An-Najah National University

Faculty of Graduate Studies

WILLINGNESS OF STONE-CUTTING AND READY-MIX CONCRETE FACTORIES TO IMPLEMENT CLEAN PRODUCTION STRATEGY CASE STUDY: INDUSTRIAL WASTEWATER IN WADI ZOMER, WEST BANK, PALESTINE

By

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This Thesis Submitted in Partial Fulfillment of the Requirements for the Degree of Master of Engineering Management, Faculty of Graduate Studies, An-Najah National University, Nablus - Palestine.

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Willingness of stone-cutting and ready-mix concrete factories to implement clean production strategy Case study: industrial wastewater in wadi Zomar, West Bank, Palestine

By

Mo'men Na'el Khaled Alqub

This Thesis was Defended Successfully on 15/8/2023 and approved by

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Dedication

To my father, to my mother, to my family, to my friends and to everyone who wished me well, all thanks and unlimited gratitude.

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Declaration

I, the undersigned, declare that I submitted the thesis entitled:

WILLINGNESS OF STONE-CUTTING AND READY-MIX CONCRETE FACTORIES TO IMPLEMENT CLEAN PRODUCTION STRATEGY
CASE STUDY: INDUSTRIAL WASTEWATER IN WADI ZOMER, WEST BANK, PALESTINE

I declare that the work provided in this thesis, unless otherwise referenced, is the researcher’s own work, and has not been submitted elsewhere for any other degree or qualification.

Student's Name: ________________________________

Signature: ________________________________

Date: ________________________________

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Abstract

One of the most serious problems in Wadi Al-Zomer area is industrial wastewater from the stone-cutting industries. There are many stonecutters in Wadi al-Zomer area in Nablus and Tulkarm, discharging 2000 $m^3/month$ from their industrial wastewater into the Wadi, bringing in Israeli financial deductions from the Palestinian revenue. This study aims to achieve a sustainable management plan to manage this industrial water for exploitation, in addition to alleviate the extensive damage to the environment.

Many researchers studies have demonstrated that industrial water produced by the stone-cutting industries can be used in the brick and ready-mixed concrete industries to improve its properties. This study focused on the potential of applying clean production strategies to the stone cutting, brick and ready-mixed concrete industries to minimize the discharge of industrial wastewater into the valley. For this purpose, a research model was developed and data from stone cutting, brick and ready-mixed concrete factories were collected by using questionnaire. Study model presented by PLS-SEM Partial Least-Squares Structural Equation Modeling using the Smart PLS program. Data analysis based on 45 responses collected from these plant managers through questionnaires. The results of the study show that stone-cutting factories managers are willing to adopt clean production strategies to manage industrial water production.

As for ready-mixed concrete and brick factories, they tend to adopt clean production strategies, but they make a number of recommendations which focus on getting approval from Palestinian Standards Institution, availability of official supervisor authority, reasonable price for sludge and easy transportation method for sludge. In addition to the economic gains by up to 530 USD monthly for each factory of stone-cutting due to reducing of water consumption and incomes through sale of the sludge, the study will benefit all Palestinians in general by reducing the environmental damage in Wadi Al-Zomer region and reduce about 5.26 Million USD from the Israeli financial deductions. The hypotheses aimed at was fully proven as all t-values are greater than 1.96.

Keywords: clean production, sustainable management, stone-cutting industries, industrial wastewater, Partial Least Square Modeling of Structural Equations, ready-mix concrete factory.

Chapter One
Introduction and Literature review

1.1 Chapter overview

In this chapter, general information about wastewater and the water sector in Palestine have presented, in addition to the problem of wastewater, particularly industrial wastewater, and how to deal with it. All of the above clarified in the background at the beginning. After that, the study area presented, where information about Wadi Al-Zomer and how the problem developed within this valley presented in detailed, and the focus is on the issue of discharging industrial wastewater from stone-cutting industries. After that, the research question, and problem statement is introduced. Then the research significance, research objectives, and research hypotheses addressed. Moreover, the theoretical background addressed, where previous research about this topic and possible solutions applied in other countries taken into consideration.

1.2 General Background

Wastewater can be defined as any freshwater used from different purposes, whether for domestic or industrial uses, so it contains pollutants such as organic or chemical substances, which makes it unusable without applying a series of treatment processes(Gallego-schmid et al., 2019). A clear problem has emerged in how to dispose of wastewater and deal with it since early times. (Kundzewicz et al., 2008) focused on modern methods of dealing with wastewater. So that it exploited, treated, and reused through many new methods such as the clean production strategy. So that wastewater exploited without causing dangers to either people or the environment.

There is a major conflict over water resources between the Palestinians and the Israelis. Where Palestinians clearly suffer from water scarcity due to the Israelis' control over the water resources. The Israelis place many restrictions on the Palestinians' exploitation of water resources, as they control the water aquifers in the West Bank (the western, the eastern, and the northeastern aquifers). As a result, this limits the ability of the Palestinians to exploit the water from these aquifers. Therefore, Palestinians must exploit all the water resources they have and transfer the waste to source (R. Barakat & Heackock, 2013).

In light of the great scarcity of available clean water suitable for drinking and other uses, it is necessary to find another source of water to reduce the consumption of potable water in the industrial and agricultural fields (Ezugbe & Rathilal, 2020). With the large and rapid increase in the population, large quantity of wastewater produced on a daily basis, whether domestic, industrial, or agricultural, and with the large increase in the demand for water, it has become necessary to work on finding logical solutions in order to properly utilize this wastewater to use it again and be considered as a source of water instead of being a source of waste (Salgot et al., 2006). All of this wastewater considered as clean water, but it contains pollutants. Through highly efficient treatment, this water can be considered as a strong source of clean water, and sometimes it reaches the point that it is suitable for drinking, so this considered one of the best ways to deal with water scarcity (Tetteh et al., 2020).

Industrial wastewater defined as water that was produced by industries after several production chains, as it contains a large quantity of heavy metals, organics, inorganics, micro pollutants, emerging contaminants, in addition to lot amounts of TSS. Therefore, this water is very harmful to the environment and various forms of life (M. A. Barakat, 2011).

The stone and marble industries are among of the popular industries in Palestine, where marble and stone are one of the most widespread natural materials here. It is also characterized by high quality stones and contains many different colors as it is used in decoration, construction, and insulation works (Nasserdine et al., 2009). Stone and marble sector play an important role in the Palestinian economy. It contributes around 20% of Palestine's total industrial income, 10% of the country's Gross National Product (GNP) (Zimmo & Petta, 2005). Water is used in stone-cutting industries for the cooling and cutting process, As a result, it produces water containing a large amount of suspended solids which affects the environment, and public health (Fahiminia et al., 2013).

This research focuses on examining the implementation of the clean production strategy in stone-cutting, ready-mix concrete and brick factories. Where clean production is defined as a strategy and a series of procedures that preserve environmental sustainability, it can contribute to maintains same production in factories with same quality of products while reducing the amount of waste produced from these factories and reducing environmental damage (Vieira & Amaral, 2016).

1.3 Study Area

This study focuses on CP strategy for stone-cutting factories that discharge industrial wastewater in Wadi Al-Zomer. Where Wadi Al-Zomer considered a transboundary Wadi between Palestine and Israel; it extends from the mountains of Nablus in the east, to the Mediterranean Sea to the west. It covers an area of 600 square kilometers and is 44 kilometers long (Tal et al., 2004). Wadi Al-Zomer extends in the Palestinian governorates of Tulkarm and Nablus, where it noted that there is a significant growth in the quantity of sewage water has discharged into the valley from each of these two governorates. It transports domestic sewage water, industrial wastewater ,and rainwater falling on the catchment area of Wadi Al-Zomer to Israel (Tal et al., 2004). The Israelis built “Yad Hanna” treatment plant nearby to apartheid wall adjacent to Tulkarm, where they treat the wastewater coming through Wadi Al-Zomer and the sewage pipes to be used for agricultural purposes. Palestinians pay the cost of this transboundary wastewater in addition to the cost of treatment (Tal et al., 2004).

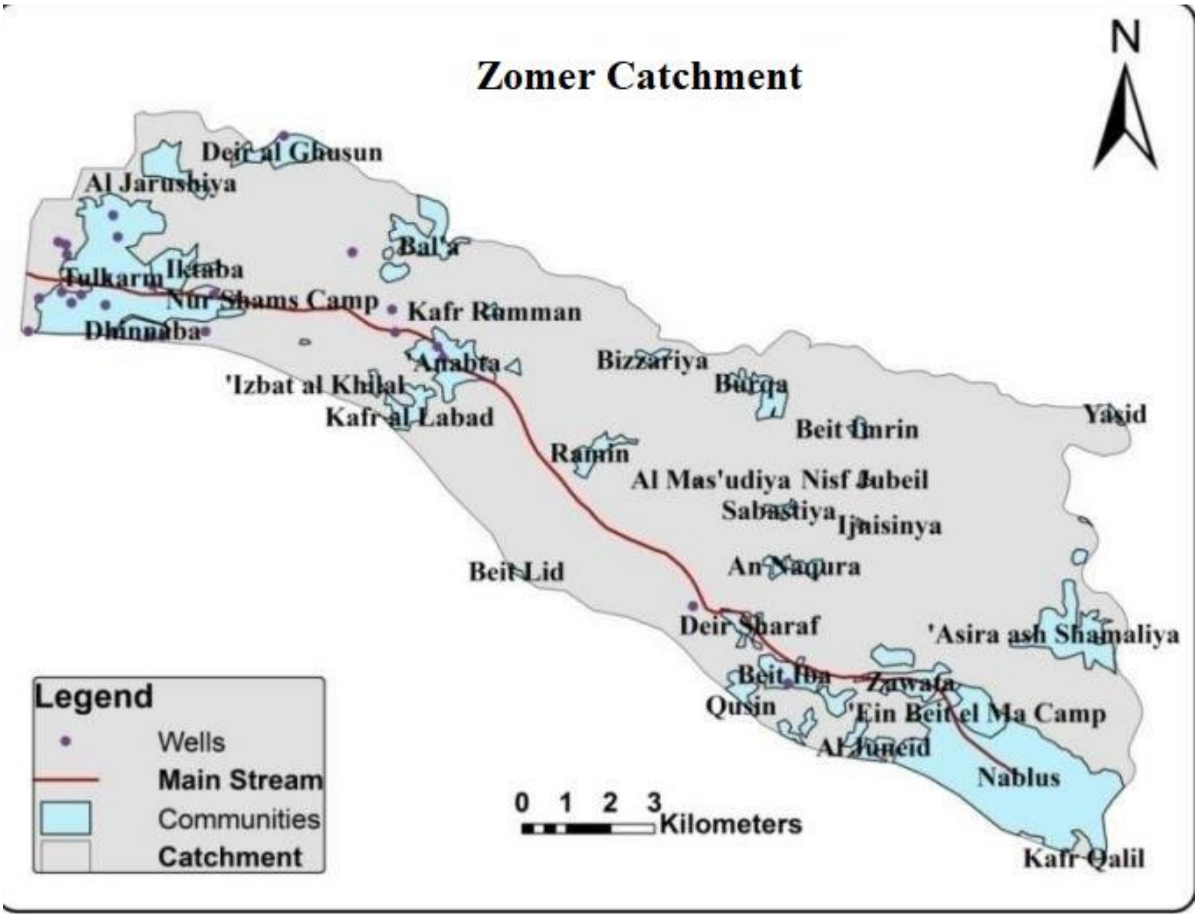
Wadi Al-Zomer located in the northern region of the West Bank, where it transports approximately 35% of the sewage water that passes from the West Bank to Israel, which is the water that discharges from Nablus and Tulkarm (Yaqob et al., 2014).

This research focuses on the area of Wadi Al-Zomer located in Tulkarm and Nablus Governorates. Whereas, Wadi Al-Zomer passing through these governorates surrounded by many industrial facilities, such as olive mils, slaughterhouses, tanneries and stone-cutting industries that discharge their industrial wastewater directly into the valley or indirectly through sewage network lines. This research concentrates on stone-cutting factories only.

Figure 1, shows the layout of Wadi Al-Zomer in addition to the main communities near Wadi in Nablus and Tulkarm governorate.

Figure 1

Wadi Al-Zomer Catchment



Source: (Directorate et al., 2013)

1.4 Problem Statement

Water scarcity is among the main problems in Palestine. Therefore, all means must explored through which additional water sources can be provided, such as the exploitation of wastewater by treating it and utilize it in different aspects on the basis of “from waste to source” (Shadeed & Lange, 2010).

This research focuses on the industrial wastewater steaming from stone cutting industries located near Wadi Al-Zomer, as this industrial wastewater causes many problems, which are environmental problems, economic and political problems, and social problems (Attili, 2020).

In the following Figure 2 and Figure 3 show collection industrial waste water ponds before discharge into the Wadi.

Figure 2

Industrial Waste Water Collection Ponds

Figure 3

Industrial Waste Water Collection Ponds

1.4.1 Environmental problems

In the area of Wadi Al-Zomer, there are many stone-cutting industries, which produce industrial wastewater that contains large amounts of TSS (Fahiminia et al., 2013). These factories dump their industrial water in Wadi Al-Zomer, and on rainy days and large storms, floods occur in the neighboring agricultural lands, which leads to high pollution with stone slurry.

In light of this large direct and indirect pumping of industrial wastewater by stone-cutting industries, some of which flow directly and others through trunk lines, and with the absence of proper treatment and proper exploitation of this water, the Palestinians suffer from many environmental problems due to stone-cutting industries (Sayara, 2016).

The following shows the environmental problems resulting from the stone-cutting industries in Wadi Al-Zomer area:

The stone-cutting process that takes place in the factories near Wadi Al-Zomer produces large amounts of dust, which leads to respiratory problems for residents close to these factories. In addition, the industrial wastewater resulting from the stone-cutting industries contains considerable amounts of suspended solids and chalk. So that, when disposed of in the valley and with the drying of the water present with it leads to the spread of large quantities of harmful dust resulting from the stone-cutting factories with the movement of the wind and along the valley (Farms, 2016).

Clogging of sewage pipes leads to wastewater leaking from the manholes and overflowing into the roads. This clogging is due to industrial wastewater resulting from stone-cutting industries pumped indirectly through factories far from the valley. These factories are connected with the manholes of the sewage network and pump the water resulting from the cutting process into it, as this water contains suspended solids in high quantities, this leads to sedimentation inside the pipes and blockage of these pipes with time (Mohsen et al., 2013).

Discharge of industrial wastewater resulting from stone-cutting industries to the valleys, rivers, and lands as in Wadi Al-Zomer case, affects the soil negatively, as it reduces the permeability of surface soil, changes the topography of the land and increases the alkalinity of the soil. As all of this affects the permeability of water through the soil, this soil becomes impermeable to water, which leads to a decrease in soil fertility and weakness of the agricultural value of this soil (Laitinen et al., 2002).

The industrial wastewater resulting from the stone-cutting industries negatively affects the vegetation cover in two ways: first, the dust and chalk that results from the cutting process and the movement of the wind covers the leaves of the plants and limits the process of photosynthesis. This process inhibits the growth of the plant, weakens it, and reduces the yield of these plants (Farmer, 1993). Secondly, the water produced from the stone-cutting industries contains huge amounts of suspended solids, which reduce the permeability of the soil and reduce soil fertility (Edwards & Withers, 2008).

1.4.2 Economic problem

Transboundary industrial wastewater through Wadi Al-Zomer directly and indirectly affects the Palestinian economy, it causes direct losses through the financial deductions that Israelis take from Palestinian money for every cubic meter of industrial wastewater that crosses the border. There is a long dispute between the Palestinians and Israelis over the amount of financial deduction that the Israelis make, in addition to the wastewater amounts that cross the borders, where they make these financial deductions as a return for the treatment they carry out for this wastewater. Moreover, Israelis treat this water through the “Yad Hanna” wastewater treatment plant then use this water for agricultural purposes (Yaqob Eyad Y.A, 2016).

In addition to the above, there are indirect economic problems that result from the transboundary industrial wastewater in Wadi Al Zomer generated from the stone-cutting industries. This wastewater is considered lost water for the Palestinians, who were not able to utilize it as a source of water, the industrial wastewater generated from the stone-cutting can be treated in several ways. Therefore, it works to reduce the suspended solids inside it and thus can be reused in the cutting and cooling process inside the stone-cutting industries (Farms, 2016).

