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The role of utilizing wasted kinetic energy on electricity generation in public utilities in Jeddah - An applied study on Red Sea Mall

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Abstract:

Energy continues to be an essential element of society. However, our dependence on limited energy sources is not sustainable in the long term. As the global population keeps growing, the demand for energy rises, depleting these resources rapidly. To tackle this problem, it is crucial to explore alternative energy sources capable of meeting the increasing energy needs. One possible solution is to utilize wasted kinetic energy, which can be converted into renewable electricity through the utilization of piezoelectric materials. By utilizing the energy produced by everyday human activities and the movement of vehicles on roads, we can make a significant contribution to establishing a sustainable energy system. This approach not only reduces our reliance on finite resources but also enhances the energy efficiency of cities. Furthermore, it is vital to educate the public about the potential of kinetic energy and its role in shaping our future energy. By raising awareness and promoting the adoption of this renewable energy source, we can pave the way for a cleaner and more sustainable future. The research underscores the significance of tapping into this wasted energy source to ensure a cleaner and more prosperous future for future generations. The potential benefits of these approaches include improved quality of life, environmental conservation, and reduced reliance on non-renewable energy sources. With the world's population and energy consumption projected to rise, transitioning to renewable energy sources becomes crucial for a sustainable energy future.

Keywords: Electricity generation; Kinetic energy; wasted energy; piezoelectric material; human movement; transportation movement.

الملخص:

لا تزال الطاقة عنصراً أساسياً في المجتمع. ومع ذلك، فإن اعتمادنا على مصادر الطاقة المحدودة ليس مستداماً على المدى الطويل. مع استمرار نمو عدد سكان العالم، يرتفع الطلب على الطاقة، مما يؤدي إلى استنفاد هذه الموارد بسرعة. لمعالجة هذه المشكلة، من الضروري استكشاف مصادر طاقة بديلة قادرة على تلبية احتياجات الطاقة المتزايدة. أحد الحلول الممكنة هو استخدام الطاقة الحركية المهدرة، والتي يمكن تحويلها إلى كهرباء متجددة من باستخدام مواد كهر ضغطية. من خلال استخدام الطاقة الناتجة عن الأنشطة البشرية اليومية وحركة المركبات على الطرق، يمكننا تقديم مساهمة كبيرة في إنشاء نظام طاقة مستدام. لا يقلل هذا النهج من اعتمادنا على الموارد المحدودة فحسب، بل يعزز أيضاً كفاءة الطاقة في المدن. علاوة على ذلك، من الضروري تثقيف الجمهور حول إمكانات الطاقة الحركية ودورها في تشكيل طاقتنا المستقبلية. من خلال زيادة الوعي والترويج لاعتماد مصدر الطاقة المتجددة، يمكننا تمهيد الطريق لمستقبل أنظف وأكثر استدامة. تشمل الفوائد المحتملة لهذه الأساليب تحسين نوعية الحياة، والحفاظ على البيئة، وتقليل الاعتماد على مصادر الطاقة غير المتجددة. مع توقع ارتفاع عدد سكان العالم واستهلاك الطاقة، يصبح الانتقال إلى مصادر الطاقة المتجددة أمراً حاسماً لمستقبل الطاقة المستدامة.

الكلمات المفتاحية: توليد الكهرباء؛ الطاقة الحركية؛ الطاقة المهدرة مواد كهر ضغطية؛ حركة الانسان؛ حركة المواصلات.

Introduction:

Energy plays a fundamental role in human civilizations. 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 to reduce energy demand in different sectors such as buildings, transportation, and industry to tackle this issue effectively. (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 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).

The increase in urbanization, lifestyle change, and increased use of technology, this led to an increase in energy consumption which requires a prototype shift toward 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).

Chapter one

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?

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. To what extent is Saudi society interested in using the wasted kinetic energy to produce electricity in public facilities in Jeddah?
2. Is he willing to use the wasted kinetic energy to produce electricity in the utility facilities 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.

According to the study conducted by Kim, S., Shen, J., & Ahad, M.A. (2015)., The potential benefits of a roadway energy harvesting system are significant, particularly in areas with high traffic volumes and lane miles on state highways. the most important outcome of this research is the potential for piezoelectric energy harvesting to be used as a viable alternative energy source for roadways, which could contribute significantly to sustainable energy production.

Furthermore, the importance of Saudi Arabia's Vision 2030, is that it aims to diversify the economy and reduce dependence on oil exports, with renewable energy investment playing a crucial role in achieving these goals. (Al-Jasser, Al-Zahrani 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:

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 by (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 (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 (Kim, S., Shen, J., & Ahad, M.A. (2015) explores the main objective of this research project is to demonstrate that the piezoelectric method is a feasible alternative energy source for roadways. The study involves investigating the energy harvesting method, a feasibility study, framework development, preparation of equipment and materials, lab experiments, and potential design using piezoelectric materials. The lab experiment aims to determine the amount of energy that can be harvested using piezoelectric materials under asphalt pavements. Although preliminary research results indicate a relatively high levelized cost of energy (LCOE), potential energy generation can be improved by various variables. Therefore, there is a pressing need to conduct further studies using available products in the U.S. The research framework, equipment, hypothesis, and statistical experimental design are all in place to conduct the research. The results of this study will help determine the feasibility of highways' self-supporting energy capacity and will be compared to other energy harvesting methods to assess economic competitiveness. In summary, the most important outcome of this research is the potential for piezoelectric energy harvesting to be used as a viable alternative energy source for roadways, which could contribute significantly to sustainable energy production.

- The study of (Duar-1te, 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 (Papagiannakis, Athanassios T., et al., 2016) Developed 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 by (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 (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 (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 (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.

- 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 innovations that fit in with the United Nations' goals for sustainable development.
- 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 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 (Zabihi, N., 2021) Designed and tested 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 (Visconti, Paolo, et al., 2022) Analyzes the state-of-art 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 (Al-Zahrani, & Al-Jasser, 2022) aimed 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 (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.

1.6. Research Methodology:

This study is descriptive and analytical, 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 sample of Saudi society, specifically in Jeddah, to gather data about the attitudes and behaviors of the local population towards this technology.

1.7. Research limits:

- Spatial Limits: The study was conducted on a sample of Saudi society taken from Red Sea Mall, one of the most important public utilities in Jeddah.
- Human limits: a sample of individuals in Saudi society.

