August 2021

IMPROVING RECYCLING IN JORDAN: USING SURVEYS AND CASE STUDIES TO PREDICT THE SUCCESS OF PROJECT TADWEER

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A capstone paper submitted in partial fulfillment of the requirements for a Master of Arts in Climate Change and Global Sustainability at SIT Graduate Institute, USA

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Acknowledgments

Conducting and writing my capstone project and paper in Jordan was not an easy feat, and it forced me to step outside of my comfort zone. I arrived in the country knowing nobody and without knowing any Arabic. I also had limited financial resources and it took me a while to finalize a capstone project that I would pursue.

Because of these difficulties, I am truly thankful for the people and organizations that were able to help me overcome these challenges and help me to have fun along the way. First, I would like to thank Dr Raed al Tabini for helping me to identify an organization to conduct my practicum and capstone project, and by serving as my practicum and capstone supervisor. Next, I would like to thank Dr Richard Waltz and Dr Xavier Silva for advocating, teaching, and supporting me throughout the process. In addition, my studies would not have been possible without the Royal Marine Conservation Society of Jordan (JREDS). There, I performed work and had support and guidance from Mohammed Al-Tawaha, Shereen Aqrabawi, Hamzeh, and from all my coworkers.

Last, I would like to thank my family and friends for providing encouragement, comfort, and financial support throughout the semester. I would also like to thank the wonderful people of Jordan for welcoming me to this interesting country and for their kinship

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Abstract

Globally, the mismanagement of municipal solid waste continues to be an environmental, human health, and economic hazard, especially in developing countries. In Jordan, solid waste production is rapidly increasing as their population continue to grow. Unfortunately, only 6 to 10% of this waste is recycled with most of it landing in landfills or open dumpsites. Because of this, project TADWEER ("recycle" in Arabic) was launched by the Royal Marine Conservation Society of Jordan's (JREDS') Eco-School program and will attempt to achieve zero waste in 10 selected schools in Al-Zarqaa and Irbid for the 2021-2022 school year. The project also plans to influence recycling behavior in surrounding communities and ultimately the nation. An aggressive plan was put together to achieve this, but only time will tell to see how successful the program will be. To predict the success of project TADWEER, numerous case studies of successful school recycling programs were examined for comparing their action plans to project TADWER's plans. In addition, 102 surveys were conducted within two malls to receive up-to-date information on recycling practices and attitudes in Jordan, and to see how responders might be influenced by the project. From the surveys, it was noted that poor recycling practices still exist in Jordan, but Jordanians view that it is important. It was also noted that people want recycling to become more convenient. From past project comparisons, it was observed that the action plans of previous successful recycling programs aligned with that of project TADWEER's. Together, the results of the surveys and case studies support that project TADWEER will be successful. The project will be able to help increase recycling rates by making it more convenient and by educating students and people of the dangers of mismanaged waste. The TADWEER project is also engaging, important, and proactive. Predicting the success of an environmental program is key to improve the planning of future projects used for forecasting. If the prediction is right, the same technique could be used to predict others.

Introduction

Solid Waste- Everybody's Problem

No matter when or where you go, you are almost guaranteed to find trash of some sort either contained in a bin or facility or free in the environment. Human waste could be found in the most remote areas on the planet which include coastal areas, deserts, floating within rivers and marine ecosystems, buried underground, or anywhere else you could imagine (Jambeck et al., 2018). Often, the original source of this trash is from municipal solid waste, which comes from cities and urban areas, and is produced by households, commercial offices, public institutions, schools, or other anthropogenic sources (Jordan GBC, 2018). This waste does not include hazardous substances and is often collected by municipal authorities or from private nonprofit or business organizations (Jordan GBC, 2018).

Globally, municipal solid waste is made up of about 4% metal, 5% glass, 12% plastic, 17% cardboard and paper, and 44% food and green waste (World Bank, 2018; Verma et al., 2016). Without proper treatment, this waste has been documented to pose serious environmental, health, and financial problems. The solid waste sector is one of the biggest contributors to climate change by adding many tons of greenhouse gas emissions to the atmosphere causing worldwide issues (Hajar et al., 2020). In addition, waste could be found in direct contact with humans or the natural environment where it could negatively affect populations or pristine ecosystems. Waste can end up in the environment in numerous ways and include being directly dumped, can be blown from landfills or waste bins, and can accidentally be dropped or slipped from marine vessels, cars, people, animals, or from other carrying agents (Smith, 2020). After this waste find its way into the environment, it could easily be transported globally by wind, ocean currents, rivers, transportation agents, or from other forces.

Although waste management is a worldwide issue, developing countries in particular struggle to find the best solutions to manage it sustainably and suffer many consequences from improper management techniques. For instance, countries like Jordan lack infrastructure, collection capabilities, transportation, proper disposal, and education of municipal solid waste (Ejaz et al., 2010; Horvath et al., 2018). As a result, it is important that Jordan finds a sustainable and eco-friendly solution to waste management to limit it consequences, and this could be achieved by increasing recycling. Globally, it is well documented that recycling can help alleviate waste problems substantially and would have numerous benefits for the economy, environment, and for human health (Elayan & Ibrawish 2017). Because of this, recycling is encouraged not only in Jordan but also the whole world. From this knowledge, numerous pioneering projects have opened in Jordan and one of these is the TADWEER project. Its goal is to help schools achieve zero waste and help spread awareness of the importance of recycling. Its aim is to encourage other sectors in Jordan and other countries to implement such policies to make the world a more sustainable and greener place.

Study Objectives

Overall, this study aimed to predict how successful the TADWEER project would be once it is implemented in selected Jordanian schools. A successful project would yield sustainable and lasting waste management skills in schools, spread knowledge and recycling practices among the community, and would leave lasting wisdom, green lifestyles, and sustainable advocacy within the students of the program. Ultimately, this will cause more pressure to be put on large organizations and the government to prioritize the recycling of waste material and switch to a circular economy. To forecast a successful program, research, case examples, and surveys were conducted throughout the duration of the project. After results were

obtained, the reliability of the TADWEER project was evaluated and measured based off past successful recycling projects and current Jordanian opinions on recycling. Understanding and making predictions about how successful a sustainable project will be is important for planning and establishing future projects for other similar environmental projects. After forecasting the reliability of a project, it is then possible to wait and see the project run, and then measure its success directly and compare it to the original predictions. If the success of the project is what the forecasting study predicted, then the study was successful and similar methods could be used to predict the effectiveness of other planned environmental projects.

Research Questions and Hypotheses

Ultimately, the main question asked before starting the study is will the TADWEER project be successful in achieving its goals? Will it achieve in making schools sustainable and increase community and national involvement in sustainable practices? What are Jordanian citizens current perspective and involvement in recycling? How will project TADWEER change the perspective of individuals who are not participating in recycling?

In all, it is hypothesized that project TADWEER will be successful because it involves all members of a community to push for sustainability in schools, the community, and the country. The TADWEER project also has a precise and well-thought-out proactive plan to achieve its goals and is ran under the Royal Marine Conservation Society of Jordan (JREDS) and the Eco-Schools FEE program; two well established organizations that has seen success in their own projects. It is also hypothesized that the surveys conducted will show that most of the people in the country have not or do not recycle much, find it to be inconvenient, but view that it is important. It is also hypothesized that the surveys will show slightly higher recycling rates and be more important for younger citizens and females based on previous surveys conducted

elsewhere. Recycling rates is also predicted to be higher for individuals now than they use to be because of increases in awareness and education on the negative effects of waste globally. Last, it is hypothesized that that the TADWEER project has high potential to change negative recycling habits and beliefs to positive ones based off the effect that education have on influencing community lifestyles and mindsets.

Waste in Jordan and Schools

Jordan's Background

Jordan is a country in the Middle East with a population of about 10 million people and it shares borders with Palestine, Israel, Syria, Iraq, and Saudi Arabia (Hajar et al., 2020). The country has experienced explosive population growth over the last numerous decades from the results of internal population growth and from the immigration of refugees from surrounding areas (Aljaradin et al., 2011). As of 2019, the country hosted about 1.4 million Syrians in which 646,700 were refugees from the conflicts in Syria (Aldayyat et al., 2019). Today, this population is continuously increasing from the reasons mentioned. Along with this growing population, the country is experiencing an increased standard of living due to cultural and economic development and this results in increasing resource demands and consumer habits (Aljaradin et al., 2011).

Figure 1: Jordan is a country in the Middle East, and it shares borders with Palestine, Israel, Syria, Iraq, and Saudi Arabia.

Figure 2: Jordan has seen explosive population growth over the last decades.

In addition to the pressures presented by population growth and development in the country, climate change is changing the "normal" natural weather patterns to become more extreme and drier. Over the past couple decades, Jordan has received significantly less rainfall and has been seeing more variable precipitation patterns (Aljaradin et al., 2013). Jordan is also experiencing a higher number of extreme hot days and a higher number of days of extreme low temperatures (Aljaradin et al., 2013). On average, the temperatures have become 0.4 to 2.8 degrees Celsius warmer which led evaporation rates to increase by 93% (JREDS Eco-schools, 2021). This high evaporation rate is coupled with precipitation decreasing by a total of 20% (JREDS Eco-schools, 2021). These changes have many negative consequences including increasing demands for energy, which puts a strain on the economy and on natural resources (Aljaradin et al., 2013).

Jordan is naturally a very arid country, but high population growth, climate change, and unsustainable groundwater exploitation has decreased the availability of freshwater resources farther than what it once was (Hajar et al., 2020). The limited freshwater available is then often contaminated by runoff, waste, and pollution which makes it not suitable to drink or use (Fanack Water, 2021). In fact, this problem is so extreme that Jordan suffers from one of the lowest renewable freshwater resources per capita in the world (Aljaradin et al., 2013). The country is in danger of running out of this precious supply if no changes are made.