Because of the possibilities of employing sludge from stone-cutting factories in the manufacturing of bricks and concrete, this research focus on ready-mix concrete manufacturers. As a result, the cost of manufacturing in the brick and ready-mix concrete industries will reduce. In addition to the option of using treated water instead of clean water, So that leads to improve the properties of concrete and bricks while lowering costs for factory owners and providing a solution that minimize industrial wastewater in Wadi Al-Zomer (Al-Joulani, 2015).

Finally, transboundary industrial wastewater generated by the stone-cutting industries in Wadi Al Zomer has an impact on the Palestinian economy in general, stone-cutting factories in particular, due to the materials resulting from manufacturing process (Alzboon & Mahasneh, 2009).

1.4.3 Social Problem

The implementation of clean production strategy in the stone-cutting industries requires consent and cooperation from the factory's managers and workers. As clean production works to modify the factory's overall strategies as well as the nature of the materials used in the production process sequence, such as switching from freshwater to treated water in the cooling process. It also introduces certain new factory functions, such as the treatment of industrial effluent generated by these stonecutters. As a result, convincing factory owners to make all of the necessary modifications to completely and easily adopt this plan is tough. (Van Berkel, 2000).

As previously stated, the use of the clean production strategy modifies the sequence of production processes that both managers and workers in these factories are accustomed. This will be another obstacle to the implementation of these strategies because workers, managers, and individuals are afraid from change and what is unknown. (Weeks et al., 2004).

The current problem is the lack of a relationship between the stone-cutting factories and the ready-mix concrete and brick factories, that relationship will achieved through CP strategy to establish a company-to-company and Win-to-Win relationship. Therefore, ability of the owners of stone-cutting industries whose treated water will be reused in their factories, as well as the ability of the owners of ready-mix concrete and brick factories whose sludge will be reused in their factories, to receive these treatment products in their factories. Since there is usually a societal refusal to use treated water (Rice et al., 2019).

1.5 Research Significance

The significance of this research comes from the problems previously mentioned, which are related to industrial wastewater resulting from stone-cutting industries that pumped to Wadi Al-Zomer. This research seeks to achieve sustainable management of the existing stone-cutting factories in order to reduce these industrial pollutants from the valley in addition to the exploitation of treated water and sludge, to implement the strategies of clean production to achieve the term "exploitation of the waste as a source of power by reuse".

1.6 Research Questions

This research focuses on three types of industries; stone-cutting, ready mix concrete and brick industries. Where the ability to adopt clean production strategy by the owners of these industries measured in terms of:

- Does the Availability of factories can use effluents from treatment process in stonecutters impact the willingness to adopt a clean production strategy?
- What is the impact of sustainability on willingness to adopt cleaner production strategy?
- Does the awareness among factory owners positively impact the willingness to adopt a clean production strategy?
- Does enforced regulation impact the willingness to adopt a clean production strategy?
- What is the relationship between the "Willingness to adopt a clean production strategy" on "environmental and economic impacts of industrial wastewater from the stone-cutting industries"?
- What is the level of awareness among stone-cutting, ready-mix concrete and brick factories?

1.7 Research Objective

This research aims to achieve a set of specific objectives that help to minimize the challenges due to stone-cutting industries from discharge the industrial wastewater in Wadi Al-Zomer. The specific objectives are:

1. Find a win-to-win relationship between availability of factories that can use effluents from treatment process in stonecutters and the willingness to adopt a clean production strategy.

2. Find the relationship among sustainability and willingness to adopt a cleaner production strategy.

3. Find the relationship between awareness among factory owners on the willingness to adopt a clean production strategy.

4. Find the relationship between enforced regulation and the willingness to adopt a clean production strategy.

5. Find the relationship of willingness on adopt clean production strategy on environmental and economic effects of industrial wastewater from the stone-cutting industries in Wadi Zomer area.

6. Raising awareness among factory owners about the importance of reuse, and encouraging them to adopt new strategies that work to achieve sustainable management within their factories.

1.8 Research Hypothesis

Several hypotheses investigated in the study:-

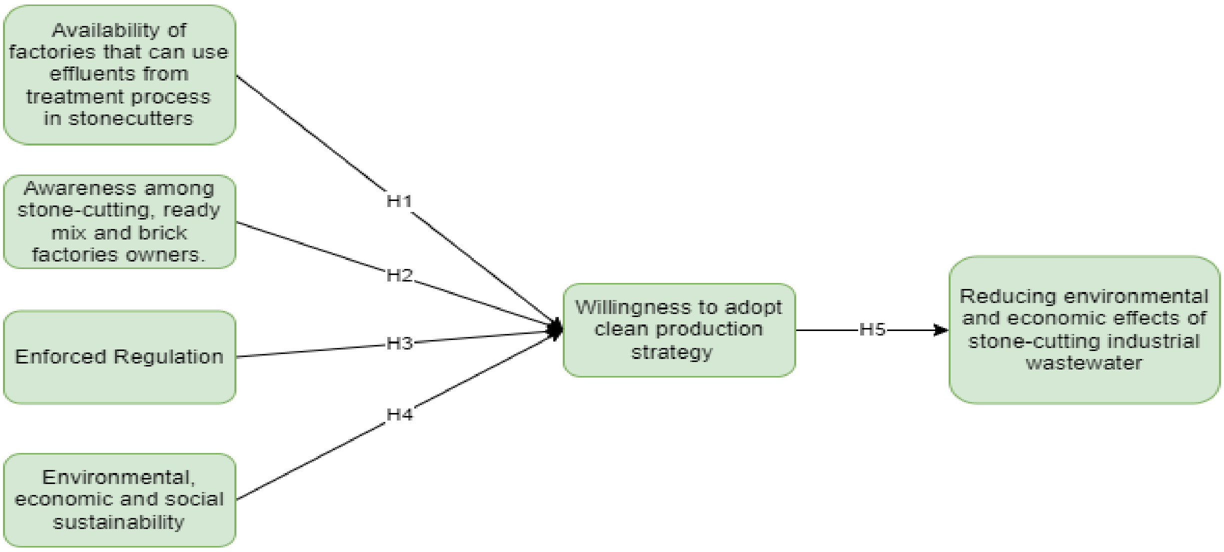
- First hypothesis: Availability of factories that can use effluents from treatment process in stonecutters positively impact the willingness of the factory owners to adopt a clean production strategy.
- Second hypothesis: Raising awareness among factory owners positively impacts the willingness of the factory owners to adopt a clean production strategy.
- Third hypothesis: Enforced regulation positively impacts the willingness of the factory owners to adopt a clean production strategy.

Fourth hypothesis: Social, environmental and economic sustainability positively impacts the willingness of the factory owners to adopt a cleaner production strategy.

– Fifth hypothesis: Willingness of the factory owners to adopt a clean production strategy positively impacts reducing environmental and economic effects of industrial wastewater from the stone-cutting industries.

Figure 4

Conceptual model



Reducing environmental and economic effects of stone-cutting industrial wastewater is the Dependent Variable (DV).

Willingness to adapt clean production strategy be as a DV and IV, DV with enforced regulation, awareness among stone-cutting ,concrete and brick industry owners, Social, environmental and economic sustainability and availability of factories that can use effluents from treatment process in stonecutters.

IV with reducing environmental and economic effects of stone-cutting industrial wastewater.

Enforced Regulation, Awareness among stone cutting, concert and brick industries owners, Social, environmental and economic sustainability, and availability of factories that can use effluents from treatment process in stonecutters (IV).

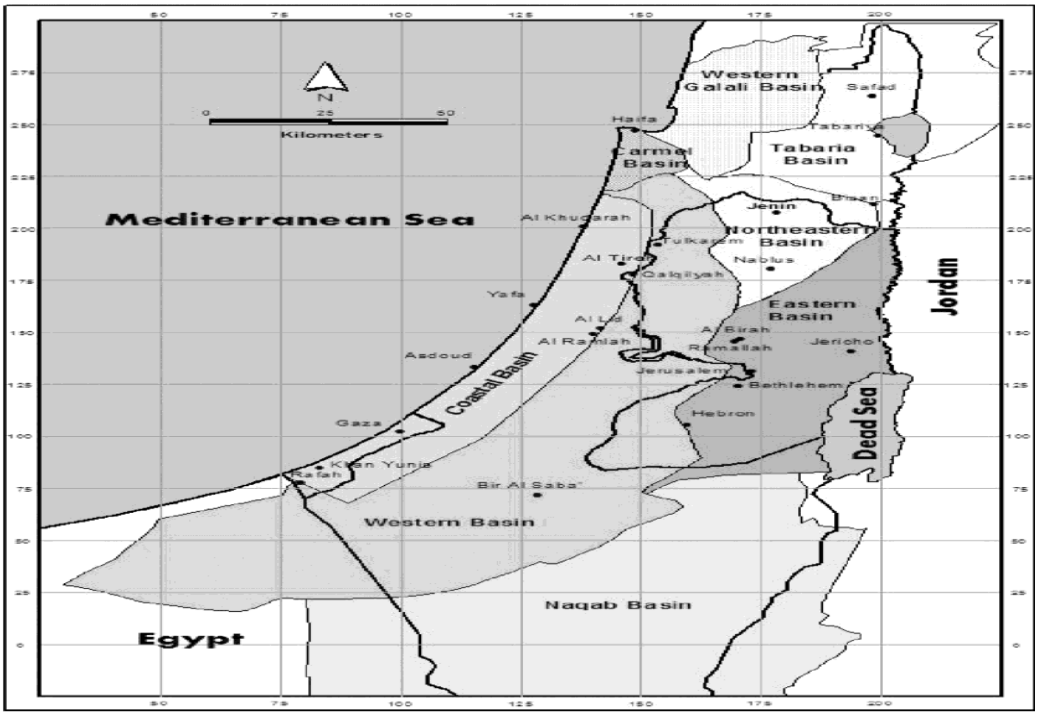
1.9 Theoretical Background

1.9.1 Wadi Al-Zomer and the water sector in Palestine

Since Israel occupied Palestine in 1948, the water conflict began over the groundwater aquifers between the two parties, as Israel initially controlled 4 water aquifers completely until the 6-Day War in 1967, when it imposed full control over the 8 water basins in Palestine (El-Fadel et al., 2001). In historical Palestine, there were eight water basins distributed as shown in Figure 3, where Israel completely controls the Naqab, Carmel, Tabria, and Western Galali aquifers. The western, eastern, and northeastern aquifers are shared aquifers between the Palestinians and the Israelis (but the Israelis control the majority of these aquifers). As for the coastal aquifer, it is shared between the Palestinians, Israelis, and Egyptians. As a result, all groundwater resources available in Palestine are controlled and shared with the Israelis, which leads to a significant scarcity of groundwater resources among the Palestinians (Mimi & Aliewi, 2005).

Figure 5

Aquifers in historical Palestine



Source :(Mimi & Aliewi, 2005)

As a result, the Palestinians are looking for all the ways through which other water resources could be exploited, including the treatment and reuse of industrial water from Wadi Al-Zomer, this research seeks to implement through the development of a clean production strategy in stone-cutting, ready-mix and brick industries near the Wadi.

According to the (Palestinian Water Authority), the Israelis deduct from taxes about 20 million NIS annually because of the transboundary industrial wastewater located in Wadi Al-Zomer from 120 million NIS deducted in 2022 for all transboundary wastewater , so Palestinians lose water and money due to lack of appropriate exploitation of industrial wastewater.

Transboundary wastewater is wastewater that is generated in one country and flows into another. It may include untreated or partially treated sewage, industrial waste, and agricultural runoff. Due to its potential to contaminate and degrade water resources, transboundary wastewater is a source of serious environmental concern in all over the world. Accordingly, many countries have issue laws and administrative policies to control and limit the pollution impacts. Such measures can include wastewater treatment, reuse and SMART Pollution Control (Dunca, 2018).

In Palestine, industrial transboundary effluent is a problem that requires special attention. The state's capability for treating industrial wastewater is limited, and much of the wastewater generated is not subjected to treatment due to political restriction from Israeli side. As a result, it crosses the green line, posing significant environmental and economic challenges. To address this issue, the Palestinian government has implemented a number of initiatives that minimize industrial wastewater pollution, such as treatment, reuse, and curbing pollution.

Accordingly, the government has established a number of programs to support and improve the water quality to manage the transboundary wastewater mainly at Wadi Al-Zomer. For example setting up meters to measure transboundary water, in addition to establishing several treatment plants (Al-Sa’ed, 2010) (Palestinian water law, 2014).

Other examples, pumping industrial wastewater resulting from stone-cutting industries is illegal. According to (Palestinian water law, 2014), as the law stipulates it is not allowed for any industrial or commercial facility to discharge into lands, valleys, or rivers except after completely treating this water and obtaining approval from the Palestinian Water Authority.

There is a wide spread of stone-cutting industries discharge industrial wastewater into Wadi Al-Zomer. Some of them discharge wastewater directly and are located next to Wadi, and some discharge industrial wastewater indirectly through the sewage networks in Tulkarm and Nablus (Yaqob et al., 2014).

Wastewater generated from stone-cutting industries can be treated through flocculation and coagulation techniques, and the resulting treated water can be used in the process of cooling the shear process, reducing the dust emitted, and facilitating the shearing process (Farms, 2016). Industrial wastewater from stone-cutting industries typically contains a range of pollutants, including fine particles, solvents and heavy metals. Treatment of this water can involve biological, physical, and chemical processes to remove the pollutants. Physical processes such as sedimentation and filtration used to remove suspended solids, while chemical processes such as coagulation and flocculation could use to remove oils, grease, and other dissolved pollutants. Finally, biological processes such as activated sludge and biofiltration can be used to remove metals and other contaminants (Al-Jabari et al., 2012).

1.9.2 Adoption of a new strategy

The adoption of new strategies by the industry affects many aspects. For example, the sequence of the process, materials entering and exiting, the number of employees, and many other aspects. Therefore, it is not easy for factories to adopt a new strategy (Andries & Debackere, 2007). However, the application of some new strategies in the factories may return in these factories' profit, greater development, and better exploitation of resources (Furr, 2019). In this research, if the stone-cutting industry adopts a clean production strategy, this is supposed to reduce the bill of fresh water used in the manufacturing process, in addition to the ability of factories to reuse the solid wastes accordingly.

Adopt sustainable management by factories depends on the extent of the enterprise's ability to adopt new strategies and achieve many environmental goals. The adoption of new strategies in the enterprise to achieve environmental sustainability leads to achieving economic profits at the factory level in particular and at the community level in general (Chams & García-Blandón, 2019).

(Geng et al., 2014) demonstrates that lack of awareness of the negative impact of industrial wastewater by the factory owners is regarded as one of the primary reasons to still discharge into Wadi Al-Zomer. Besides, there is a great need to increase factory owner's knowledge of the damages produced by the industrial wastewater, which they are working to discharge in the valley. Doing so could increase the likelihood that the owners of these factories respond to the measures restricting the industrial water in the valley.

Adopting a new strategy can be a complex process that requires careful planning and execution (Wang & Qualls, 2007). Below are some general steps organizations can follow to successfully implement a new strategy:

SWOT Analysis: Before implementing a new strategy, it is essential to perform a SWOT analysis of the organization's current circumstances as well as the outside factors that may affect its success. This analysis ought to include (strengths, weaknesses, opportunities, and threats) analysis along with an assessment of the organization's assets, capabilities, and competitive position (Dyson, 2004).

Set particular objectives: Once the investigation is complete, the organization must decide on specific goals for the new strategy. This strategy must be specific, measurable, realistic, relevant, and time-bound (smart) goals should be set (Bovend'Eerdt et al., 2009).

Create an action plan: The next stage is to create an action plan which outlines the steps needed in order to put the new strategy into effect for implementation accordingly to timetable, milestones, and responsibilities for each should be a part of the work plan (Scobbie et al., 2011).

Communicate the strategy: It is essential to inform all stakeholders, including staff, clients, vendors, and partners, about the updated strategy. To receive buy-in and support, this communication should be clear, consistent, and transparent (Freeman & Mcvea, 2008).

Implement the strategy: After the strategy has been clearly expressed, it is time to put it into action. This may necessitate modifications to the structure, methods, and culture of the organization. It is critical to track success and modify the strategy as needed (Fernandez et al., 2019).

Outcome analysis: It is critical to analyze the results accordingly to the new strategy before it has been implemented. This assessment should include a comparison of actual results to the aims and objectives established in stage 2. The organization's strategy may need to be adjusted as a result of the examination (Pernas & Tolaney, 2019).

