



جامعة الجميع الذكية

كلية الإدارة

تخصص إدارة مشاريع

أثر استغلال الطاقة الحركية المهدرة على توليد الكهرباء في المرافق العامة بجدة

The Effect of Utilizing wasted kinetic energy on electricity generation in public utilities in Jeddah

مشروع تخرج

إعداد

Team leader: Muroj Damanhour (221001145)

Team member: Duaa Bishara (221000592)

Team member: Mohamad Alsabban (221001816)

إشراف

د. وليد سليمان

1444/2023

List of Contents

Introduction:	3
First Chapter:	5
1-1 Research Problems:.....	5
1-2 Importance Of the Research:	5
1-3 Research Aims:.....	6
1-4 Research Hypotheses:	6
1-5 Literature Review:	6
Second Chapter:	10
2-1 Research Methodology:.....	10
2-2 Research limits:	10
2-3 The general perception of the research:	10
Initial reference list:	11

Introduction:

Energy plays a fundamental role in human civilizations. Where our environment offers a wide array of renewable energy options, including wind energy, solar energy, bioenergy, and other options to generate different types of energy. Addressing the global energy challenge is critical for sustainable development, economic growth, and reducing carbon emissions. Governments, international organizations, and private companies are investing in research and development of clean energy technologies and infrastructure to accelerate the transition to a sustainable energy system.

Exploiting population growth in power generation is a promising field for generating clean and sustainable energy. Therefore, it is imperative to raise public awareness to consider the importance of exploiting this huge amount of wasted energy and converting it into energy that contributes to improving the quality of life and the environment.

According to the study findings, it showed that energy is a key driver of economic progress and development, but the growing global population has led to an increase in energy demand, which has depleted non-renewable energy sources like coal, oil, and natural gas. This depletion has caused energy prices to rise, which could threaten modern economic well-being. Therefore, it is crucial to pursue and adopt an alternative energy source that can meet the rising energy demand. (Rehman, A., Alam, M. M., Ozturk, I., Alvarado, R., Murshed, M., Işık, C., & Ma, H.2023.).

With the world's population growing rapidly and living standards improving, it is expected that global energy consumption will increase by 50% between 2018 and 2050, especially since the current consumption rate is close to 100 million barrels of oil per day and the average energy demand per person has risen from 57 to 75.7 gigajoules per year. Consequently, numerous countries have introduced energy efficiency plans aimed at reducing energy demand in different sectors such as buildings, transportation, and industry to effectively tackle this issue. (فاتح بلعيد، محمد الديبان 2021).

As the demand for energy increases, it becomes challenging for cities to meet the energy needs of their residents. This issue can cause various problems, such as power outages, increased costs, and a greater reliance on non-renewable energy sources. To address this issue, cities are now looking towards renewable and non-consumable energy sources to ensure a sustainable energy future. To tackle this issue, many cities are adopting renewable and non-consumable energy sources. Piezoelectric materials have gained significant interest lately as they can convert vibration energy into electricity. as a result, researchers explored that using piezoelectric tiles and other energy harvesting can be an adequate way to generate

energy and reduce previous problems. (Anton & Sodano, 2007; Mak, et al., 2011; Shwehdi, et al., 2015; Moussa, 2017, Moussa, 2018; Rawat and Vadhera, 2019; Vinod & Sinha, 2019; Moussa, 2020.).

The researchers turned to the possibility of exploiting the rapid population growth and benefiting from the movement of the human body from our daily activities, as studies have shown that it contains huge amounts of energy, which we can exploit to generate electricity. (Staff, S. 2009, January 30).

One significant result of energy harvesting from roads is the potential for clean and efficient energy generation while promoting environmental conservation. Roads and transportation systems can be harnessed for various types of energy sources. Piezoelectric materials have emerged as a promising technology for energy harvesting, as they can generate power when compressed or vibrated. thus, the most significant result of using piezoelectric devices in roadways is the ability to harvest energy from the vibrations and pressure generated by vehicle tires. Additionally, the potential for utilizing piezoelectric technology to harvest vibration energy from people walking, machinery vibrating, or vehicles moving on a roadway is promising, as it presents a clean and cost-effective energy solution. (Moussa, R., & Solban, M. 2021).

Due to the increase in urbanization, lifestyle change, and increased use of technology, this lead to an increase in energy consumption which requires a prototype shift towards renewable energy sources. The concept of wasted energy harvesting, specifically from the road surface, has been proposed as a solution for electric power generation (Duarte, F.J.J.2018).

First Chapter

1-1 Research Problems:

The research problem is represented in the existence of deficiencies in the exploitation of wasted kinetic energy and its exploitation to produce electrical energy in public utilities in Jeddah?