1.8. The general perception of the research:

- Introduction: This section will encompass research problems, the 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 talk about the first and second variables.
- Chapter Four: This chapter will explore the methods and techniques used to utilize wasted kinetic energy.
- Chapter Five: This section will encompass the field study carried out as part of the research.
- Chapter Six: Result and analysis from the research and the recommendations.
- Conclusion: This section will summarize the major findings.
- References: This section will list all the sources used in the research.
- Appendix.

Chapter Two

2.1. Importance of utilizing wasted kinetic energy and converting into alternative energy:

In recent years, there has been global attention on investing in renewable energy as a means to achieve sustainable economic, social, and environmental development (Wüstenhagen & Menichetti, 2012; Al Garni et al., 2016; Hashemizadeh et al., 2021). It is widely recognized that there is a strong correlation between energy consumption and development. This relationship became evident during the Industrial Revolution when there was a significant shift from human labor to machine-based production and an increased reliance on coal for steam generation (Safa, 2017). Numerous studies have shown a positive and significant connection between global economic growth and energy demand (AlKhars et al., 2020). Consequently, it is expected that the energy demand will continue to rise in the future due to population and economic growth. Specifically, Saudi Arabia has the highest energy consumption among Middle Eastern countries (Krane, 2019). In 2019, the Kingdom of Saudi Arabia consumed an average of 4.3 million barrels per day (bpd) of oil, compared to an average of 4.1 million bpd in 2018 (Ministry of Energy, 2020). By the end of 2018, Saudi Arabia's energy consumption reached approximately 289.9 terawatt-hours (TWh), showing an annual increase of 0.42 percent compared to 2017. The high domestic energy consumption in Saudi Arabia is attributed to the rapid non-oil economic growth, averaging 4.5 percent annually from 2010 to 2019, population growth of 3.2 percent annually from 2012 to 2017, and the need for water desalination (Rambo et al., 2017). According to Negewo et al. (2012), it is projected that the Kingdom's domestic energy consumption will require around 8 million bpd of oil barrels by 2050. Such high levels of domestic energy consumption limit the Saudi government's ability to export more oil barrels (Sdrilevich et al., 2014; Rentschler & Bazilian, 2017; Blazquez et al., 2017). Therefore, it is essential for the Saudi government to manage and control the growth of domestic energy demand. Renewable energy can serve as an additional energy source for Saudi Arabia, reducing the dependence on fossil fuels and alleviating the pressure on demand.

A study conducted by Mosly and Makki (2018) examined the social reactions toward the acquisition and utilization of renewable energy by administering questionnaires to a specific group of individuals. The primary determinant influencing the choice to embrace renewable energy is the economic aspect. The findings from the questionnaires indicated that individuals within the age range of 18 to 29 demonstrated a greater willingness to adopt alternative energy sources, specifically renewable energy, at an earlier stage. This inclination could be attributed to the higher level of awareness within this age group compared to other demographics. Consequently, the government must allocate additional efforts towards educating the population about this emerging technology.

The data from 2020 and 2021 demonstrates a consistent growth in electrical energy production and consumption in Saudi Arabia. Although production saw a slight increase, the upward trend in consumption reflects the ongoing demand for electricity in the country. To address this escalating consumption and its potential consequences, it is imperative to explore alternative energy sources. Alternative sources have the potential to significantly reduce electricity consumption and play a crucial role in this regard. By investing in renewable energy infrastructure and promoting its adoption, Saudi Arabia can decrease its dependence on traditional energy sources and consequently lower overall electricity consumption. Encouraging the widespread use of renewable energy technologies is a key aspect of achieving this goal. Furthermore, implementing energy efficiency measures and fostering awareness about responsible energy consumption among individuals and businesses can further contribute to minimizing electricity usage. This can involve initiatives such as enhancing building insulation, adopting energy-efficient appliances, and integrating smart grid technologies. In conclusion, Saudi Arabia can make substantial progress in reducing electricity consumption and working towards a sustainable and environmentally friendly energy future by embracing alternative energy sources and implementing energy-efficient practices.

Chapter Three

3.1. Kinetic energy:

Human kinetic energy (HKE) is the energy produced as a result of human movement. This form of energy holds great promise as a renewable resource that can effectively power various devices, including wearable electronics, sensors, and lights. HKE harvesting represents a highly encouraging technology that has the potential to make a substantial impact on the global energy landscape. (Wang, L., Fei, Z., Qi, Y., Zhang, C., Zhao, L., Jiang, Z., & Maeda, R. 2022)

The utilization of human kinetic energy harvesting has been the subject of investigation across diverse fields, including wearable electronics, healthcare devices, and smart infrastructure. Scientists and researchers have placed their attention on integrating energy-harvesting technologies into wearable devices such as smartwatches, fitness trackers, and biomedical sensors. The aim is to establish sustainable power solutions that lessen dependence on batteries or external charging methods.

In essence, human kinetic energy signifies the immense potential of this renewable energy source. It delves into methods for effectively capturing, converting, and employing the energy produced by human movement in practical and meaningful ways. (Cicchella, A. 2023)

3.2. Electricity generation:

In 2020, there was a 0.77% rise in total electrical energy production, reaching a production quantity of 338,031 GWh, compared to 335,445 GWh in 2019. Similarly, electrical energy consumption experienced a 0.21% increase in 2020, reaching a consumption level of 289,333 GWh, compared to 288,713 GWh in 2019 (*General Authority for Statistics, 2023*).

In 2021, the western region of Saudi Arabia had the highest electric energy consumption, totaling 93.92 TWh, which accounted for 31.14% of the country's total consumption. The central region followed closely with 91.47 TWh, representing 30.33% of the total consumption. The eastern region recorded a consumption of 83.28 TWh, making up 27.62% of the total. On the other hand, the southern region had the lowest consumption at 32.89 TWh, representing 10.91% of the total (*General Authority for Statistics, 2023*).

