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Circular Economy Based Model for End-of-Life Tire Management in Emerging Economies

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Sustainable Engineering

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Abstract

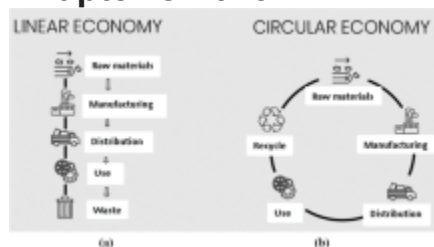
End-of-life tires (EOLTs) are challenging waste sources belonging to a solid waste type, called “bulky” in the management of waste. It presents a variety of eco-friendly problems ranging from fire hazards to health and hygiene risks. Nonetheless, most developing countries are having heaps of EOLT loitering on their streets and dumping sites. An evolution to the circular-based economy suggests the opportunity to provide quality and resource-efficient services and improved material recovery along the value chain. The authors conducted a systemic analysis to ascertain the need for sustainable EOLT management for developing countries, based on literature review and observational data. A group of waste management specialists from six developing countries were semi-structurally interviewed to examine the applicability of the established EOLT waste management strategies in the developed states to the developing countries. The analysis indicated that a “new” model is necessary to promote sustainable EOLT management toward the circular economy. The authors proposed an EOLT management system designed to accommodate the specificities of socioeconomic disadvantages of an emerging economy. The model would be beneficial for the government and other stakeholders in the waste management sector.

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References

- Agovino M, Garofalo A, Mariani A (2020) Effects of environmental regulation on separate waste collection dynamics: empirical evidence from Italy. *J Clean Prod* 124:30–40. <https://doi.org/10.1016/j.jclepro.2016.02.082>
- Ahmed V, Batool S (2015) *India-Pakistan Trade: Perspectives from the Automobile Sector in Pakistan*.

Google Scholar

- Antoniou N, Zabaniotou A (2015) Experimental proof of concept for a sustainable End of Life Tyres pyrolysis with energy and porous materials production. *J Clean Prod* 101:323–336. <https://doi.org/10.1016/j.jclepro.2015.03.101>
- Athanassiades E (2013) Waste tyre pyrolysis: sustainable recovery and reuse of a valuable resource. Retrieved from <http://easyaccess.lib.cuhk.edu.hk/login?url=http://search.proquest.com/docview/1780249748?accountid=10371%5Cn>, http://findit.lib.cuhk.edu.hk/852cuhk/?url_ver=Z39.88-2004&rft_val_fmt=info:ofi/fmt:kev:mtx:dissertation&genre=dissertations+%26+theses&sid=ProQ:P
- Bittencourt ES, Hora C, Fontes DO (2020) Modeling the Socioeconomic Metabolism of End-of-Life Tires Using Structural Equations: A Brazilian Case Study. *Sustainability* 12.

Google Scholar

- Blomsma F, Tennant M (2020) Circular economy: Preserving materials or products? Introducing the Resource States framework. *Resources, Conserv Recycl.* <https://doi.org/10.1016/j.resconrec.2020.104698>
- Bonah E, Nii M, Ansah S et al (2020) Nuclear energy for sustainable development: SWOT analysis on Ghana's nuclear agenda. *Energy Reports* 6:107–115. <https://doi.org/10.1016/j.egy.2019.11.163>
- Campbell A (2008) Determining a Waste Tyre Management System for Hong Kong. *Waste Manag* 04(44).

[Google Scholar](#)

- Cao J, Lu B, Chen Y et al (2016) Extended producer responsibility system in China improves e-waste recycling: Government policies, enterprise, and public awareness. *Renew Sust Ener Rev* 62:882–894. <https://doi.org/10.1016/j.rser.2016.04.078>
- Defra (2012) *The Economics of Waste and Waste Policy*. Retrieved from Department for Environment, Food and Rural Affairs website: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/69500/pb13548-economic-principles-wr110613.pdf
- Derakhshan Z, Ghaneian MT, Mahvi AH et al (2017) A new recycling technique for the waste tires reuse. *Environ Res* 158:462–469. <https://doi.org/10.1016/j.envres.2017.07.003>
- Dobrot D, Dobrot G, Dobrescu T et al (2019) The Redesigning of Tires and the Recycling Process to Maintain an Efficient Circular Economy. *Sustainability* 11:5204.

