



RENEWABLE ENERGY PRODUCTION USING HUMAN GYM ACTIVITIES: A BEHAVIORAL STUDY IN SAUDI ARABIA

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Abstract

This research aims to understand the exercise behavior of gymnasium (gym) users. Moreover, it investigates their awareness and willingness to utilize the potential energy output to produce renewable energy (RE). For this research, 96 responses were collected via an electronic survey representing the population with a 10% confidence interval. The resulting data were analyzed to determine participants' demographics, behavior, awareness, and willingness to partake in RE

production. The results show promising indicators from the users as they express positive awareness on the topic of using RE in general. Also, it shows considerable willingness toward utilizing the generated energy as a source of RE. Moreover, behavior analysis showed that the majority of participants had an average exercising time of 8 hours per week using more than two types of exercises. However, current studies did not reach out to all stakeholders. Future work should investigate compatible and efficient RE harvesting methods compatible with the demographic scope of this work.

Keywords: Renewable Energy, Human Kinetic Energy, Social Acceptance, Motivation, Energy Harvesting

INTRODUCTION

There is untapped potential for harvesting human kinetic energy at most fitness facilities and converting it into Renewable Energy (RE) resources (Haji, Lau, & Agogino, 2010). Nowadays, the trend of exercising in the gym is increasing rapidly (Gaurav et al. 2015). In addition, some countries are forcing this behavior as part of their vision and strategic objectives. For example, in Saudi Arabia, one of the strategic goals related to the 2030 vision is to set a primary target of producing 9.5 GW of RE annually. Another goal of the 2030 vision is to increase the ratio of individuals exercising at least once a week from 13% of the population to 40% by encouraging widespread and regular participation in sports and athletic activities. This goal is targeted to be achieved by a partnership with the private sector via establishing additional dedicated facilities and programs (Saudi_Vision2030, 2016). These two strategic objectives motivate the researchers to link the two objectives together. Thus, the idea came to investigate the possibility of harvesting Human Kinetic Energy (HKE) in gyms to produce clean RE.

This work aims to determine the awareness and willingness of the Saudi society to participate in producing energy out of physical activity in gyms and sports clubs to produce renewable energy. The ultimate goal of the research is to establish a new renewable energy source in the Saudi market. Also, it aims to determine the level of awareness of society about the subject of partaking in the production of RE. This work focuses on studying people's behavior in the gym. Also, it focuses on investigating different motivation methods that could be used to increase people's participation in RE production out of their HKE at gyms.

LITERATURE REVIEW

Nowadays, the world is changing rapidly due to new technologies contributing to the well-being of society. Moreover, due to the rapid increase in the world's population, industrialization, and modernization, the demand for electricity is increasing worldwide. Fossil fuels are depleting and have a negative effect on the environment. Thus, researchers are looking for an energy source that is both renewable and sustainable. In a gym, HKE is used to drive physical exercise devices. This means kinetic energy is generated through these devices. Thus, there are a number of exercise devices that have the potential to generate electricity during physical exercise (Mustafi, et al. 2017).

The modern generation is attracted to gym exercise. So, the energy generated from a gym bicycle could play a significant role. As the amount of gym equipment increases, the total power generation will increase, which could be helpful in reducing today's energy demand (Bidwai, et al. 2017). Thus, it is good to focus on the feasibility of capturing this energy at fitness facilities, particularly the Recreational Sports Facility (RSF) as at the University of California, Berkeley, which averages over 2,800 patrons per day. It is estimated that patrons using 28 elliptical machines would supply approximately 10,000 KWH into the electric grid over a year. This accounts to only 0.7% of the RSF's total energy needs but is valuable nonetheless. An additional benefit of human power generation is the positive social impact since the trend of exercising in the gym is increasing rapidly (Haji, Lau, & Agogino, 2010; Gaurav et al., 2015). Energy can be harvested from the most commonly-used physical exercise devices used in gyms, which are paddling and chin up. The power generation from the devices depends upon the speed at which the alternator runs and the age limit (Mustafi, et al. 2017).

This research's contribution to the literature is mainly to investigate the willingness of Saudi Arabian society to accept ideas and participate which has not been examined in the literature before. However, a framework paper intended to devise a solution to harvesting human kinetic energy in the gym throughout various stages (Rowejeh, Sounni, & Fawzy, 2020). The aforementioned paper is highly recommended because it discusses social acceptance and stakeholder perspective in this matter, so this paper can be regarded as a step toward achieving RE harvesting.

