

Grand design policy for economic empowerment through waste management: A case study of Pekanbaru City's environmental and energy strategies

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Abstract. Waste management has emerged as a compelling issue within the global environmental crisis context. The escalating waste production and its consequential impact on the environment necessitate proactive management solutions. This research aims to delve into the potential of economic empowerment through waste management and scrutinize the ramifications of environmental and energy policies on the populace of Pekanbaru City. Employing a mixed methods approach, through field surveys, direct perspectives from the public and stakeholders concerning economic empowerment through waste management were meticulously amassed. The results from the data analysis underscore the potential benefits of economic empowerment via waste management. These findings substantiate the exigency for an integrative and sustainable policy stance in confronting the multifarious challenges posed by waste management. This necessitates not only an integrated food system policy but also the provision of community training and education, alongside governmental support for waste management programs. The realm of waste management exhibits a substantial capacity to augment the economic empowerment of the community. However, the optimization of waste management practices in Pekanbaru City mandates a comprehensive strategy facilitated through a multi-sectoral collaboration, involving government, private enterprises, and the community.

1 Introduction

Waste management has become a central issue in the context of the global environmental crisis [1]. This phenomenon has gained increasing importance in tandem with the ongoing growth of the global population, rapid urbanization, and escalating consumerism. The rise in waste production has significant social, economic, and environmental implications. Therefore, it is crucial to explore innovative solutions for effective waste management that also provide economic benefits to communities. According Wulandari et al. [2], effective waste management is not solely a matter of waste disposal but also an opportunity to implement sustainable environmental policies. One critical aspect to consider is how waste

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management can empower community economies, including job creation, business potential in the recycling sector, renewable energy production through waste-to-biomass conversion, and efficient management of natural resources for economic gain [3, 4].

Indonesia, as one of the rapidly growing economies with significant urbanization, faces specific challenges in managing waste issues [1]. Large cities like Pekanbaru in Riau Province serve as tangible examples of how the increasing trend in waste production has become an urgent concern. Rapid urban population growth has resulted in increased consumption and waste generation, subsequently causing serious environmental pollution issues. Addressing waste management issues in Pekanbaru requires a holistic understanding of its root causes, waste production dynamics, environmental impacts, and potential solutions to alleviate the environmental burden.

Limited community involvement in waste sorting and collection, despite the presence of 63 Temporary Collection Points/TPS in Pekanbaru, can be analyzed intriguingly through the lens of community-based social capital theory [5–7]. The concept of social capital refers to the extent to which social relationships and networks within a community can be utilized to solve problems and achieve common goals [8]. In the context of waste management, community-based social capital can influence the extent of community participation and support for sustainable waste sorting and collection efforts. According to Andriani [5], one key aspect of social capital theory is social norms and expectations within the community. In this context, the lack of motivation and awareness regarding sustainable environmental concepts may indicate that social norms related to waste management have not strongly developed in Pekanbaru's society. This issue is attributed to the lack of effective communication and coordination among stakeholders, including the government, to promote these norms [5].

The government, as the primary regulator, should play a role in formulating policies that support waste management. However, in some cases, these policies have not been optimal due to a lack of coordination with relevant stakeholders such as the private sector and the community. According to Coleman [8], communities have the potential and capacity to actively participate in waste management. One potential resource that can help communities turn waste into economic value is community-based social capital. Community-based social capital refers to the relationships, networks, and norms that facilitate cooperation and coordination among community members [9]. Social capital is understood as a resource created from relationships [8], formed through ongoing interactions among individuals that result in the exchange of information, values, and beneficial knowledge among individuals. These relationships create bonds among individuals, social relationships, and social networks [10].

According to Bourdieu, enhancing community capabilities in waste management should be done through education, training, and awareness of waste risks. Communities need to be involved in planning, decision-making, and waste management program implementation. According to Aguilera & Massey [11], Coleman [12], and Portes [13], social capital can act as a unifying factor for everyone in the community through shared values expressed in personal relationships, trust, and a common sense of collective responsibility, transforming communities from mere collections of individuals into value-driven entities [11–13]. The key concepts contributing to the social capital discussion [6, 12, 14–20] define social capital as an investment in social relationships with expected feedback from the surrounding environment. To reap benefits, individuals interact and build social networks.