[Google Scholar](#)

- Duangburong J, Tantayanon S, Bhandhubanyong P (2015) A Breakthrough Challenge with Tyre Waste Management: Thailand Perspective. *Int J Soc Sci Hum* 5(9):768–772. <https://doi.org/10.7763/IJSSH.2015.V5.553>
- Duarte-Ribeiro-de-Souza C, D'Agosto M. De AD (2013) Value chain analysis applied to the scrap tire reverse logistics chain: An applied study of co-processing in the cement industry. *Res, Conserv Recycl* 78:15–25. <https://doi.org/10.1016/j.resconrec.2013.06.007>

- Dufton PW (2001) *End-of-Life Tyres – Exploiting their Value*.

[Google Scholar](#)

- ERIA (2016) *Towards a Circular Economy: Corporate Management and Policy Pathways* (V. Anbumozhi & Jootae Kim, Eds.). Jakarta: ERIA.

[Google Scholar](#)

- ERJ (2020) ETRMA Calls Policy Makers Support Sustainability Bid. *European Rubber Journal*.

[Google Scholar](#)

- ETRMA (2015) *End-of-life Tyre Report 2015*.

[Google Scholar](#)

- ETRMA (2017) *Moving Innovation That Cares*.

[Google Scholar](#)

- ETRMA (2019a) Circular Economy. Retrieved from <https://www.etrma.org/key-topics/circular-economy/>
- ETRMA (2019b) *Sustainable and Resilient Natural Rubber Supply Chain*.

[Google Scholar](#)

- Ewijk S Van Stegemann JA (2016) Limitations of the waste hierarchy for achieving absolute reductions in material throughput. *J Clean Prod* 132:122–128. <https://doi.org/10.1016/j.jclepro.2014.11.051>
- Ezeudu OB Ezeudu TS (2019) Implementation of Circular Economy Principles in Industrial Solid Waste Management: Case Studies from a Developing Economy (Nigeria). *Recycl* 4(42).

[Google Scholar](#)

- Ferronato N, Torretta V (2019) Waste Mismanagement in Developing Countries: A Review of Global Issues. *Int J Envir Res Pub Health*. <https://doi.org/10.3390/ijerph16061060>

- Forbord M, Hansen L (2020) Enacting sustainable transitions: A case of biogas production and public transport in Trøndelag, Norway. *J Clean Prod.* <https://doi.org/10.1016/j.jclepro.2020.120156>
- Gall M, Wiener M, Chagas C et al (2020) Building a circular plastics economy with informal waste pickers: Recyclate quality, business model, and societal impacts. *Res, Conserv Recycl.* <https://doi.org/10.1016/j.resconrec.2020.104685>
- Garnett K, Cooper T (2014) Effective dialogue: Enhanced public engagement as a legitimising tool for municipal waste management decision-making. *Waste Manag* 34(12):2709–2726. <https://doi.org/10.1016/j.wasman.2014.08.011>
- Gipser M (2000) A Tire Model for Ride & Durability Simulations. *International ADAMS/FTire User's Conference*, 1–13. Tokyo.

[Google Scholar](#)

- Godfrey L, Oelofse S (2017) Historical Review of Waste Management and Recycling in South Africa. *Resources*, 6(4):57. <https://doi.org/10.3390/resources6040057>
- Gomes TS, Neto GR, De-Salles ACN et al (2019) End-of-Life Tire Destination from a Life Cycle Assessment Perspective. In *New Frontiers on Life Cycle Assessment-Theory and Application*. IntechOpen.

[Google Scholar](#)

- Gravagnuolo A, Angrisano M, Girard LF (2019) Circular Economy Strategies in Eight Historic Port Cities: Criteria and Indicators Towards a Circular City Assessment Framework. *Sustainab* 11(3512).

[Google Scholar](#)

- Hartley K, Santen RV, Kirchherr J et al (2020) Policies for transitioning towards a circular economy: Expectations from the European Union (EU). *Res, Conserv Recycl.* <https://doi.org/10.1016/j.resconrec.2019.104634>
- Hu N, Cheng CM, Wen XF et al (2014) Comparison Study of Scrap Tires Management between China and the USA. *Adv Mat Res* 878:90–98. <https://doi.org/10.4028/www.scientific.net/AMR.878.90>

- Ishola, F. A., Oyawale, F. A., Inegbenebor, A. O., & Boyo, H. (2018a). Design of a high Temperature 'Anaerobic Gas-Furnace' suitable for Pyrolysis. IOP Conference Series: Materials Science and Engineering, 413, 012079. <https://doi.org/10.1088/1757-899x/413/1/012079>
- Ishola F, Ajayi O, Oyawale F. A et al (2018b) Sustainable End-of-Life Tyre (EOLT) Management for Developing Countries – A Review. *Industrial Engineering and Operation Management (IEOM) Conference, South Africa.*

[Google Scholar](#)

- Ishola F, Oyawale F, Inegbenebor A et al (2020a) Mathematical Analysis and Thermal Modelling of a Pilot-Scale Pyrolysis Gas Furnace. *J Adv Res Fluid Mech Therm Sci* 65(1):81–93.