Jordan's Waste Production and Management

Due to Jordan's rapid population growth, increasing standard of living, and industrialization, the country has experienced rapid and increasing production of solid waste. Every year, millions of tons of municipal solid waste is produced and puts tremendous pressure on the current waste management facilities and collecting transportation agents (Jordan GBC, 2018). Daily, it is averaged that Jordan produces about 3,700 tons of waste per day, but this number is growing as the migration of refugees and internal population increases (Aldayyat et al., 2019). So far, from only the inflow of refugees alone, the total amount of waste produced have grown by 340 tons daily (Aldayyat et al., 2019). On a yearly basis, the country produces 2 million tons of municipal waste, but this number is growing by 3% every year (Aldayyat et al., 2019; Hosking, 2016).

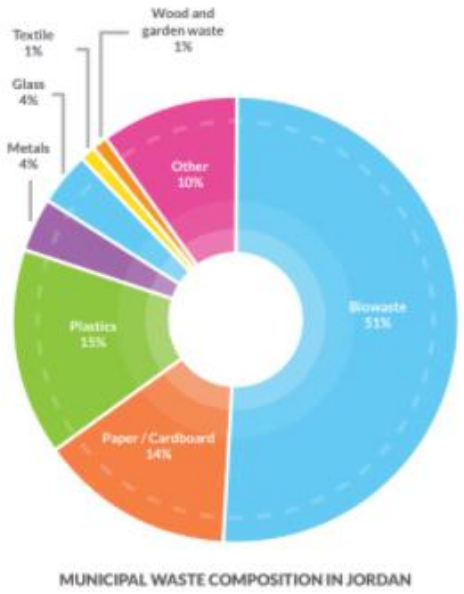

Figure 3: A diagram showing exactly what municipal solid waste is composed of in Jordan.

Municipal solid waste in Jordan originates from many different sources in which 80% comes from commercial and domestic sources while the other 20% is produced from activities from the industrial sector (Aldayyat et al.' 2019). In addition, the type of solid waste produced could be broken down by category. In total as of 2012, 50% of the solid waste that is disposed is organic while 16% is plastic, 15% is paper and cardboard material, while the remaining 19% composes of metal, glass, and other solids (Aldayyat et al., 2019). Without proper management, this waste could have numerous negative consequences for the country.

In all, there are a total of 18 disposal sites in operation in Jordan currently. These include four landfill sites in the northern part of the country, five in the central region, and nine in southern Jordan (Jordan GBC, 2018). The largest landfill is the Al-Ghabawi Landfill, and it is located near the capital and largest city Amman (Hajar et al., 2020). The Al-Ghabawi Landfill holds about half of the country's waste while the other half is dumped in 17 other sites dispersed throughout the country or is openly dumped or recycled (Hajar et al., 2020; (Aldayyat et al., 2019). Unfortunately, many of the disposal sites are outdated and do not have appropriate lining, proper leachate prevention or collection mechanisms, or biogas recovery methods (Hajar et al., 2020). As a result, stored waste in these sites have more potential to cause environmental harm than waste stored at updated landfills. In total, 50% of generated waste is stored in these engineered landfills, 35% is stored in controlled dumpsites, 6 to 10% is recycled, and 5% is openly dumped (Aldayyat et al., 2019).

Figure 4: Trash can be found outside in many areas in Jordan.

Schools and Solid Waste

Schools are an important source of municipal solid waste worldwide and in Jordan. Schools and universities often contain many students and staff members and they could be

considered small communities on their own. Because of this, educational facilities could have a substantial impact on the surrounding urban area, city, and nation (Moqbel, 2018). Unfortunately, one of these impacts is the amount of waste they generate. A large percentage of the waste schools produces stems from food and paper, but the waste is also composed of clothes and housewares items, electronics, maintenance waste, furniture, art supplies, and biological waste (Wastebusters, 2013; ERC, 2021). In many educational institutes, most of this waste ends up in landfills and contributes to the already existing waste problems. Especially in developing countries, educational institutes often rely on the government or on individual efforts to manage their solid waste (Moqbel, 2018). This has proved to be unsuccessful numerous times.

Waste has been audited in numerous schools and universities worldwide. For instance, the University of Johannesburg in South Africa produces about 310 kilograms of waste per day in their established waste management system (Moqbel, 2016). In addition, from a period from 1996 to 1999, the University of British Columbia located in Canada reported that 2,834 tons of waste was produced per year on the campus (Moqbel, 2016). Within the country of Jordan, Moqbel's study revealed that the University of Jordan produces 8,113 kilograms of waste per day during regular semester hours. Moqbel's study has also shown that the amount of food waste, glass, plastics, metals, and hot beverage cups discarded fluctuates depending on the semester and holiday throughout the year. For example, paper waste increased during breaks, indicating facilities were cleaned after final exam sessions were concluded and excessive paper material was discarded for the next semester (Moqbel 2018).

In addition to the amount of waste produced in Jordan, many of the educational facilities there lack proper disposal containers. In a report, 50% of Jordanian schools have completely no waste disposal bins (Ministry of Education, 2016). Schools with this problem practiced waste

management by burning rubbish or by scattering around trash within the school premise (Ministry of Education, 2016). The survey also revealed that 73% of the school that did have waist bins reported that there are not enough collection bins, or that the existing ones are too small to properly handle produced waste (Ministry of Education, 2016). Without better waste managing techniques, students and the community will continue to be exposed to waste pollution.

The Problem of Municipal Solid Waste?

The Dangers of the Mismanagement of Municipal Solid Waste Overview

The effects of solid waste on the environment, economics, and human health are well researched and documented throughout the world. This is because proper waste managing techniques decreases or eradicates harmful environmental or human health degradation (Jordan GBC, 2018). Once this is achieved, economic and social growth would result. It is important to implement, pursuit, and support projects the aim to reduce waste to achieve these goals.

One of the main dangers of solid waste is that it contributes to climate change highly. In Jordan, municipal solid waste management accounts for around 10% of the country's net greenhouse gas emissions (Hajar et al., 2020). The main two gases that are produced are carbon dioxide and methane, both of which have profound impacts in supporting radioactive forcing on our planet. In the year 2000, the waste industry added 20.14 million tons of carbon dioxide to the atmosphere in Jordan alone, and account for 91.6% of the country's total methane emissions (Aljaradin et al., 2013). Most of the greenhouse gases originating from the waste industry is

caused from the breakdown of solid waste. For instance, globally, food that is wasted is accountable for increasing the planet's greenhouse gases by 3.3 billion tons per year (The POD, 2016). As food and other organic products breakdown in landfills, they produce mostly carbon dioxide under aerobic conditions, but this carbon dioxide production process decreases as the waste is covered and experiences decreased oxygen availability. When materials experience anaerobic conditions, the carbon dioxide production decreases while methane production increases (Aljaradin et al., 2013; The POD, 2016). Methane is very damaging to the Earth's atmosphere and is over 80 times more powerful than carbon dioxide over a 20-year period (The POD, 2016; EDF2, 2021). In turn, conditions that support aerobic conditions like composting supports carbon dioxide over methane production.

Municipal solid waste management is also a major contributor to air and water pollution. This pollution is displayed through a country's hydrology, geology, or climatic systems (Aljaradin et al., 2013). As pointed out earlier in the manuscript, some of the waste that is managed is burnt and this produces greenhouse gases and air pollution (Verma et al., 2016). Air pollution has both negative effects for human health and the environment and it has been well documented worldwide. The mismanagement of waste in landfills also has the potential to affect water resources and containment soil. Electronic waste such as TV's, computers, and mobile phones are discarded into these land fields and are degrading to the environment because they contain pollutants such as mercury, lead, and other toxic chemicals. Once these chemicals escape

from their devices, they could leak and spread within the landfill or to unintended areas outside (The POD, 2016). The linings in many landfilled sites are often not completely sealed and allows for the escape of such pollutants into the surrounding environment. On top of this, many arid regions experience heavy rainfall erosion within their disposal sites and allows for the contamination of ground and surface water (Aljaradin et al., 2013). Precipitation is not very common in these areas, but when it does happen, the runoff could carry build up pollutants to contaminate soil, groundwater, or the scarce freshwater sources nearby (Ejaz et al., 2010).

Landfills may not only experienced leakage, but large pieces of trash could escape from them or may be directly dumped into an environment. For instance, plastic pollution requires immediate attention as it litters our globe and could be found almost anywhere. Around 32% of plastic packaging escapes dumps or landfilled sites and becomes free in the environment (Milton, 2018). It has been reported that there is 12 million tons of plastic leakage that ends in the oceans each year, and this has altered the characteristics of both marine environments and coastal communities (IUCN, 2021). This has also helped result in 60 to 80% of the waste found on beaches or coastal areas to be composed of plastic material (Verma et al., 2016). As this plastic waste sits in the environment, it can degrade over time into smaller pieces call microplastics. Microplastics could indirectly enter the environment by being produced from large plastic pieces when they are broken down from the mechanical action of waves or wind or by sunlight's UV rays photodegrading the material into smaller plastic parts (Milton, 2018). Microplastics could

also accumulate in the environment from direct sources like from hand creams or other personal care products, in which contained microplastics or beads and can easily escape sewage treatment centers and into the environment (Milton, 2018). Once outside, plastics take a long time to decompose and can remain in the environment for hundreds of years. Eventually, trillions of pieces of plastic accumulate in the ocean and can affect all ecosystems and coastal communities, including Jordan's Gulf of Aqaba (Jambeck et al., 2018).

Environmental Impacts of Solid Waste

Once in the environment, solid waste could have profound impacts for biodiversity in its ecosystem. Many ecosystems are affected by the smallest of changes caused from human activity and are altered in negative ways (JREDS Eco-schools, 2021). This could occur either from wildlife being directly exposed to the waste or from the leakage and pollution of chemicals originating from solid waste into the environment.

