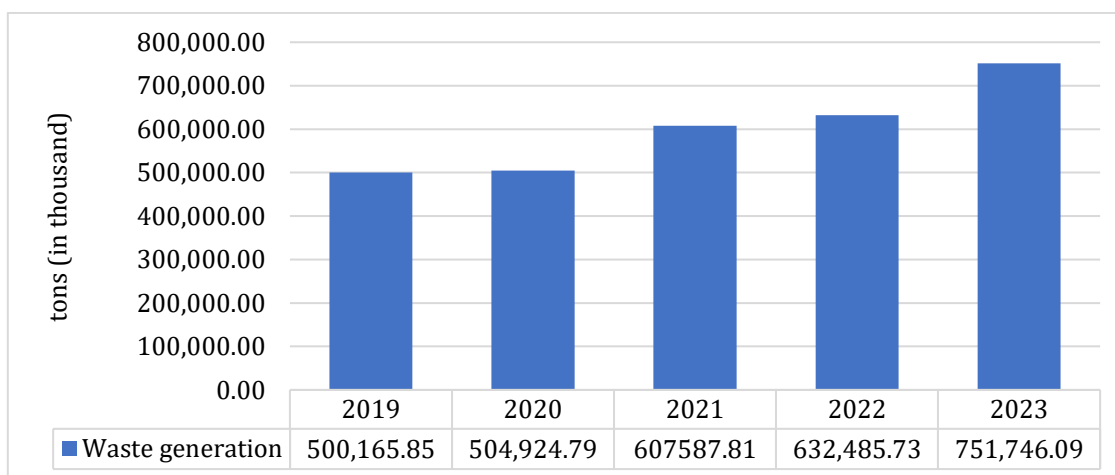


Fig. 1. Dynamics of waste generation in the peri-urban areas of Denpasar City

The total increase from 2019 to 2023 reached 50.30%, which indicates that peri-urbanization in the peri-urban areas of Denpasar City has a direct impact on increasing waste production. Changes in lifestyle, increased consumption, and urbanization that occur in this area are the main factors driving the increase in the amount of waste. Subsequent studies, such as Alhazmi et al. (2021) have shown that urbanization increases the amount of generated waste, shifts in composition of waste-streams and presents greater issues for requisite infrastructure. Urban growth outstrips the capacity of local government to deliver effective waste service appropriate for many developing cities, leading to environmental impacts and public health hazards (Evide et al., 2021). The same can be said in peri-urban areas around Denpasar, where economic growth and urbanisation have outpaced conventional waste management facilities, resulting in the rise of informal waste disposal practices like open dumping and burning.

Another issue which has extensively been discussed in the research is the transition from organic to non-biodegradable waste mainly plastic waste. Research conducted by Borrelle et al (2020) demonstrates that this is an effect of the transformation in consumption patterns in urbanized regions, where accessibility to packaged goods from companies has increased plastic waste production. In peri-urban areas around Denpasar, informants noted much greater use of plastic and packaging than in the past. Our results are consistent with those of Egun & Evbayiro (2020), who find that urbanization expands the volume of waste to be dealt with as well as shifts the type of waste disposed, thereby adding difficulty when first collecting and disposing such materials.

Past researches have also conducted a broader understanding of the environmental and health impacts of mismanagement of waste in peri-urban areas. Studies by Alzamora et al (2022), shows that waste management system of open dumping and burning can pollute soil, water and air from particles received nations may experience health issue waves, respiratory collapse caused by the burning plastic waste. In Denpasar, for instance, informants stated that soil quality reached its worst condition because the water sources had been polluted as a result of burning plastic waste and children experienced respiratory problems. This is consistent with broader global patterns found in other rapidly urbanizing regions (Debolini et al., 2015).

Nevertheless, the study also brings out certain nuances of peri-urban waste management that are under-emphasized in the literature. Along one key dimension, however, comes the hope that communities could have a say in how waste is managed. While urban areas operate under highly institutionalised waste management schemes, peri-urban local government areas manage their waste informally. However, as this study discovered, there was a significant scope of improvement for waste management outcomes through community-based initiatives. Informants expressed a willingness to support and educate, provided with literature on how waste sorting is done by the community through local government efforts. This finding is important for the literature as it sheds light on the relevance of local engagement in shaping waste management solutions in peri-urban area (Argent et al., 2007), a factor which has not been so thoroughly accounted for by the dominant discourses.

The findings of this study have significant implications for waste management policy and practice in peri-urban settings, especially those located in rapidly urbanizing regions such as Denpasar, such as improving waste collection and infrastructure services, supporting community-based waste management initiatives, mitigating environmental and health impacts, integrating peri-urban places into urban planning processes. These costs were exacerbated through failure to extend adequate waste collection services and infrastructure into the peri-urban areas. One way of addressing this, is for local government to make sure that all their peri-urban catchment areas are fully serviced with regard to waste collection. This can include introducing more regular collections of waste, expanding the covered area to areas not serviced before and investing in new collection trucks and trained collectors. Second, it requires local waste processing such as composting and MRFs to decrease the volume of landfilled waste and increase recycling. They could even generate jobs in peri-urban areas, meaning better economic development. This study points to the

opportunities for community-based strategies within peri-urban waste. Local governments and NGOs can work together to implement programs which will enable communities to play a larger role in regards to how waste is managed locally.

4. Conclusions

This study investigates waste management dynamics in the peri-urban areas of Denpasar City where rapid movement of urbanization has reinforced on high-waste generation and unstable solid waste management practices. Urban spatial expansion has exhibited major effects over the years on waste generations, both in terms of volume growth and composition shift especially to non-biodegradable materials like plastics. The present waste management infrastructure is not perfect with sporadic waste collection services and limited capability to process waste. Consequently, informal waste disposal practices that include open dumping and burning predominate, resulting in severe environmental and health hazards. There are several main implications for practice identified by the study. Local governments need to first invest in improving waste collection services and facilities (composting, recycling centers) to tackle the growing peri-urban waste issue, as this study shows that residents are unwilling to pay for better waste management alone. The projects in the villages can be very beneficial for good results on waste management. Encouraging and promoting education Process for local governmental programs to engage citizens in waste reduction, sorting, and recycling efforts is important. Ultimately, efforts to mitigate the environmental and health consequences of waste mismanagement need reinforced regulation enforcement as well as public health programs designed for reducing risks from informal waste disposal. In addition, more focus should be placed on the particular issues faced in peri-urban areas, which tend to fall between urban and rural. Longitudinal studies monitoring the progression of waste treatments in urban-rural transition zones would offer useful insights into the outcomes of urbanization over time. In cities undergoing rapid urbanization in the global South, such as Indonesia, research on socio-economic determinants that cause variation in community participation could provide key insights to enhance waste management policies strategies which are both sustainable and equitable.

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