To adopt a new strategy by factories, it is also necessary to review the existing laws in this regard and to identify the agencies and institutions responsible for monitoring the implementation (Yusup et al., 2014).

Whereas, the issue of dumping industrial wastewater resulting from stone-cutting industries in Wadi Al-Zomer affects the Palestinian economy and the environment surrounding the Wadi. Therefore, legislation, laws, and institutions that will oblige factory owners to adopt a clean production strategy must be determined, as the existence of such laws and institutions that will contribute significantly in changing the strategies of the factories and motivating them to adopt new clean strategies (Padda & Asim, 2019)

In addition to the above, the existence of deterrent laws and oversight institutions is not limited to the field of penalties and violations only, but can affect improving the level of culture and community awareness of the importance of compliance with laws, values and ethics, thus improving practices and behaviors by factories (Huang & Lei, 2021).

Overall, adopting a new strategy needs careful planning, communication, execution and monitoring by following the previous steps, organizations can increase the likelihood of successfully implementing a new strategy.

Moreover, Governments and institutions can contribute to the realization of this new strategy by gradually applying the law to factories and try to achieve awareness and improve the cultural level of these factories. According to what previously mentioned, this increases the probability of success in implementing the new strategy.

1.9.3 Clean production strategy and sustainability

A clean production strategy relates to a set of practices and techniques that aim to reduce or eliminate waste, pollution, and other negative environmental impacts from the manufacturing process. A clean production plan aims to build a more sustainable and efficient production system that reduces natural resource consumption, lowers emissions and waste, and improves the company's environmental performance (Dong et al., 2019). A clean production strategy may comprise the following critical elements:

1. Resource efficiency entails optimizing the use of resources, energy, and water in the manufacturing process in order to eliminate waste and improve efficiency (Diaz Lopez et al., 2019).
2. Pollution reduction entails detecting and eliminating pollution sources in the manufacturing process, such as emissions and waste products (de Oliveira Neto et al., 2019).
3. Product design: This entails creating environmentally friendly products, such as employing recycled materials, decreasing packaging, and creating things that can be easily mended or recycled (Nguyen et al., 2020).
4. Employee engagement entails teaching and involving employees in the clean production plan to ensure that they understand the significance of sustainability and are motivated to contribute to the company's environmental goals (Farooq & Salam, 2021).

Overall, a clean production strategy can help firms to minimize their environmental impact, enhance their reputation, and reduce costs by reducing waste and improving efficiency.

According to (Kjaerheim, 2005) The clean production strategy helps to achieve sustainability at the environmental, social and economic levels. It works to increase the quality of the life by improving material utilization, reducing energy consumption, and minimum emission levels. It also works to prevent pollution. In factories that apply the clean production strategy, it is called "greening the supply chain".

This research focuses on application the clean production strategy on the stone cutting industries that discharge industrial wastewater Wadi Al-Zomer in order to reduce the various damages resulting from this water. As it will encourage the reuse of this industrial wastewater in various factories, whether inside the factories themselves or in the factories of bricks, concrete and tiles.

There is also a clear impact of this sustainable management on the economic side. As previously mentioned, according to the Palestinian Water Authority, the implementation of the clean production strategy in Wadi Al-Zomer contributes to reducing Israeli deductions from Palestinian funds amounting to approximately 15-20 million NIS from 120 million NIS for total wastewater deduction annually. In addition to the possibility of using wastewater from stone factories for many other uses, such as the ceramic industry (Menezes et al., 2005), and the concrete industry, it works to raise the efficiency of concrete (Awawdh et al., 2018). In addition to that, Many studies have proven that sludge from Stone cutting treatment plants enhances the properties of concrete and bricks, whether in its ability to withstand pressure, tension or bending (Al-Zboon et al., 2010) (Alzboon & Mahasneh, 2009).

According to (Joulani & Awad, 2019) which was conducted in Palestine, it proven that the use of industrial wastewater from stone-cutting factories in concrete production does not negatively affect the strength and properties of concrete.

Many countries are implementing clean production measures to reduce the environmental impact of industrial wastewater from stone-cutting factories. Some of these countries include:

Italy: Using water recycling systems and adopting circular economy principles, to reduce the discharge of contaminated water from stone-cutting factories (S. W. Bai et al., 2015).

Brazil: Using non-toxic and biodegradable cutting fluids and implementing lean manufacturing principles, to reduce the environmental impact of industrial wastewater from stone-cutting factories (Silvestre & Silva Neto, 2014).

China: Using advanced wastewater treatment technologies and implementing water recycling systems, to reduce the discharge of contaminated water from stone-cutting factories (S. Bai et al., 2019).

India: Using non-toxic cutting fluids and implementing water conservation measures, to reduce the environmental impact of industrial wastewater from stone-cutting factories. In addition, they manufacture granite through the outputs of industrial wastewater treatment processes resulting from stone-cutting industries, which encouraged the achievement of integrated sustainable management (Mendoza et al., 2014).

Spain: Using advanced wastewater treatment technologies and implementing circular economy principles, to reduce the discharge of contaminated water from stone-cutting factories (Bianco & Blengini, 2019).

But the case that is closest to the one proposed here in this research is in Jordan, where there are some stone-cutting factories apply the clean production strategy and treat the resulting industrial wastewater to extract the resulting sludge and use as a row material for production process in many factories, for example, concrete and bricks production (Ammary, 2007).

Chapter Two

Methodology

2.1 Chapter overview

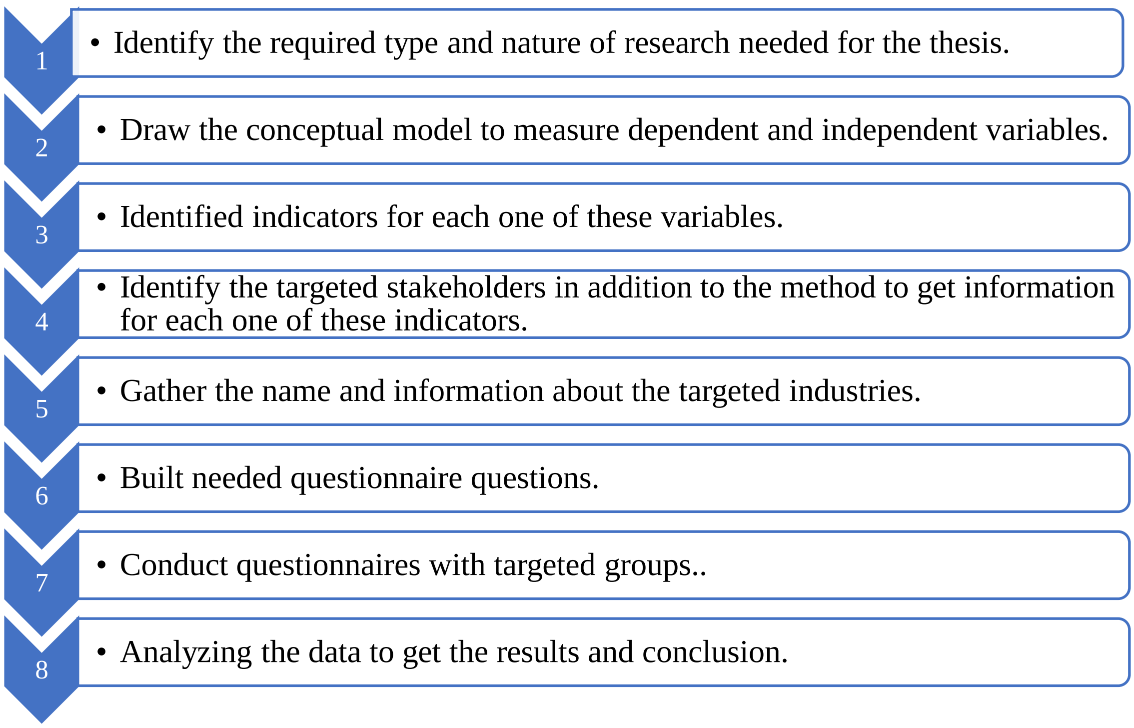
In this chapter, the methodology used for conducting this research is discussed. It starts with a discussion of the types of research used, identifying the target groups in this research and from whom the information will be collected, determining the strategy for collecting information, sampling techniques, and the basis used to determine the sample size needed. Then assess the relationships between the model constructs, So that data analysis approaches offered.

2.2 Methodology flow chart

In the following figure, roadmap provides a brief overview of the systematic steps and procedures that have carefully curated to discover insights and answers in the field of research.

Figure 6

Methodology flow chart.



2.3 Research Type

In this study, predictive research method is used, through which it will be possible to predict the success of applying the clean production strategy in the stone-cutting, bricks and ready-mix concrete factories located near Wadi Al-Zomer. predictive research seeks to forecast future events or trends based on current data (Sreejesh et al., 2014).

In addition, the study is predictive research that includes questionnaires. Therefore, it is quantitative research. A questionnaire is designed containing questions representing the indicators that clarified each variable, where these questions are answered through a scale from one to five.

This research use 5-point Likert scale, contain numbers from one to five in the questionnaire, that scale indicate the validity of these questions and their compatibility with the people who will answer them, as their meaning as follows. 1: Strongly disagree, 2: Disagree, 3: Neutral, 4: Agree, 5: to Strongly agree.

2.4 Population and Sample Size

In this research, a study sample adopted from the stone-cutting factories, in addition to the brick and ready-mix concrete factories located in Tulkarm and Nablus Governorates, so that the necessary questionnaires conducted with them. There are 45 factories of stone cutting, ready-mix concrete and brick located in the Tulkarm and Nablus governorate that are close to Wadi Zomer area. Due to the small number of targeted factories in the study area, the sample size will be all targeted study population.

Interviews conducted with the Chamber of Commerce in addition to the Ministry of Economy in Tulkarm and Nablus in order to determine the number of these factories, and accordingly, all the names of these factories, locations and contact numbers were obtained.

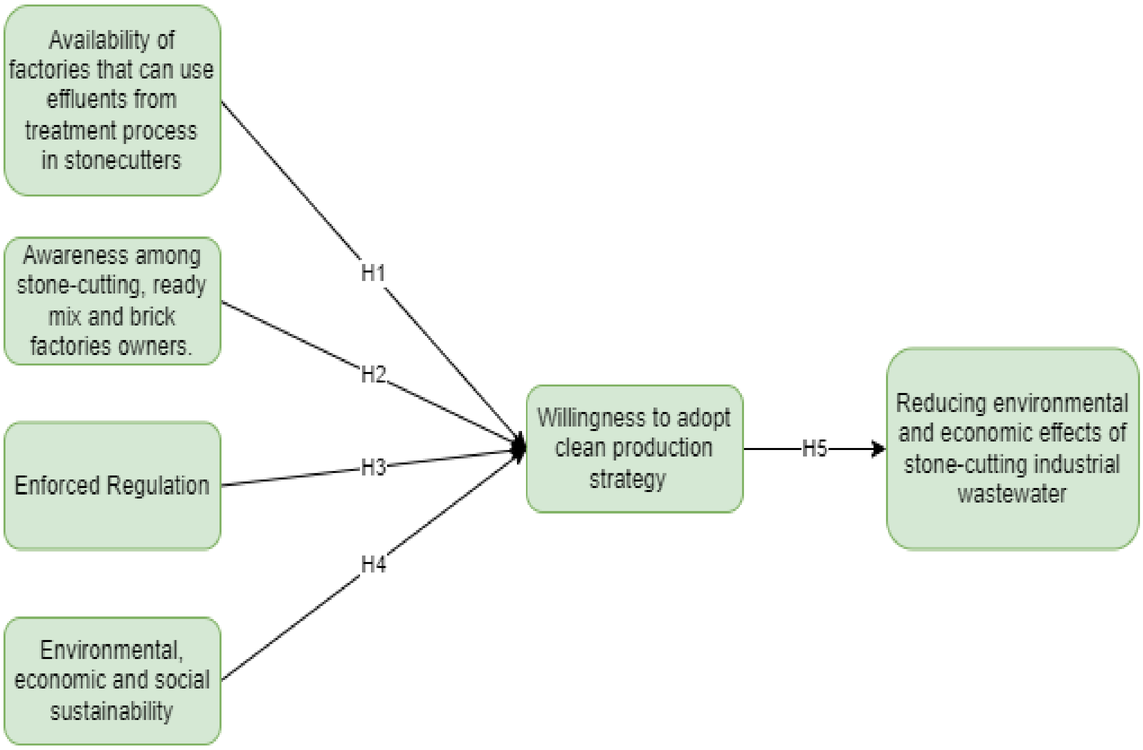
2.5 Questionnaire Development

The questionnaire for this research developed by several steps. At first, identifying the indicators for each of the variables in this research. Secondly, search for literature and previous researches to get questions and methods through which these indicators can be measured. Thirdly, after preparing this questionnaire, evaluation conducted for it by present it to three academics and get notes on it.

In the beginning, the indicators were determined for each of the variables in this research. In figure (5), shows the conceptual model for that research, then there is an explanation of all the indicators obtained.

Figure 7

Conceptual model



Here the following show the clear indicator for each of the previous hypothesis:

- Environmental and economic impact of adopting a clean production strategy→ Economic impact on the Palestinians in general and Environmental effects on Palestinians in general.
- Willingness to adopt a clean production strategy → Ability to implement with full financial support, Ability to implement with partial financial support, Available of sufficient space in factories, and the orientation towards treatment plant.
- Available factories to use treated effluents → Sludge reuse and Treated water reuse.

- Awareness among stone cutting, concrete and brick industries owners → extent of knowledge about the environmental risk of that wastewater, extent of knowledge about the economic losses due to that wastewater, Reuse of treated water and sludge.
- Enforced regulation → Availability of law, responsibility & awareness by the authority, Available ways to enforce the law, and Licensing for discharge in Wadi Al-Zomer.
- Social, environmental, and economic sustainability → Effects on the population surrounding to Wadi Al-Zomer, Resources efficiency and costs saving, Deduction by Israel on Palestinian money, increase the operation efficiency, minimize negative environmental effects, and minimize waste generation.

To gather the required information for all of the above indicators there is a need to conduct a set of questionnaires with stone cutting, concrete and bricks factory owners.

Table 1, shows the indicators for each variable in addition to the method to gather information's.

Table 1

Variable, Indicators, and method to gather information

Variable	Indicator	Method to get the information
Reducing environmental and economic effects of industrial wastewater from stone-cutting industries.	Environmental effects on the Palestinians in general	Questionnaire
	Economic effects on the Palestinians in general	Questionnaire
Willingness to adopt a clean production strategy	Ability to implement with full financial support	Questionnaire
	Ability to implement with partial financial support	Questionnaire
	Available of sufficient space in factories	Questionnaire
	Orientation to install the treatment plant.	Questionnaire
Available factories to use treated effluents	Sludge reuse	Questionnaire
	Treated water reuse	Questionnaire
Social, environmental, and economic sustainability	Effects on the population surrounding to Wadi Al-Zomer	Questionnaire
	Resources efficiency and cost saving	Questionnaire
	Deduction by Israel on Palestinian money	Questionnaire
	Increase the operation efficiency	Questionnaire
	Minimize negative environmental effects	Questionnaire
Awareness among stone cutting, concrete and brick industries owners	Minimize waste generation	Questionnaire
	extent of knowledge about the environmental risk of that wastewater	Questionnaire
	extent of knowledge about the economic losses due to that wastewater	Questionnaire
	Reuse of treated water and sludge.	Questionnaire
Enforced regulation	Availability of law	Questionnaire
	Responsibility & awareness by the authority	Questionnaire
	Available ways to enforce the law	Questionnaire
	Licensing for discharge in Wadi Al-Zomer.	Questionnaire

As shown Table 1 in (Appendix A), after reviewing a set of researches and literature review in relation to the indicators under investigation, a summary of adapted questions that influence on the implementation clean production strategy in addition to their references as literature review.

2.6 Data analysis technique

2.6.1 An Overview on Structural Equation Modelling

By software program SmartPLS 4.0, the (PLS) approach from (SEM) was used to examine the casual correlations between constructs. Because it was predictive exploratory research, the PLS technique was chosen. (Hair et al., 2011). The two-step approach was used in data analysis as suggested by (Henseler et al., 2009). The measurement model analyzed in the first stage, and the structural links between the latent constructs tested in the second. Prior to analyzing the structural relationship of the model, the two-step technique tries to establish the reliability and validity of the measurements.