One of the largest threats that escaped garbage poses to the environment is it could cause organisms to become entangled within it or cause them to consume the waste. This is seen within seabirds as it has been documented in more than 100 species (Lange et al., 2018). Often, birds may mistake plastic pellets to be fish eggs while whales and sea turtles may mistake plastic bags to be squid or jellyfish (Milton, 2018). In other instances, animals may accidentally consume marine debris when it is mixed with their natural diet (Milton, 2018). In fact, this problem is so important that a study found that 61% of green sea turtles have some form of marine waste in

their digestive track, and this included rope, string, plastic bags, and cloth (Milton, 2018). Unfortunately, many animals that consume this excessive waste die as it could cause malnourishment (Horvath et al., 2018). Entanglement of this waste could also cause the death of organisms by allowing them to suffocate, starve, become infected, cause lacerations, and can reduce reproductive success (Kibria, 2017). Altogether, plastic debris causes the death of over a million seabirds and kills more than 100,000 marine mammals annually (Smith, 2020).

Escaped large pieces of solid waste do not only affect individual organisms but also the whole ecosystem. Once a large piece of waste sits on the ground, it may cover up soft sand or soil and act as a barrier. As a result, hard trash could trouble burrowing creatures and could keep them from laying eggs or finding food (Lange et al., 2018). Large pieces of trash may also float in the ocean and act as a transport vector for invasive species from one location to another (Jambeck et al., 2018). If this trash is not floating in oceans, debris may damage coral reefs or aquatic plants by sinking or drifting and this could smother, suffocate, or cause blunt force to physically damage these organisms (Milton, 2018).

Although large waste is harmful, it does not have to be big to make a negative impact on the environment, and this is demonstrated through the effects of microplastics. These plastic particles are less than 5 millimeters in size and wreak havoc on ecosystems (Smith, 2020). Like large pieces of trash, microplastics may be mistaken for food by small fish or swallowed by larger organisms eating their natural diets containing these small plastic pieces. As this behavior

continues, plastic may accumulate in the digestive track of these animals and could cause infection, starvation, and possibly death (Kibria, 2017).

Other forms of waste like leakage and chemical spills originating from municipal solid waste also poses environmental impacts. For instance, in aquatic ecosystems, heavy metals like mercury have been found to negatively influence the behavior and survival percentage of various fish species (Wreg, 2021). In addition, the pollution resulting from heavy metals could affect terrestrial ecosystems by contaminating soils. This pollution stays in the soil for a very long time and negatively influence the health of bacteria, fungi, and other microorganisms (Wreg, 2021). Contaminated soils or also bad for the health of plants which serve as the basis of the food chain (Wreg, 2021).

Lastly, poor waste management techniques harm the environment by polluting the air and causing climate change. In a study, air pollution has been shown to cause negative respiratory issues within organisms that inhabit near major urban areas (Wreg. 2021). In addition, air pollution has been demonstrated to have negative reproductive success rates in mice and other mammal species (Wreg, 2021). Climate change on the other hand has been displayed to host all type of negative effects on the environment including altering the climate towards more extreme weather events, changing the composition and quality of ecosystems, putting stress on organisms, displacing individuals, and more (EDF, 2021).

Because the negative effects of solid waste and spills in the environment are well known, efforts to remove it are ongoing in many cases. However, efforts for this removal process may also harm the ecosystem. It has been documented that physically removing or using mechanical devices to remove waste could cause adverse effects on shoreline habitats (Milton, 2018). As a result, the best way to prevent this is to keep waste from entering the environment at all.

Solid Waste Mismanagement Impacts on Humans

The mismanagement of solid waste is not only negative for the environment but for people as well. The effect of this waste is well documented and includes causing infrastructure problems, negatively impacting human health, induces disease spread, and hurts the economy of Jordan and other countries.

One negative effect of solid waste in urban areas is it may clog drainage systems or clutter streets or open areas. Waste, especially in the form of plastic bags may end up in sewer lines or cover storm drains preventing the passage of water (Agape, 2021). If it rains, water will not be able to properly drain into spillways and flooding may result. Because of this, human lives may be impacted directly from floods by causing drowning or the buildup of standing water may create unsanitary conditions or create mosquitoes/ other water-boring insect breeding grounds (Horvath et al., 2018; Ejaz et al., 2010). Numerous insects that breed in water can carry and transmit diseases to the human population, and with an increase in breeding in still water, the number of transmitted diseases would increase (WHO, 2019). Poorly managed waste could also

block traffic and clogged open areas which would discourage efforts to keep these areas clear of being dumped on and considered for further development (Ejaz et al., 2010).

Being in direct exposure or proximity to municipal solid waste also is damaging to human health. A person may accidentally consume foods or drinks that contain microplastics like fish or contaminated drinking water (Smith, 2020). After ingesting, these plastic additives might alter various biological mechanisms such as the endocrine function (Lange et al., 2018). Unfortunately, it is estimate that a person may consume around 39000 to 52000 particles of microplastics depending on their age and sex every year (Cox et al., 2019). In addition, waste could cause harm to people by physical injury. Items such as razorblades, needles, broken glass, pressurized cans, and chemical and biological hazardous waste increases the risk of injury or poisoning to people, especially to collectors, scavengers, and school children (Ejaz et al., 2010). Last, just the odor of the waste could cause problems directly to human health. As waste breaks down, it produces a lot of odors. Like the effects on surrounding wildlife, these odors are unpleasant and could cause respiratory diseases in people (Ejaz et al., 2010; JREDS Eco-schools, 2021).

One of the other dangers of waste is it can serve as a breeding ground for many pests. Like waste harboring waterborne insects from the blockage of drainage systems and sewers, terrestrial insects and animals like flies originate from the waste on dry lands. The linkage between waste and fly population is positively correlated and they have the capacity to spread

diseases to humans (Ejaz et al., 2010). Food waste and other thrown out materials can also serve as food and shelter for rats who have been reported to cause electrical damage to wires, spread illnesses, and damage infrastructure (Ejaz, 2010).

Financial Impact of Solid Waste Mismanagement

In addition, the mismanagement of waste hurts the economy. One of the major industries that it impacts is the agriculture industry. Livestock has been documented to consume plastic waste and this negatively affect their size, quality, and milk production, and thus, reducing how much they could be sold from by farms (Lange et al., 2018). Unfortunately, this is more common than we might think as a study shown that over 50% of cattle near an urban area had plastic bags in their stomachs (Lange et al., 2018). Mismanagement of waste in a country may also lead to less tourism there (Jambeck et al., 2018; Milton 2018). Waste makes an area less aesthetic and less appealing to tourists, keeping them from visiting it (Milton, 2018). Reduced tourism activity is also associated with the reduction of the quality of recreational activities because of trash interference (Kibria, 2017). Interfere of waste is also damages vessels and effect energy-producing businesses, as production may be decreased with waste obstruction (Kibria, 2017).

Overall, these impacts of the mismanagement of solid waste are expensive. It negatively impacts the environment which provides ecosystem services such as being a food source, medicine supplier, and income generator and causes negative impacts for humans directly (JREDS Eco-schools, 2021). Globally, only from plastic damage to the marine ecosystem alone, it is estimated that it costs JD 9.2 billion per year (Milton, 2018). In Jordan itself, the overall cost of environmental degradation is estimated to be between JD 143 to 332 million in 2006; 2.35% of the GDP at the time (Cervigni & Naber, 2010). Waste mismanagement contributes to this number significantly as it ranks as the third most important cost towards environmental

degradation, falling behind only air pollution and the impact of inadequate water supply (Cervigni & Naber, 2010). If waste management is improved, the economies of Jordan and other like countries would be better.

TABLE 3.1 ANNUAL COST OF ENVIRONMENTAL DEGRADATION, 2006

Sector	Minimum (million JD)	Maximum (million JD)	Mean (million JD)	Percent of GDP
Air	29.1	200.3	114.8	1.15
Water	76.8	89.2	83.1	0.81
Waste	20.6	25.2	22.9	0.23
Soil	10.7	10.7	10.7	0.11
Coastal zone	5.9	5.9	5.9	0.06
Total	**143.1**	**331.3**	**237.4**	**2.36**

Source: Authors' calculations.
Note: GDP = gross domestic product; JD = Jordanian dinars.

Figure 5: Waste is a major contributor to the cost of environmental degradation.

Recycling: The Better Way to Manage Waste

Overview

One of the best ways to manage waste is through recycling. In summary, recycling municipal waste is the mechanism to reuse this "trash" to make a new product out of it (Jordan, GBC). This effectively reduces waste in the landfills or waste that ends up in the environment. It also prevents primary resources from being extracted to make new products and uses secondary resources (Ragossnig & Schneider, 2019). Upcycling is a type of recycling form and could be used to reuse waste material in a way to turn unwanted products into a product of better value

and quality (Jordan, GBC 2018). Last, biodegradable byproducts could be recycled by composting and being used to fertilize soil, thus keeping it from achieving negative effects by being stored in landfills (Tweib et al., 2011).

In all, it is believed that recycling prevents the negative side effects of municipal solid waste and benefits a society by reducing greenhouse gas emissions, decreasing pollution, aiding in job creation, reducing transport and disposal of waste, saves energy, and protects natural resources from being extracted (Elayan & Ibrawish, 2017). Recycling also promotes a circular economy. A circular economy is a template that aims to eradicate the consumption of finite resources and promote the use of secondary sources (waste) to produce a good (MacArthur, 2017). This model is based on three principles and include the eradication of pollution and waste, to keep products and materials in use and without an end life, and to restore the natural environment (MacArthur, 2017).

As recycling techniques develop, some materials have produced items that has been proven to be reliable and strong. For instance, glass is 100% recyclable and does not lose its strength or quality after being recycled an infinite number of times (The POD, 2016). Recycling glass also prevents new glass from being created which takes a lot of energy and resources (sand) to make, and in turn, contributes to decreased greenhouse gas emissions (The POD, 2016. In addition, 17 trees are saved from every ton of paper that is recycled and that the recycling of e-waste yields the recovery of precious metals like gold and silver (The POD, 2016).