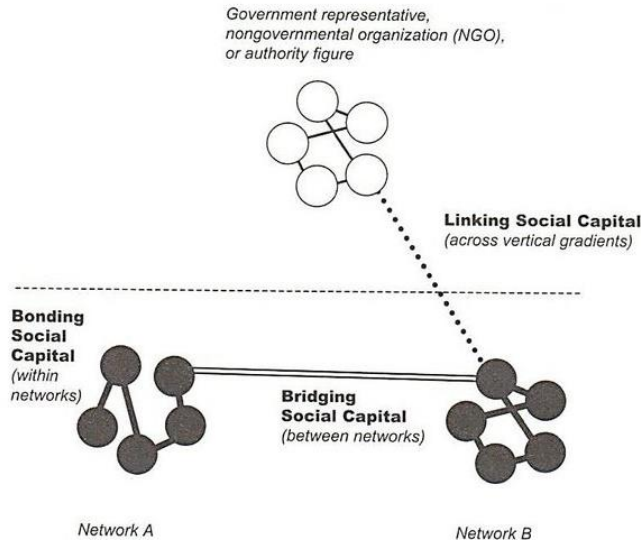


Fig. 1. Community social capital framework.

According to Andriani & Christoforou [20] and Febrian et al. [6], bonding social capital signifies strong familial ties in which social relationships are characterized by trust and reciprocity [6, 20]. Indicators of bonding social capital include (1) family composition, (2) spatial proximity among family members, (3) relevance of other relatives, and (4) the quality of relationships, both within the family and with other relatives. Bridging social capital involves relationships between groups bound by cultural, ethnic, lineage, personality similarity, and other foundations of connection. Indicators of bridging social capital encompass (1) social relationships for information acquisition, (2) relationships rooted in kinship, culture, and tradition, and (3) social relationships for accessing other resources. In contrast, linking social capital refers to connections between different social networks. Indicators of linking social capital include (1) networks between diverse groups and (2) cross-sector social networks that can readily access resources held by other institutions [21–23].

Based on its functions, community-based social capital contributes within the framework of economic empowerment policies through effective and sustainable waste management. Within this framework, proper waste management can reduce negative environmental and energy resource impacts while creating economic opportunities for communities. Community-based social capital facilitates collaboration among stakeholders, including the community, government, private sector, academia, and mass media, to develop a grand design for community empowerment policies through more effective waste management. With increased community participation in waste management, economic empowerment can be realized, thereby supporting goals of environmental and sustainable energy.

Understanding the impact of environmental policies and renewable energy on the people of Pekanbaru, this research aims to formulate a grand design and explore the potential for economic empowerment through sustainable waste management. The results of this research are expected to provide valuable insights for decision-makers at the governmental level and assist in designing sustainable solutions to address waste management challenges in this city, as well as in various other urban areas in Indonesia and worldwide.

2 Methods

This research employs a Mixed Methods approach aimed at elucidating causal relationships between the variables under investigation using data collected from the residents of Pekanbaru city. Quantitative data are derived from community groups, while qualitative data consist of expert judgments obtained from the Head of Waste Handling and Final Processing at the Pekanbaru Environmental Department, Non-Governmental Organizations, or companies in Pekanbaru directly involved in waste management processes (e.g., PT. Samhana Indah), academics from the University of Riau, and one of the local mass media outlets in Pekanbaru.

The population for this study comprises residents residing in areas surrounding Temporary Collection Points (TPS) across Pekanbaru city, including the districts of Sukajadi, Senapelan, Pekanbaru Kota, Sail, Bukit Raya, Tenayan Raya, Kulim, Limapuluh, Marpoyan Damai, Payung Sekaki, Tuah Madani, and Bina Widya. The total population across these 12 districts amounts to 983.356 peoples. In this research, respondent selection employs probability sampling through random sampling, with the consideration that each member of the population has an equal chance of being included in the study sample. Subsequently, the sample size is determined using the Slovin formula [24], resulting in a sample of 100 individuals (rounded to the nearest decimal).

$$n = \frac{N}{1 + Nd^2} = \frac{983.356}{1 + (983.356)(0,10)^2} = 99,98 \quad (1)$$

Where, n = Sample size, N = Population, d = Precision Value, d =10%.