The SEM's capacity to judge the construct validity of measurements is one of its key advantages. Construct validity here relates to the precision of the measures (Hair et al., 2006). Convergence validity and discriminant validity are the basic factors used in SEM measures to evaluate concept validity.

2.6.2 Convergent Validity

Convergent validity indicates the level of similarity and variance between the items, Which are the indications of a certain construct. The amount of factor loading (standardized regression weights), Average Variance Extracted (AVE), Construct Reliability (CR) between sets of items in the construct, and internal reliability analysis (Cronbach's alpha) might all be used to quantify the convergent validity. The extracted average variance of 0.5 or higher and factor loading estimates of at least 0.6 indicate satisfactory convergence of the construct's components (Hair et al., 2006). By dividing the sum square of the standardized factor loading by the factor loading number, the average variance extracted can be computed. According to (Bagozzi and Yi 1988), the construct reliability (CR) must be 0.7 or greater to demonstrate sufficient internal consistency. The square sum of factor loading and the sum of error variance components for a construct used to calculate the CR (Hair et al., 2006).

Internal reliability analysis should also be used to confirm the measurement items that correspond to each individual variable. The degree of error-freeness in a metric is its reliability. It is important to look at Cronbach's alpha ratio of inner consistency to make sure the elements create a reliable scale. With a value range of 0 to 1, Cronbach's alpha indicates the degree of dependability. Based on (Nunnally and Bernstein 1994), Cronbach's alpha must not be less than 0.7 for a credible scale.

2.6.3 DISCRIMINANT VALIDITY

Discriminant validity evaluation has the aim to ensure that a reflective construct has the greatest relationships with its indicators in the PLS model (Hair et al., 2017).

In this research, two approaches have been used for assessing discriminant validity:

1) (Fornell and Larcker, 1981) Fornell-Larcker method
2) (Henseler et al., 2015) Heterotrait-Monotrait Ratio of Correlations (HTMT)

By comparing the square root of the AVE for two constructs and their relationships, the method put forward by(Fornell and Larcker 1981) allows discriminant validity to be evaluated. When the relationships between the two constructs is less than the square root of the AVE for each concept, there is evidence of discriminant validity (Fornell and Larcker, 1981; Hair, et al., 2017). Additionally, correlations between the variables shouldn't be higher than 0.85 (Kline, 2011).

Heterotrait-Monotrait Ratio of Correlations (HTMT) was employed in this study (Henseler et al., 2019) to measure discriminant validity. Fornell-Larcker discriminant method results supplemented by the Heterotrait-Monotrait proportion of Correlations (HTMT), which is depends on the multitrait-multimethod matrix to evaluate discriminant validity. (Henseler et al., 2019) use a Monte Carlo simulation analysis to compare the novel technique to the Fornell-Larcker criterion and the evaluation of (partial) cross-loadings in order to show the improved performance of this method. Discriminant validity has been proven between two reflective constructs if the HTMT value is less than 0.85 (Franke and Sarstedt, 2019).

2.6.4 Hypotheses Testing

For the aim of testing hypotheses, bootstrapping with 5000 replications was used to assess parameter estimates and coefficient values (Wetzels et al., 2009). Bootstrapping, according to (Hair et al. 2017), is a non-parametric method that enables testing of statistical significance by creating subsamples with randomly chosen observations from the original set of data (with replacement).

The hypothesis can be designated to be supported under three circumstances, according to (Hair et al. 2019): (1) when the orientation of the beta value coincides with the orientation of the hypothesis; (2) when the t-value is more than or equal to 1.96; and (3) when the p-value is less than or equal to 0.05. The relationships among the constructs and the model's propensity for prediction are examined in order to measure the outcomes of the structural model (Hair et al., 2018).

2.6.5 Coefficient of Determination (R^2)

One of the important factors in the PLS-SEM evaluation of the structural model is the coefficient of determination, often known as R square (R^2). Based on (Hair et al. 2017), R^2 number really shows the percentage of variation in the endogenous variables that can be accounted for by one or more exogenous variables. The level and significance of the path coefficients, along with the R^2 measurements, serve as the structural model's major evaluation criteria. According to (Hair et al. 2011), the main goals of the prediction-oriented PLS-SEM method is to explain the variance of the endogenous latent variables, the level of R^2 for the major target constructs should be high. To verify the precision of the structural model, the value of R^2, which shows the distribution of variance in dependent variable explained by its predictors, should be more than 0.30 as mentioned by (Cohen 1992). (Cohen 1988) suggested that the R-square values from 0.02 to 0.12, from 0.12 to 0.25, and from 0.25 to 1 are small, moderate, and significant respectively. Thereby, the quality of structural mode relies on the values of R-square, which show the ability of the endogenous variables be explained by exogenous variables.

2.6.6 Effect Size (F^2)

A modification in R-square could be examined to see whether the effect of a particular independent latent variable on a dependent latent variable has a meaningful impact

(Chin, 2010). This is known as an effect size (F^2) assessment. The effect size measures the effect on the endogenous constructs when a stipulated exogenous construct is excluded from the structural model (Hair et al., 2018).

Effect size measures the strength or value of relationship among the latent variables. It is vital since the effect size encourages scientists to analyze the overall impact of a research study.

(Chin et al., 1996) clearly put forward that researcher should not focus only on the relationship among variables significant or not, but also study the effect size among these variables. Based on (Carte & Russell 2003), there is no effect size for f^2 below 0.02, small if the f^2 ranges within 0.02 to 0.15, moderate if varies between 0.15 to 0.35 and large for the f^2 more than 0.35.

2.6.7 Model Fit Analysis

This study examines a model fit measurements that are endorsed by the SmartPLS application:

2.6.7.1 Goodness of Fit (GoF)

According to (Tenenhaus et al., 2005), described (GoF) goodness of fit of the model, it is the square root for the mean of both (AVE) and the average of R-square of the endogenous variables. Actually, main goal of goodness of fit is to focus on the study model at both stages, specifically measurement and structural model with concentrate on overall quality of the model (Chin, 2010), (Henseler & Sarstedt, 2013). According to (Wetzels et al., 2009), goodness of fit values that 0.1 up to 0.25 were small, 0.25 up to 0.36 moderate, and larger than 0.36 define as large goodness of fit of the model.

Chapter Three
Data Analysis and Results

3.1 Introduction

The present study focuses on investigating the impact of (Available factories to use treated effluents, Social-environmental and economic sustainability, Awareness among stone-cutting, ready-mix concrete and brick industries owners, and Enforced regulation) on willingness to adopt a clean production strategy. It also aimed to examine the effect of willingness to adopt a clean production strategy on the reducing environmental and economic effects of industrial wastewater from stone-cutting industries.

This chapter shows the results obtained from analysis of the data in accordance with analysis techniques described in Chapter (2). First, the chapter presents response rate. Second, it presents the general information of the respondents and stone-cutting, ready-mix concrete, and brick industries, which provides a better understanding of the respondents' characteristics pertaining to the phenomena being investigated in the current study. Third, the data preparation and screening steps for the assessment including detection of the outliers and normality.

Descriptive analysis of the attributes of the questionnaire is presented in section four. Fifth, it reports the results of the reliability of the survey items as to measure the quality of questionnaire scale and the data. This is followed by analyzing and discussing the results of the analysis of the measurement model and the structural model as well as testing the study hypotheses by applying the partial least square structural equation modeling in section six and seven. Finally, the chapter also describes the results of model validation through the model fit indices in section nine.

3.2 Economic benefits

Based on the data collected from the factories, the quantities of fresh water used in stone-cutting factories equal 2000 m^3/month and 600 m^3/month is the quantity of produced sludge from all factories.

Based on the previous data the average value of fresh water and sludge in each one of the 25 stone-cutting factories is 80 m^3/month and 24 m^3/month respectively. So that it's profitable for stone-cutting factories as each one from them will get nearly 2000 NIS monthly by adopting that strategy.

For ready-mix concrete and brick factory it will be profitable for them too, because the cost of the sludge less than the cost of other used raw materials.

In general, the main feasibility that will be obtained is an environmental feasibility through minimizing the resulting environmental damage, in addition to an economic feasibility at the government level by reducing financial deductions amounting to 20 million shekels.

3.3 Descriptive Analysis: Profile of Respondents

A descriptive assessment of the participant profile was employed in the current research. Before performing any other forms of statistical analyses, this kind of analysis carried out at the beginning for any data analysis. The features of the sectors are significant in this study since they offer more accurate insights or data on the study population.

3.3.1 Response Rate

In this research, 45 questionnaires were distributed to stone-cutting, ready-mix concrete and brick factory owners in (Tulkarm and Nablus). The questionnaire was conducted face-to-face, so the response rate to the questionnaire was 100%.

3.3.2 Demographic Profile of the Respondents

This section describes the background information of the stone-cutting, ready-mix concrete and brick industries owners who involved in the present study. Specifically, it provides the general information about industries including their factory type, factory name, The location of the factory from Wadi Al-Zomer, mechanism for discharge of wastewater generated from the factory, average monthly water consumption in the factory, and the number of years the factory has been operating.

3.3.2.1 Factory type

In Table 2, from the total number of 45 usable questionnaires, 55% of them were Stone-Cutting respondents, 20% of them were ready-mix concrete respondents, and 25% were brick respondents.

Table 2

Factory type

Type	Frequency	Percentage
Stone-Cutting	25	55%
Concrete	9	20%
Brick	11	25%

3.3.2.2 Working Years

In Table 3, most of the respondents working since more than 15 years, thus comprising 50% of all responses. The second largest group of the respondents contained those respondents who were 11 to 15 years (30% of the respondents). The group who were 5 to 10 years represented only 15% of the respondents, and finally 5% of respondents were less than 5 years.

Table 3

Respondents' working years

Category	Frequency	Percentage
More than 15 years	23	51.1%
11 to 15 years	15	33.3%
5 to 10 years	5	11.2%
Less than 5 years	2	4.4%

3.3.2.3 Industrial Wastewater Discharge Method

This question was asked to the 25 stone-cutting factories only, where it found that 16 of them discharge industrial wastewater directly into the valley, and nine of them discharge the industrial wastewater through perfusion tanks, where, as reported by the owners of these factories, the owners of perfusion tanks are emptied either in the valley or in the sewage network.

3.4 Data screening and cleaning

The second stage in the process of analysis was the stage of data preparation and screening. It pointed out that techniques of multivariate analysis including multiple regression, factor analysis and SEM have an excellent capacity to assist researchers in analyzing their research hypotheses though have their own constraints and limitations (Tabachnick & Fidell 2007). SEM known as a multivariate statistical technique was used in the present study. Indeed, it demands or needs that the data has certain assumptions, specifically the accuracy as well as the distributional characteristics of the data set (Kline 2011). Kline (2011) also cautions researchers on problems pertaining to the data that may arise and may result into the researcher’s failure to estimate the model. Therefore, the following section discusses the tow aspects of data preparation and screening: outliers and normality.

3.4.1 Outliers

Outliers are data points within a dataset that possess extreme values on either independent or dependent variables, deviating significantly from the remaining observations in the same dataset (Kline, 2011). As stated by Hair et al. (2010), outliers can be identified as cases that stand out distinctly compared to others. Generally, two types of outliers exist: univariate outliers and multivariate outliers. An outlier exhibiting an extreme value on a single variable is known as a univariate outlier, whereas an outlier with extreme values on two or more variables is referred to as a multivariate outlier. The presence of outliers can be attributed to various factors, such as errors in observation, respondents providing incorrect responses, mistakes during data entry, flaws in the questionnaire design, complex instructions, inadequate representation of the target population under study, and genuine extreme values derived from self-report data (Tabachnick & Fidell, 2007).

(Schmacker and Lamax 2004) assume that outliers could impact on the statistical check. It also discuss that outliers could affect the mean, standard deviation, and correlations coefficient values. Additionally other emphasized that outliers may also have an impact on estimates of parameter values, model fit, and standard errors. (Byrne 2013) also interpret that when the parameters are outside in statistical analysis the allowable range among latent variables are more than one, there is a possibility that such outliers exist in the data set.

The above discussion indicates that the emergence of outliers in a given data set affects the statistical analysis. Therefore, it is necessary for a researcher to meet outliers in the data set, explain them, delete them, or accommodate them accordingly (Schmacker & Lamax 2004). In order to find the univariate outliers, (Klline 2011) the univariate skewness and univariate kurtosis should be examined by the researcher. If the kurtosis index is larger than ±10 and the skewness values are larger than ±3, it is possible that there could be a potential outliers in the data set. Furthermore, detection of multivariate outliers can be accomplished by calculating squared Mahalanobis distance (D^2) in all conditions. Squared Mahalanobis distance (D2) or Mahalanobis distance is an indication of the distance in the units of standard deviations among a set of values for each singular case and the average for all constructs (Kline 2011), (Byrne 2013). Furthermore, it focuses on one observation in comparison to the med of all observations on a group of constructs (Haier et al. 2010). On the other hand, an outlying case can be reveal if D^2 value different from the set of all other D^2 measurements in a data set (Byrene 2013).

For the purpose of identifying univariate and multivariate outliers, the SPSS 27 software was utilized in this study. A thorough examination of skewness and kurtosis (refer to Appendix A-1) indicated that there were no potential univariate outliers in the dataset, as the values of skewness and kurtosis fell below the predetermined threshold. It is worth noting that the SPSS program also enables the detection of multivariate outliers using the Mahalanobis distance. In line with the approach described by Hair et al. (2006), the Mahalanobis distance was calculated for each variable using SPSS and then compared with a $\chi 2$ value, with the degrees of freedom equal to the number of independent variables, at a significance level of $p<0.001$. The results obtained from (D2) (refer to tables 2 and 3 in Appendix A) confirm that all questionnaire responses were complete, with no presence of outliers. Therefore, it is appropriate to retain all 45 cases and proceed with the subsequent steps of statistical analysis.

3.4.2 Assessment of the Data Normality

One crucial assumption in multivariate analysis pertains to assessing the distribution's normality. It is essential to identify any deviations from normality among variables, especially when utilizing Structural Equation Modelling (SEM), which assumes a multivariate normal distribution for the data (Hair et al., 2010). Normality serves as a fundamental assumption within multivariate analysis, encompassing the shape of the data distribution for each metric variable and its alignment with the standard normal distribution, which acts as the reference for statistical techniques.

In the current study, to measuring the normality of data distribution, there is a need to check the values of kurtosis, and skewness for the measurement items. The complete values is shown in Table 4, the skewness values ranged from -0.583 to 0.309, thus falling within value recommended by (Byrne 2013), properly among the agreeable range of ± 3. Kurtosis measures varied between -1.186 to 0.747 within the needed amount of the agreeable range of ± 7 (Byrne 2013). The normal distribution of the data showed that the statistical values of kurtosis and skewness were stable and in the agreeable ranges.

Table 4

Data normality results

Descriptive Statistics					
	N	**Skewness**		**Kurtosis**	
	Statistic	**Statistic**	**Std. Error**	**Statistic**	**Std. Error**
ER1	45	-.016	.354	-.760	.695
ER2	45	-.132	.354	-.540	.695
ER3	45	.309	.354	.162	.695
ER4	45	.087	.354	.747	.695
ASCB1	45	-.348	.354	-.443	.695
ASCB2	45	-.583	.354	.343	.695
ASCB3	45	-.268	.354	.553	.695
SEES1	45	-.205	.354	-.629	.695
SEES2	45	-.268	.354	.553	.695
SEES3	45	-.185	.354	-.040	.695
SEES4	45	-.122	.354	-1.186	.695
SEES5	45	-.290	.354	-.595	.695
SEES6	45	-.205	.354	-.919	.695
AFTE1	45	.129	.354	-.353	.695
AFTE2	45	.043	.354	-.606	.695
WACP1	45	-.189	.354	-.874	.695
WACP2	45	-.183	.354	.115	.695
WACP3	45	-.107	.354	.002	.695
WACP4	45	-.096	.354	-.806	.695
REEE1	45	-.320	.354	-.659	.695
REEE2	45	-.082	.354	-.871	.695
Valid N	45				

As shown in Table 4, standard error has been fixed for certain values in order to determine if an anomaly has occurred for these values from this deviation to find any outlier exists.

After screening, cleaning and handling the dataset used in the current study for outliers, normality, and missing observations, the next steps that were needed are internal consistency, descriptive analysis, and confirmatory factor analysis.