Recycling in Jordan

Currently in Jordan, only 5 to 10% of the municipal solid waste is recycled (Jordan GBC, 2018). There is currently no advanced recycling facility that separates waste at large scales and most of the recycling there occurs at informal levels occurring only within internal organizations,

NGOs, private sectors, and by community members (Jordan GBC, 2018; Aldayyat et al., 2019). Jordanian recycling ventures are also considered pilot projects and are still under development (Aldayyat et al., 2019).

In all, the municipal solid waste management industry in Jordan has made strides in development over the past few decades, but it still has a way to go to become a sustainable industry (Hajar et al., 2020). Fortunately, Jordan's government announced a National Green Growth plan whose goal is to become greener in six different sectors which includes the management of solid waste. The plan has set a goal to reduce solid waste in landfills and dumpsites by 33% by the year 2025 (Hajar et al., 2020). In addition, the Ministry of Municipal Affairs introduced the National Strategy for Municipal Solid Waste Management plan which aims to establish national collecting and separating centers for recycling by the year 2034 (Hosking, 2016). With the creation of these plans, there is hope for Jordan to transition into a nation that recycles most of its material, but these goals will become more achievable if people and organizations within their country push for change and set positive examples.

Recycling in Schools

As pointed out earlier in this paper, school are playing a critical role in influencing communities' decisions and opinions and is a large contributor to municipal solid waste. Keeping up with proper waste management at educational facilities is key to keeping environments sanitary and clean (Ministry of Education, 2016). As a result, many schools participate in recycling programs to meet hygiene and environmental standards but not all do so. In a study conducted at the University of Jordan, it was found that at least 87% of the trash produced on campus is recyclable (Moqel, 2018). In fact, this percentage increases to 93% during Ramadan

(less food is consumed and wasted with its packaging), and the proportion of recyclable material fluctuates throughout the year (Moqel 2018). Unfortunately, like the rest of Jordanian schools, the university of Jordan does not run a recycle program and experiences waste problems.

Kickstarting Jordanian Recycling

What is Holding Back Recycling?

Recycling is often thought to be one of the best management practices for handling waste, but reasons for lack of it are variable and include the limited mindset of people, lack of convenience, and economy of a nation (Elayan & Ibrawish, 2017). One of the first barriers for causing non-recycling practices is to end people's perception that waste is "waste" (Ragossnig & Schneider, 2019). Many people grow up with this principle in their mind and it is difficult to change their life habits. In addition in Jordan, the awareness and willingness of the public to participate in recycling projects is low and that any pro-recycle campaigns that were launched was short lived and not highly developed (Jordan GBC, 2018). Consumers are often not fully aware of the negative environmental impacts of their consuming lifestyles (Horvath et al., 2018).

Recycling may also not be practiced by people or organizations because of how inconvenient it could be. For instance, there are a total of several hundred types of plastic polymers, and some are more recyclable than others (Milton, 2018). Composite plastic is challenging to recycle as it contains multiple layers of resin codes and is problematic for recycling facilities (Horvath et al., 2018). Because of this, either people must invest in more time Solid waste management in educational institutions: the case of the University of Jordano identify and separate this plastic from other plastic waste or industries must spend more energy resources to recycle this plastic or separate it using better technology within their facilities. On

top of this, Jordanian recycled waste must be cleaned, separated, and free of organic material for it to be affectively recycled and to prevent chaotic flow within recycling facilities (Al Bloushi et al., 2020). The act of separating one waste type from another requires discipline and knowledge and most people are unwillingly to invest their time for this habit (Al Bloushi et al., 2020; Elayan & Ibrawish, 2017).

Last, the economic value of recycling is often viewed to be low. In Jordan, one of the main challenges to recycling plastics is the high electricity prices associated with it (Jordan GBC, 2018). With high energy cost, the product being sold may not be enough to profitably offset this initial cost. In addition, at specific instances, if collected recycled material contains a high volume of contaminants from organic waste or chemicals, the resulting product will be of low quality and result in low market values (Horvath et al., 2018; Jordan GBC, 2018).

Solutions to Increase Recycling in Jordan and Schools

Although recycling rates are low today, they are higher than they used to be. As global public awareness of the issue grows, less plastic and waste is entering landfills despite the increased number of products being used (the POD, 2016). This trend is expected to continue as recognition of waste problems intensifies, but it is currently nowhere near where it needs to be in many areas like Jordan. As a result, efforts on spreading awareness needs to continue and be improved upon to see greater increases in recycling. The perceived benefit of recycling is one of the largest motivation factors for people to get involved and the more people realize this, the more they are willing to recycle or get more involved (Elayan & Ibrawish, 2017). Other solutions to improve recycling rates is for facilities to sort mixed waste at their stations to increase recycling convenience, and for composting to be implemented more which could be accomplished in individual households or within industries (Jordan GBC, 2018).

Another important way to increase recycling is to use schools to spread knowledge and awareness of the benefits of it. Because of school's large role in influencing community choices and educating citizens of various issues, their potential to implement change is large. As a result, important figures and organizations in Jordan recognize this and try to get schools involved to kickstart recycling projects. For instance, Hussain Mhaidat, the director of local councils at the ministry concurs and states "First we should start from the source, especially from houses, universities, and schools" (Hosking, 2016). This statement is valid as a study pointed out that most of what people know about recycling stems from educational institutions. The results show that 27.3% of Jordanian people learn of recycling through schools, 20.3% from universities, and only 17.3% from municipalities (Aljaradin et al., 2011). Despite the higher numbers being indicated in schools, they are still low and can be improved.

One of the ways schools can get individuals to reduce waste production is by educating the dangers associated with it, like the ones mentioned earlier in this paper. Schools also could teach and make students familiar with the basic "waste hierarchy" of the three R's: reduce, reuse, and recycle. In addition to this hierarchy, three more Rs could be added and include rethink, refuse, and repair (Milton, 2018). These six Rs are easy to remember and could be ingrained in students' heads. Once these ideas are ingrained, it is essential that the school have enough space to store the recyclable items or waste and have proper facilities for training and to sort and cleaning waste (Aljaradin et al., 2011).

According to the Wastebusters organization, there are numerous ways that schools could reduce waste which would result in substantially less municipal solid waste. The first five ways are: waste needs to stop being produced in the first place, items need to be reused, waste needs to be recycled, old items need to be swapped or gave away, and only items that are made from

recycled material need to be purchased. In addition, paper waste could be reduced by using internet sources for testing or teaching, initiatives are supported by the whole school with all students and staff members involved, and school recycling projects could be spread outside to the community or even nation (Wastebuster, 2013).

With these facts, some attempts to start recycling programs in schools have risen. For example, “Sort It to Win” is a campaign that prizes schools for reaching a certain financial value for recyclables in collected waist bins every four weeks (Jordan GBC, 2018). However, lack of data on the project shows how effective it became was never found. In addition, the “School Preservation, Maintenance and Hygiene Practices Awareness Campaign” was launched in 2017 and it teaches children the responsibility of recycling through games and art competitions (Dupire, 2018). Like “Sort It to Win,” recent data on its success is limited.

Most recently, a new project was formed called TADWEER, and it targets schools to recycle. The project was not started yet but is scheduled to begin the next school year during fall of 2021. If it is successful, it will reduce school waste and could possibly cause positive changes in the community and country.

Project TADWEER and Supporting Organizations

Overview of the Project

In Arabic, the word “tadweer” means recycle and that is the exact thing that the TADWEER project pushes for. In all, this project’s goal is to support sustainable waste management and recycling in the Zarqa Municipality and to ultimately scale it up throughout Jordan (Tadweer, 2020). The project will specifically take place in Al-Zarqa and Irbid’s schools which are northeast and north of Amman. Over a year’s span during the 2021-2022 academic

year, the TADWEER project will target 10 schools, 20 teachers, 200 students, and around 16 logistic staff members. Longer term plans are also mentioned to achieve sustainability throughout the country.

Once ongoing, the project aims to achieve zero waste in selected schools and to raise awareness for students about the benefits of recycling and how to sort it in proper ways. Once taught, better environmental and sustainable behaviors will follow in the students. Altogether, the project has numerous steps to achieve these goals. Step one plans the separation, collection, and treatment of various waste types. During this step, the recycling of mixed flexible plastic will also take place; a feat that has never been accomplished in Jordan (Tadweer, 2020). Step two includes scaling up efforts to commercial areas with public involvement. This would aid in saving more waste from entering landfills. Last, the TADWEER project will introduce extended producer responsibility by creating a system where producers pay compensation to fund collection and recycling efforts (Tadweer, 2020). This would help pay for the recycling of material and help the industry grow.

Project TADWEER arises from the Eco-Schools Program, an international program that recognizes and awards schools for achieving green behavior. Since 2009, awarded schools in Jordan are subjected to evaluations, announcements, and unannounced annual visits from the Royal Marine Conservation Society of Jordan (JREDS) when JREDS became the national operator for the international program.

About the Royal Marine Conservation Society of Jordan, JREDS

The key principles of JREDS are to promote marine conservation, outreach and advocacy, and sustainable development in Jordan. This organization was established in 1993 by

a group of concern divers and was originally called the Jordan Royal Ecological Divers Society (JREDS, 2021). Because of its conservation goals, a series of five strategic directions have been established and include building and employing successful marine conservation programs, establishing community involvement via educational and public awareness programs, advocating for sustainable use of marine ecosystems through combining environmental conservation alongside social-economic development, establishing advocacy programs through networking on national, regional, and global levels, and developing institutional, technological, and financial ability to maximize its brand value (JREDS 2021).

JREDS serves the role as the national operator for the Foundation for Environmental Education (FEE) and has implemented three of their programs to accomplish sustainable development program successfully. These programs include Green Key, Blue Flag, and the Eco-School Program. Out of these three, the Eco-Schools Program aims to educate and spread awareness of the concerns and importance of marine ecosystems in participating schools. JREDS is a national operator of this program and is working with more than 200 schools across the country (JREDS 2021). The Eco-Schools program has also given birth to the TADWEER project where JREDS is carrying out the project.