The technique for quantitative data collection involved the distribution of questionnaire surveys. In addition to surveys, qualitative data were collected through in-depth interviews with informants and field observations. Causal analysis was employed to investigate influence relationships and to test the framework using Structural Equation Modeling (SEM). Data processing in this research utilized the Partial Least Squares (PLS) method because all variables were latent variables measured by indicators, even in the presence of multicollinearity among these variables Wold, 1973. The purpose of using Partial Least Squares was to confirm the theory applied in the development of the grand design for economic empowerment policy through waste management in Pekanbaru city. The designed grand design resulted in patterns of synergy, socialization, and potential strategies for waste management that yield economic value for the residents of Pekanbaru city.

Referring to Tenenhaus et al. [27], the quantitative data analysis was conducted in two steps. First, a descriptive analysis was performed, followed by a causal analysis. In the descriptive analysis, the study employed the outer model, inner model, and structural model testing. Second, the results of the descriptive analysis were interpreted based on theory and empirical phenomena to design the grand design using a community-based social capital approach. The grand design was developed based on the SEM-PLS modeling pathway and bootstrapping, which provides a more accurate means of predicting the model.

3 Results and discussion

In this section, the results of quantitative data analysis will be discussed first, followed by the use of qualitative data as supporting evidence for the validation and confirmatory aspects of the quantitative data. The output of the Partial Least Squares (PLS) analysis is assessed through the outer model, inner model, and structural model analyses. In the outer model analysis, construct reliability testing, as suggested by Chin [25], is measured using composite reliability and Cronbach's alpha [25]. A construct is considered reliable if it has a composite

reliability value above 0.70 and a Cronbach's alpha above 0.60. The adequacy value of Average Variance Extracted (AVE) to measure construct validity is 0.5 [26]. The following table presents the results of the outer model analysis. Based on the criteria in Table 1, the output data indicate that all criteria of the outer model are met, thus affirming the good validity and reliability of the research data. Consequently, we can proceed to the inner model analysis.

Table 1. Cronbach alpha, composite reliability dan average variance extracted.

No.	Criteria	Cut-off-Value	Bonding	Bridging	Linking
1	Cronbach's Alpha	>0,6	0,618	0,595	0,817
2	Composite Reliability	>0,7	0,739	0,756	0,916
3	Average Variance Extracted	>0,5	0,585	0,512	0,844

The purpose of the inner model analysis is to ensure the robustness and accuracy of the constructed model. According to Ghazali [26], the inner model analysis can be assessed through several factors, namely the coefficient of determination (R2), predictive relevance (Q2), and the goodness of fit index (GoF). Based on the R2 analysis, social capital within the community falls into the moderate category as it exceeds 0.324 [25,26]. To analyze Predictive Relevance (Q2), we utilize the following formula:

$$Q^2 = 1 - (1 - R_1^2) \times (1 - R_2^2) \times \dots \times (1 - R_n^2) \tag{2}$$

$$Q^2 = 1 - (1 - (0,539)^2) \times (1 - (0,584)^2) \times (1 - (0,539)^2) \tag{3}$$

$$Q^2 = 0,668 \tag{4}$$

Predictive relevance (Q²) is performed to determine the predictive capability through blindfolding procedures. According to Chin [25], if the accepted value is 0.35, the model demonstrates strong predictive ability. The calculation of Q² yields a value of 0.668, indicating a very strong predictive capability for the model. To analyze the structural model, the Goodness of Fit (GoF) index is obtained and calculated mathematically following the formula [27]:

$$GoF = \sqrt{AVE^2 \times R^2} \tag{5}$$

The GoF index is determined by squaring the AVE value and multiplying it by R².

$$AVE = \frac{\sum \lambda_i^2}{\lambda_i^2 + \sum_i var(\epsilon_i)} \tag{6}$$

$$AVE = 1,174 \tag{7}$$

Where λ_i represents the loading component to the indicator, and $var(\epsilon_i) = 1 - \lambda_i^2$. With AVE at 1,174 and an average R² is 1,302. The GoF is calculated using the following formula:

$$GoF = \sqrt{AVE^2 \times R^2} \tag{8}$$

$$GoF = \sqrt{1,174^2 \times 1,302} \tag{9}$$

$$GoF = 1,339 \tag{10}$$

According to Tenenhaus et al. [27], the GoF value is considered small if it's 0.10, moderate if it's 0.25, and strong if it's 0.38. Based on the calculated GoF of 1.339, the structural model demonstrates a strong and robust GoF value [27]. After analyzing the outer model and inner model, we proceeded to test hypotheses through Bootstrapping analysis.