3.5 Descriptive Analysis: Attributes of the Questionnaire

To achieve a general overview of how those 45 responses, a descriptive analysis was conducted on all attributes of the research variables. Moreover, all the items of the questionnaire were measured on a five-point Likert scale (from 1 = strongly disagree to 5 = strongly agree).

A detailed examination of the bellow results in Table 5 reveals the respondents' responses pertaining to the reducing environmental and economic effects of industrial wastewater from stone-cutting industries (REEE). In this regard, the AVG score is moderately high, with a AVG of 3.36 (SD) = 1.16. This means that many of the owners/mangers tend to perceive the REEE to be moderately high after willingness to adopt a clean production strategy. The highest mean value was achieved by this item "The dumping of industrial wastewater into the valleys affects the environmental aspects of the Palestinians (REEE1)" (AVG = 3. 40). However, the lowest mean value was scored by this variable "The dumping of industrial waste water into the valleys affects the economic aspects of the Palestinians (REEE2)" (AVG = 3.31). Consequently, the most consistent answer given in the questionnaire is related to the "REEE2", since the (SD) is less varied.

Table 5

Results of the descriptive statistic: Reducing environmental and economic effects of industrial wastewater from stone-cutting industries (REEE).

Statements	**AVG**	**SD**
The dumping of industrial wastewater into the valleys affects the environmental aspects of the Palestinians (REEE1)	3.40	1.176
The dumping of industrial waste water into the valleys affects the economic aspects of the Palestinians (REEE2)	3.31	1.145
Average Score	3.36	1.16

Table 6 presents the results obtained from the descriptive analysis of each item of the willingness to adopt a clean production strategy (WACP). These results revealed that the highest mean value is for this item "The ability to adopt a clean production strategy with full financial support (WACP1)" (AVG = 3.40). It was followed by "The space available in the factory to adopt a clean production strategy (WACP3)" (AVG = 3.20). In contrast, the lowest mean value for this variable was obtained by the item " The extent of your general orientation towards industrial waste water treatment plants (WACP4)" (AVG = 3.13). This was followed by " The ability to adopt a clean production strategy with partial financial support (WACP2) (AVG = 3.16). Consequently, the opinion pertaining to the item "The space available in the factory to adopt a clean production strategy (WACP3)" is the most consistent item among all items under the WACP since the SD is less varied.

Table 6

Results of the descriptive statistic: Willingness to adopt a clean production strategy (WACP)

Statements	AVG	SD
The ability to adopt a clean production strategy with full financial support (WACP1)	3.40	1.074
The ability to adopt a clean production strategy with partial financial support (WACP2)	3.16	0.999
The space available in the factory to adopt a clean production strategy (WACP3)	3.20	0.968
The extent of your general orientation towards industrial waste water treatment plants (WACP4)	3.13	1.179
Average Score	**3.22**	**1.06**

Table 7 illustrates the results of the descriptive statistics for each of the available factories to use treated effluents (AFTE) items investigated in this study. In this regard, the mean score is moderately high, with a AVG of 3.37 (SD) = 0.830). This means that many of the owners/mangers tend to perceive the AFTE to be moderately high. This item “Treated water reuse. (AFTE1)" (AVG = 3. 42). However, the lowest AVG value was scored by this variable "Sludge reuse. (AFTE2)" (AVG = 3.31). Consequently, the most consistent answer given by respondents is related to the "AFTE1", since the (SD) is less varied.

Table 7

Results of the descriptive statistic: Available factories to use treated effluents (AFTE)

Statements	AVG	SD
Treated water reuse. (AFTE1)	3.42	0.812
Sludge reuse. (AFTE2)	3.31	0.848
Average Score	**3.37**	**0.83**

The results in Table 8 below obtained from the descriptive analysis of the items related to social, environmental, and economic sustainability (SEES) showed this item, "Implementing a clean production strategy will reduce negative impacts on the environment (SEES5)," scored the highest mean value (AVG = 3.49). Following this was the item "Implementing a clean production strategy will increase operational efficiency (SEES4)" (AVG = 3.44). However, the results indicated that the lowest mean values were scored by "Implementing a clean production strategy will reduce waste production (SEES6)" (AVG = 2.89). The most consistent answers from the respondents are that "cost savings on the factories in the event of adoption of a clean production strategy (SEES2)" and "Implementing a clean production strategy will reduce negative impacts on the environment (SEES5)" because these items have a less varied standard deviation.

Table 8

Results of the descriptive statistic: Social, environmental, and economic sustainability (SEES)

Statements	AVG	SD
The presence of complaints by citizens living near the factories and those living on the sides of the valley because of the dust (SEES1)	3.42	1.118
Cost savings On the factories in the event of adoption clean production strategy (SEES2)	3.13	0.869
The impact of industrial wastewater on the economic sustainability of the Palestinians (SEES3)	3.29	0.991
Adapt a clean production strategy will increase operational efficiency (SEES4)	3.44	1.253
Adapt a clean production strategy will reduce negative impacts on the environment (SEES5)	3.49	0.869
Adapt a clean production strategy will reduce waste production (SEES6)	2.89	1.265
Average Score	**3.28**	**1.06**

Table 4 in (Appendix A) obtained from the descriptive analysis of the items related to Awareness among stone cutting, concrete and brick industries owners (ASCB) showed this item, I don't have previous knowledge about environmental damage resulting from dumping of industrial wastewater in Wadi Al-Zomer (ASCB1) scored the highest mean value (AVG = 3.33). Following this was the item I don't have previous knowledge about economic damage resulting from the dumping of industrial wastewater in Wadi Al-Zomer (ASCB2) (AVG = 3.18). However, the results indicated that the lowest mean values were scored by I don't have previous knowledge about the possibility of reusing industrial water treatment effluents from stone-cutting (ASCB3) (AVG = 2.13). The most consistent answers from the respondents are that "I don't have previous knowledge about economic damage resulting from the dumping of industrial wastewater in Wadi Al Zomer (ASCB2)" because these items have a less varied standard deviation.

Table 5 in (Appendix A) presents the descriptive statistics for each of the Enforced Regulation(ER) items investigated in this study. Regarding this, it was found that this item "There are institutions working to provide continuous monitoring of factories to reduce the dumping of industrial wastewater in valleys (ER2)" achieved the highest mean value (AVG = 3.07). The second highest mean value was achieved by this item "The licenses that the factories possess do not allow industrial water to be pumped into the valleys (ER4)" (AVG = 2.96). However, the lowest mean value was for this variable "There are laws that prevent factories from dumping their industrial water into valleys (ER1)" (AVG = 2.87). Moreover, the respondents were more likely to state that the licenses that the factories possess do not allow industrial water to be pumped into the valleys (ER4). This is because such item showed a less varied standard deviation.

3.6 Internal Consistency

(Tavakol and Dennick 2011) says, "The reliability is a basic needed for instruments to be valid". Cronbach's alpha is a typical measure of reliability, because it shows assessment of the internal consistency of a standards and is varied between zero and one (Nor 2009). Regarding the internal consistency, it is known as the degree to which the items can measure the same sense (Tavkol & Derick 2011). So that, in the present study, To determine the overall reliability, an exploratory internal consistency measurement using Cronbach's alpha was applied at this level to all the items. Based on to George (2003), the rule for calculating the internal consistency is as follows: (1) alpha value < 0.5 is unacceptable, (2) alpha value ≥ 0.5 is poor, (3) alpha value ≥ 0.6 is questionable, (4) alpha value ≥ 0.7 is acceptable, (5) alpha value ≥ 0.8 is good, and (6) alpha value ≥ 0.9 is excellent. As mentioned in Table 6 in (Appendix A), the Cronbach's alpha is 0.935, which is an indicative of the excellent internal consistency. Additionally, it shows how reliable dose the research tool which used for this study.

3.7 Assessment of Measurement Model

The measurement model consists of the indicators and the paths that connect them to their latent variables intended to be measured as shown in Reducing environmental and economic effects of industrial wastewater from stone-cutting industries (REEE), Willingness to adopt a clean production strategy (WACP), Available factories to use treated effluents (AFTE), Social, environmental, and economic sustainability (SEES), Awareness among stone cutting, concrete and brick industries owners (ASCB), Enforced regulation (ER)

Figure 8

the research measurement model

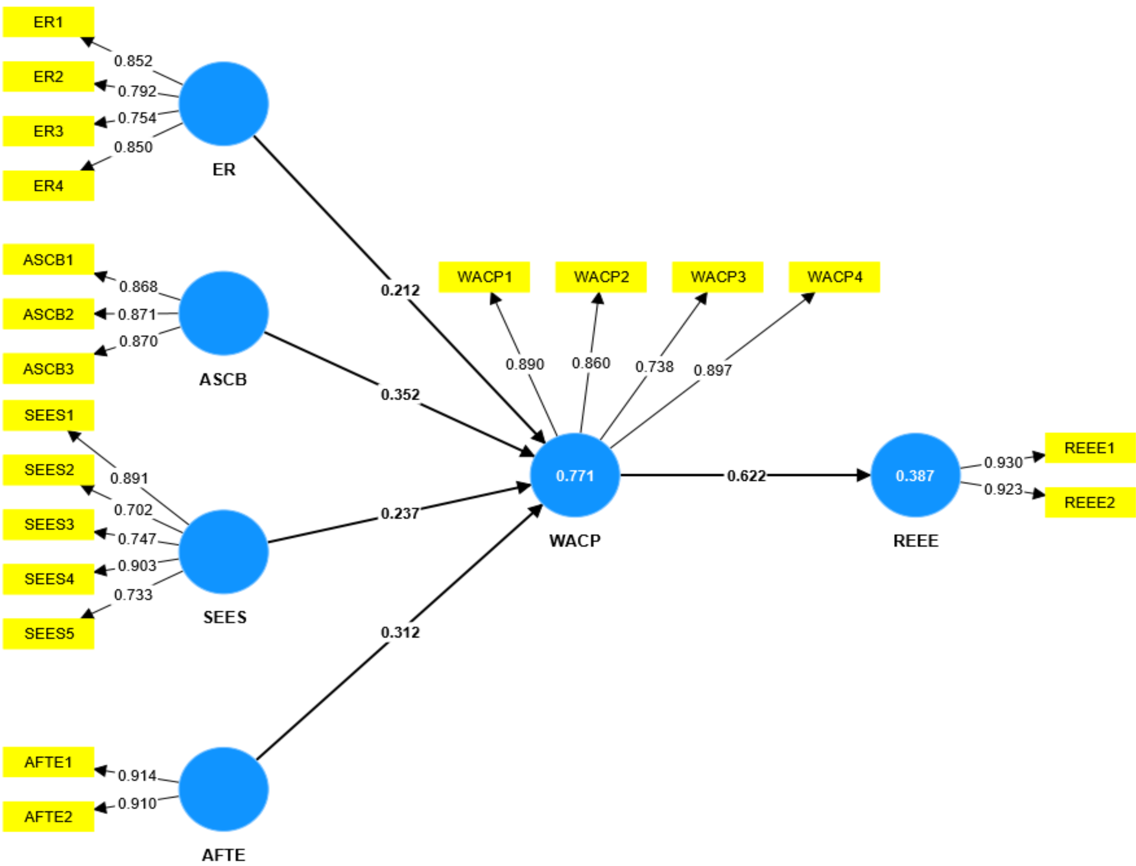


Figure 6. Shows the measurement model and relationships among latent variables and their indicators (Henseler et al. 2009). Calculating of the measurement model focuses at measuring its validity and reliability in addition to the inner path model estimates (Hensler et al. 2009). In that study, measurements executed by the following analyses

methods: convergent validity, internal consistency reliability, indicator reliability, and discriminant validity.

Note: Reducing environmental and economic effects of industrial wastewater from stone-cutting industries (REEE), Willingness to adopt a clean production strategy (WACP), Available factories to use treated effluents (AFTE), Social, environmental, and economic sustainability (SEES), Awareness among stone cutting, concrete and brick industries owners (ASCB), Enforced regulation (ER)

3.7.1 Indicator Reliability

The factor loadings for each indicator examined in order to evaluate the measurement model's indication reliability. Each factor loading needs to be at least 0.7 in order to say that the measurement model has a good indicator reliability (Hair et al. 2010). A higher level or degree of confidence that the measurement items cluster in the underlying estimated construct is also indicated by larger factor loadings, which range from 0.7 to 0.9 (Chin 2010).

The measurement model was tested using 21 reflective indicators. One item SEES6 had factor loadings less than 0.70. According to (Hair et al. 2011) and (Henseler et al. 2009), in case that the factor loading value less than 0.70, the indictor should be removed if its deletion will increase the composite reliability above the recommended threshold value. Therefore, in this study, each individual indicator was deleted separately by performing the PLS algorithm test for each case.

Based on this, the indicator SEES6 was deleted due to low factor loading. Thus, the revised model had 20 indicators. Table 7 in (Appendix A) shows the factor loading for each indicator in the initial model and the revised model.

The results shown in the table indicate that in the measurement model test, the factor loadings varies between 0.702 to 0.930 for all items. Therefore, the measurement model with the 20 indicators shows high levels of indicator reliability.

3.7.2 Internal Consistency Reliability

Cronbach's alpha and Composite Reliability (CR) were used to determine the measurement model's and internal consistency reliability. As (Hensler et al. 2009) suggested using composite reliability instead of the Cronbach’s Alpha in assessing the internal consistency reliability because it is reliable and more effective, (Hair et al. 2013) emphasized the need for using both. This is because the lower bound of the internal consistency reliability can be measured by the Cronbach’s alpha, and the upper bound for the true reliability can be measured by CR. The Cronbach's alpha and composite reliability of each variable must be greater than 0.70 for the measurement model to have an acceptable internal consistency reliability (Nunally 1994). On the other hand, (Hensler et al. 2009) mentioned using composite reliability values more than 0.8 or 0.9 to achieve the internal consistency reliability specially and the research in general as favorable. Using the partial least square algorithm check, Table 8 in (Appendix A) shows the composite reliability and Cronbach’s alpha values of each variable.

As shown in the Table, the ranges of the CR values were from 0.898 to 0.924, while those of the Cronbach’s alpha values were from 0.798 to 0.868. The threshold value of 0.70 is where all of the aforementioned numbers fall. Additionally, it is clear that CR is a better measuring criteria for evaluating the internal consistency reliability when compared to Cronbach's alpha values. As a consequence, the findings of Cronbach's alpha and CR show that the examined constructs of the current study have high levels of internal consistency dependability.

3.7.3 Convergent Validity

Due to their unidimensionality, a group of indicators can be shown to have convergent validity when they represent the same underlying construct (Henseler et al. 2009). Convergent validity depends on the correlations between results obtained while assessing the same construct using several methodologies (Gotz et al. 2010). As mentioned by (Fornell & Larcker 1981) Average Variance Extracted (AVE) criteria are a popular way to assess convergent validity.

For a measurement model to have an adequate convergent validity, the constructs should have an AVE value of 0.5 or above (Hair et al. 2013). This implies that the indicators share at least half of their variance with the construct (Henseler et al. 2009). For the current study, Table 9 in (Appendix A) illustrates the Average Variance Extracted values for the variables in this research using the partial least square algorithm check.

The results show that the AVE for the constructs ranged from 0.640 to 0.858. They also exceeded the suggested threshold value of 0.5, which indicates that the values of convergence validity for all constructs of the present study are within the recognized value.

3.7.4 Discriminant Validity

Discriminant validity, also referred to as divergent validity, is the measure of how distinct a construct is from other constructs based on empirical standards (Hair Jr. et al., 2013, 2016). The development of discriminant validity demonstrates the unique nature of a construct, enabling it to capture phenomena that cannot be explained by other existing constructs within a model. It is possible to assess discriminant validity at both the indicator and construct levels.

At the indicator level, the evaluation of discriminant validity involved the examination of item cross-loadings. This examination focused on ensuring that the factor loading of an indicator, in relation to its associated construct, exceeded its loadings on other constructs within the presented model. Ideally, no cross-loading should be present, as the presence of such cross-loadings indicates a problem with discriminant validity. Cross-loadings indicate that discriminant validity has not been established (Hair Jr. et al., 2013, 2016).

The results in Appendix A's Table 10 show that the influence of factors of each indicator on its related construct is greater than its loadings on other constructs (as underlined in color in the Table). This finding implies that there are no cross-loadings between the indicators of each construct and other constructs. It is possible to conclude that discriminant validity has been demonstrated based on this measure of cross-loading.