About Eco-School's Foundation for Environmental Education, FEE Program

Eco-Schools is a program that is ran internationally and is operated by the international nonprofit organization FEE based in Denmark (Meiboudi et al., 2019). It was introduced in 1994 and its overall objective is to increase the awareness of students of environmental issues using schools and community-based events (Meiboudi et al., 2019). Any school can participate with FEE and the program will aid schools to achieve sustainability by reducing waste and helping schools save up to 40% off their electricity and water bills (JREDS Eco-schools, 2021). In all, a

total of over 51,000 schools located in 64 countries take part in the program. Schools that meet high environmental standards are then awarded and recognized and receive a green flag, a feat that is noticed by The United Nations and serves as an excellent example as an educational institute from the evaluation of the Decade of Education for Sustainable Development in Japan 2015.

In June of 2008, JREDS was approved to become a member of FEE to represent Jordan and has been the national operator since 2009 (JREDS Eco-schools, 2021). In doing so, JREDS became the first Middle Eastern country to establish such a relationship with the program. As a result, program TADWEER is operated and supported by JREDS in schools throughout the country.

Methods

Location and Timeframes

Overall, the duration of the study occurred from June 6th to July 30th, 2021. Studies were conducted in the capital and largest city of Amman, Jordan, mostly within the northwestern part of the municipality. Data was gathered within the JREDS' Amman-based office, City Mall, Mecca Mall, and within personal accommodations for independent study and analysis.

Obtaining Data on Project TADWEER

Most of the data obtained about the TADWEER project came through project organizers and workers who are employees for JREDS. Information was either provided through email, PowerPoint, word documents, PDFs, three online workshops, two face-to-face workshops, or from mouth-to-mouth with the coordinators. Some data was also provided through search on the web or from TADWEER's website. After data was obtained, it was noted and used for evaluation for predicting the project's success. The advantages of gathering information this way

was it came directly from primary sources with up-to-date information. One of the disadvantages of this was seldomly experiencing English to Arabic or Arabic to English language barriers between the surveyor and responder. In addition, many documents relating to the TADWEER project was written all Arabic making it inaccessible to the English-speaking researcher. However, this was often overcome with persistence and patience and by using English-Arabic speakers or by using translation websites to convert Arabic to English to obtain more information.

Past and Future Action Plans of Project TADWEER

The project of TADWEER was originally started and funded by Wastebuster CIC – UK in October of 2019 through the FEE Eco-Schools and presented to JREDS for support in starting it up. However, during 2020, COVID-19 forced schools to close and go online, which delayed the startup of the project and postponed it for the school next year. Because of this, JREDS changed the original action plan and focused on establishing a preparatory period for working out the logistics of the project in an orderly manner. This included building targeted school's capability to host effective environmental supervisors, students, and staff members through online training and workshops.

Online workshops took place during April and May of 2021. The purpose of these workshops was to help prepare club supervisors and teachers on writing and planning a year's worth of activities that is centralized around educating students about solid waste and waste sorting. The workshop also distributed training material among the teachers for it to be taught to students about the Eco-Schools program and about sustainable practices. In addition, the teachers in participating schools have been qualified to start the waste sorting and recycling education and process at the beginning of the 2021 school year.

A face-to-face workshop occurred on June 26, 2021 and involved the employees of the AL-Zarqa municipality. There, a TADWEER project coordinator informed the invitees about the project and how they could work together to achieve environmental sustainability. In addition, experiences were shared on how various government departments and social and civil organizations could create a more sustainable environment together. Obstacles and solutions to the project were identified along with the generating of ideas of how to create more green schools.

Figure 6: A workshop with stakeholders conducted by Project TADWEER's coordinator.

Once school starts, there will be a coordination role between the Zarqa municipality and schools to maintain the sustainability process for the whole year. Solid waste will be sorted and audited on school grounds and would be prepared to be recycled. After this waste is sorted, the municipality will be collected and transfer it to a station for processing and selling. Part of the solid waste will be recycled to make pieces for art at an art exhibition for instance.

Surveying

Mall-intercept surveys were conducted from July 18th to July 30th of 2021 between Mecca Mall and City Mall. These two malls were chosen because they attracted many people who displayed wide variety of traits including different genders, age groups, nationalities, and

beliefs. The shopping centers in Jordan are convenient and local people from around like to shop in them (Akroush et al., 2011). With this diversity, the gathered findings would yield results that would display different Jordanian backgrounds.

Figure 7: City Mall is one of the locations where surveys were conducted.

The mall-intersect surveys were printed out on half sheets of paper and required a pen or pencil for filling. Questions were written in both English and Arabic to accommodate all speakers. A series of questions were developed and asked about the recycling habits and opinions of people. The first two questions asked to identify the respondent's age and sex. The next two questions asked, "do you recycle now" and "have you recycled in the past," and they had four listed answers that included, "no," "little," "sometimes," or "often." The next five questions had yes or no answers to them and were, "is recycling convenient to you," "should recycling become more convenient," "should recycling be enforced and advocated more in Jordan," "should you recycle more," and "is recycling important?" The survey was kept brief to encourage people to complete it in a minute or less for convenience purposes.

Most of the surveying was conducted around dinnertime (5-7 pm), a time where the malls seemed to have the most people. However, some occurred outside of this time for optimistic sampling and to include populations that would walk in at other times. Most of the surveys were also concentrated around food courts or sitting areas where people had a table and were relaxed or waiting for food without having a need to rush to shop or leave the vicinity. Though, other malls workers and participants outside of these zones were included as well. Selected participants were chosen based off walking randomly through an area until non-occupied individuals were stumbled upon or identified. Selection was also based off missing gender or age gaps in the surveys to keep representation even. Selection bias was minimized by trying to keep the selection pattern ongoing.

People were approached and asked to partake in surveys by asking a quote along the lines of "would you like to participate in my survey for project TADWEER? I am recording public opinion and recycling practices and Jordan". Identified candidates either agreed, disagreed, or stated they do not speak English; in which case, surveys would be shown to them (containing Arabic), and they would either approve or decline. In many cases, respondents would be with a group of friends or family in which multiple members would want to fill out the surveys as well. When surveys were being filled out, the interviewer would stand near and look away until the handout was completed. Sometimes, questions would be asked about an uncertainty in which, the surveyor would do their best to answer, or a nearby Arabic speaker would assist. After surveys were completed, they were briefly looked over to make sure the answers were filled out and were put inside a bag for later evaluations. The interviewer would then move to a new person to conduct the survey.

Completed survey were marked with a number and location of where they were conducted. The data of the surveys were then transferred to Microsoft Excel where they would be further evaluated. In it, the respondents answers were then converted to a numeric value to make analyzing comparable and to run statistical tests. The two questions with the answers of "no," "little," "sometimes," or "often" we're giving the numeric values of "0'" "1," "2," and "3" respectably. The five other questions with the answers of "no" and "yes" were given the numeric values of "0" and "1" to calculate percentage. In addition, a new category was created titled "changes in practicing habits" which describes how participants changed their recycling habits based off their answers from "do you recycle now" and "did you recycle in the past." The difference of the numeric value between "do you recycle now" from "did you recycle in the past" gave a positive, negative, or zero value for changes in recycling habits.

Statistical tests were performed on Microsoft Excel. By comparing significance differences between the means of two groups, a two-sided t-test was performed. T-tests were run to check for significant differences between average values between the genders, age groups, and past recycling practices. The people interviewed served as the independent variable while their response served as the dependent variable.

Survey Pros and Cons

One of the biggest problems that was encountered in doing the surveys was overcoming language barriers. Often if an individual did not feel comfortable speaking English, they were discouraged from taking the survey. As a result, the results might be biased in favor of more English speakers who might have better education then once who do not know the language. To offset this, an Arabic speaker was sometimes present with the interviewer who knows English, or surveys (containing Arabic) were shown to state that they do not need to know English to

complete it. Another problem that was encountered was getting a good sample size from older individuals and from individuals who may be of low income. Malls are often more demographically favorable to contain populations of young, middle income shoppers (CanView, 2019). To overcome this, more older individuals, and mall workers (who may make less income than the shoppers) were targeted and were included in the surveys. Unfortunately, like global trends, many identified older individuals refused to take part in the questionnaire (Wagner et al., 2019) and resulted in lower sample sizes for their age group.

The surveys that were given were very brief, did not ask much about demographics, and were multiple choice. This limited the amount of information that they could potentially yield but made it possible to conduct many surveys under a short period of time. Longer open-ended surveys given in malls or elsewhere may be inconvenient for the people filling them out, so by making them short, it made them more likely for a person to agree to partake (CanView, 2019). In addition, making a short multiple-choice survey made it easier for the English analyzer to interpretate the data without having to translate open responses from Arabic.

The biggest drawback of the methods used for surveying is it is biased for young mallgoers. It excludes populations that may not shop at malls, so the results of the surveys cannot be generalized to Jordan's population (CanView, 2019). In addition, because selected participants were not randomly drawn, biases do exist from human error as selected people may have been more comforting to approach. Last, not all mallgoers live in Jordan and may be visiting from other countries. Often, this was stated by the selected participant, and they were dismissed from taking the survey. However, this may have been unknown from others and the recycling practices of other countries may have been documented and included in the practices for Jordan.

One of the biggest positives of a mall intersect survey is it is easier to convince someone to participate in a questionnaire as opposed to emailed or computer-based ones. Participants can verify that they are talking to a real person and that the research may have actual meaning (CanView, 2019). In addition, participants could ask questions while completing the survey to get help, which keeps them from guessing or putting false information. Last, conducting mall intercept surveys allows the interviewer to spread knowledge and learn of recycling issues. For instance, numerous stories were told about personal or national recycling practices while giving surveys.