Bootstrap is a non-parametric procedure that allows for statistical significance testing of various PLS-SEM results such as path coefficients, Cronbach's alpha, T-Statistics, and R². Based on the bootstrap output, the path coefficients have values above 1.962, with the following t-statistics values in sequence: Bonding = 11.330, Bridging = 12.431, Linking = 3.813. This indicates that the constructs of bonding social capital, bridging social capital, and linking social capital, as antecedents to Community Social Capital, can effectively explain the endogenous constructs as reflective confirmatory factors.

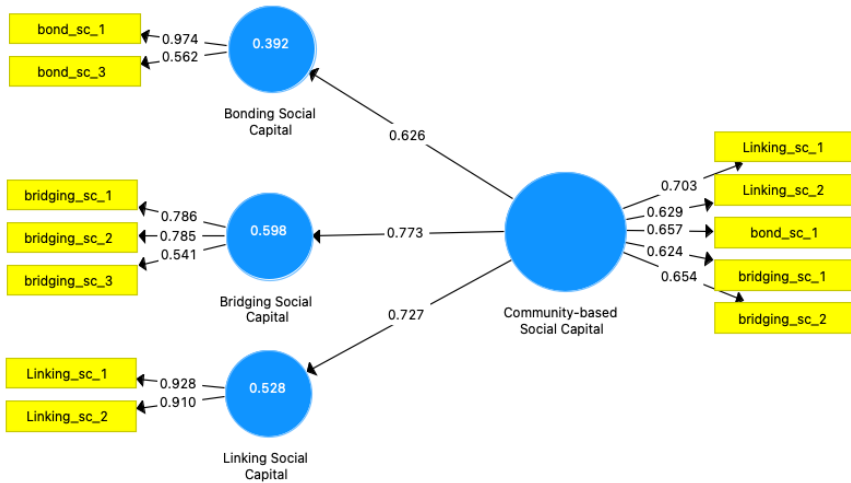


Fig. 2. Output bootstrapping SEM-PLS.

The results of the bootstrapping analysis using the Partial Least Squares approach demonstrate a significant positive influence of social capital within the community on its endogenous constructs, namely bonding social capital, bridging social capital, and linking social capital. These findings are consistent with previous research conducted by Febrian et al. [6], Kuschminder [28], and Netto et al. [29], which have indicated that social capital represents bonding social capital, bridging social capital, and linking social capital [6, 28, 29]. Social capital will impact interactions within the community in Pekanbaru concerning waste management. The output generated from this analysis yields benefits for the community and has an impact on sustainability. These findings serve as a foundation for designing a pattern of synergy as a solution to address miscoordination and misunderstanding among stakeholders involved in waste management in Pekanbaru.

Based on the quantitative data results presented above, the subsequent discussion involves causal analysis to comprehend the relationships among various factors or variables within a system. The focus is particularly on the fundamental analysis of laws and concepts, typology analysis, analysis of community empowerment potential, patterns of synergy, potential strategic patterns, socialization patterns, and contributions of optimal and effective waste management in Pekanbaru. Causal analysis aims to generate a comprehensive, integrated, and sustainable grand design for waste management in Pekanbaru.

Waste management policies in Indonesia are governed by Law No. 18 of 2008 on Waste Management (Waste Management Law), followed by derivative regulations such as Government Regulation (PP) No. 81 of 2012 on Household Waste and Similar Household Waste Management and PP No. 27 of 2020 on Specific Waste Management. The Waste Management Law recognizes that the increase in population and changes in consumption patterns have led to an increase in the volume, types, and characteristics of diverse waste, particularly non-biodegradable plastic waste. The consequences include threats to human

health and environmental damage. Therefore, waste management needs to be comprehensive and integrated, covering collection to disposal, with the aim of achieving economic benefits, protecting public health, and changing behavior.