METHODOLOGY

This work focuses on investigating the acceptance level of society regarding the idea. Using a survey to investigate the subject of this research came from the advantages of using it as a data collection channel to reach the desired random sample. Surveys allow the collection of a large amount of data in a comparatively short time. Also, they are beneficial in representing

the characteristics of a large population, which ensures more accurate conclusions will be drawn through decision making. Moreover, they are inexpensive when compared to other methods of data collection techniques and can be formulated instantly. They can be used to collect information on a broad range of topics, including personal facts, attitudes, past behaviors, and opinions (Cherry, 2020).

To determine the sample size needed with at most a 10% margin of error, the population number must first be determined. The scope of this study is aimed at individuals in the age group of 15 years old or more. According to the General Authority for Statistics in Saudi Arabia, there are around 26,400,000 individuals in this age group (General Authority for statistics Kingdom of Saudi Arabia, 2021). By using statistics, it was estimated that the sample size needed for the survey is 96 responses. Results were used to examine the user's perspective and their thoughts about the expected success of implementing the concept in fitness centers/gyms. The data is collected from a sample of people who are users in sports clubs in Saudi. To obtain results, a random sampling method was used, in which the participant was chosen not based on any background or biased criteria. This method was used due to its numerous advantages. For example, it requires little knowledge about the population. In addition, this method has a high level of internal and external validity. Also, its ease of analysis is one of the advantages of this method. Finally, using this method leads to gaining insights regarding the population as a whole (Acharya, Prakash, & Saxena, 2013).

This work studies users' acceptance rate for generating energy from gym activities. For the acceptance level measurement, a survey was designed. Then, a pilot study was conducted to check the survey quality. The survey was designed in an electronic format and divided into four parts; each part has a set of questions that focus on the research objectives' main idea. The survey validation was measured by distributing it to four users in sports clubs; based on their feedback, the survey was modified. Based on the pilot study, the participants took three minutes to finish filling out the survey on average. Moreover, based on the feedback, two new questions were added, the first being to exclude any participant unsubscribed to gyms in Saudi Arabia. The second regarded the participant's interest in the energy source. Moreover, in some questions, the answer ranges were re-grouped. Finally, one of the answers to a question was canceled, and participants were able to choose more than one category.

After that, the final version of the survey was distributed and data collected. The electronic survey was distributed using different social media channels. 160 responses were collected. Then, the data were examined, and only 96 responses were used based on the sample size calculated. Exhibit 1 summarizes the steps used.