Similar Project Comparisons

Numerous other manuscripts about similar recycling projects were read and compared to project TADWEER. Manuscripts were obtained from Google Scholar and where focused on increasing recycling efforts in school. Their success or failures was taken into consideration for predicting the success of the TADWEER project. However, the cons of this are these completed projects have taken place outside of Jordan, thus, may not be completely successful or poor within the country.

Results

Participants

In all, a total of 102 surveys was conducted for evaluation. Not all surveys were filled out entirely as some surveys contained missing information about gender, age, or for a particular question. This missing information was considered when tallying the results. In all, 57 males and 44 females registered. The survey was also broken off into three age groups and included young (13-21 years old), middle (22-39 years old), and old (40+ yes old). In all, a total of 40 young, 45 middle aged, and 15 old people registered for this mall-intercept survey. The youngest person

surveyed was 13 years old while the oldest one was 73 years old. The average age of male population was 27.47 years while the average age of the females was 25.70 years for a combined average age of 26.84 years old. Gender and age groups were not compared to each other when evaluating recycling rates. The same individual may be present in both groups, and this would yield non-meaningful data.

Do you Recycle now?

A total of 101 participants answered, “do you recycle now.” In all, 51% answered no, 25% answered little, 18% responded sometimes, and 6% replied often. In total, this generated an average numeric value of 0.78. This means that the average person surveyed recycles less than little when the value of 1 is “little” and the value of 3 is “often.” The group that recycles the most is females, where their value is “1.05.” This group is then followed by the younger group, the old group, the middle-age group, and then the male group with values being “1,” “0.8,” “6.1,” and “0.59” respectively. Participants who agreed that recycling is convenient to them displayed a numeric value of 0.79. A significant difference was noted between males and females with a P-value of 0.02. In addition, young versus middle-ages were almost significantly different from each other with a P-value of 0.06.

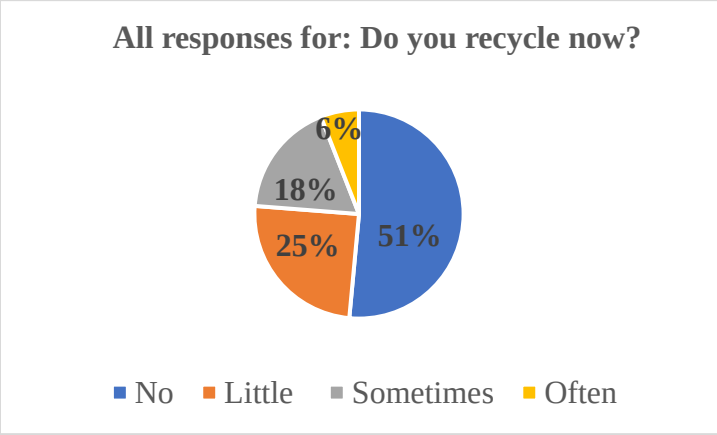

Figure 8: All responses for: “Do you recycle now?”: A total of 101 people answered this question with either “no," “little,” “sometimes,” or “often.” The pie chart shows the percentage of the respondent’s answers

Have you recycled in the past?

A total of 102 participants answered the question “have you recycled in the past?” Altogether, 47% answered “no,” 21% stated “little,” 22% answered “sometimes,” and 10% responded as “often.” These results yielded an average numeric value of 0.95, which is slightly below the “little” threshold. The group that used to recycle the most is the young group, followed by females, then the old group, then males, and finally the middle-aged group. Their numeric values are 1.23, 1.07, 0.87, 0.86, and 0.78, respectively. No groups were significantly different from each other but the differences between the young and middle-aged groups approached significance by having a P-value of 0.05.

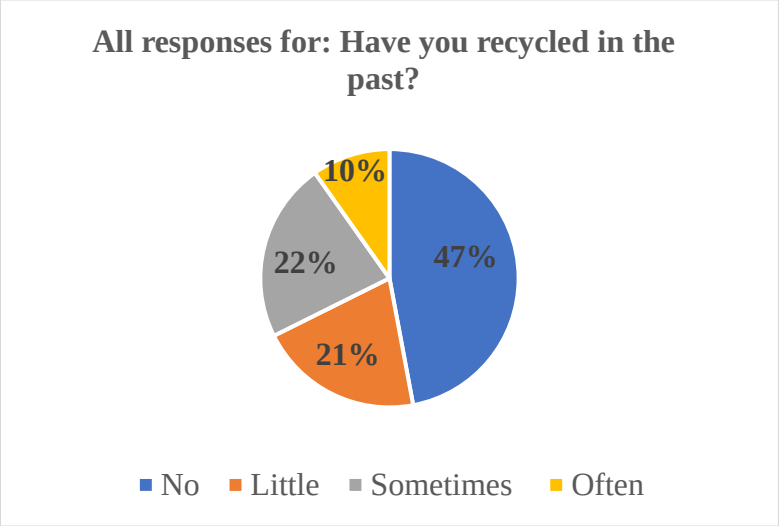

Figure 9: All responses for: “Have you recycled in the past?”: A total of 102 people answered this question with either “no," “little,” “sometimes,” or “often.” The pie chart shows the percentage of the respondent’s answers.

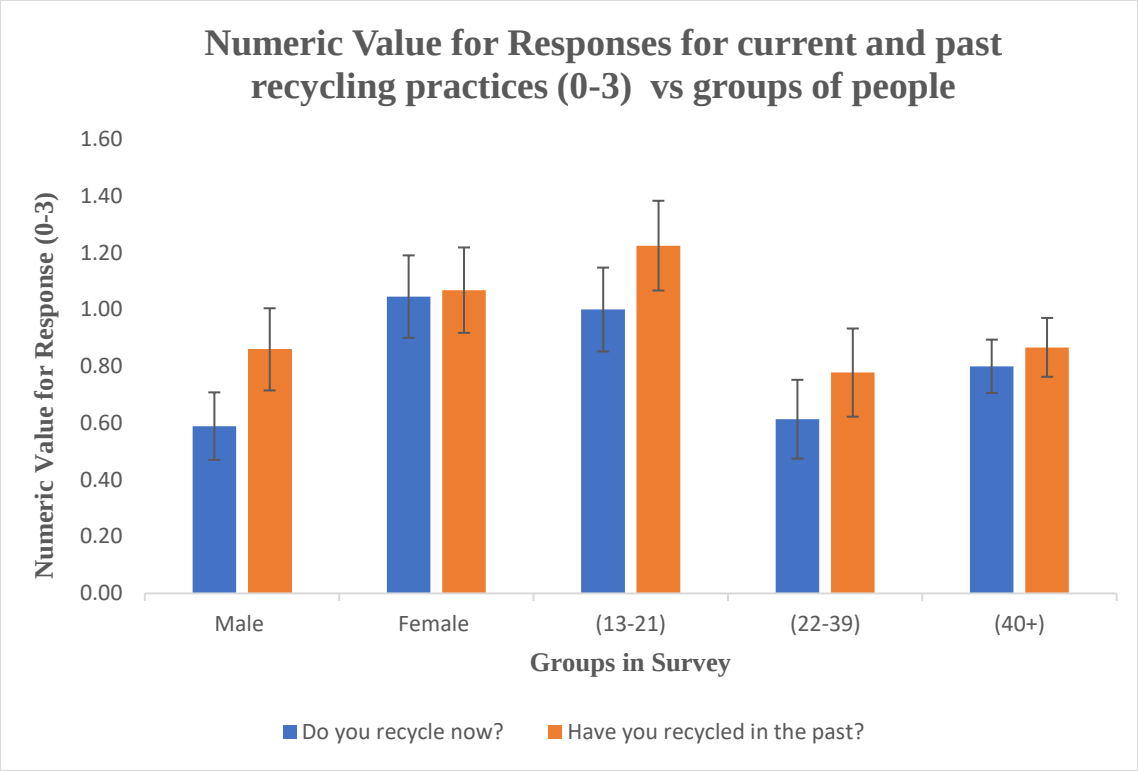

Figure 10: Average Numeric Value for Response (0-3) among different gender and different aged subgroups for the questions of "do you recycle now?" and "have you recycled in the past?" A total of 101 answers were generated for "do you recycle now?" and 102 answers were generated for "have you recycled in the past?" Bars represent the numeric value for the responses. A value of 0 indicates no recycling while 3 indicates recycling often. Error bars represent ±1 SE.

Changes in Recycling Habits

A total of 101 calculations were conducted for determining changes in recycling behavior. In all, 61% of people kept the same recycling habits while 24% decreased, 7% improved, 4% highly improved, and 4% highly decreased. When given a numeric value, the average number for all participants is -0.17 which indicates that recycling habits have decreased from what participants can remember. A value of -2 indicates strong decreases, positive 2 indicates great improvements, and 0 suggests no improvement or declines. Males experienced the strongest declines, and this was followed by the young group, the middle-aged group, the old group, and then females, all with values under 0. The values for this are -0.27. -0.23, -0.16, -0.07, and -0.02 in the respected order. No significant differences were detected between any group.

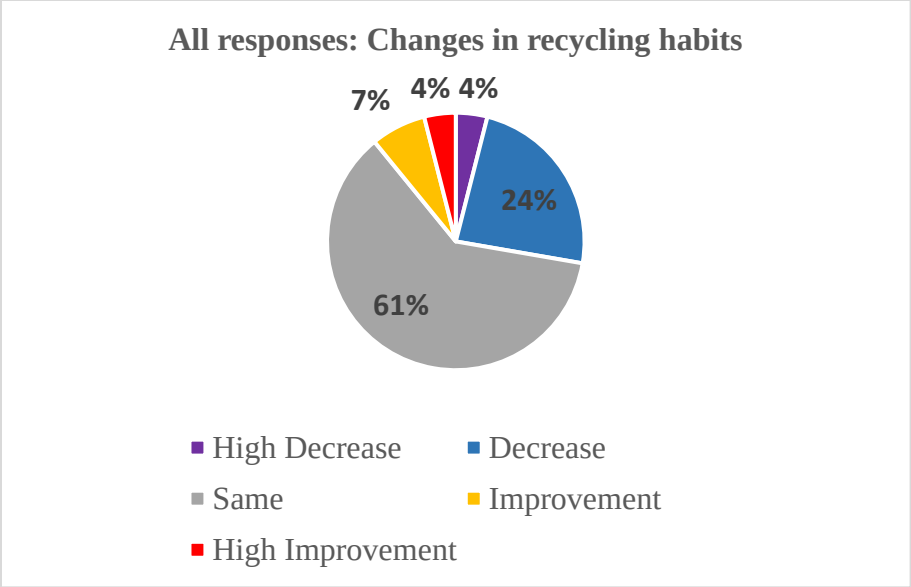

Figure 11:All calculated responses for: Changes in recycling habits. A total of 101 people's changes in recycling habits were determined by either "high decrease," "decrease," "same," "improvement.," or "high improvement." The pie chart shows the percentage of the respondent's answers.