The Fornell-Larcker criterion (Fornell & Larcker, 1981) and the Heterotrait-Monotrait ratio of Correlations (HTMT) criterion (Franke & Sarstedt, 2018; Henseler, Ringle, & Sarstedt, 2015) are used to assess discriminant validity at the construct level. The first criterion, the Fornell-Larcker criterion, assesses discriminant validity in a more conservative manner (Fornell & Larcker, 1981). The square root of each construct's Average Variance Extracted (AVE) is compared to its correlation with other constructs in this method. To show discriminant validity, the square root of the AVE of each construct should be greater than the maximum correlation it has with other constructs in both its corresponding row and column.

The results reported in Appendix A's Table 11 show the diagonal values, which represent the square root of each construct's Average Variance Extracted (AVE). Each diagonal value is found to be bigger than the highest correlation it has with any other construct in its associated column and row. In other words, each diagonal value outperforms every other value in its column and row. For example, the CBI construct's square root of the AVE is 0.862, which exceeds its connection with other constructs as displayed in its column. This pattern is also seen for other structures' AVEs on the diagonal, where they outperform the other values in their respective columns and rows. The Fornell-Larcker Criterion indicates that discriminant validity has been established.

The second method utilized to evaluate construct level discriminant validity involves the application of the Heterotrait-Monotrait ratio (HTMT) of correlations (Franke & Sarstedt, 2018; Henseler et al., 2015). The HTMT approach provides insights into the true correlation between any two constructs, and a correlation above 0.90 indicates a lack of discriminant validity (Hair Jr. et al., 2016). In this regard, the results of the HTMT assessment are presented in Table 12 of (Appendix A), demonstrating correlation values below 0.90 for all constructs. Consequently, it can be inferred that each construct is more closely associated with its respective indicators, thereby satisfying the criterion for discriminant validity.

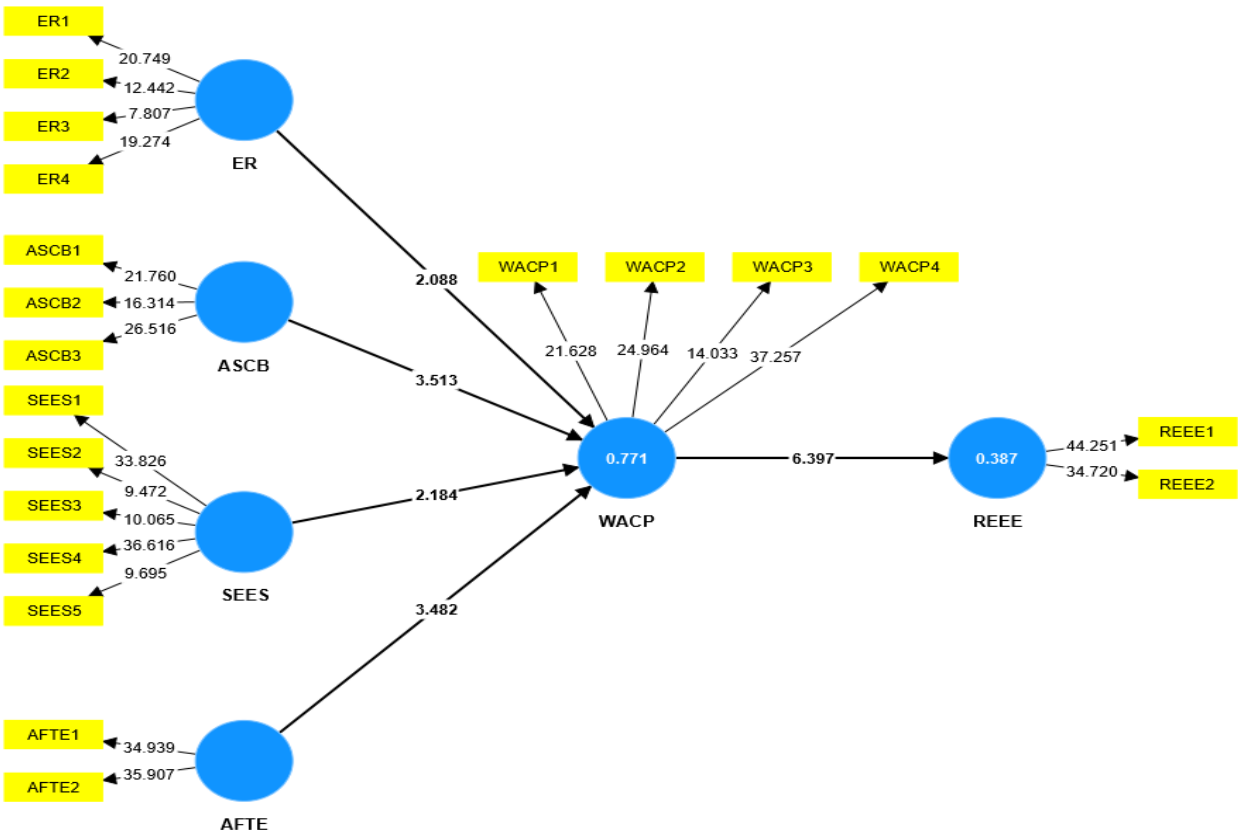
In conclusion, the evaluations of the reflective measurement model indicate that the desired outcomes of internal consistency (composite reliability), convergent validity, and discriminant validity have been successfully attained.

3.8 Assessment of the Structural Model

The constructs or latent variables and the routes that link them together make up the structural model, as depicted in Figure 7. The goal of structural model assessment is to identify the connections between the latent variables (Henseler et al. 2009). In other words, the structural model assessment intends to test the suggested research hypotheses by assessing the reliability of the proposed research model and the path estimations (Hair Jr et al. 2013). effect size (f^2), path coefficients (β), and Coefficient of determination (R^2) analyses are used in the assessment process.

Figure 9

The research structural model



3.8.1 Coefficient of Determination

The amount of variance in the dependent variables is referred to as the coefficient of determination. Typically, the independent variable explains or predicts it (Hair et al. 2012). As a result, it assesses how well the regression function fits the manifest variables that were discovered through empirical research. The percentage of variance explained will increase as the coefficient of determination (R^2) value increases. This is true for the R^2 value, which typically varies from zero to one (Hair et al. 2010).

In PLS path models, it is important for the values of the model to be adequately high in order to achieve a minimum level of explanatory power. According to Cohen (1988), the R^2 values between 0.02 and 0.12 are small, between 0.12 and 0.25 are moderate, and between 0.25 and 1 are significant. From another point of view, Mitchll and Joley (2013) state that the R^2 values between 0.01 to 0.09 are small, between 0.09 to 0.25 are moderate, and those between 0.25 to 1 are high. Using the PLS algorithm test, the R2 values of the dependent variables of the current study are displayed in Table 13 in (Appendix A).

Based on the results in table 12, the R^2 value for the construct of REEE is 38.7% as predicted by the WACP. Meanwhile, the R^2 value for the WACP itself is 77.1% predicted by AFTE, SEES, ASCB and ER. So that, the results indicate that the coefficient of determination values for REEE and WACP are high.

3.8.2 Effect Size

The F-test is a further tool for evaluating the structural model (Cohen 1988). This assesses how an independent variable incrementally explains a dependent variable (Henseler et al. 2009). Therefore, F^2 measures if a given (IV) substantially affects or impacts a given DV (Urbch & Ahlmann 2010). So that, the (f^2) measured as the increase in the R^2 related to the change in the value of the (DV) that remains unexplained (Henseler et al. 2009), (Urbach & Ahlemann 2010).

The effect size values from 0.02 to 0.15 indicate small, from 0.15 to 0.35 indicate medium, and exceeding 0.35 indicate major effects on the (DV) by (IV) (Hair et al.

2013). Table 14 in (Appendix A). Illustrated the results of the effect size of the model for the current study.

As seen in Table 13, the f^2 values of the independent variables were analyzed using the PLS algorithm. All f^2 values ranged from 0.097 to 0.298. In more detail, this analysis shows that ASCB has the strongest effect on WACP (f^2 = 0.298, medium), followed by AFTE (f^2 = 0.222, small), perceived threat (f^2 = 0.078, small), and switching cost (f^2 = 0.024, medium). However, SEES have the lowest effect on the WACP (f^2 = 0.097, small).

3.8.3 Testing the Research Hypotheses

The research hypotheses were examined by analyzing the results obtained from the assessment of path coefficients within the structural model. This involved utilizing the path estimates, along with their corresponding T-statistics and p-values, to either support or reject the research hypotheses. The PLS algorithm test was then employed to compute the path coefficient values (β). It is worth noting that according to Cohen (1988), path coefficient values of 0.02, 0.15, and 0.35 are indicative of small, medium, and large effect sizes, respectively. Additionally, the critical t-values for a two-tailed test are 1.65, 1.96, and 2.58 at p-values of 0.1, 0.05, and 0.01, as mentioned by Hair et al. (2013).

In addition, (Lehner and Haas 2010) explained that when the path coefficient value ranges from 0 to 1, it is an indication that the correlation is perfectly positive, which means that the change in the (IV) shows the same change in the respective (DV). However, when the domain of the path coefficient value falls between 0 and -1, this implies that the correlation is perfectly negative, which means that an increase in the independent variable results into an equal decrease in the respective dependent variable. Table 15 in (Appendix A). presents the results of testing the research hypotheses using the path coefficients, T-statistics, and significance levels.

The results show that all research hypotheses are supported. The results of the hypotheses testing are explained as follows:

H1) Available Factories to use Treated Effluents has a significant positive effect on Willingness to Adopt a Clean Production strategy

As shown in Table 16 in (Appendix A), the t-value and p-value of (AFTE) in predicting (WACP) were 3.482 and 0.001 respectively. It means that the probability of getting a t-value as large as 3.482 in absolute value is 0.001. In other words, the regression weight for (AFTE) in predicting (WACP) is significantly different from zero at the 0.001 level. Moreover, the standard path coefficient was 0.312, indicating a positive relationship. It means, when (AFTE) goes up by 1 standard deviation, Willingness to adopt a clean production strategy (WACP) goes up by 31.2% standard deviations. These results demonstrated that H1 is supported; $\beta = 0.312$, $t > 1.96$, $p < 0.05$.

H2) Awareness among Stone cutting, Concrete and Brick industries owners has a significant positive effect on Willingness to Adopt a Clean Production strategy

As shown in Table 16 in (Appendix A), the t-value and p-value of (ASCB) in predicting (WACP) were 3.513 and 0.000 respectively. It means that the probability of getting a t-value as large as 3.513 in absolute value is 0.000. In other words, the regression weight for (ASCB) in predicting (WACP) is significantly different from zero at the 0.001 level. Moreover, the standard path coefficient was 0.352, indicating a positive relationship. It means, when (ASCB) goes up by 1 standard deviation, (WACP) goes up by 35.2% standard deviations. These results demonstrated that H2 is supported; $\beta = 0.352$, $t > 1.96$, $p < 0.05$.

H3) Enforced Regulation has a significant positive effect on Willingness to adopt a clean production strategy

As shown in Table 16 in (Appendix A), the t-value and p-value of (ER) in predicting (WACP) were 2.088 and 0.037 respectively. It means that the probability of getting a t-value as large as 2.088 in absolute value is 0.037. In other words, the regression weight for (ER) in predicting (WACP) is significantly different from zero at the 0.037 level. Moreover, the standard path coefficient was 0.212, indicating a positive relationship. It means, when (ER) goes up by 1 standard deviation, (WACP) goes up by 21.2%

standard deviations. These results demonstrated that H3 is supported; $\beta = 0.212$, $t > 1.96$, $p < 0.05$.

H4) Social, Environmental, and Economic Sustainability has a significant positive effect on Willingness to Adopt a Clean Production Strategy

As shown in Table 16 in (Appendix A), the t-value and p-value of (SEES) in predicting (WACP) were 2.184 and 0.029 respectively. It means that the probability of getting a t-value as large as 2.184 in absolute value is 0.029. In other words, the regression weight for (SEES) in predicting (WACP) is significantly different from zero at the 0.037 level. Moreover, the standard path coefficient was 0.237, indicating a positive relationship. It means, when (SEES) goes up by 1 standard deviation, (WACP) goes up by 23.7% standard deviations. These results demonstrated that H4 is supported; $\beta = 0.237$, $t > 1.96$, $p < 0.05$.

H5) Willingness to Adopt a Clean Production strategy has a significant positive effect on Reducing Environmental and Economic Effects of industrial wastewater from stone-cutting industries

As shown in Table 16 in (Appendix A), the t-value and p-value of (WACP) in predicting (REEE) were 6.397 and 0.000 respectively. It means that the probability of getting a t-value as large as 6.397 in absolute value is 0.000. In other words, the regression weight for (WACP) in predicting (REEE) is significantly different from zero at the 0.000 level. Moreover, the standard path coefficient was 0.622, indicating a positive relationship. It means, when (WACP) goes up by 1 standard deviation, (REEE) goes up by 62.2% standard deviations. These results demonstrated that H5 is supported; $\beta = 0.622$, $t > 1.96$, $p < 0.05$.

3.9 Model Fit

The purpose of validating the research model in PLS is to examine its predictive capability because it is based on variance that has a strong orientation towards prediction. Since validation of all parts of the research model including the measurement model, the structural model and the overall model is necessary, the main fit indices is Goodness of Fit (GoF) index (Esposito Vinzi & Russolillo 2013).

3.9.1 Goodness of Fit

Previous researchers (Vinzi et al. 2010), (Henseler & Sarstedt 2013) have proposed a global criterion of goodness of fit (GoF). This criterion is intended to be used as a means of measuring the overall fit for the validation and confirmation of the PLS model. The GoF index has been used in various studies in PLS path modeling (Sarstedt & Ringle 2010). The GoF recognized as an operational method for verifying and confirming the performance of the PLS model at the measurement as well as the structural models, thus specifically focusing on the overall performance of the model (Chin 2010), (Esposito Vinzi et al. 2010). In this regard, Tenenhaus et al. (2005) stated, "the GoF is meant as an index for validating the PLS model globally".

The GoF is also known as the geometric mean of the average communality and the average R2 (Henseler & Sarstedt 2013). In addition, while the mean communality is used as an indicator to calculate the predictive performance of the measurement model, the mean R^2 is used as an indicator to calculate the predictive performance of the structural model. In the other hand, the mean communality of a model shows to the complete squared loadings, which are associated to the indicators for all resent construct and divided by the number of indicators (Kocke 2013). The coefficients of determination measurements obtained by using the partial least square algorithm check as mentioned earlier in the measurements of the structural model. Table 15 and Table 17 in (Appendix A) shows the average R^2 of the model.

However, (Esposito Vinzi and Russolillo 2013) recommended the use of the average variance extracted as an index that is similar to the mean communality. This is because the AVE for each latent construct show the same to the communality. Moreover, (Kock 2013) mentioned that the mean R^2 is indeed one of the model fit indicators.

The goodness of fit value change from zero to one (Esposito Vinzi & Russolillo 2013). Moreover, the threshold values of 0.1, 0.25, and 0.36 indicate that the goodness of fit is small, medium and high, respectively (Wetzels et al. 2009). Those investigators construct their suggestion based on the assumption that employing Cohen's thresholds for small, medium, and large effect sizes, and a minimum average AVE of 0.5. Using

H2 and R^2 values, the goodness of fit value was measured based on the following equation:

$$GOD = \sqrt{\overline{R}^2 \text{ x } (\overline{\text{Com}})} \quad \text{……………………….(1)}$$

The goodness of fit for the model in this research was evaluated using the aforementioned formula. The resulting goodness of fit value was determined to be 0.657, indicating a high level of fit.

$GOF = \sqrt{\mathbf{0.579 * 0.745}}$

GOF =**0.657**

Given the previously mentioned threshold values, the model goodness of fit is adequately high, which is an index that the global model validity is true. Finally, the results of the analysis supported these research hypotheses H1, H2, H3, H4, and H5 with appropriate path coefficients and significant t-values.

3.10 Conclusion of analysis

This study used a partial least square structural equation modeling technique for answering the research questions. For this, a thorough analysis of both the measurement model and the structural model was carried out to achieve the research objectives. In other words, this aimed at testing the research hypotheses. Based on the results obtained from the analysis of the measurement model, the measurement model of that research established that the current study was reliable and valid. This is because all factors under investigation had loadings that were higher than the suggested value of 0.7, demonstrating that the indication dependability was adequate. The findings also showed that construct composite reliability and Cronbach's alpha values were higher than the recommended value of 0.7, indicating that the internal consistency reliability was satisfactory. In terms of the AVE of the constructs, they likewise went beyond the value of 0.5 that prior study had shown, thus underlying the acceptable level of the convergent validity. In this study, it found that the values of the square root of the constructs AVE were higher than the correlations among the constructs. The loadings of all indicators on their own constructs were also higher, which is indication of the acceptable discriminant validity.