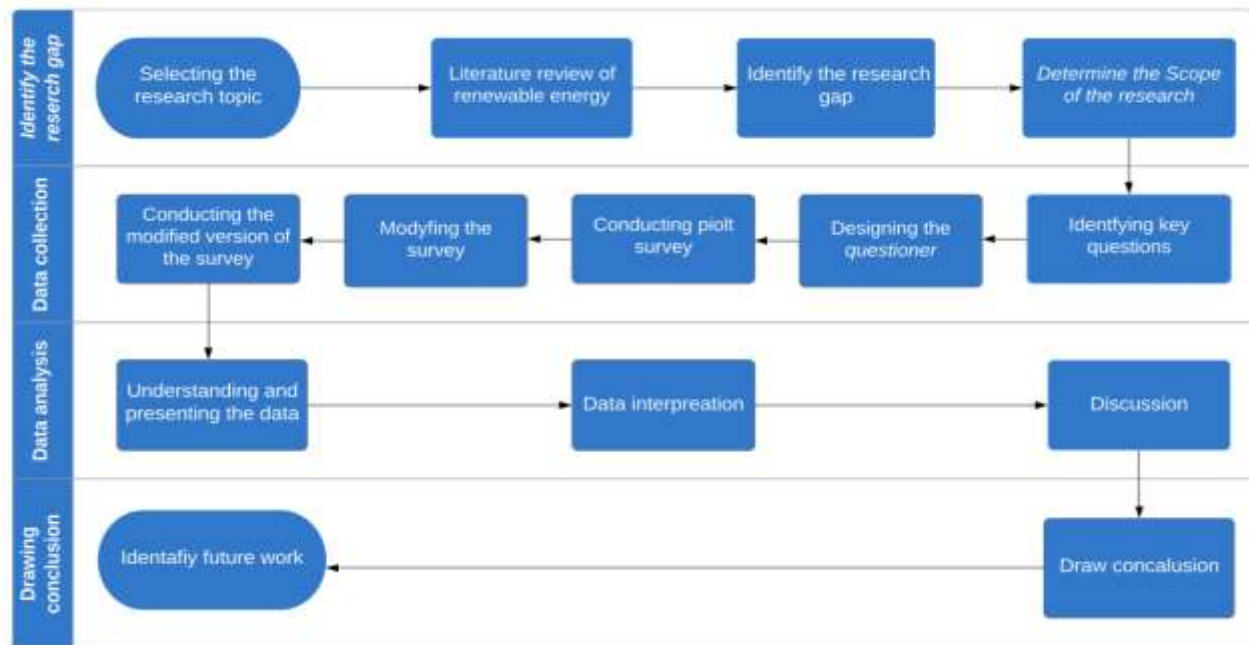


Exhibit 1: Research methodology

RESULTS AND DISCUSSION

The survey analysis focused on describing the gym practitioner's overall behavior. With that being said, the researchers disregard gender as an analysis criterion in this work. Most responses came from male participants, accounting for about 58.3% of the total participants in the survey, and this is expected given that gyms for female users were officially licensed by the Saudi government in September 2017, which is considered relatively near. The results are classified into four main sections: the first set of questions concentrates on displaying the demography and variety of the survey participants. The second segment mainly concentrated on providing information about the participants' workout behavior inside the gym. The third section of the survey regards the participant's acceptance level of RE in general and especially in producing/using RE in their daily life. The final section of the survey covers the participants' willingness to be part of the idea based on whether they have financial or moral motivations.

Demographics

The researchers found that the survey participants are from 5 different regions in Saudi Arabia, as shown in Exhibit 2. Around 84% of the participants are from the Makkah region. This result was expected due to the researchers' connections in that region corresponding to other regions in the country. As for age variation, around half of the participants are young individuals (18-24 years old), accounting for 47%. Thus, as a result, most participants are young individuals

aged 40 years old or younger. Exhibit 3 shows the detailed spread of the participants' age groups.

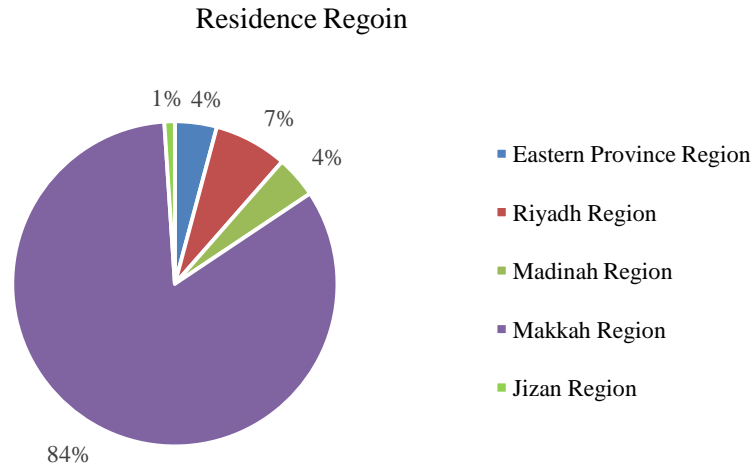


Exhibit 2: Participants' regions

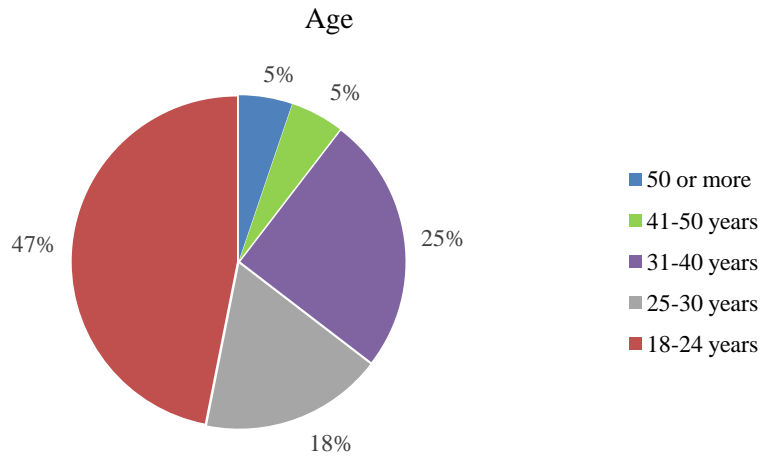


Exhibit 3: Participants' Ages

Behavior

The result shows that in regard to the duration of their subscription to the gym, the highest share of participants had been going for fewer than six months at 48%; the other durations are shown in Exhibit 4. As for the number of visits per week, it is found that around 61% of the participants visit the gym from 4 to 6 times a week which indicates a high level of commitment to working out; Exhibit 5 shows the rest of the visit data.