Results of the other questions

In total, 84% of participants agreed that recycling is convenient to them, 98% stated that recycling should become more convenient, 97% states that recycling should be enforced more in Jordan, 95% agreed that they should recycle more, and 98% agreed that recycling is important. In all the categories but "is recycling convenient to you," similar answers were agreed upon in each subgroup as over 92% of each agreed by stating "yes." For "is recycling convenient to you." the answers varied slightly across the groups. Recycling was most convenient to the middle-aged group followed by males, females, the young group, and then the old group. The percentages that agreed recycling was convenient are 91%, 87.5%, 79%, 77.5%, and 77%, respectively. No significant differences between any groups were detected, but significance approached the differences between the young and middle age group by there being a P-value of 0.09.

Groups	Sample Size #	Average Age	Do you recycle now? (Avg numeric value)	Have you recycled in the past? (Avg numeric value)	Change of habits (Avg numeric value)	Is recycling convenient to you? (% Yes)	Should recycling become more convenient? (% Yes)	Should recycling be enforced and advocated more in Jordan? (% Yes)	Should you recycle more? (% Yes)	Is recycling Important? (% Yes)
Male	**57**	**27.47**	**0.59**	**0.86**	**-0.27**	**87.50**	**98.21**	**96.49**	**94.74**	**98.25**
standard Div			0.89	1.09	0.70	0.33	0.13	0.19	0.23	0.13
standard error			0.12	0.14	0.09	0.04	0.02	0.02	0.03	0.02
Female	**44**	**25.70**	**1.05**	**1.07**	**-0.02**	**79.07**	**97.73**	**97.67**	**95.35**	**97.73**
standard Div			0.96	1.00	0.85	0.41	0.15	0.15	0.21	0.15
standard error			0.15	0.15	0.13	0.21	0.02	0.02	0.03	0.02
(13-21)	**40**	**x**	**1.00**	**1.23**	**-0.23**	**77.50**	**95.00**	**95.00**	**92.50**	**95.00**
standard Div			0.93	1.00	0.83	0.42	0.22	0.22	0.27	0.22
standard error			0.15	0.16	0.13	0.07	0.03	0.03	0.04	0.03
(22-39)	**45**	**x**	**0.61**	**0.78**	**-0.16**	**91.11**	**100.00**	**100.00**	**97.78**	**100.00**
standard Div			0.92	1.04	0.61	0.29	0.00	0.00	0.15	0.00
standard error			0.14	0.16	0.09	0.04	0.00	0.00	0.02	0.00
(40+)	**15**	**x**	**0.80**	**0.87**	**-0.07**	**76.92**	**100.00**	**92.86**	**92.86**	**100.00**
standard Div			1.01	1.13	1.10	0.44	0.00	0.27	0.27	0.00
standard error			0.26	0.29	0.28	0.12	0.00	0.07	0.07	0.00
All	**102**	**26.84**	**0.78**	**0.95**	**-0.17**	**84.00**	**98.02**	**97.03**	**95.05**	**98.04**
standard Div			0.94	1.05	0.78	0.37	0.14	0.17	0.22	0.14
standard error			0.09	0.10	0.08	0.04	0.01	0.02	0.02	0.01

Table 1: A table containing all the subgroups, values, and percentages to the questions of the survey. Standard deviation and standard error were also included.

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Discussion

Poor recycling habits

As expected, the recycling habits of the Jordanian population is not high. This result supports previous research and surveys handed out in Jordan exploring the recycling habits of people. This is because knowledge of the benefits of recycling and the danger from municipal solid waste is not well known as it is not taught in educational institutes (Aljaradin et al., 2011). Past studies have also shown that the population do not know what, how, and where to recycle (Elayan & Ibrawish 2017). In addition, this study most likely underestimates recycling practices in because it was conducted within malls that contain wealthier people who may be more educated on the issues. Adding to this, self-reporting on recycling behaviors tends to be overestimated. For example, it has been observed that only 50% of the population recycle in Britain, but 83% of the respondents in a survey reported that they do participate in it (Martin et al., 2006). Last, recycling rates may be overestimated because people who do not participate in it may not want to complete the survey that asks about it. Although, not measured in this study, the acceptance rate was low when surveys were presented to people in the malls, especially by older people. Surveys receive high response rates if they are tailored to the people they are presented to (Wagner et al., 2019). By the survey being looked at and declined by people indicates that they are most likely not involved in recycling activities.

In addition, changes in recycling habits do not support the initial hypothesis that “people are recycling more than they used to.” Over 60% of people reported not increasing or decreasing their recycling habits from the past which means they had no personal reasons to change that, or had they had external factors that prevented adjustments. For individuals that recycle less than they used to, they either lost convenience or motivation to continue the intensity in which they

use to. In addition, because recycling is perceived as good, individuals may have overestimated the amount that they have recycled in the past because they find that recycling is desirable, and this desirability might be a stronger predictor in forecasting the overestimation of a past event (Tully & Meyvis, 2017). In turn, a small percentage of individuals reported that they recycle more now than they used to. As opposed to ones who decreased recycling, they may have found a motivation or found better convenience for their change of habits.

Effects of gender and age on recycling

From the conducted surveys, the hypothesis of "females recycle more than males" was supported. This finding also agrees with other investigations. For instance, from a study, 73% of people interviewed over the age of 21 felt like it is their responsibility to recycle, but 69% of whom were female (Aljaradin et al., 2011). In addition, surveys conducted in Cyprus found recycling rates to be higher among females as opposed to males (Hadjimanolis, 2013). The higher willingness for females to recycle over males is thought to originate from their innate principles in which they believe recycling is good and necessary (Oztekin et al., 2017). Males on the other hand are often needed to be taught or are self-learned through experiences that perceive recycling as good and valuable (Oztekin et al., 2017).

The results obtained from this survey did not support the hypothesis that the young group would recycle significantly more than the older groups, but it was near significant in both current and past recycling practices between the middle aged and young groups with the younger group recycling more. Recycling rates may be higher in younger individuals than the middle-aged group because recycling is more prevalent now than it once was, and kids may grow up with this idea in mind. Despite this, recycling rates in old individuals are found to be non-significantly higher than ones in the middle age. Similar trends are also consistent with other pieces of

literature. For instance, the surveys in Cyprus revealed that recycling rates were noticed to be higher for older individuals (Hadjimanolis, 2013). Another study found that a person becomes more likely to recycle the older and more affluent they become (Martin et al., 2006). The study also found that people in the age range from 25 to 44 years old had the lowest recycling percentage, and this may be due to familial commitments (Martin et al., 2006).

Convenience

Before the surveys, it was predicted that most people would find recycling to be inconvenient in Jordan. However, this turned out not to be true for any group. Despite this result, over 98% of the participants agreed that recycling should become more convenient than what it currently is. Just based on these statistics, it can be concluded that people know facilities that are nearby and may have enough time to recycle, but they agree that it should be easier. As pointed out earlier, the primary deciding factor in getting people to recycle stems from the conveniences to do so (either from more facilities or more time) in many cases (Martin et al., 2006). This convenience could come from the placement and distance of recycling bins or from the aid of municipal workers (Aljaradin et al., 2011). In a survey, participants were asked if they would recycle if they had to walk 20, 200, or 1000 meters, and 53%, 42%, and 27% agreed in that order. Like the results obtained from this study, a recycling bin may be placed close and be "convenient," but many people may choose not to recycle still. The bin may be placed closer to make it even more "convenient," but this is not practical in many instances. Based on these results and from other studies, an individual does not only need to find recycling to be convenient, but they must also have self-motivation and discipline (Al Bloushi et al., 2020). This motivation in people could be increase by educating individuals on the problems of solid waste to empower them to make positive sustainable changes.

In the survey, recycling was the most convenient for the middle-aged group despite them reporting the second lowest “recycling now” numeric values and the lowest “have recycled” numeric values. From this, the group appears to be the least motivated or not as educated on the issues of solid waste impacts, and this may be a factor and keeping them from participating in it. In turn, recycling was least convenient to the old group in the survey, but they had the third highest “recycling now” numeric value. Based on this result, they may not be as mobile as younger groups (carrying recyclable items or reaching recycling facilities), but they know the important of achieving zero waste.

Recycling importance

In all, recycling in Jordan was viewed as important and is thought that it should be implemented and pushed for more in the country. This is consistent with other studies despite the low recycling results obtained. Most participants from every group agreed that they should recycle more, so people are aware of their bad habits. With this being noted, individuals expect the government and large organizations to recycle more themselves and help them achieve their goals without them having to put in too much effort. However, people could push for this change more effectively if they become more educated and identify sustainable goals for the country.

Connecting surveys with the TADWEER project

From the completed surveys alone, it is seen that Jordan needs a supporting project to help increase recycling among people. The TADWEER project is mostly catered to support schools in the beginning stages, which would initially help increase recycling rates and awareness in young individuals. Eventually, these students will grow up to become the “middle-aged group,” who currently has the second-lowest recycling rate of the measured groups from the surveys. The second stage of project TADWEER calls to get the community (ones of all

backgrounds and age groups) involved and increase the number of recycling bins. Last, the project hopes to push for national changes which would result in major solid waste reductions if successful. The surveys conducted also indicate that people are aware of the benefits of recycling for the most part, so educating people should not be too much of a task but should still be reinforced. More of the project's efforts could be put into making recycling more convenient. To the best of the author's knowledge, the response from the surveys is the most up to date from other Jordanian surveys completed in the past and they support the launch of project TADWEER to achieve a more sustainable environment.