In relation to the analysis of the structural model, the results obtained in this study demonstrated an acceptable level of validity of the model. The R^2 values for were high. As demonstrated by the path coefficients, the levels of significance exceeded the suggested β value of 0.1 at t-statistics values of 1.96. Based on the path coefficient assessment, the hypotheses were tested are supported. The values of the effect size were found to be within the recommended values. In other words, they underlined the small and medium effect size of the independent variables.

Finally, the model was validated using the model fit indices that showed the appropriate model validity. The level of The GoF of the model was large at 0.657. This indicates that the global model validity was excellent.

Chapter Four
Discussion, Conclusion and Recommendations

4.1 Chapter Overview

In this chapter, the results obtained from the analysis of the questionnaires in the previous chapter are interpreted and discussed. Moreover, the impact of the hypotheses and indicators that have been developed were considered, as it contains many sections, which are, discussion of results, discussion of environmental and economic effect of stone-cutting factories, hypothesis testing discussion, theoretical implications, practical implications, conclusions, recommendations, research limitations, and future research directions.

4.2 Discussion of Results

This research aims to study the possibility of applying a clean production strategy in stone-cutting plants, brick, and ready-mixed concrete factories near Wadi Zomer area. There is a set of hypotheses and conceptual model that was developed in this research; it has been proven that the adoption of a clean production strategy by factories contributes to reducing the pollutants resulting from industrial water flowing into Wadi Zomer from stone-cutting plants, which leads to reducing the economic deductions and environmental damage resulting from that industrial wastewater in Wadi Zomer area.

4.3 Discussion of Environmental and economic Effects of Stone-Cutting Factories

After analyzing the results of the questionnaire conducting on stone-cutting factories, it turned out that the environmental damage in the valley has accumulated for a long time. As there are 50% of the stone-cutting factories have been operating for more than 15 years, there are 30% of the factories have been operating for 11 to 15 years, there are 15% of the factories have been operating for 5 to 10 years ,and 5% for less than 5 years. Thus, the amount of industrial wastewater pumped by each of these factories over the period of its operation has caused huge environmental damage from soil and groundwater problems.

During face-to-face questionnaire with the owners of stone-cutting factories, it turned out that some of them dispose of industrial wastewater through septic tanks, where these tanks empty the waste water into the sewerage network, which causes clogging in the network pipes, in addition to malfunctions at the Nablus West treatment plant, as this water causes the closure of refineries in this station in addition to harming bacteria that work on wastewater treatment.

In addition to the above, it was found that there are huge direct and indirect economic losses resulting from industrial wastewater steaming from Stone-cutting factories in the Wadi Zomer. As it turned out from the questionnaire that these factories consume about 2000 cubic meters of water per month, which is disposed of after use, so they are a source of loss of large amounts of water, as this water can be reused several times in factories if clean production strategies are followed. In addition, the cake or sludge resulting from the stone residue in the shearing process will become a source of income in the factory by selling it to ready-mix concrete factories instead of being Waste. Thus, this reduces the raw material costs also on ready-mix concrete and brick factories.

Based on data gathered from Palestinian Water Authority, there are direct economic losses resulting from industrial wastewater in Wadi Zomer, in addition to the indirect economic losses mentioned above which are the financial deductions practiced by Israel against Palestinians as a result of industrial wastewater crossing the border.

4.4 Hypothesis Testing Discussion

Based on the hypotheses put forward and studied (H_1, H2, H3, H4, and H_5) as proposed in section 1.8 of this research, the results of the analysis show in general that there is a significant and positive relationship between the adoption of a clean production strategy and reducing the environmental and economic damage caused by industrial wastewater from stone-cutting industries, which is consistent with the results of previous researches (Giannetti et al., 2020) (Kubota & Da Rosa, 2013).

Furthermore, regarding the first proposed hypothesis that was studied, which states that the “Availability of fields to use treated wastewater from stone-cutting industries positively impacts the willingness to adopt a clean production strategy". It is proved through the analysis that it is a significant and positive relationship, and thus hypothesis No. 1 of this research has been proven, which corresponds to the results of (Mosaferi et al., 2014).

The results of the relationship between “Environmental, economic, and social sustainability” and “Willingness to adopt a clean production strategy” is significant and with a positive relationship, which approves hypothesis NO.2 and corresponds with the results from (Amran et al., 2020).

The results of the relationship between “Raising awareness among factory owners” and “Willingness to adopt a clean production strategy” is significant and with a positive relationship. Which approves hypothesis NO.3 and corresponds with the results from (Nunes et al., 2019).

The results of the relationship between “Enforced regulation” and “Willingness to adopt a clean production strategy” is significant and with a positive relationship. Which approves hypothesis NO.4 and corresponds with the results from (D’Souza et al., 2020).

Finally, as mentioned earlier and explained in the analysis. All the first four hypotheses positively affect the willingness of adopting a clean production strategy, and as it appears in the analysis, the higher the willingness of adopting a clean production strategy, the less environmental and economic damage caused by industrial wastewater from stone-cutting industries in Wadi Al-Zomer area in Tulkarm-Palestine, which is proved through this study.

4.5 Theoretical Implication

This study contributes to deepening the understanding of the topic of clean production, green factories, and their relationship to sustainable performance, as it provides a comprehensive presentation of industrial wastewater in Wadi Zomer area, especially industrial wastewater produced from stone-cutting factories. This study adds to the previous studies that examined the possibility of applying a clean production strategy in stone-cutting, ready-mix concrete, and brick factory near Wadi Zomer area. In addition, it carries out many variables from previous studies and these variables have proven to be correct and proposed a new variable that this study has proven is the relationship between the willingness of adopting a clean production strategy with reducing the environmental and economic impacts of industrial wastewater from Stone-cutting factories. Moreover, it is the first study to fully address this topic for Stone-cutting, ready-mix concrete, and brick factories in Wadi Al-Zomer area in Palestine, as this study focuses on sustainable performance.

4.6 Practical Implication

This study has many practical implications for managers and owners of stone-cutting, ready-mixed concrete, and brick factories. As the clean production strategy in these factories will contribute significantly to reducing expenses on these factories and finding other sources of income, for example, stone cutting factories, cake or sludge produced from industrial water will be a source of income by selling to ready-mixed Concrete and brick factories. Ready-mixed Concrete and brick factories will reduce the costs of raw materials involved in their production processes when they purchase industrial water products from stone-cutting factories. Thus, these factories are working to achieve many environmental goals in addition to supporting the sustainability of green factories.

The study also shows that the impact of clean production on sustainable performance is not limited only to the strategies of factories in general, but there is a role for green innovation as well, it works to reduce the environmental damage caused by these products in addition to improving the reputation of these factories.

4.7 Conclusion

Interest in green issues is increasing all over the world, which has motivated governments and institutions to reduce waste production and work to convert it from waste to source, thereby motivating the adoption of a clean production strategy.

This research deals with the adoption of a clean production strategy in stone-cutting, ready-mixed concrete, and brick factories in the Wadi Al-Zomer area in both Tulkarm and Nablus governorates. The existing problem is industrial wastewater from stone-cutting plants that are pumped into the Valley. The proposed solution to this problem is proven by many previous researches, which proposed separating these industrial wastewater products into sludge and treated water so that the sludge is reused in brick and ready-mix concrete factories to introduce it into manufacturing processes, where stone-cutting factories sell it and get financial benefits from it. As for the treated water, it is never disposed of, but it is reused for cooling operations in stone-cutting factories, and if there are large quantities of it, it is also exported to ready-mix concrete and brick factories.

This study was conducted on the entire research population, which is 45 factories, taking into account all the ready-mixed concrete and brick factories, in addition to stone-cutting factories near the Wadi Al-Zomer area. The number of stone-cutting factories was 25 factories, which accounted for 55% of the study sample, and ready-mixed concrete and brick factories accounted for 45% of the target factories in this study.

Based on the results obtained through the analysis of the questionnaire by Smart PLS program. It showed that all relationships are significant and there is a positive trend in general to adopt a clean production strategy, except for some ready-mixed concrete and brick factories where they had some conditions to accept the adoption of a clean production strategy. These conditions have been set in the research recommendations to be taken into account.

4.8 Recommendation

The following are two types of recommendations, the first one shows overall research recommendation. The second one shows the recommendations that obtained from face-to-face questionnaire with factories.

4.8.1 Overall recommendations

- Increase the focus of factory owners and senior management in factories on making their factories green and reducing waste output by adopting a clean production strategy.
- Conducting awareness-raising and motivation courses for factory owners to urge them to adopt a clean production strategy.
- Providing government incentives and encouragement for factory owners to adopt a clean production strategy by providing full or partial financial support from external donor countries or from the government itself.
- Enhancing public privet partnership.

- Facilitate the implementation of this strategy by the Palestinian government due to environmental and economic benefits for all.
- Contribution of the Palestinian government in providing transportation methods for sludge between factories to encourage the owners of these factories to adopt the strategy.

4.8.2 Factory owner’s recommendations

During the questionnaires with the owners of Ready-Mixed Concrete and brick factories, they illustrate that they had some conditions and recommendations to adopt a clean production strategy and use some of the industrial wastewater treatment products from stone-cutting factories, these recommendations are as follows:
- Approved a new mixture of concrete and cement, which contains the products of the industrial wastewater treatment process from stone-cutting plants by the Palestinian Standards Institution.
-Conduct tests and experiments through locally recognized laboratories and present these results to specialized people and the Palestinian standards institution to prove that the hypotheses of this research are correct and do not adversely affect the specifications of concrete and bricks.
- An official supervisory authority should be provided to manage the process of reusing the products of the treatment process in Ready-Mixed Concrete and brick factories.
- Sludge prices from stone-cutting plants are provided At Reasonable Prices so that it is economically feasible for Ready-Mix Concrete and brick factories.
- Providing easy transportation methods for that sludge from stone-cutting plants to Ready-Mix Concrete and brick factories.

4.9 Researcher point of view

After we reach to the final results of this research, these results were expected, as by returning to other cases similar to the case in Wadi Zomer around the world, all the research conducted in this field showed the clear ability to adopt a clean production strategy by factory owners. Additionally, Palestinians are in dire need of such strategies and solutions to get rid of the environmental and economic problems they face due to industrial wastewater.

However, it must also be noted that for achieve successful in this strategy, the matter must be taken seriously and everyone must carry out his duties, including the important and fundamental role of the Palestinian government.

4.10 Research Limitation

This research, like many others, has faced many limitations. Firstly, the data was collected from factories near the Wadi Al-Zomer area in Tulkarm and Nablus, as the numbers of these factories were few, which forced us to take the entire study community. Secondly, it is difficult to move between Tulkarm and Nablus to collect data and conduct the interviews required for this research due to the prevailing political situation in Palestine and the ongoing closures on Nablus city by Israel's occupation. Thirdly, the lack of updated records containing the classifications and names of the correct factories and their addresses, in addition to ways to communicate with them, leads to many problems in reaching the places of the target factories in this study.

4.11 Future Research Directions

There are many types of research in the same field that can be touched upon in the future, as this study was based on a case study of the reuse of stone-cutting treatment products in Ready-Mixed Concrete and brick factories. Another proposed area for future researches, first, to search for other solutions for industrial wastewater resulting from Stone-cutting industries, which may be more economically feasible than the solution proposed in this research. Secondly, there is another industrial wastewater in Wadi Al Zomer that should be completely disposed of in order to achieve a complete economic and environmental recovery from this industrial wastewater in the valley. Preferably, there should be a study examining the possibility of applying the clean production strategy in other factories that discharge their industrial wastewater in the valley, such as olive mills and slaughterhouses. Thus, if the previous studies are available and integrated with this research, it is possible that they will lead to stopping the Israeli deductions from the Palestinian funds, in addition to stop all environmental damage caused by this industrial wastewater in the Valley.

List of Abbreviations

Abbreviation	Meaning
PLS	Partial Least Square
SEM	Structural Equation Modeling
TSS	Total Suspended Solids
GNP	Gross National Products
CP	Clean Production
DV	Dependent Variable
IV	Independent Variable
SWOT	Strength, Weaknesses, Opportunity and Threats
SMART	Specific, Measurable, Achievable, Reliable and Time
PWA	Palestinian Water Authority
CR	Composite Reliability
AVE	Average Variance Extracted
R^2	Coefficient of Determination
SPSS	Statistical Package for the Social Science
HTMT	Heterotrait-Monotrait Ratio
F^2	Effect Size
GoF	Goodness's of Fit
AVG	Average
SD	Slandered Deviation
H	Hypotheses
REEE	Reducing Environmental and Economic Effect of industria waste water from stone-cutting industries
WACP	Willingness to Adopt a Clean Production strategy

AFTE	Available Factories to use Treated Effluents
SEES	Social, Environmental, and Economic Sustainability
ASCB	Awareness among Stone-cutting, Concrete and Brick industry owners
ER	Enforce Regulations

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Appendices

Appendix A

Information and Data Analysis Table

Table 1

Construct and item resources

Variable	Indicator	Question	Reference
Reducing environmental and economic effects of industrial wastewater from stone-cutting industries.	Environmental effects on the Palestinians in general	The dumping of industrial wastewater into the valleys affects the environmental aspects of the Palestinians	(Cesar da Silva et al., 2021)
	Economic effects on the Palestinians in general	The dumping of industrial wastewater into the valleys affects the economic aspects of the Palestinians	(Al-Sa'ed, 2010)
Willingness to adopt a clean production strategy	Ability to implement with full financial support	The ability to adopt a clean production strategy with full financial support	(Zhang et al., 2013)
	Ability to implement with partial financial support	The ability to adopt a clean production strategy with partial financial support	(Zhang et al., 2013)
	Available of sufficient space in factories	The space available in the factory to	(Ramos et al., 2018)

		adopt a clean production strategy	
	Orientation to install the treatment plant.	The extent of your general orientation towards industrial waste water treatment plants	(Varella et al., 2022)
Available factories to use treated effluents	Sludge reuse	The possibility of utilization and reuse of sludge resulting from the industrial water treatment for stone-cutting effluents	(Wu et al., 2019)
	Treated water reuse	The possibility of reusing treated water from stone cutting plants in the cooling/making process	(Mohd Udaiyappan et al., 2017)
Social, environmental, and economic sustainability	Effects on the population surrounding to Wadi Al-Zomer	The presence of complaints by citizens living near the factories and those living on the sides of the valley because of the dust	(Amrutha & Geetha, 2020)
	Resources efficiency and cost saving	Cost savings On the factories in the event of adoption clean production strategy	(Cesar da Silva et al., 2021)

	Deduction by Israel on Palestinian money	The impact of industrial wastewater on the economic sustainability of the Palestinians	(Al-Sa’ed, 2010)
	Increase the operation efficiency	Implementing a clean production strategy will increase operational efficiency	(Cesar da Silva et al., 2021)
	Minimize negative environmental effects	Implementing a clean production strategy will reduce negative impacts on the environment	(Cesar da Silva et al., 2021)
	Minimize waste generation	Implementing a clean production strategy will reduce waste production	(Tayyab et al., 2020)
Awareness among stone cutting, concrete and brick industries owners	extent of knowledge about the environmental risk of that wastewater	I don’t have previous knowledge about environmental damage resulting from dumping of industrial wastewater in Wadi Al-Zomer	(Nunes et al., 2019)
	extent of knowledge about the economic losses due to that wastewater	I don’t have previous knowledge about economic damage resulting from the dumping of industrial wastewater in Wadi	(Cesar da Silva et al., 2021)

		Al Zomer	
	Reuse of treated water and sludge.	I don't have previous knowledge about the possibility of reusing industrial water treatment effluents from stone-cutting	(Nunes et al., 2019)
Enforced regulation	Availability of law	There are laws that prevent factories from dumping their industrial water into valleys	(Yusup et al., 2014)
	Responsibility & awareness by the authority	There are institutions working to provide continuous monitoring of factories to reduce the dumping of industrial wastewater in valleys	(Yusup et al., 2014)
	Available ways to enforce the law	Existence of legal measures taken by institutions to reduce the dumping of industrial water in valleys	(Yusup et al., 2014)
	Licensing for discharge in Wadi Al-Zomer.	The licenses that the factories possess do not allow industrial water to be pumped into the Wadi	(Yusup et al., 2014)