Where exploiting population growth in power generation is a promising field for generating clean and sustainable energy. Therefore, it is imperative to raise public awareness to consider the importance of exploiting this huge amount of wasted energy and converting it into energy that contributes to improving the quality of life and the environment.

- The central question:
 1. To what extent does the exploitation of wasted kinetic energy contribute to the generation of electricity in public utilities in Jeddah?
- The Sub questions:
 1. What is the most important exploitation of wasted kinetic energy in generating electricity in public utilities in Jeddah?
 2. What is the effect of exploiting the wasted kinetic energy in improving electricity generation in public utilities in Jeddah?

1-2 Importance Of the Research:

The importance of this research lies in raising public awareness about the significance of utilizing wasted kinetic energy to reduce electricity consumption. It highlights how individuals in society can contribute to minimizing the use of electricity by employing renewable and eco-friendly energy sources.

According to the study conducted by Xie & Cai (2014), energy harvesting technologies can be utilized to convert kinetic energy from human movement into electrical energy. This electrical power can then be utilized.

Furthermore, the importance of Saudi Arabia's Vision 2030, as it aims to diversify the economy and reduce dependence on oil exports, with renewable energy investment playing a crucial role in achieving these goals. (الجاسر, الزهراني 2022).

1-3 Research Aims:

1. Identify the most important exploitation of wasted kinetic energy in generating electricity in public utilities in Jeddah?
2. Identify the extent of the impact of the exploitation of wasted kinetic energy in improving electricity generation in public utilities in Jeddah?

1-4 Research Hypotheses:

In order to accomplish the goals of this research, we will test the following proposed assumptions. Main assumption:

1. There is a statistically significant effect of the exploitation of wasted kinetic energy (people - vehicles) in generating electricity in public utilities in Jeddah Governorate.
 - Sub-hypothesis:
 1. There is a statistically significant effect of exploiting the wasted kinetic energy of people as one of the sources of electricity generation.
 2. There is a statistically significant effect of exploiting the wasted kinetic energy from vehicles as one of the sources of electricity generation.

1-5 Literature Review:

The study of (Duarte, F., & Ferreira, A., 2015) Discusses the need for alternative energy sources and the irreversible environmental damage caused by the current energetic paradigm, which relies on fossil fuel combustion. The paper focuses on the development of energy-harvesting technologies for road pavements, which is a very recent area of research.

The study of (Zabihi, N., 2021) Designed and test a compact mechanical energy harvester based on the crank mechanism to recover wasted energy from roadways and convert it into electricity to power the sensors, signaling devices, and potentially lighting infrastructure in smart cities.

The study of (Duarte, Francisco João., 2018) Describes the methods used in the study, including the development of a software tool to simulate and study vehicle-road interaction and the evaluation of the interaction between the vehicle and the road pavement.

The study of (Visconti, Paolo, et al., 2022) Analyzes the state-of-art of smart energy harvesting floors to determine the best solution to feed a lighting system and charging columns, and discusses the fundamentals of the main harvesting mechanisms applicable in this field, as well as an overview of scientific works related to energy harvesting floors and a survey of the commercial energy harvesting floors proposed by companies and startups.

The study of (Papagiannakis, Athanassios T., et al., 2016) Develop an energy harvesting system using piezoelectric elements embedded into the pavement structure. The system is designed to generate electric power from the stress caused by traffic on the roadways. preview of an ongoing study that involves designing and testing prototypes in the laboratory, numerical modeling of stress distribution, and economic analysis of the value of the electric power generated. The technology shows promise in powering LED traffic lights and wireless sensors embedded into pavement structures.

The study of (Al-Zahrani, & Al-Jasser, 2022) aimed to was to figure out the best strategy for investing in renewable energy in Saudi Arabia to achieve sustainable development in the region in line with Vision 2030, The study provides useful information about the benefits of investing in renewable energy in Saudi Arabia and highlight the importance of government and businesses working together to promote sustainable development in the region. Additionally, the study examined the environmental, economic, and social impacts of renewable energy investments, which aligns with the United Nations goals for sustainable development that prioritize making energy more sustainable and promoting economic growth.

The study of (Xie, L, & Cai, M, 2014) aimed to figure out how to harvest human kinetic energy and generate an amount of electricity that could power wearable devices, The study gives useful information about the advantages of energy harvesting technologies for wearable devices as they found it can successfully convert human movement into electrical power. thus, they highlight the importance of creating sustainable and creative solutions to provide power for these kinds of devices.

The study of (Mahapatra, S. D., Mohapatra, P. C., Aria, A. I., Christie, G., Mishra, Y. K., Hofmann, S., & Thakur, V. K. 2021) clarified the efficiency of using piezoelectric materials for energy harvesting applications. Piezoelectric materials are considered smart materials because they can convert mechanical pressure into electrical signals and vice versa, The study provides valuable insights into how well piezoelectric materials can work for harvesting energy. Piezoelectric materials are "smart" because they change electrical signals back and forth into mechanical pressure. The study gives useful

information about how piezoelectric materials could be used to harvest energy and describes recent improvements in this area. The review focuses on how important it is to create sustainable energy solutions and innovation that fits in with the United Nations goals for sustainable development.