Waste management in Pekanbaru is regulated by Regional Regulation (Perda) Number 8 of 2014 on Waste Management, issued in 2014. This regulation mandates that cleanliness management is the responsibility of the local government, which includes waste handling, reduction, and the provision of waste management infrastructure. Based on interviews with one community member, it was mentioned that "waste management is decentralized to the neighborhood (RT/RW) level, as they are directly involved with their residents' daily waste, so residents are encouraged to contribute." However, according to interviews conducted by DLHK 2023, it was stated that "the burden of waste management is not solely the responsibility of RT/RW. In the context of Integrated Sustainable and Solid Waste Management (ISSWM) or Integrated Solid Waste Management (PSPTB), this burden should be evenly distributed among polluters – waste generators (households, institutions), the government, local authorities, private sector, and academia. The complexity of waste cannot be solved by one party alone." Based on this data, the solutions involving bonding, bridging, and linking social capital become synergistic strategies for waste management in Pekanbaru.

The waste management practices are examined from the perspectives of concepts, principles, and practices. This study is based on both literature and empirical evidence. An understanding of the subject matter is necessary to strengthen the design of the grand plan, taking into account alternative options and the resulting consequences. Legal aspects and conceptual considerations form the basis for typology analysis, which includes criteria such as (1) the government's focus on waste management, (2) the form and type of waste management, (3) the driving force or responsibility, and (4) the implementation. These steps are taken to assess the existing conditions based on observations and field data processing. Subsequently, the results of this Typology analysis will be transformed into the formulation of potentials and contributions, ultimately leading to the establishment of patterns of synergy, socialization, and strategies for waste management in Pekanbaru.

The next step involves a systematic waste management process in Pekanbaru, which should be based on community empowerment through five stages: (1) Waste reduction, which involves efforts to reduce the quantity and volume of waste, (2) Source separation, which encompasses waste management before disposal at Transfer Points (TPs), (3) Waste transportation from the initial location to TPs or landfill sites (TPAs), (4) Final waste processing, aiming to convert waste into products or materials with higher economic or environmental value through physical, chemical, biological, or thermal processes, and (5) Monitoring and evaluation, which includes regular monitoring of the waste management system's performance through relevant and objective indicators. Next is the potential for community empowerment in waste management, using the 3P (People, Profit, Planet) approach. At this stage, the potential for empowerment is described in terms of economic, social, and environmental benefits, including profit, increased margins, community health and participation, community cooperation, renewable energy, and pollution reduction [30].

The concept of synergy patterns explains how community-based social capital can be formed and developed through three stages: bonding, bridging, and linking. Social capital refers to social networks and norms that facilitate cooperation and coordination among individuals and groups within a community. The first stage is bonding, which involves the formation of social bonds among individuals in a community based on shared norms, values, and culture [31]. Bonding can enhance mutual respect, honor, and assistance among community members. The second stage is bridging, which entails the development of shared assets and resources among individuals in a community through cooperation and collaboration. These assets and resources can include knowledge, skills, information, technology, or capital. The third stage is linking, which involves the establishment of social

connections between individuals in a community and individuals or groups outside the community. These social connections can involve involvement, participation, advocacy, or negotiation. Such social connections can enhance the community's access and influence over policies and decisions related to waste management [5, 13, 21, 32, 33].

Based on the SEM-PLS results, the dimension of social capital that is important to consider is bridging social capital. Bridging social capital can stimulate new ideas and alternative solutions from various perspectives and backgrounds. It can enhance the capacity and productivity of individuals and groups. Compared to bonding and linking social capital, bridging social capital has the advantage of creating broad, flexible, and dynamic social networks. Bonding tends to be limited to homogenous and closed groups, making it less adaptable to change or challenges. On the other hand, linking social capital tends to rely on power-balanced relationships, making it less capable of empowering or advocating for community interests. Therefore, the bridging aspect is crucial to creating social networks that enable communities to participate in and manage waste effectively. The grand design of waste management in Pekanbaru can be seen in Figure 3.