Period of subscription

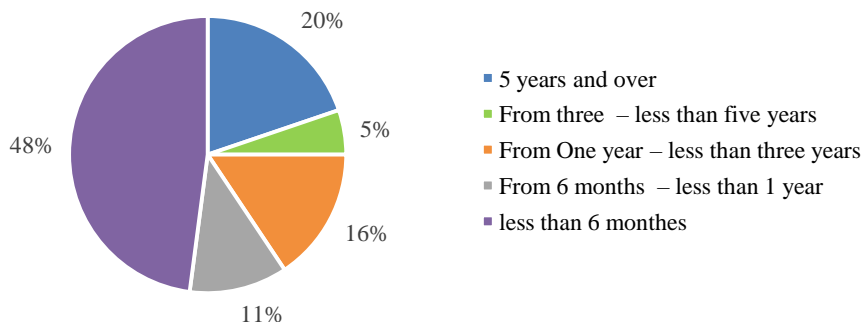


Exhibit 4: Participants' duration of the subscription

Visits per week

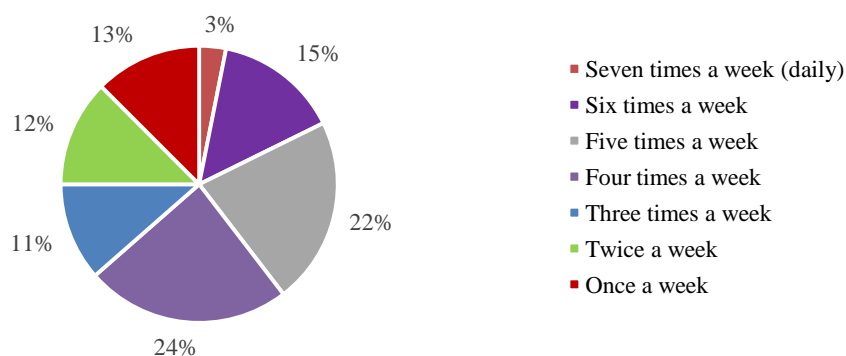


Exhibit 5: Participants' number of visits per week

As for the duration of the exercise per visit, more than half of the participants (62%) spend 1-2 hours exercising per visit, the rest of the data is provided in Exhibit 6. Meanwhile, 58% of participants were found to engage in 2 or more types of exercises as shown in Exhibit 7.