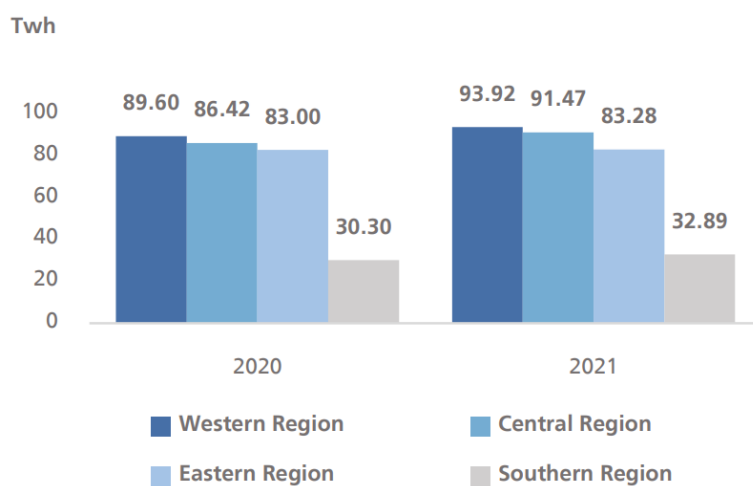


Figure 1: Electric Energy Consumed by Regions

Chapter Four

4.1. Methods and techniques:

There are various methods available to convert kinetic energy into electrical energy, including electromagnetic generators, piezoelectric generators, and frictional electric generators.

Electromagnetic generators: This technology is commonly used to convert kinetic energy into electrical energy. It involves rotating a coil of wire within a magnetic field, which generates electricity through electromagnetic induction.

Piezoelectric generators: These generators convert kinetic energy into electrical energy by deforming a piezoelectric material. When the material is subjected to mechanical stress or deformation, it generates an electric charge.

Frictional electric generators: This type of generator converts kinetic energy into electrical energy by utilizing the contact and separation of materials with different triboelectric properties. When these materials come into contact, an electric charge is produced.

Each technology has its advantages and disadvantages. Electromagnetic generators are typically more efficient and reliable, but they can be larger and costlier. Piezoelectric generators are smaller and lighter, but their efficiency may not match that of electromagnetic generators. Frictional electric generators are less efficient but are simpler and cheaper to manufacture.

Kinetic energy conversion holds promise for contributing to the global energy supply. However, some challenges need to be addressed before widespread adoption can occur.

Potential applications of kinetic energy conversion include generating electricity for residential and commercial use, electric vehicle charging, and powering street lighting and other public infrastructure.

As the technology continues to advance, it is expected to become more efficient and cost-effective, making it a viable option for generating electricity from renewable sources. (Ahsan, M. M., Alam, N., Khan, M. A., & Khan, A. A. 2022)

Chapter Five

Methodology

5.1. Introduction:

This chapter describes the research methodology employed in this research. This chapter describes the research instruments and measurements derived from the literature. In addition, it describes the population of the current research, details the data collection method, and reports on the method of analysis used in this study. Furthermore, this research followed and employed quantitative research methods.

5.2. Participant Recruitments:

The survey was distributed in Red Sea Mall through a method of sending the survey via Airdrop to the people present at the mall to participate. according to Sekaran and Bougie with a margin of error of 5% a total of 385 people agreed to participate in this study. The questionnaire was created using Microsoft Forms and was distributed using the Airdrop feature available on Apple devices. The questionnaire is divided into two sections. The first section consists of 3 questions that highlight the Demographic information of the participants. The second section consists of 20 questions inquiring about the effect of utilizing wasted kinetic energy on electricity generation in public utilities in Jeddah.

5.3. Questionnaire Design:

A questionnaire was developed to collect data from the study sample:

Section one: Demographics Characteristic that includes the respondent's gender (Male, Female), and Age variable described for categories (20-29 Years Old, 30-39 Years Old, 40-49 Years Old, 50 Years old or more), and Years of Experience variable described for categories (5 Years & Less, 5-10 Years, 11-15 Years, 16 or more Years)

Second Section: The following set of statements measures the effect of utilizing wasted kinetic energy on electricity generation in public utilities in Jeddah:

Wasted kinetic energy which was (18) items, the first axis is Human kinetic energy which was (7) items: the second axis is about Transport movement which was (6) items, and the third axis is Electricity generation which was (7) items.

5.4. Scaling and Sampling Technic:

The questionnaire items were assessed on a 5-point Likert scale (strongly agree — strongly disagree). The questionnaire was distributed to people who participated in this study number 385.

5.4.1. First: Demographic sample characteristic:

The researcher has used statistical description and analytical methods to analyze the data by using (SPSS) to analyze the sample characteristics to figure out the frequencies and percentages of the population sample. These questions were analyzed through SPSS to study their statistics and frequencies. table (1) shows its frequencies and percentages.

Table 1: Frequencies and percentages of the variable of the study

variable	Subgroup	Frequency	Percentage
gender	Male	189	49.1
	Female	196	50.9
	Total	385	100.0
Age	20-29 Years Old	87	22.6
	30-39 Years Old	199	51.7
	40-49 Years Old	47	12.2
	50 years old or more	52	13.5
	Total	385	100.0
Years of Experience	5 Years & Less	102	26.5
	5-10 Years	160	41.6
	11-15 Years	52	13.5
	16 or more Years	71	18.4
	Total	385	100.0

Table (1) indicates the distribution of the study sample for the gender variable, as their gender achieved (Female), 50.9% rate, and the lowest (male), achieved 49.1% rate.

Table (1) indicates the distribution of the study sample for the Age variable, as their Age achieved (30-39 Years Old), 51.7% rate, and finally (40-49 Years Old), 12.2% rate.

Table (1) indicates the distribution of the study sample for the Years of Experience variable, as their Years of Experience achieved (5-10 Years), 41.6% rate, and finally (11-15 Years), 13.5% rate.

5.5. Test:

To ensure that the questionnaire and its items that represent the variables of the study and the results of the responses of the sample members are appropriate for the statistical analysis, a test has been carried out. These tests are (i) face validity; (ii) constructed validity; and (iii) reliability; Two types of validity test were used to reflect if the measure represent the true nature of the study interest.

5.6. Face validity:

It is the first criterion, which must be valid after a common agreement among a panel of experts. In this view, the researcher developed a questionnaire to fulfill the purposes of this study after reviewing previous research. Then it was distributed to a panel of experts to ensure the content's meaning, relevance, and clarity.

5.7. The constructed validity:

To examine the constructed validity of the scale, the researcher calculated Calculation a coefficient of Pearson's correlation between the grades of each item with the overall grade of the scale. Table (2,3 and 4) shows the results of this procedure.