The study of (Kakihara, R., Kariya, K., Matsushita, Y., Yoshimura, T., & Fujimura, N., 2018, July) explores the potential of energy harvesting from human foot motion as a source of electrical power for wearable sensors. The study discovered that we could get electricity from the movement of our feet by they used of different tools and sensors to measure how much energy our feet can produce.

The study of (Nia, E. M., Zawawi, N. A. W. A., & Singh, B. S. M, 2017, December) shows the benefits of harvesting kinetic energy from walking as a sustainable method for generating electricity without depleting natural resources by comparing different technologies used for converting walking energy into electricity and identify the most effective one, The study concludes that the pavement equipped with harvesters is more reliable than body located technologies because it is independent of physiological parameters. Moreover, it is also providing insights into the most effective method of harvesting walking energy to generate electricity sustainably.

The study of (Moussa & Solban,2021) aims to develop sustainable energy projects that reduce dependence on fossil fuels by replacing traditional floor tiles with piezoelectric ones.it is motivates engineers and interior designers to use piezoelectric tiles as a form of renewable energy, especially in poor countries, which helps generate clean energy that reduces carbon emissions, which is one of the main problems facing developing countries, The study concluded that piezoelectric tiles can be used as a source of clean energy to protect the environment and address the problem of global warming, especially in developing countries with a large population.

The study of (Helmy & Micheal,2023) is concerned with energy production using the characteristics and elements found in ordinary residential communities. The study focused on the physical features such as sidewalks and rooftops, and the psychological features of the communities, including the social-spatial activities of the occupants, as potential sources of energy collection in the Al-Banafseg neighborhood. The study focuses on the residential district of Banafseg as a source of energy production from the environment, which is the first of its kind in the Egyptian environment, The study focuses on the idea that society is a smart and self-sufficient society of energy. According to the analysis of the results obtained from the flow of pedestrian traffic, the study found possible locations for piezoelectric tiles to harvest kinetic energy in the

Al-Banafseg residential neighborhood, in addition to the possibility of installing photovoltaic cells on the roofs of neighboring residential blocks.

The study of (Li & Ma,2023) is to study the possibility of integrating photovoltaic paving units with different components to generate basic energy. The study found that external environmental conditions greatly affect the energy production of photovoltaic systems, causing instability and unpredictability. For this reason, the research focused on improving collection and storage techniques. Integrated hybrid power, will increase the rates of self-sufficiency and self-consumption of the system, increase flexibility and reduce operational costs. The research touched on the physical models of photovoltaic pavement, and the research concluded that the use of photovoltaic cells makes the natural ability of the pavement to generate green energy possible and changes it from a consumer to an energy producer.

The study of (Zhao & You,2014) is to study the possibility of operating wearable sensors using piezoelectric energy harvesters. The reaper was specially designed to be slim and compatible with the shoe. The reaper's performance and endurance were then tested in studies by researchers, who measured the average energy produced while walking at a frequency of about 1 Hz, the study showed that piezoelectric energy harvesters could be a practical and effective way to power wearable sensors for health monitoring and activity recognition. Piezoelectric energy harvesters can also be used to obtain clean and sustainable electrical energy from parasitic mechanical energy in shoes generated by human motion.

The study of (Rowejeh, S., & Sounni, I. 2020, August) explores the use of Human Kinetic Energy (HKE) as a renewable energy source. The paragraph emphasizes the benefits of renewable energy, such as meeting energy, environmental, and economic security requirements, and cites the Saudi 2030 vision as the main motivation for this research. The primary objective of the research is to develop a framework that effectively utilizes the wasted HKE in gyms to generate electricity, which can help meet security requirements and contribute to the strategic goals of the Saudi 2030 vision. The paragraph explains that the developed framework will provide a comprehensive understanding of the challenges of utilizing HKE in gyms in Saudi Arabia and will consider the perspectives and requirements of various stakeholders.

Second Chapter

2-1 Research Methodology:

This study is descriptive and analytical in nature, aiming to describe the effect of utilizing wasted kinetic energy on electricity generation in public utilities in Jeddah. It also aims to identify and analyze the relationships between the independent variables that express wasted kinetic energy through people and vehicles and the dependent variable that expresses electricity generation in public utilities in Jeddah.

The study methodology includes the following:

- Literature related to the description and effect of Utilizing wasted kinetic energy on electricity generation.
- Conducting a field survey of a random sample of Saudi society, specifically in Jeddah, in order to gather data about the attitudes and behaviors of the local population towards this technology.