Duration of Exercise

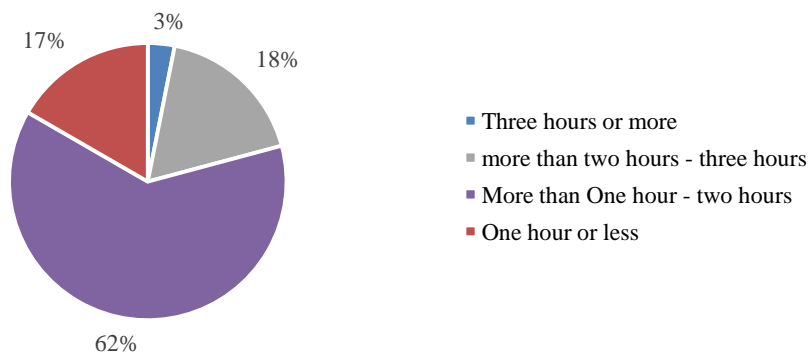


Exhibit 6: Participants' duration of the exercise per visit

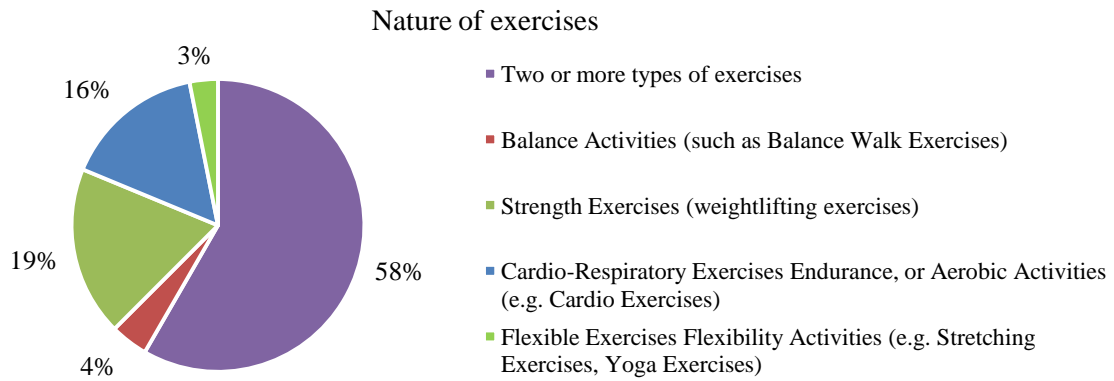


Exhibit 7: Participants' nature/type of the exercises

As for how the participants exercise, the most significant share (46.9%) of participants prefer to mix between working out in a group and individually, as seen in Exhibit 8. As for the training style in the gym, 55.2% of participants exercise without guidance (without a coach/solo); meanwhile, the rest of the data are provided in Exhibit 9.

Do you exercise outside the gym

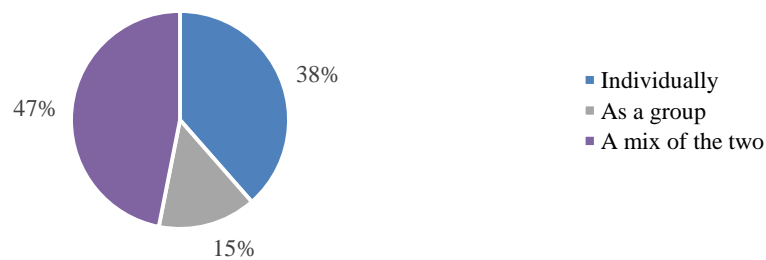


Exhibit 8: How the participants exercise

Do you have a sports coach (private) to guide and supervise the exercises you do within the gym?

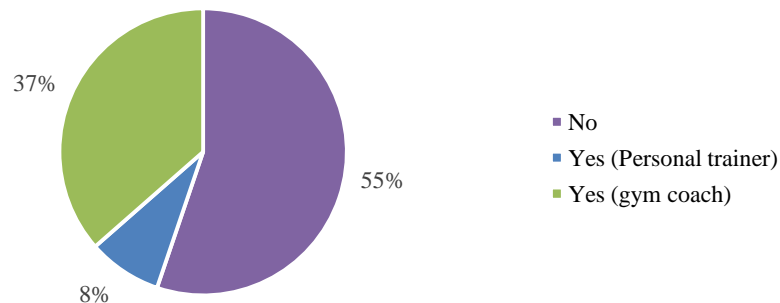


Exhibit 9: Participants' training style in the gym

Based on the data, the average exercising time can be an indicator of the potential energy output from gym users. Based on the behavior interpreted, 61% of participants visit the gym between 4 - 6 times per week, and 62% exercise with a duration of 1-2 hours, thus giving us an average exercising time of 8 hours per week for each participant. Nonetheless, other factors such as the type and intensity of the exercise and the efficiency of converting the energy should be considered to get a more accurate indicator.

Awareness

For the third part of the survey, the result illustrates that around 74% prefer to use energy from clean (renewable) sources, while 17.7% do not mind using energy from any source, as shown in Exhibit 10. However, 62.5% are willing to be part of the RE production, while 32.3% have no preference about being part of it, as shown in Exhibit 11.

Do you prefer that the energy sources you use in your daily life come from renewable energy source?

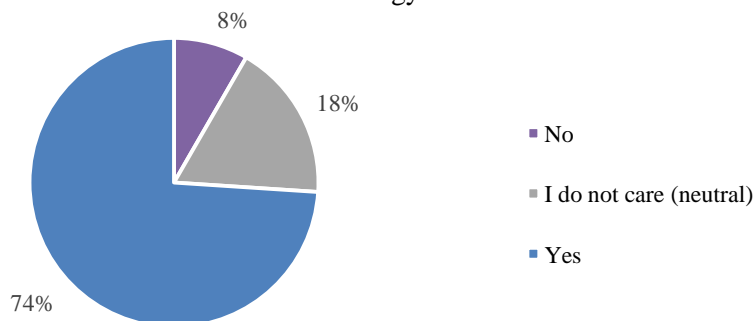


Exhibit 10: Participants' preference for energy sources as used in daily life

Do you mind using your physical exertion as part of the production of renewable energy?