5.8. Human Kinetic energy:

Table 2: shows the coefficients of Pearson's associations of the items with each other in the overall scale grade.

N	items	Pearson's Correlation with		N	items	Pearson's Correlation with	
		Dimension	overall			Dimension	overall
1	I think that human use in public places to generate electric power can be a solution to the electricity situation we are facing.	.783**	.684**	5	Human movement in public places can become a major source of electricity generation in the future.	.701**	.582**
2	I believe that human movement contributes to the provision of clean and sustainable electric energy.	.821**	.716**	6	Using human kinetic energy in public areas for electricity generation can encourage walking, and increase the population's engagement in this form of exercise.	.768**	.702**
3	Raising people's awareness about kinetic energy can help in environmental conservation efforts.	.678**	.641**	7	To what extent you will support or participate in projects that use human movement in public places to generate electrical energy.	.736**	.652**
4	Human movement contributes to providing an additional source of electricity in crowded areas.	.783**	.683**				

**Correlation is significant at (0.01) level.

*Correlation is significant at (0.05) level.

It is clear from Table (2): which shows the correlation of the scale items with each other and the correlation of the scale items with the overall scale, as the correlation coefficients of all items are strong ranging between (.678**-.821**), and with a statistical significance.

5.9. Transport movement:

Table 3: shows the coefficients of Pearson's associations of the items with each other in the overall scale grade.

N	items	Pearson's Correlation with		N	items	Pearson's Correlation with	
		Dimension	overall			Dimension	overall
1	Using transportation in public places to generate electricity can solve some of the energy problems we face.	.812**	.766**	4	The use of technology to convert wasted kinetic energy from transportation movement in public areas into electrical energy can be cost-effective and efficient.	.787**	.595**
2	The movement of transportation for the generation of electric energy in public places can contribute to reducing the use of fossil fuels and harmful emissions.	.835**	.632**	5	There should be more investment in research and development of technologies to capture and use wasted kinetic energy from transportation movement in public areas.	.755**	.733**
3	Using transportation movement in public areas to generate electricity can provide an extra source of electricity for public use.	.806**	.755**	6	The development of technologies that can convert the kinetic energy from transportation in public areas into electrical energy is a positive initiative.	.747**	.710**

**Correlation is significant at (0.01) level.

*Correlation is significant at (0.05) level.

It is clear from Table (3): which shows the correlation of the scale items with each other and the correlation of the scale items with the overall scale, as the correlation coefficients of all items are strong ranging between (.747**-.835**), and with a statistical significance.

5.10. Electricity generation:

Table 4: shows the coefficients of Pearson's associations of the items with each other in the overall scale grade.

N	items	Pearson's Correlation with		N	items	Pearson's Correlation with	
		Dimension	overall			Dimension	overall
1	Using wasted kinetic energy to generate electrical energy in public places is a good idea.	.830**	.730**	5	The generation of electrical energy through wasted movement can play a role in saving energy in the future.	.868**	.734**
2	Government and public authorities should support the use of wasted kinetic energy for the generation of electric energy in public places.	.831**	.710**	6	The technology of generating electric energy from wasted kinetic energy can contribute to meeting the growing demand for electric energy in public places.	.841**	.758**
3	The generation of electrical energy through wasteful movement is important to preserve the environment.	.875**	.781**	7	To what extent you will use the technology of generating electrical energy from wasted kinetic energy in your daily life?	.817**	.702**
4	Directing more investments, research, and development to the generation of electric energy through wasted movement is necessary.	.860**	.760**				

**Correlation is significant at (0.01) level.

*Correlation is significant at (0.05) level.

It is clear from Table (4): which shows the correlation of the scale items with each other and the correlation of the scale items with the overall scale, as the correlation coefficients of all items are strong ranging between (.817**-.875**), and with a statistical significance.

5.11. Reliability results:

Table 5: Shows that result of **Reliability Statistics**

No	Dimensions	Cronbach's Alpha	N of Items
1	Human kinetic energy	0.872	7
2	Transport movement	0.873	6
3	Electricity generation	0.933	7
	overall	0.943	20

From the above table (5) we note that overall Cronbach's alpha coefficient was (0.943), the Cronbach's alpha coefficient for tool dimension ranged between (0.872-0.933).

5.12. Judgment Standard:

Means and standard deviations were assessed for each construct and related items, items were then ranked in descending order according to the following scale:

1.00 - 1.80 Very Low

1.81 – 2.60 Low

2.61 – 3.40 Middle

3.41 – 4.20 High

4.21 – 5.00 Very High

Chapter five discussed the methodology followed for collecting the data for analysis, and the analytical procedure used in analysing the data. This chapter will show the results of the questions of the study

- (1) To what extent does the exploitation of wasted kinetic energy contribute to the generation of electricity in public utilities in Jeddah?

To result Question (1) was used to analyze the mean and standard deviation for exploitation of wasted kinetic energy contribute to the generation of electricity in public utilities in Jeddah, showing the rank of the mean and its importance level according to the class interval.

Table 6: Means and standard deviations for exploitation of wasted kinetic energy contribute to the generation of electricity in public utilities in Jeddah

NO	Axis	Mean	Standard deviation	Rank	Importance level *
1	Human kinetic energy	4.20	0.53	2	High
2	Transport movement	4.11	0.60	3	High
Overall		4.16	0.51	-	High

Based on table (6) which presents the exploitation of wasted kinetic energy contributing to the generation of electricity in public utilities in Jeddah, it can be noticed that axis number (1) “Human kinetic energy” recorded the High-level mean value among the statements being rated by the study sample, thus was ranked first with a mean of (4.20), while axis number (2) “Transport movement” was ranked last with a mean of (4.11) a High. The overall theme of this variable was rated by a mean of (4.16), suggesting a high level of agreement in the study sample.