2-2 Research limits:

- Spatial Limits: The study was conducted specifically in public utilities located in Jeddah.
- Human limits: a sample of individuals in Saudi society.

2-3 The general perception of the research:

- Introduction: This section will encompass research problems, importance of the research, research aims, research hypotheses, literature review, research methodology, research limits, and the general perception of the research.
- Chapter One: This chapter will examine the concept of alternative energy and its significance.
- Chapter Two: This chapter will emphasize the importance of utilizing wasted kinetic energy and converting it into alternative energy.
- Chapter Three: This chapter will explore the methods and techniques used to harness and utilize wasted kinetic energy as an alternative energy source.

- Chapter Four: This chapter will discuss successful experiments conducted in the conversion of wasted kinetic energy into electrical energy. The first topic will cover local experiences in using waste kinetic energy, while the second topic will cover global experiences.
- Chapter Five: This chapter will analyze the economic and social motivations for using waste kinetic energy and converting it into electrical energy.
- Chapter Six: This chapter will scrutinize the consequences and impacts of using waste kinetic energy and converting it into electrical energy.
- Chapter Seven: This section will encompass the field study carried out as part of the research.
- Conclusion: This section will summarize the major findings and provide recommendations.
- References: This section will list all the sources used in the research.
- Index: This section will provide an index of all the topics covered in the research.

Initial reference list:

1. Duarte, F., & Ferreira, A. (2015). Energy harvesting on road pavements: state of the art. Proceedings of the Institution of Civil Engineers, 168(6), 299-309.
2. Zabihi, N. (2021). Converting Road Kinetic Energy to Electricity for Smart City Infrastructure. Journal of Energy Research and Reviews, 7(2), 1-14.
3. Duarte, F. J. J. (2018). *Pavement energy harvesting system to convert vehicles kinetic energy into electricity* (Doctoral dissertation, Universidade de Coimbra (Portugal)).
4. Visconti, P., Bagordo, L., Velázquez, R., Cafagna, D., & De Fazio, R. (2022). Available technologies and commercial devices to harvest energy by human trampling in smart flooring systems: A review. *Energies*, 15(2), 432.
5. Papagiannakis, A. T., Dessouky, S., Montoya, A., & Roshani, H. (2016). Energy harvesting from roadways. *Procedia Computer Science*, 83, 758-765.
6. Xie, L., & Cai, M. (2014). Human motion: Sustainable power for wearable electronics. *IEEE Pervasive Computing*, 13(4), 42-49.

7. Mahapatra, S. D., Mohapatra, P. C., Aria, A. I., Christie, G., Mishra, Y. K., Hofmann, S., & Thakur, V. K. (2021). Piezoelectric materials for energy harvesting and sensing applications: Roadmap for future smart materials. *Advanced Science*, 8(17), 2100864.
8. Kakihara, R., Kariya, K., Matsushita, Y., Yoshimura, T., & Fujimura, N. (2018, July). Investigation of piezoelectric energy harvesting from human walking. In *Journal of Physics: Conference Series* (Vol. 1052, No. 1, p. 012113). IOP Publishing.
9. Nia, E. M., Zawawi, N. A. W. A., & Singh, B. S. M. (2017, December). A review of walking energy harvesting using piezoelectric materials. In *IOP Conference Series: Materials Science and Engineering* (Vol. 291, No. 1, p. 012026). IOP Publishing.
10. Moussa, R., & Solban, M. (2021). Investigating the potential of using human movements in energy harvesting by installing piezoelectric tiles in Egyptian public facilities. *Journal of Engineering research*, 9(4A).
11. Helmy, M., & Micheal, A. (2023). The neighborhood as an energy-generating community: the case of the El Banafseg residential neighborhood, East Cairo. *Frontiers in Built Environment*, 9, 1146471.
12. Li, S., Ma, T., & Wang, D. (2023). Photovoltaic pavement and solar road: A review and perspectives. *Sustainable Energy Technologies and Assessments*, 55, 102933.
13. Zhao, J., & You, Z. (2014). A shoe-embedded piezoelectric energy harvester for wearable sensors. *Sensors*, 14(7), 12497-12510.
14. الجاسر ل. ع. (2022). الاستثمار الأمثل للطاقة المتجددة لتحقيق التنمية الإقليمية المستدامة في المملكة & .الزهراني أ. م. *مجلة العلوم الإنسانية و الإجتماعية .العربية السعودية وفق رؤية 2030*, 6(15), 130–143.
15. Rowejehe, S., & Sounni, I. ,2020, August. Harvest Human Kinetic Energy: Framework for Gym's Wasted Energy Usage. In *Proceedings of the 5th NA International Conference on Industrial Engineering and Operations Management*, Detroit, MI, USA (pp. 10-14).