[Google Scholar](#)

- Ishola F, Towoju O, Mamudu A et al (2020b) Nigerian Oil Palm Industry as a Sustainable Renewable Energy Resource. *E3S Web of Conferences, 152*, 02005.

[Google Scholar](#)

- Ishola FA, Azeta J, Agbi G et al (2019a) Simulation for Material Selection for A Pico Pelton Turbine ' s Wheel and Buckets. *Proc Manuf* 30.

[Google Scholar](#)

- Ishola FA, Inegbenebor AO, Oyawale, FA (2019b) Thermal Modelling for A Pilot Scale Pyrolytic Furnace for Production of Carbon Black. *J Phy: Conf Ser*, 1378(3):032089. <https://doi.org/10.1088/1742-6596/1378/3/032089>
- Ishola FA, Ogunrinola I, Onwardi PN et al (2018c) 2-Dimensional CFD Simulation of A Gas-Fired Pyrolysis Furnace. *Int J Mech Eng Tech* 9(12):383–394.

[Google Scholar](#)

- Ishola FA, Olatunji OO, Ayo OO et al (2019c) Sustainable Nuclear Energy Exploration in Nigeria – A SWOT Analysis. *Proc Manuf* 35:1165–1171. <https://doi.org/10.1016/j.promfg.2019.06.072>

- Islam MR, Islam MN, Mustafi NN et al (2013). Thermal recycling of solid tire wastes for alternative liquid fuel: The first commercial step in Bangladesh. Proc Eng. <https://doi.org/10.1016/j.proeng.2013.03.162>
- Jain A (2016) *Compendium of Technologies for the Recovery of Materials/Energy from End of Life (EOL) Tyres*.

[Google Scholar](#)

- Jansen S, Schmeitz A, Akkermans L (2016) *Study on some safety-related aspects of tyre use*. <https://doi.org/10.2832/67191>
- Januszewicz K, Kazimierski P, Kosakowski W et al (2020) Waste Tyres Pyrolysis for Obtaining Limonene. Materials 1–30.

[Google Scholar](#)

- Juan D (2013) Waste Tyre Pyrolysis. Renew Sust Energ Rev 23:179–213. <https://doi.org/10.1016/j.rser.2013.02.038>
- Kanters J (2020) Circular Building Design: An Analysis of Barriers and Drivers for a Circular Building Sector. Buildings 10(77):1–16.

[Google Scholar](#)

- Karagiannidis A, Kasampalis T (2010) Resource recovery from end-of-life tyres in Greece : A field survey, state-of-art and trends. Waste Manag Res 28(6):520–532. <https://doi.org/10.1177/0734242X09341073>
- Keefe LO, Fellow C (2016) *Investigating global best practice waste tyre management*. 1–42.

[Google Scholar](#)

- Kinobe JR, Gebresenbet G, Vinnerås, B (2012) Reverse Logistics Related to Waste Management with Emphasis on Developing Countries—A Review Paper. J Environ Sci Eng B(1):1104–1118.

[Google Scholar](#)

- Landi D, Vitali S, Germani M (2016) Environmental Analysis of Different End of Life Scenarios of Tires Textile Fibers. Proced CIRP 48:508–513. <https://doi.org/10.1016/j.procir.2016.03.141>