5.13. First axis: Human Kinetic energy:

To result for Human kinetic energy was used to analyze the mean and standard deviation, showing the rank of the mean and its importance level according to the class interval

Table 7: Means and standard deviations for Human kinetic energy

NO	Items	Mean	Standard deviation	Rank	Importance level *
3	Raising people's awareness about kinetic energy can help in environmental conservation efforts.	4.40	0.64	1	very High
6	Using human kinetic energy in public areas for electricity generation can encourage walking, and increase the population's engagement in this form of exercise.	4.29	0.67	2	very High
4	Human movement contributes to providing an additional source of electricity in crowded areas.	4.18	0.72	3	High
2	I believe that human movement contributes to the provision of clean and sustainable electric energy.	4.17	0.69	4	High
7	To what extent you will support or participate in projects that use human movement in public places to generate electrical energy.	4.14	0.74	5	High
5	Human movement in public places can become a major source of electricity generation in the future.	4.14	0.72	5	High
1	I think that human use in public places to generate electric power can be a solution to the electricity situation we are facing.	4.10	0.71	7	High
Overall		4.20	0.53	-	High

Based on table (7) which presents Human kinetic energy, it can be noticed that statement number (3) "Raising people's awareness about kinetic energy can help in environmental conservation efforts." recorded a very High-level mean value among the statements being rated by the study sample, thus was ranked first with a mean of (4.40), while statement number (1) "I think that human use in public places to generate electric power can be a solution to the electricity situation we are facing" was ranked last with a mean of (4.10) a High. The overall assessment of this variable was rated by a mean of (4.20), suggesting a high level of agreement in the study sample.

5.14. Second axis: Transport movement:

analyze the mean and standard deviation for Transport movement, showing the rank of the mean and its importance level according to the class interval

Table 8: Means and standard deviations for Transport movement

NO	Items	Mean	Standard deviation	Rank	Importance level *
5	There should be more investment in research and development of technologies to capture and use wasted kinetic energy from transportation movement in public areas.	4.27	0.62	1	very High
6	The development of technologies that can convert the kinetic energy from transportation in public areas into electrical energy is a positive initiative.	4.24	0.69	2	very High
3	Using transportation movement in public areas to generate electricity can provide an extra source of electricity for public use.	4.17	0.65	3	High
1	Using transportation in public places to generate electricity can solve some of the energy problems we face.	4.13	0.71	4	High
2	The movement of transportation for the generation of electric energy in public places can contribute to reducing the use of fossil fuels and harmful emissions.	3.95	0.88	5	High
4	The use of technology to convert wasted kinetic energy from transportation movement in public areas into electrical energy can be cost-effective and efficient.	3.87	0.95	6	High
Overall		4.11	0.60	-	High

Based on table (8) which presents Transport movement, it can be noticed that statement number (5) "There should be more investment in research and development of technologies to capture and use wasted kinetic energy from transportation movement in public areas." recorded the very High-level mean value among the statements being rated by the study sample, thus was ranked first with a mean of (4.27), while statement number (4) "The use of technology of converting wasted kinetic energy from transportation movement in public areas into electrical energy can be cost-effective and efficient." was ranked last with a mean of (3.87) a High. The overall assessment of this variable was rated by a mean of (4.11), suggesting a high level of agreement in the study sample.

5.15. Third axis: Electricity generation:

analyze the mean and standard deviation for electricity generation, showing the rank of the mean and its importance level according to the class interval

Table 9: Means and standard deviations for electricity generation

NO	Items	Mean	Standard deviation	Rank	Importance level *
2	Government and public authorities should support the use of the wasted kinetic energy for the generation of electric energy in public places.	4.38	0.64	1	very High
5	The generation of electrical energy through wasted movement can play a role in saving energy in the future.	4.36	0.66	2	very High
1	Using wasted kinetic energy to generate electrical energy in public places is a good idea.	4.32	0.68	3	very High
4	Directing more investments, research, and development to the generation of electric energy through wasted movement is necessary.	4.31	0.71		very High
3	The generation of electrical energy through wasteful movement is important to preserve the environment.	4.30	0.72		very High
7	To what extent you will use the technology of generating electrical energy from wasted kinetic energy in your daily life?	4.28	0.73		very High
6	The technology of generating electric energy from wasted kinetic energy can contribute to meeting the growing demand for electric energy in public places.	4.26	0.72		very High
Overall		4.32	0.59	-	very High

Based on table (9) which presents Electricity generation, it can be noticed that statement number (2) “Government and public authorities should support the use of the wasted kinetic energy for the generation of electric energy in public places.” recorded the very High-level mean value among the statements being rated by the study sample, thus was ranked first with a mean of (4.38), while statement number (6) “The technology of generating electric energy from wasted kinetic energy can contribute to meeting the growing demand for electric energy in public places” was ranked last with a mean of (4.26) a very High. The overall assessment of this variable was rated by a mean of (4.32), suggesting a very high level of agreement in the study sample.

5.16. Multi–Collinearity Diagnostic:

Before testing the hypotheses of the study, some tests were conducted to ensure the adequacy of the data for the assumption’s regression analysis, variables were tested for Multicollinearity. The results confirm that there are no high correlations between the independent variables using the Variance Inflation Factor (VIF), Tolerance test for each variable to ensure the independence of errors. Taking into account the Variance Inflation Factor not to exceed the allowable value (10), Tolerance value greater than (0.05). Table (10) shows the results of these tests.

Table 10: Results of Variance Inflation Factor and Tolerance

variables	Tolerance	VIF
Human kinetic energy	0.527	1.896
Transport movement	0.527	1.896

Table (10) shows that VIF values for each dimension of the independent variables are less than 10, with tolerance (0.970-0.992). This indicates that there is no Collinearity diagnostics problem in the regression model (Gujarati and Porter, 2003). Therefore, the researcher can conduct the study hypotheses as follows.

5.17. Study Hypotheses Test:

***H₁*: There is a statistically significant effect of the exploitation of wasted kinetic energy (people - vehicles) in generating electricity in public utilities in Jeddah Governorate.**

Multiple linear Regressions are used to test the above hypothesis to ensure that there is an effect of the exploitation of wasted kinetic energy (people - vehicles) in generating electricity in public utilities in Jeddah Governorate

Table 11: Multiple linear regression

<i>Independent variables</i>	β	<i>t</i>	<i>Sig.</i>	<i>R</i>	<i>R²</i>	<i>F calculate</i>	<i>Sig.</i>
<i>Constant</i>	1.007	5.583	0.000	.690	0.476	173.395	.000
Human kinetic energy	0.466	8.167	0.000				
Transport movement	0.329	6.540	0.000				
Dependent Variable: Electricity generation							

Table (11) indicated that the results of the multiple regression analysis show that the regression model of the study is significant, as the value of F calculated value =173.395 and Sig value is (0.00) which is less than ($\alpha=.05$). the null hypothesis is rejected and the alternative one is accepted which means the validity of simple regression, so there is there is a statistically significant effect of the exploitation of wasted kinetic energy (people - vehicles) in generating electricity in public utilities in Jeddah Governorate. Table 11 also indicated that the correlation coefficient was ($R=.690$), which indicates a positive relation between independent variables and dependent variable, in addition value of the Coefficient of Determination (R^2) is (0.476) which indicates that (47.6%) of variance in electricity generation may be intercepted through Wasted kinetic energy while the rest percent (52.4%) is due to other variables that are not included in the mode.