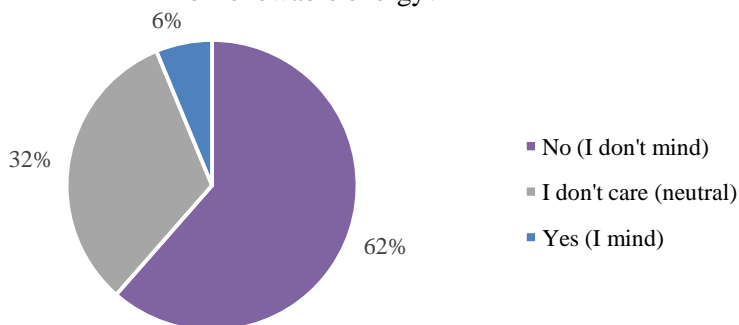


Exhibit 11: Participants' allowance to use their effort in the production of RE

Willingness

For the final part of the survey, Exhibit 12 shows that around 43.8% are willing to be part of the RE production with moral motivation. However, when a choice of financial motivation was given, around 63.5% were willing to be part of the production of RE, as shown in Exhibit 13. Thus, due to the financial motivation, the willingness to partake in RE production increased by 19.7%, which indicates that it can be a controlling factor in RE production from gym users.

Would you prefer to receive moral compensation only for your contribution to the production of renewable?

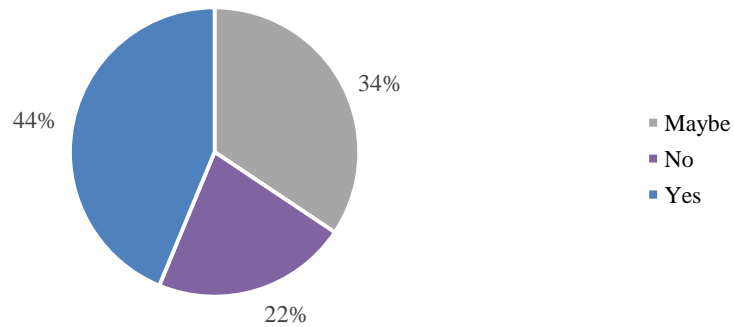


Exhibit 12: Participants’ preference to receive moral compensation only (thanks, internal satisfaction, and membership benefits such as a private car park, etc.)

Would you prefer to receive financial compensation only for your contribution to the production of renewable?

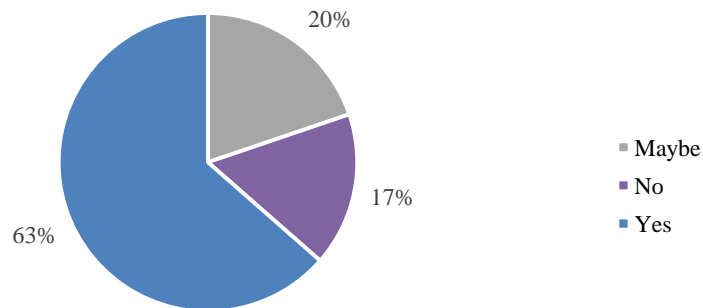


Exhibit 13: Participants’ preference to receive financial compensation only (subscription fee reduction, free additional subscription period, payment, etc.)

Limitations of the work include that the researchers have covered only 5 out of the 13 administrative regions in Saudi Arabia. Also, the researchers chose to use the maximum acceptance margin of error in determining the sample size, which is 10%. Moreover, the

analysis did not include neither the type of exercise nor the gender difference in describing the behavior of the users.

FUTURE WORKS AND RECOMMENDATIONS

In general, RE is growing fast. It is in high demand globally. As for generating energy from physical activity, it seems to be a revolutionary idea, and as established, it has untapped potential. It also appears that society has been adequately educated about the proposed idea in this research, and people are generally supportive of its implementation. However, future work might include a similar study that is conducted considering a narrower margin of error, such as a 5% confidence interval, to get more representative results of the population and to validate the result and analogize it with the current study. Also, other factors could be included, such as the type and intensity of the exercise and the efficiency of converting the energy to get a more accurate indicator of potential RE output. Finally, a study of investors' and gyms owners' perspectives should be carried out to get the perspective of all stakeholders.

CONCLUSION

In conclusion, the market is demanding more sustainable energy resources. The results show Saudi's awareness of RE. Moreover, it also shows their willingness to use their HKE, out of gym activities, to general RE. In addition, both moral and financial incentives motivate participation in such initiatives. Furthermore, financial incentives increase participants' acceptance by approximately 20%. Also, the results show an average exercising time of 8 hours per week per practitioner. This is an indicator of the potential energy output from gym users.

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