- Lebreton B, Tuma A (2006) A quantitative approach to assessing the profitability of car and truck tire remanufacturing. *Int J Prod Econ* 104:639–652. <https://doi.org/10.1016/j.ijpe.2004.11.010>
- Luth J, Koppejan R (2020) Extended producer responsibility for lamps in Nordic countries: best practices and challenges in closing material loops. *J Clean Prod* 123(2016):167–179. <https://doi.org/10.1016/j.jclepro.2015.06.131>
- Makinde T (2005) Problems of Policy Implementation in Developing Nations: The Nigerian Experience Problems of Policy Implementation in Developing Nations. *J Soc Sci* 11(1):63–69. <https://doi.org/10.1080/09718923.2005.11892495>
- *Managing End-of-Life Tires*. (2015) Retrieved from www.wbcasd.org/web/tires or from tires@wbcasd.org
- Marshall RE, Farahbakhsh K (2013) Systems approaches to integrated solid waste management in developing countries. *Waste Manag* 33(4):988–1003. <https://doi.org/10.1016/j.wasman.2012.12.023>
- Martínez JD, Puy N, Murillo R et al (2013) Waste tyre pyrolysis – A review. *Renew Sust Ener Rev* 23:179–213. <https://doi.org/10.1016/j.rser.2013.02.038>
- Mmereki D, Machola B, Mokokwe K (2017) Status of waste tyres and management practice in Botswana. *J Air Waste Manag Ass.* <https://doi.org/10.1080/10962247.2017.1279696>
- Muzenda E (2014) A Discussion of Waste Tyre Utilization Options. *Eng Tech.* <https://doi.org/10.15242/IIIE.E0314593>
- Niza S, Santos E, Costa I et al (2014) Extended producer responsibility policy in Portugal: a strategy towards improving waste management performance. *J Clean Prod* 64:277–287. <https://doi.org/10.1016/j.jclepro.2013.07.037>
- Ogunmakinde OE (2019) A Review of Circular Economy Development Models in China, Germany and Japan. *Sustainability* 4(27).

[Google Scholar](#)

- Oh J, Hettiarachchi H (2020) Collective Action in Waste Management: A Comparative Study of Recycling and Recovery Initiatives from Brazil, Indonesia, and Nigeria. *Recycling* 5(4).

[Google Scholar](#)

- Olukanni DO, Adeleke JO, Aremu DD (2016) A Review of Local Factors Affecting Solid Waste Collection in Nigeria. *Pollution* 2(3):339–356. <https://doi.org/10.7508/pj.2016.03.008>
- Olukanni DO, Aipoh AO, Kalabo IH (2018) Recycling and Reuse Technology: Waste to Wealth Initiative in a Private Tertiary Institution, Nigeria. *Recycling*. <https://doi.org/10.3390/recycling3030044>
- Olukanni DO, Nwafor CO (2019) Public-Private Sector Involvement in Providing Efficient Solid Waste Management Services in Nigeria. *Recycling* 4(19).

[Google Scholar](#)

- Omole DO, Isiorho SA, Ndambuki JM (2016) Waste management practices in Nigeria: Impacts and mitigation. *The Geolog Soc America Special Paper* 2520(33):377–386. [https://doi.org/10.1130/2016.2520\(33\)](https://doi.org/10.1130/2016.2520(33))
- Park J, Díaz-posada N, Mejía-dugand S (2018) Challenges in implementing the extended producer responsibility in an emerging economy: The end-of-life tire management in Colombia. *J Clean Prod* 189:754–762. <https://doi.org/10.1016/j.jclepro.2018.04.058>
- Parvez N, Agrawal A, Kumar A (2019) Solid Waste Management on a Campus in a Developing Country: A Study of the Indian Institute of Technology Roorkee. *Recycling* 4(28):1–22.

[Google Scholar](#)

- Pehlken A, Essadiqi E (2005) *Scrap Tire Recycling in Canada* (Vol. 08). <https://doi.org/10.13140/2.1.1941.8400>
- Pieroni MPP, Mcaloone TC, Pigosso DCA (2019) Configuring New Business Models for Circular Economy through Product – Service Systems. *Sustainability* 11(3727).

[Google Scholar](#)

- Pisitsankkhakarn R, Vassanadumrongdee S (2020) Enhancing purchase intention in circular economy: An empirical evidence of remanufactured automotive product in Thailand. *Res Conserv Recycl* 156:104702. <https://doi.org/10.1016/j.resconrec.2020.104702>
- Poulikakos LD, Papadaskalopoulou C, Hofko B et al (2017) Harvesting the unexplored potential of European waste materials for road construction. *Res Conserv Recycl* 116:32–44. <https://doi.org/10.1016/j.resconrec.2016.09.008>
- Rosendorfová M, Vybochová I, Beukering P (1998) Waste management and recycling of tyres in Europe. In *Institute for Environmental Studies*. Retrieved from <http://dare2.uvu.vu.nl/handle/1871/22424>
- Rousta K, Zisen L, Hellwig C (2020) Household Waste Sorting Participation in Developing Countries A Meta-Analysis. *Recycling* 5(6).