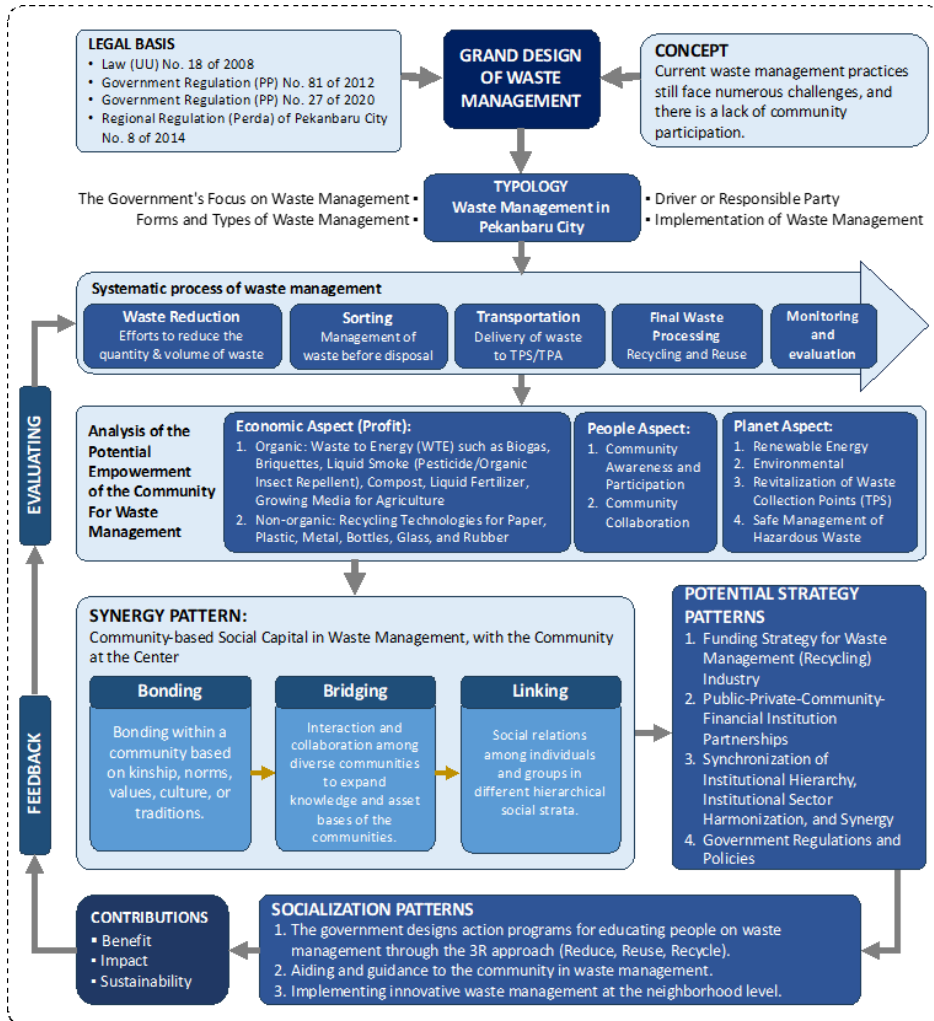


Fig. 3. Grand design of waste management in Pekanbaru City.

In the sub-analysis of potential strategies, there is a need for financing strategies to manage waste and transform it into economic value through recycling methods. Networking and innovation factors play a role in developing waste management programs aligned with economic values, which in turn attract funding at the national level. Within the internal scope of Pekanbaru, an intensive approach is required, including forums to encourage private sector participation in development efforts. The subsequent step involves a socialization pattern, which consists of three main steps; (1) The government designs action programs for educating the public on waste management through the 3R approach (Reduce, Reuse, Recycle); (2) Providing Waste Management Assistance to Communities; (3) Creating Waste Management Innovation Programs from the neighbourhood level to the RT/RW level. The final step is to assess the effectiveness of waste management, considering the benefits, impacts, and sustainability of the waste management program.

4 Conclusion

In the analysis presented above, several key points can be summarized. The results of the analysis indicate that social capital has a positive and significant influence on critical components of waste management, such as bonding social capital, bridging social capital, and linking social capital. This finding is consistent with previous research that also underscores the vital role of social capital in waste management. Therefore, social capital emerges as a key factor influencing interactions within the community of Pekanbaru in the context of waste management.

Furthermore, waste management in Pekanbaru faces various challenges, including coordination issues among stakeholders, increasing waste volumes due to changing consumption patterns, and financing problems. To address these challenges, the concept of synergy patterns becomes a relevant solution. In this regard, strategies for developing bonding, bridging, and linking social capital are crucial for enhancing the effectiveness of waste management.

Lastly, the effectiveness of waste management in Pekanbaru requires a comprehensive approach that encompasses various stages, such as waste reduction, source sorting, waste transportation, final waste processing, and monitoring and evaluation. Additionally, empowering the community through the People, Profit, Planet (3P) approach and intensive socialization are essential steps in creating awareness and behavioral changes that support sustainable waste management. Through collaboration among various stakeholders, Pekanbaru can design a holistic, integrated, and sustainable waste management grand design for the benefit of all and environmental preservation.