Will Project TADWEER be successful?

From the results of the surveys, research, and from the action plans of the TADWER project, it is predicted that the project will be successful because it follows Jordan's goals in waste reductions and the world's trends in achieving a sustainable society. It is proactive, necessary, engaging, and is following the same guidelines as other past successful projects in other areas of the world. The project will not only be successful in at schools and nation but will also set an example for other recycling projects to follow.

Despite all the environmental challenges that waste presents to societies and the environment, the waste management system is moving in the right direction as people become more aware (Milton, 2018). People now realize that changes are needed to be made and might be more supportive of organizations that are trying to achieve sustainability. In addition, many pilot projects and research studies have helped project managers to understand and identify factors that influence recycling behavior in people, such as the ones presented in this manuscript. This is one of the biggest ways to achieve sustainable waste management (Suttibak & Nitivattananon, 2008). Once these factors are identified, they can be addressed to influence people's thoughts

and attitudes (Horvath et al., 2018). Along with these, project TADWEER will stay persistent and discipline on its way to achieve zero waste (Al Bloushi et al., 2020).

Being a successful program for increasing recycling is not an easy task and requires help from other organizations (Moqbel, 2018). For instance, studies conducted at Massey University at New Zealand and the Autonomous University of Baja California shown that all sectors and various party members are needed to establish a successful program (Moqbel, 2018). They could aid in the education of students, host events relating to the project, or perform other tasks that support the organization. Last, a program may not be successful if not all their members are involved. For instance, one cannot expect all participants to participate if they are not encouraged to do so or are not provided proper facilities or equipment (Aljaradin et al., 2011). Project TADWEER plans to encourage involvement of all members in schools and is in a partnership with the Eco-Schools program and JREDS to achieve its success. Both the Eco-Schools program and JREDS have established winning cultures and have seen achievements in their program histories and will aid project TADWEER towards success.

The success of recycling programs has also ben dependent on the incentives they provide to the schools. These incentives could be monetary, tax reductions, training, staff exchanges, technical assistance, or other offers that help the school after they meet milestones or guidelines. For example, in Thailand schools, the success of recycling programs significantly improved when schools were awarded compensatory goods for ones involved, cuts in transportation costs, and low investing expenses (Suttibak & Nitivattananon, 2008). Project TADWEER present awards (green flags) to schools that achieve environmental excellence, and this award is recognized by the United Nations. This is a huge deal and should be a large motivation factor for the 10 participating schools.

Successful programs also leave lasting impacts after the program is finished. For example, schools in Wales that participated in successful recycling programs left lasting legacies in students. These students stayed involved in environmental projects, were still practicing recycling, energy, and water saving habits, and still purchased eco-friendly products (Meiboudi et al., 2019). In addition, projects could spread their legacy to other organizations and include more collaborators alongside the value chain (WWF, 2021). Project TADWEER plans to grow and expand after it finishes it's project in schools to achieve as much sustainability as possible within the waste management sector. This is very practical as many other respondents of the survey believe that better waste management strategies should be pushed for in Jordan.

Conclusion

Managing municipal solid waste in a sustainable way is key to achieve environmental and social excellence throughout the world. Today, solid waste pollution is found in all environments including oceans, cities, grasslands, or anywhere else you can go. This waste is made of various materials and could have negative profound impacts on the environment, people, and on economics. Although it is a global issue, proper waste management continues to be a struggle in developing countries like Jordan. Because of this, different organizations like TADWEER are launched to reduce solid waste by enforcing recycling in schools.

The objective of the study is to predict how successful the TADWER project will be this upcoming school year. If it is successful, the project would leave sustainable and lasting waste managing skills among the schools and the surrounding communities it targets. This will then be spread all throughout Jordan as it put more pressure on the government and large organizations to increase recycling rates. For predicting a successful program, a survey was conducted asking about recycling practices and attitudes, the action plans of project TADWER was evaluated, and

successful case studies were compared. Overall, the research question was “will project TADWEER achieve its goals?” This manuscript attempted to answer this question based off research and surveys.

Jordan is an arid country located in the Middle East that has experienced exploding population growth and have been receiving refugees from surrounding countries. As a result, this has put tremendous strains on natural resources like fresh water, and this population growth has resulted in a huge increase of municipal solid waste production. Every year, over 2 million tons of waste is produced in Jordan, and this is increasing every year as the population and standard of living continue to grow. Unfortunately, prior research has shown that little of this waste is recycled. In total, 50% of waste is thrown in landfills, 35% is stored in controlled dumpsites, 6 to 10% is recycled, and 5% is dumped openly. Schools are also an important source of solid waste as they contain many students and staff and could be look at like a small community. Many schools in Jordan mismanage waste and do not have proper disposal systems.

Properly managing municipal solid waste is key to avoid adverse environmental, human health, and financial impacts. Solid waste is a major contributor to climate change and aids in air and water pollution. As waste decomposes, it produces carbon dioxide if exposed to oxygen or methane with lack of oxygen. Waste may also directly escape into the environment as many landfills and dumpsites in Jordan are not up to date and often experiences leakages of waste material. Once in the environment, garbage may be consumed by or entangle wildlife which has potential to injure, make ill, or kill an organism. Garbage may also prevent burying creatures from digging, may act as a transport vector for invasive species as it floats in the ocean, can suffocate and break coral and other aquatic plants, and can contaminate soils and water. For humans, solid waste could clog drainage systems and block streets and lots. This can result in

floods and inconveniences in traffic flow and development. Solid waste could also support the spread of disease as it can breed flies and rodents on land and mosquitoes and water borne insects in areas where drains are clogged. In addition, the consumption of microplastics or the inhalation of odors originating from solid waste can have negative health impacts on humans. Last, the mismanagement of waste hurts the economy of Jordan and other nations. In Jordan alone, the overall cost of environmental degradation is estimated to be between JD 143 to 332 million in 2006, and the mismanagement of municipal solid waste is a large contributor to this number.

Because of these issues, reducing waste is a priority and one of the best ways to achieve this is by recycling. Recycling does not only reduce waste in landfills, but it also supports the circular economy, reduces the extraction of raw material, and saves energy that would be used to produce new material. Jordan's government recognized this and has proposed a National Green Growth Plan whose goal is to become more eco-friendly in six different sectors. In addition, the Ministry of Municipal affairs announced the National Strategy for Municipal Solid Waste Management whose goal is to establish national collecting and separating centers to support recycling by the year 2034. However most recently, various recycling school projects like project TADWEER have been launched to kickstart recycling.

Project TADWEER have arisen from the Eco-school program; an international program that recognizes and awards schools for achieving sustainable practices. The Royal Marine Conservation Society of Jordan (JREDS) have become the national operator since 2009 and is helping to run project TADWEER. The project will take place during the 2021 school year and occur in 10 schools in Al-Zarqa and Irbid targeting a total of 20 teachers, 200 students, and 16

logistic staff workers. In preparation, the program ran various workshops and online sessions to train staff members and to prepare facilities for waste sorting and recycling.

While looking at TADWEER's action plan, a series of surveys were conducted to gather up-to-date information on recycling practices and thoughts. In addition, research on successful projects was conducted and compared to the action plans of the TADWEER project to forecast its success. Results from the surveys suggest that recycling practices in Jordan are still very low, but the public views it to be important. In addition, people viewed recycling to be convenient but believe that this convenience needs to be improved to increase their recycling. These results suggest that people are open to participate in better waste management techniques because it is important but want it to be easier to do so. By project TADWEER training people and increasing convenience of recycling, the recycle rate of targeted areas should be greatly improved.

The action plans of past successful recycling programs in schools also share many similarities with the action plans of project TADWEER. As a result of this and of the surveys, it is predicted that project TADWER will be successful in achieving a most sustainable way to manage municipal solid waste and in achieving its goals. The world is craving better waste management techniques and it will thrive off the goals of the project and be heavily supported. Project TADWEER is very necessary, proactive, engaging, and will serve as an example for similar projects to follow.

This study was significant because it tested the validity of a launched project to help solve the mismanagement of solid waste in Jordan. In today's world, there are numerous other environmental issues that need to be addressed, and several organizations are launched in attempts to fix or mitigate them. Some of these programs are successful while many are not. Evaluating the success or failure of these organizations is key for planning the start of a new

program aimed to tackle an environmental issue. The failure of an organization to achieve its ecological goals does not only not help the environment fully, but also could be a waste of money and time. In addition, making predictions about the success of a program and following it up once completed tests the reliability of the study that made the prediction. If it is accurate, it could test how reliable future projects may be. If the study is not accurate, it could be refined and adjusted for making predictions for other projects and test it again or abandoned altogether.

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Appendices

Jordan Recycling Survey مسح إعادة التدوير في الأردن

Gender الجنس	Male ذكر	Female أنثى

Age العمر	

	No لا	Little القليل	Sometimes بعض الأحيان	Often غالبا
Do you recycle now? هل تقوم بإعادة التدوير الآن؟				
Have you recycled in the past? هل قمت بإعادة التدوير في الماضي؟				

	Yes نعم	No لا
Is recycling convenient to you? هل إعادة التدوير مناسبة لك؟		
Should recycling become more convenient? هل يجب أن تصبح إعادة التدوير أكثر ملاءمة؟		
Should recycling be enforced and advocated more in Jordan? هل ينبغي تطبيق إعادة التدوير والدعوة إليه أكثر في الأردن؟		
Should you recycle more? هل يجب إعادة التدوير أكثر؟		
Is recycling Important? هل إعادة التدوير مهمة؟		