5.17.1. The following is a Sub- hypotheses test:

H_{1_1}: There is a statistically significant effect of exploiting the wasted kinetic energy of people as one of the sources of electricity generation.

To determine the relationship between the effect of exploiting the wasted kinetic energy of people as one of the sources of electricity generation, a regression model was used. Table 11 shows that the value of Beta (the slope parameter in the regression model) for the effect of exploiting the wasted kinetic energy of people as one of the sources of electricity generation was 0.466. Furthermore, the value of t-calculated is 8.167, which is larger than t-tabulated at 1.65 with a significance level or p-value of 0.05.

H_{1_2}: There is a statistically significant effect of exploiting the wasted kinetic energy from vehicles as one of the sources of electricity generation.

To determine the relationship between the effect of exploiting the wasted kinetic energy from vehicles as one of the sources of electricity generation, a regression model was used. Table 11 shows that the value of Beta (the slope parameter in the regression model) for the effect of exploiting the wasted kinetic energy from vehicles as one of the sources of electricity generation was 0.329. Furthermore, the value of t-calculated is 6.540, which is larger than t-tabulated at 1.65 with a significance level or p-value of 0.05.

5.18. Open-ended questions analysis:

1. First question: proposals to improve the use of wasted kinetic energy?

- Generalizing the experience to all regions of the kingdom: It is important to generalize the experience and develop the use of kinetic energy in various regions of the kingdom, in addition to the city of Jeddah, to comprehensively enhance energy efficiency in the kingdom.
- Awareness and education: educating citizens, companies, and public utilities about the benefits of using kinetic energy in electricity generation and encouraging them to apply it.
- Application in places with large traffic: The area of the Two Holy Mosques and the holy sites of Mecca and Medina can be a suitable place for the application of this technology, as there is a large movement of people, and provides the opportunity to use wasted kinetic energy to generate electricity.
- The use of spring tracks: spring tracks can be designed and installed with suitable power and connected to electrical circuits to convert kinetic energy into electrical energy, this electrical energy can be used to power various electrical appliances and thus save energy and reduce the cost of electricity production by traditional methods.
- Conservation of fossil energy: the application of the use of kinetic energy to generate electricity contributes to reducing dependence on fossil energy such as crude oil, reducing the associated carbon emissions and their impact on the ozone layer.
- Adoption of successful experiences: Local needs and the availability of resources should be considered and benefit from successful experiences in the application of this technology in the Kingdom and ensure its success.
- Explanation of the mechanism of power generation work: Detailed explanations should be provided on how motion power generation devices work, their type, and their sustainable lifespan, society needs a clear understanding of this technology to increase its acceptance and adoption.
- Encourage the practice of walking: The use of wasted kinetic energy can be promoted by encouraging the community to practice walking, green spaces can be allocated for various sports to convert kinetic energy into electricity by power generation devices.
- Provide a questionnaire with different designs: Different designs of questionnaires can be used to survey the opinions of the community about the use of kinetic energy in electricity generation, and use the results to identify to address weaknesses, improve strengths, and direct awareness and educational efforts on the importance of these studies.
- Take advantage of nanotechnology: nanotechnology can be used to optimize the process of converting kinetic energy into electricity. This technology can be effective in improving the efficiency and effectiveness of power generation devices and making them more sustainable over time.

- Cooperation with government and private entities: support and encouragement should be provided by the government and private entities to promote the use of kinetic energy in public utilities, these incentives may include in the form of financial incentives or technical facilities for the application of this technology.

2. Second question: Please provide any comments regarding which aspect seems to be missing in this study?

- The study did not address the technical details of the places of kinetic energy generation in Saudi Arabia; this study should include information about the facilities located at these sites, such as wind turbines, solar energy, and wave energy, these details can explain how kinetic energy can be exploited more and make the most of it.

- The provision of services or incentives for the most effective use of kinetic energy was not touched upon in the study. People can be encouraged to use kinetic energy by offering rewards such as bus tickets or purchase vouchers, and the study should also include efforts to raise media awareness of the benefits of kinetic energy environmentally and healthily, these efforts can help promote awareness among the public and encourage them to use kinetic energy more.

- Measures should be taken to facilitate studies and overcome the difficulties faced by developers in applying ideas related to kinetic energy in our daily lives, and the principles of the absence of conflicts of interest should also be considered, so that the success of experiments is supported, and the necessary legislation and licenses are provided for the application of ideas.

- The study touched upon the importance of circumnavigation around the Kaaba in generating electricity saving part of the waste, and exploiting the movement of people during circumnavigation in generating electricity through systems such as kinetic energy platforms that convert rotational motion into electrical energy, This can be an innovative and effective solution to achieve energy sustainability in the city.

- The study also needs to clarify similar examples of the utilization of kinetic energy in neighboring countries. These examples can be a source of inspiration and support for the application of ideas in the city of Jeddah.