[Google Scholar](#)

- Sagar M, Nibedita K, Manohar N et al (2018) A potential utilization of end-of-life tyres as recycled carbon black in EPDM rubber. *Waste Management* 74:110–122. <https://doi.org/10.1016/j.wasman.2018.01.003>
- Salguero-Puerta L, Leyva-Díaz JC, Cortés-García FJ et al (2019) Sustainability Indicators Concerning Waste Management for Implementation of the Circular Economy Model on the University of Lome (Togo) Campus. *Int J Environ Res Pub Health* 16(12):2234.

[Google Scholar](#)

- Šandrak-Nukić I, Miličević I (2019) Fostering Eco-Innovation: Waste Tyre Rubber and Circular Economy in Croatia. *Inter Desc Compl Syst* 17(2-B):326–344. <https://doi.org/10.7906/indecs.17.2.9>
- Scott E (2016) End-of-life Tyre Report 2015. In *European Tyre & Rubber Manufacturers Association (ETRMA)*.

[Google Scholar](#)

- Sebola MR, Mativenga PT, Pretorius J (2018) A Benchmark Study of Waste Tyre Recycling in South Africa to European Union Practice. *Proced CIRP* 69:950–955. <https://doi.org/10.1016/j.procir.2017.11.137>

- Svetlana, Dabic-Miletic Vladimir, Simic Selman, Karagoz (2021) End-of-life tire management: a critical review Abstract Environmental Science and Pollution Research 28(48) 68053–68070. <https://doi.org/10.1007/s11356-021-16263-6>
- Singhal D, Tripathy S, Kumar S (2020) Remanufacturing for the circular economy: Study and evaluation of critical factors. Res Conserv Recycl 156:104681. <https://doi.org/10.1016/j.resconrec.2020.104681>
- Soni T, Gaikwad A (2017) Waste Pyrolysis Tire Oil As Alternative Fuel For Diesel Engines. Inter J Mech Prod Eng Res Dev 7(6):271–278.

Google Scholar

- Strydom WF (2018) Applying the Theory of Planned Behavior to Recycling Behavior in South Africa. Recycling. <https://doi.org/10.3390/recycling3030043>
- Torrente-velásquez JM, Ripa M, Chifari R et al (2020) A waste lexicon to negotiate extended producer responsibility in free trade agreements. Res Conserv Recycl 156. <https://doi.org/10.1016/j.resconrec.2020.104711>
- Torretta V, Cristina E, Ragazzi M et al (2015) Treatment and disposal of tyres: Two EU approaches. A review. Waste Manag 45:152–160. <https://doi.org/10.1016/j.wasman.2015.04.018>
- Urbinati A, Chiaroni D (2019) Managing the Introduction of Circular Products: Evidence from the Beverage Industry. Sustainability 11(3650):1–12.

Google Scholar

- Uriarte-Miranda ML, Caballero-Morales SO, Martinez-Flores JL et al (2018) Reverse Logistic Strategy for the Management of Tire Waste in Mexico and Russia: Review and Conceptual Model. Sustainability. <https://doi.org/10.3390/su10103398>
- Vanhamäki S, Virtanen M, Luste S et al (2020) Transition towards a circular economy at a regional level: A case study on closing biological loops. Res Conserv Recycl. <https://doi.org/10.1016/j.resconrec.2020.104716>

- Wang KS, Hsu FS, Liu PP (2002) Modeling the bathtub shape hazard rate function in terms of reliability. *Rel Eng Syst Saf* 75:397–406.

[Google Scholar](#)

- Weissman SL, Sackman JL, Gillen D et al (2003) *Extending the Lifespan of Tires*. Berkeley, California.

[Google Scholar](#)

- Williams PT (2013) Pyrolysis of waste tyres: A review. *Waste Manag.* <https://doi.org/10.1016/j.wasman.2013.05.003>
- Wilson DC, Velis CA, Rodic L (2013) Integrated sustainable waste management in developing countries. *Institution of Civil Engineers: Waste and Resource Management*.

[Google Scholar](#)

- Winternitz K, Heggie M, Baird J (2019) Extended producer responsibility for waste tyres in the EU: Lessons learnt from three case studies – Belgium, Italy and The Netherlands. *Waste Manag* 89:386–396. <https://doi.org/10.1016/j.wasman.2019.04.023>
- Zedler Ł, Przybysz-romatowska M, Haponiuk J et al (2020) Modification of Ground Tire Rubber — Promising Approach for Development of Green Composites. *J Compos Sci* 4(2):1–11.

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