References

1. I. Muthoharoh. *Adv Econ Bus Manag Res.* **168** (2018)
2. D. Wulandari, S. H. Utomo, *Int J Energy Econ Policy.* 7, 3, 36–41 (2017)
3. B. Bilitewski, G. Härdtle, K. Marek. *Waste management.* Springer Science & Business Media (1996)
4. J. K. Seadon, *J Clean Prod.* **18**, 16–17, 1639–51 (2010)
5. L. Andriani, *Social capital: A road map of theoretical frameworks and empirical limitations.* (2013)
6. A. F. Febrian, E. Maulina, M. Purnomo, *Adv Soc Sci Res J.* **5**, 12 (2018)

7. I. K. Sari, M. Azrin, S. Suyanto, Gambaran Pengetahuan Pemulung terhadap Aspek Kesehatan Keselamatan Kerja (K3) dalam Pengelolaan Sampah di Tempat Pembuangan Sementara (Tps) Kota Pekanbaru. Riau University. (2016)
8. J. S. Coleman, *Am J Sociol.* **91**, 6, 1309–35 (1986)
9. R. A. T. Muhamad, B. Sekarningrum, Y. M. Agma, *Sosioglobal J Pemikir dan Penelit Sociol.* **1**, 2, 101–14 (2017)
10. Z. Hamstead, P. Coseo, S. Alkhaled, E. F. Boamah, D. M. Hondula, A. Middel, *Build Cities.* **1**, 1, 218–32 (2020)
11. M. B. Aguilera, D. S. Massey, *Soc Forces.* **82**, 2 (2003)
12. J. Coleman, *Social Capital in the Creation of Human Capital.* In: *Knowledge and Social Capital.* (2000)
13. A. Portes, *Annu Rev Sociol.* **24** (1998)
14. W. Jati, Analisis motivasi wirausaha perempuan (wirausahawati) di kota malang. *Humanity.* (2009)
15. A. Fulda, Y. Li, Q. Song, *J Contemp China.* (2012)
16. S. Hean, L. Worswick, L. A. Fenge, C. Wilkinson, S. Fearnley. *Public Money Manag.* **33**, 1, 23–30 (2013)
17. S. S. Ibrahim, *J Hum Dev.* **7**, 3, 397–416 (2006)
18. D. Bachriadi, *Mining in a state forest? This is Indonesia! Inside Indonesia.* (2007)
19. A. Omri, M. Ayadi-Frikha, *Int Entrep Manag J.* (2014)
20. L. Andriani, A. Christoforou. *J Econ.* **50**, 1, 4–22 (2016)
21. R. L. Hawkins, K. Maurer, *Bonding, Br J Soc Work.* **40**, 6 (2010)
22. W. Poortinga, *Heal Place.* **18**, 2 (2012)
23. S. Dressel, M. Johansson, G. Ericsson, C. Sandström, *Environmental Science & Policy*, 104, 88-97 (2020)
24. H. Umar, *Metode riset perilaku konsumen jasa.* Jakarta Ghalia Indones. 64 (2003)
25. W. W. Chin, *Mod methods Bus Res.* **295**, 2, 295–336 (1998)
26. I. Ghozali, *SEM Metode Alternatif dengan menggunakan Partial Least Squares (PLS).* Semarang: Badan Penerbit Universitas Diponegoro. (2014)
27. M. Tenenhaus, V. E. Vinzi, Y. M. Chatelin, C. Lauro, *Comput Stat Data Anal.* **48**, 1, 159–205 (2005)
28. K. Kuschminder, *Asian Pacific Migr J.* **25**, 4, 401–21 2016
29. G. Netto, M. Hudson, M. Noon, F. Sosenko, De Lima P, N. Kamenou-Aigbekaen, *Migration, Soc Policy Soc.* **14**, 4, 509–22 (2015)
30. R. Hambleton, *Public money & management.* **39**, 4, 271-279 (2019)
31. T. Claridge, *Functions of social capital – bonding, bridging, linking.* *Soc Cap Res.* (2018)
32. R. R. Alford, P. Bourdieu, J. S. Coleman *Social Theory for a Changing Society.* *Contemp Sociol.* **22**, 2 (1993)
33. G. Cofré-Bravo, L. Klerkx, A. Engler, *J Rural Stud.* **69** (2019)