Chapter Six

6.1 Result and analysis:

The results of this study indicate that most of them were females in percentage (50.9%), and males were the lowest percentage (49.1%). And indicates that most of them Age aged (30-39 Years Old), 51.7% rate, and finally (40-49 Years Old), 12.2% rate. And indicates the distribution of the study sample for the Years of Experience variable, as their Years of Experience achieved (5-10 Years), 41.6% rate, and finally (11-15 Years), 13.5% rate.

indicates the result of this study that presents exploitation of wasted kinetic energy contributes to the generation of electricity in public utilities in Jeddah, it can be noticed that axis number (1) "Human kinetic energy" recorded the high-level mean value among the statements being rated by the study sample, thus was ranked first with a mean of (4.20), while axis number (2) "Transport movement" was ranked last with a mean of (4.11) a High. The overall theme of this variable was rated by a mean of (4.16), suggesting a high level of agreement in the study sample.

indicated that the results of the multiple regression analysis show that the regression model of the study is significant, as the value of F calculated value =173.395. The null hypothesis is rejected and the alternative one is accepted which means the validity of simple regression, so there is a statistically significant effect of the exploitation of wasted kinetic energy (people - vehicles) in generating electricity in public utilities in Jeddah Governorate. Also indicated a positive relation between independent variables and dependent variable, in addition, which indicates that (47.6%) of variance in electricity generation may be intercepted through Wasted kinetic energy while the rest percent (52.4%) is due to other variables that are not included in the mode.

6.2 Recommendations:

- Educate the public about the potential of kinetic energy as a renewable energy source. Raising awareness and promoting its adoption will play a vital role in shaping a cleaner and more sustainable future.
- Utilizing wasted kinetic energy by the use of piezoelectric materials in a smart pavement system. This innovative technology can convert the movements of pedestrians and vehicles in everyday life into renewable electricity.
- Encourage Private Sector Investment: It is advisable to promote and incentivize private companies to invest in renewable energy sources, such as kinetic energy. By doing so, they can reduce their carbon footprint and play a significant role in fostering a cleaner and more sustainable future.
- Expand Research Efforts: Further research should be undertaken to fully explore the potential of kinetic energy in various settings and applications. This includes investigating its viability in industrial and commercial sectors, where significant energy consumption occurs. Understanding the effectiveness and scalability of kinetic energy in these contexts will contribute to its broader adoption and impact.
- Create Sustainable Energy Systems: By integrating the harvesting of kinetic energy into our infrastructure, we can make a substantial contribution to the establishment of sustainable energy systems. This method decreases our dependence on limited resources and improves the energy efficiency of urban areas.
- To apply this approach to various government and private agencies such as government agencies' facilities, economic cities, NEOM, airports, the Two Holy Mosque, playgrounds, pedestrian walkways, sports clubs, large markets (malls), and during Al-Haj season.

Chapter Seven

7.1. Conclusion:

In conclusion, this study highlights the significant role of exploiting wasted kinetic energy in the city of Jeddah. The findings from the field study analysis revealed valuable insights into the perceptions and opinions of participants concerning various aspects related to its utilization. These results reaffirm the importance of harnessing wasted kinetic energy, as it presents substantial untapped potential for electricity generation. Recognizing the value of this resource and exploring innovative methods to effectively harness it are crucial. By converting wasted kinetic energy into electricity, we can contribute to a more sustainable and environmentally friendly energy landscape. Increasing awareness and providing education on this topic can inspire individuals, communities, and organizations to embrace the concept of utilizing wasted kinetic energy. Furthermore, supportive legislation and policies should be implemented to incentivize and promote its adoption in public facilities.

Investment in research and development, along with the adoption of modern technology, will play an integral role in optimizing the conversion process and making it more efficient and sustainable. Collaboration among stakeholders, both locally and globally, will facilitate knowledge exchange and the sharing of best practices.

Harnessing wasted kinetic energy can reduce reliance on traditional energy sources, decrease carbon emissions, and minimize our environmental impact. Additionally, implementing kinetic energy projects can create new employment opportunities and contribute to economic growth.

It is hoped that this study will encourage policymakers, companies, and stakeholders to collaborate and take proactive measures to optimize the utilization of kinetic energy across all sectors.

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Appendix:

Survey Structure:

The questions of the survey were judged by two faculty members, who are Dr. Mohammed Fekry a Professor of Architecture from Effat University, and Dr. Hatem Sindi an Associate Professor, of electrical power engineering from King Abdulaziz University, the following table shows the most important results by them:

Question before correction	Dr.MohamedFekry's Comment	Dr.Hatem Sindi 's Comment																																																																								
The following set of statements measure the effect of utilizing wasted kinetic energy on electricity generation in public utilities in Jeddah. Please mark according to your level of agreement. Section A: Wasted kinetic energy <table><thead><tr><th>I. Wasted kinetic energy</th><th>1 Strongly Disagree</th><th>2 Disagree</th><th>3 Natural</th><th>4 Agree</th><th>5 Strongly Agree</th></tr></thead><tbody><tr><td>Utilization of wasted kinetic energy contribute to reducing noise pollution and improving overall well-being</td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>Utilizing wasted kinetic energy has the potential to positively impact public health</td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>Government should offer incentives and support for the development and implementation of projects that utilize wasted kinetic energy</td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>Utilizing wasted kinetic energy can have a significant positive impact on the environment</td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>Education and awareness initiatives are necessary to promote the use of wasted kinetic energy for electricity generation</td><td></td><td></td><td></td><td></td><td></td></tr></tbody></table> Section B: Electricity generation <table><thead><tr><th>I. Electricity generation</th><th>1 Strongly Disagree</th><th>2 Disagree</th><th>3 Natural</th><th>4 Agree</th><th>5 Strongly Agree</th></tr></thead><tbody><tr><td>Energy generation is critical for economic development and growth</td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>Renewable energy sources should be prioritized over traditional fossil fuels for energy generation</td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>Development of new and innovative energy generation technologies is necessary to address the challenges of climate change</td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>Government should play an active role in promoting the development and implementation of renewable energy technologies for energy generation</td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>Energy storage technologies can help to reduce the cost of renewable energy sources for energy generation</td><td></td><td></td><td></td><td></td><td></td></tr></tbody></table>	I. Wasted kinetic energy	1 Strongly Disagree	2 Disagree	3 Natural	4 Agree	5 Strongly Agree	Utilization of wasted kinetic energy contribute to reducing noise pollution and improving overall well-being						Utilizing wasted kinetic energy has the potential to positively impact public health						Government should offer incentives and support for the development and implementation of projects that utilize wasted kinetic energy						Utilizing wasted kinetic energy can have a significant positive impact on the environment						Education and awareness initiatives are necessary to promote the use of wasted kinetic energy for electricity generation						I. Electricity generation	1 Strongly Disagree	2 Disagree	3 Natural	4 Agree	5 Strongly Agree	Energy generation is critical for economic development and growth						Renewable energy sources should be prioritized over traditional fossil fuels for energy generation						Development of new and innovative energy generation technologies is necessary to address the challenges of climate change						Government should play an active role in promoting the development and implementation of renewable energy technologies for energy generation						Energy storage technologies can help to reduce the cost of renewable energy sources for energy generation						The questionnaire questions need to be studied more I also think that they need to be measured on two axes: -The first is to measure the degree of awareness. -The second is related to the return and contribution to the application. Another thing you need to classify is section A based on your two sources which are (Human and transport movement).	1-There are numerous sources of kinetic energy; which one specifically are you discussing here? Please clarify. 2-You have to be more specific in terms of what are your variables and what you want to measure exactly.
I. Wasted kinetic energy	1 Strongly Disagree	2 Disagree	3 Natural	4 Agree	5 Strongly Agree																																																																					
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- Survey before corrections:

Survey form:

We are students in the Project Management Department of ESU University. This questionnaire is part of the requirements of our graduate scientific research. Currently, we are conducting a study titled.

"The role of utilizing wasted kinetic energy on electricity generation in public utilities in Jeddah- an applied study on Red Sea Malla.

The questionnaire is intended to examine the awareness of using wasted kinetic energy and determine the significance of this utilization in enhancing the generation of electricity in these public utilities.

Any information obtained will be kept confidential and only used for academic purposes. We would be grateful if you could devote a few minutes of your time to fill out this questionnaire.

If you have any questions, please do not hesitate to contact:

Supervisor:

Dr. Walid Seddik.

Research team:

Arch. Duaa Bishara

Dbusharah@gmail.com

Arch. Muroj Damanhour

Muroj-faiz@hotmail.com

Mr. Mohammed AlSabban

Alsabban.moh@gmail.com

* Indicates a required question

*اختر اللغة التي تناسبك

عربي

انجليزي

Section A:

Demographic Characteristics

1- Gender*

Male

Female

2- Age*

20-29 Years Old

30-39 Years Old

40-49 Years Old

50 years old or more

3- Years of Experience*

5 Years & Less

5-10 Years

11-15 Years

16 or more Years

Section B

Section A: Wasted kinetic energy

I. Human kinetic energy

1- I think that human use in public places to generate electric power can be a solution to the electricity situation we are facing. *

Strongly Agree

Agree

Neutral

Disagree

Strongly Disagree

2- I believe that human movement contributes to the provision of clean and sustainable electric energy. *

Strongly Agree

Agree

Neutral

Disagree

Strongly Disagree

3- Raising people's awareness about kinetic energy can help in environmental conservation efforts. *

Strongly Agree

Agree

Neutral

Disagree

Strongly Disagree

4-Human movement contributes to providing an additional source of electricity in crowded areas. *

Strongly Agree

Agree

Neutral

Disagree

Strongly Disagree

5- Human movement in public places can become a major source of electricity generation in the future. *

Strongly Agree

Agree

Neutral

Disagree

Strongly Disagree

6-Using human kinetic energy in public areas for electricity generation can encourage walking, and increase the population's engagement in this form of exercise. *

Strongly Agree

Agree

Neutral

Disagree

Strongly Disagree

7- Will you support or participate in projects that use human movement in public places to generate electrical energy. *

Strongly Agree

Agree

Neutral

Disagree

Strongly Disagree

Section A: Wasted kinetic energy

II. Transportation Kinetic Energy

1-Using transportation in public places to generate electricity can solve some of the energy problems we face. *

Strongly Agree

Agree

Neutral

Disagree

Strongly Disagree

2-Movement of transportation for the generation of electric energy in public places can contribute to reducing the use of fossil fuels and harmful emissions. *

Strongly Agree

Agree

Neutral

Disagree

Strongly Disagree

3-Using transportation movement in public areas to generate electricity can provide an extra source of electricity for public use. *

Strongly Agree

Agree

Neutral

Disagree

Strongly Disagree

4-The use of technology of converting wasted kinetic energy from transportation movement in public areas into electrical energy can be cost-effective and efficient. *

Strongly Agree

Agree

Neutral

Disagree

Strongly Disagree

5-There should be more investment in research and development of technologies to capture and use wasted kinetic energy from transportation movement in public areas. *

Strongly Agree

Agree

Neutral

Disagree

Strongly Disagree

6- The development of technologies that can convert the kinetic energy from transportation in public areas into electrical energy is a positive initiative. *

Strongly Agree

Agree

Neutral

Disagree

Strongly Disagree

Section B: Electricity generation

I. Electricity generation

1-Using wasted kinetic energy to generate electrical energy in public places is a good idea. *

Strongly Agree

Agree

Neutral

Disagree

Strongly Disagree

2- Government and public authorities should support the use of the wasted kinetic energy for the generation of electric energy in public places. *

Strongly Agree

Agree

Neutral

Disagree

Strongly Disagree

3- Generation of electrical energy through wasteful movement is important to preserve the environment. *

Strongly Agree

Agree

Neutral

Disagree

Strongly Disagree

4- Directing more investments, research, and development to the generation of electric energy through wasted movement is necessary. *

Strongly Agree

Agree

Neutral

Disagree

Strongly Disagree

5- The generation of electrical energy through wasted movement can play a role in saving energy in the future. *

Strongly Agree

Agree

Neutral

Disagree

Strongly Disagree

6-The technology of generating electric energy from wasted kinetic energy can contribute to meeting the growing demand for electric energy in public places. *

Strongly Agree

Agree

Neutral

Disagree

Strongly Disagree

7- Are you willing to use the technology of generating electrical energy from wasted kinetic energy in your daily life? *

Strongly Agree

Agree

Neutral

Disagree

Strongly Disagree

Section C: Open-ended questions

- 1- Please provide any other comments regarding this study.

- 2- Please provide any comments regarding any aspect that appears to be lacking in this study.

Gratitude:

We appreciate you for sparing your time to fill out the survey. your involvement means a lot to us and we highly value it.

The information shared is significant to our analysis and will enable us to make improvements in our bank's performance.

Once again, we are very grateful for your contribution!

دور الاستفادة من الطاقة الحركية المهدرة في توليد الكهرباء بالمرافق العامة بجدة -

دراسة تطبيقية على رد سي مول

إعداد الطالب/

مروج دمنهوري (221001145)

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العام الدراسي:

1445/2023