Table 2

Univariate outliers results

Descriptive Statistics					
	N	**Skewness**		**Kurtosis**	
	Statistic	**Statistic**	**Std. Error**	**Statistic**	**Std. Error**
ER1	45	-.016	.354	-.760	.695
ER2	45	-.132	.354	-.540	.695
ER3	45	.309	.354	.162	.695
ER4	45	.087	.354	.747	.695
ASCB1	45	-.348	.354	-.443	.695
ASCB2	45	-.583	.354	.343	.695
ASCB3	45	-.268	.354	.553	.695
SEES1	45	-.205	.354	-.629	.695
SEES2	45	-.268	.354	.553	.695
SEES3	45	-.185	.354	-.040	.695
SEES4	45	-.122	.354	-1.186	.695
SEES5	45	-.290	.354	-.595	.695
SEES6	45	-.205	.354	-.919	.695
AFTE1	45	.129	.354	-.353	.695
AFTE2	45	.043	.354	-.606	.695
WACP1	45	-.189	.354	-.874	.695
WACP2	45	-.183	.354	.115	.695
WACP3	45	-.107	.354	.002	.695
WACP4	45	-.096	.354	-.806	.695
REEE1	45	-.320	.354	-.659	.695
REEE2	45	-.082	.354	-.871	.695
Valid N	45				

Note: Not outliers if the value of Skewness less than±3 and Kurtosis less than±10, else outliers values

Table 3

Multivariate outliers results

Case #	Mahalanobis Distance values	Probability-MD	Result
1	7.84553	.165	Not Outliers
2	8.33375	.139	Not Outliers
3	3.89070	.565	Not Outliers
4	.90723	.970	Not Outliers
5	3.99110	.551	Not Outliers
6	7.25699	.202	Not Outliers
7	2.21238	.819	Not Outliers
8	1.63351	.897	Not Outliers
9	2.88304	.718	Not Outliers
10	7.98761	.157	Not Outliers
11	3.71553	.591	Not Outliers
12	10.01881	.075	Not Outliers
13	4.39775	.494	Not Outliers
14	5.26317	.385	Not Outliers
15	6.33556	.275	Not Outliers
16	2.07451	.839	Not Outliers
17	2.55918	.768	Not Outliers
18	1.50468	.913	Not Outliers
19	9.99948	.075	Not Outliers
20	2.58763	.763	Not Outliers
21	2.10775	.834	Not Outliers
22	3.21642	.667	Not Outliers
23	6.21191	.286	Not Outliers
24	7.74216	.171	Not Outliers
25	8.52658	.130	Not Outliers
26	3.58116	.611	Not Outliers
27	10.18051	.070	Not Outliers

28	1.87974	.866	Not Outliers
29	5.57967	.349	Not Outliers
30	5.53481	.354	Not Outliers
31	4.16087	.526	Not Outliers
32	3.49462	.624	Not Outliers
33	3.15872	.676	Not Outliers
34	6.11364	.295	Not Outliers
35	3.86384	.569	Not Outliers
36	4.12232	.532	Not Outliers
37	3.00163	.700	Not Outliers
38	1.00352	.962	Not Outliers
39	2.87078	.720	Not Outliers
40	7.96551	.158	Not Outliers
41	3.44101	.632	Not Outliers
42	3.41979	.636	Not Outliers
43	8.93339	.112	Not Outliers
44	6.93324	.226	Not Outliers
45	7.55826	.182	Not Outliers

Note: Not outliers if the value of probability-MD>0.001, else outliers values

Table 4

Results of the descriptive statistic: Awareness among stone cutting, concrete and brick industries owners (ASCB)

Statements	AVG	SD
I don't have previous knowledge about environmental damage resulting from dumping of industrial wastewater in Wadi Al-Zomer (ASCB1)	3.33	1.044
I don't have previous knowledge about economic damage resulting from the dumping of industrial wastewater in Wadi Al Zomer (ASCB2)	3.18	0.860
I don't have previous knowledge about the possibility of reusing	3.13	0.869

industrial water treatment effluents from stone-cutting (ASCB3)		
Average Score	**3.213**	**0.924**

Table 5

Results of the descriptive statistic: Enforced regulation (ER)

Statements	AVG	SD
here are laws that prevent factories from dumping their industrial water into valleys (ER1)	2.87	1.140
There are institutions working to provide continuous monitoring of factories to reduce the dumping of industrial wastewater in valleys (ER2)	3.07	0.863
Existence of legal measures taken by institutions to reduce the dumping of industrial water in valleys (ER3)	2.93	0.939
The licenses that the factories possess do not allow industrial water to be pumped into the valleys (ER4)	2.96	0.852
Average Score	**2.96**	**0.95**

Table 6

Reliability: Items of the questionnaire

Cronbach's alpha	No. of items
0.935	21

Table 7

Indicator Reliability

Construct	Indicator	Factor loading
Reducing environmental and economic effects of industrial wastewater from stone-cutting industries (REEE)	REEE1	0.930
	REEE2	0.923
Willingness to adopt a clean production strategy (WACP)	WACP1	0.890
	WACP2	0.860
	WACP3	0.738
	WACP4	0.897
Available factories to use treated effluents (AFTE)	AFTE1	0.914
	AFTE2	0.910
Social, environmental, and economic sustainability (SEES)	SEES1	0.891
	SEES2	0.702
	SEES3	0.747
	SEES4	0.903
	SEES5	0.733
Awareness among stone cutting, concrete and brick industries owners (ASCB)	ASCB1	0.868
	ASCB2	0.871
	ASCB3	0.870
Enforced regulation (ER)	ER1	0.852
	ER2	0.792
	ER3	0.754
	ER4	0.850

Table 8

Values of CR and Cronbach's alpha for the constructs

Construct	Cronbach's Alpha	Composite Reliability
Available factories to use treated effluents (AFTE)	0.798	0.908
Awareness among stone cutting, concrete and brick industries owners (ASCB)	0.839	0.903
Enforced regulation (ER)	0.829	0.886
Reducing environmental and economic effects of industrial wastewater from stone-cutting industries (REEE)	0.835	0.924
Social, environmental, and economic sustainability (SEES)	0.858	0.898
Willingness to adopt a clean production strategy (WACP)	0.868	0.911

Table 9

The AVE values for the constructs of the study

Construct	AVE
Available factories to use treated effluents (AFTE)	0.832
Awareness among stone cutting, concrete and brick industries owners (ASCB)	0.756
Enforced regulation (ER)	0.661
Reducing environmental and economic effects of industrial wastewater from stone-cutting industries (REEE)	0.858
Social, environmental, and economic sustainability (SEES)	0.640
Willingness to adopt a clean production strategy (WACP)	0.720

Table 10

Cross loading of reflective indicators

	AFTE	ASCB	ER	REEE	SEES	WACP
AFTE1	**0.914**	0.390	0.471	0.319	0.529	0.656
AFTE2	**0.910**	0.319	0.528	0.363	0.596	0.641
ASCB1	0.375	**0.868**	0.251	0.570	0.457	0.599
ASCB2	0.319	**0.871**	0.156	0.360	0.585	0.597
ASCB3	0.322	**0.870**	0.360	0.557	0.702	0.616
ER1	0.492	0.288	**0.852**	0.429	0.517	0.538
ER2	0.445	0.251	**0.792**	0.292	0.364	0.444
ER3	0.435	0.091	**0.754**	0.361	0.182	0.381
ER4	0.414	0.294	**0.850**	0.427	0.306	0.532
REEE1	0.392	0.511	0.419	**0.930**	0.574	0.588
REEE2	0.298	0.547	0.449	**0.923**	0.377	0.564
SEES1	0.658	0.518	0.408	0.460	**0.891**	0.712
SEES2	0.322	0.870	0.360	0.557	**0.702**	0.616
SEES3	0.398	0.257	0.249	0.297	**0.747**	0.382
SEES4	0.603	0.560	0.464	0.463	**0.903**	0.740
SEES5	0.409	0.345	0.150	0.188	**0.733**	0.442
WACP1	0.544	0.642	0.436	0.544	0.738	**0.890**
WACP2	0.673	0.587	0.622	0.551	0.620	**0.860**
WACP3	0.425	0.525	0.383	0.542	0.517	**0.738**
WACP4	0.747	0.599	0.544	0.482	0.683	**0.897**

Table 11

Inter-correlation matrix (Fornell and Larcker criterion)

	AFTE	ASCB	ER	REEE	SEES	WACP
AFTE	**0.912**					
ASCB	0.389	**0.870**				
ER	0.548	0.295	**0.813**			
REEE	0.374	0.571	0.468	**0.926**		
SEES	0.617	0.670	0.434	0.516	**0.800**	
WACP	0.711	0.695	0.590	0.622	0.757	**0.849**

Table 12

Discriminant Validity Based on HTMT

	AFTE	ASCB	ER	REEE	SEES	WACP
AFTE						
ASCB	0.475					
ER	0.676	0.339				
REEE	0.457	0.682	0.559			
SEES	0.725	0.752	0.477	0.579		
WACP	0.848	0.814	0.681	0.734	0.837	

Table 13

The R square values

Construct	R2	Power
REEE	0.387	High
WACP	0.771	High

Table 14

Results of the effect size

Path	f^2	Effect Size
AFTE-> WACP	0.222	Medium
SEES-> WACP	0.097	Small
ASCB-> WACP	0.298	Medium
ER-> WACP	0.135	Small

Table 15

Hypotheses testing results

No.	Hypothesis	Path Coefficients	T-statistics	P-value	Result
H1	AFTE -> WACP	0.312	3.482	0.001	Supported
H2	ASCB -> WACP	0.352	3.513	0.000	Supported
H3	ER -> WACP	0.212	2.088	0.037	Supported
H4	SEES -> WACP	0.237	2.184	0.029	Supported
H5	WACP -> REEE	0.622	6.397	0.000	Supported

Note: Reducing environmental and economic effects of industrial wastewater from stone-cutting industries (REEE), Willingness to adopt a clean production strategy (WACP), Available factories to use treated effluents (AFTE), Social, environmental, and economic sustainability (SEES), Awareness among stone cutting, concrete and brick industries owners (ASCB), Enforced regulation (ER)

Table 16

The average of R^2 values

Construct	R2
WACP	0.771
REEE	0.387
Average	**0.579**

Table 17

The average of AVE values

Construct	AVE
Available factories to use treated effluents (AFTE)	0.832
Awareness among stone cutting, concrete and brick industries owners (ASCB)	0.756
Enforced regulation (ER)	0.661
Reducing environmental and economic effects of industrial wastewater from stone-cutting industries (REEE)	0.858
Social, environmental, and economic sustainability (SEES)	0.640
Willingness to adopt a clean production strategy (WACP)	0.720
Average	**0.745**

Appendix B

Research Questionnaire in English

An-Najah National University

Faculty of Graduate Studies

Engineering Management Program

“A questionnaire on evaluating the extent to which stone-cutting, concrete and brick factories are able to adopt a clean production strategy”

Dear factory manager ،

The researcher is conducting a study on "**the stone-cutting , concrete and brick factories near Wadi Al-Zomer**". The study focuses on the issue of wastewater generated by factories, and the mechanism of applying the clean production strategy, to reduce the damages resulting from this water.

This questionnaire consists of two parts:

-The first section: aims to collect general information about factories.

-The second section: consists of six parts aimed at evaluating the extent to which the clean production strategy can be applied in these factories.

It will take a maximum of ten minutes to answer this questionnaire, please read all parts carefully, and choose the appropriate answer accurately and impartially with full appreciation for your participation.

As a decision-maker in one of the stone-cutting, concrete and brick factories in Palestine, your opinion is very important. Therefore, I greatly appreciate your volunteering a few minutes of your precious time to fill out this questionnaire, and be confident that your participation in this questionnaire is for scientific research purposes only.

Researcher: Mo'men Nael Alqub
MSc Engineering management
Email: Alqub119981@gmail.com
Phone No. : 00972598984818

First section: General information

Please kindly answer the following questions:

1- Factory type

( ) Stone-Cutting ( ) Ready-Mix Concrete ( ) Brick

2- Factory name (optional) --

3- What is the mechanism for disposing of wastewater generated from the factory?

( ) Directly to the Wadi ( ) To Sewer line ( ) through douche tanks

4- Average monthly water consumption in the factory------------------------------

5- The number of years the factory has been operating

( ) Less than 5 years ( ) 5 to 10 years ( ) 11-15 years ( ) more than 15 years

Second section:

First part: the environmental and economic impacts on the Palestinians resulting from the dumping of industrial wastewater in the valleys

(Important note: The clean production strategy in this study includes the installation of an internal treatment plant, in addition to its operation and the necessary transportation inside and outside the factory to implement reuse)

Dimension		**Environmental and economic effects**				
No.	Description	Very high extent (5)	High extent (4)	Moderately (3)	Low extent (2)	Very low extent (1)
1	The dumping of industrial wastewater into the valleys affects the **economic** aspects of the Palestinians					
2	The dumping of industrial wastewater into the valleys affects the **environmental** aspects of the Palestinians					

Second part: assessing the extent to which the owners of cement, brick and stone cutting factories tend to adopt a clean production strategy.

Dimension		**Adopt a clean production strategy**				
No.	Description	Very high extent (5)	High extent (4)	Moderately (3)	Low extent (2)	Very low extent (1)
1	The extent of your general orientation towards industrial waste water treatment plants					
2	The space available in the factory to adopt a clean production strategy					
3	The ability to adopt a clean production strategy if full financial support is provided					
4	The ability to adopt a clean production strategy if partial financial support is provided					

Third part: Evaluation of the reusability of traded industrial water effluents resulting from stone-cutting factories

Dimension		**Reuse**				
No.	Description	Very high extent (5)	High extent (4)	Moderately (3)	Low extent (2)	Very low extent (1)
1	The possibility of utilization and reuse of sludge resulting from the industrial water treatment for stone-cutting effluents					
2	The possibility of reusing treated water from stone cutting plants in the cooling/making process					

Fourth part: Economic, Social and Environmental Sustainability

Dimension		**Sustainability**				
No.	Description	Very high extent (5)	High extent (4)	Moderately (3)	Low extent (2)	Very low extent (1)
1	The presence of complaints by citizens living near the factories and those living on the sides of the valley because of the dust					
2	Cost savings On the factories in the event of adoption clean production strategy					
3	Implementing a clean production strategy will increase operational efficiency					
4	Implementing a clean production strategy will reduce negative impacts on the environment					
5	The impact of industrial wastewater on the economic sustainability of the Palestinians					
6	Implementing a clean production strategy will reduce waste production					

Fifth part: Awareness among factory owners of the damage caused by stone-cutting and the possibility of implementing a clean production strategy

Dimension		**Awareness**				
No.	Description	Very high extent (5)	High extent (4)	Moderately (3)	Low extent (2)	Very low extent (1)
1	I don't have previous knowledge about the possibility of reusing industrial water treatment effluents from stone-cutting					
2	I don't have previous knowledge about environmental damage resulting from dumping of industrial wastewater in Wadi Al-Zomer					
3	I don't have previous knowledge about economic damage resulting from the dumping of industrial wastewater in Wadi Al-Zomer					

Sixth part: Availability of laws regarding the dumping of sewage water in valleys

Dimension		**Legal**				
No.	Description	Very high extent (5)	High extent (4)	Moderately (3)	Low extent (2)	Very low extent (1)
1	There are laws that prevent factories from dumping their industrial water into valleys					
2	There are institutions working to provide continuous monitoring of factories to reduce the dumping of industrial wastewater in valleys					
3	Existence of legal measures taken by institutions to reduce the dumping of industrial water in valleys					
4	The licenses that the factories possess do not allow industrial water to be pumped into the valleys					

Notes: ---

Thanks for your cooperation

Appendix C

Research Questionnaire in Arabic

جامعة النجاح الوطنية

كلية الدراسات العليا

برنامج الإدارة الهندسية

"استبانة حول تقييم مدى قابلية مصانع الحجر ومصانع الاسمنت والطوب في تبني استراتيجية الإنتاج النظيف"

السادة مدراء المصانع المحترمين،

تحية طيبة،

يقوم الباحث بإجراء دراسة حول **"قطاع مقصات الحجر ومصانع الطوب والأسمنت القريبة من وادي الزومر"**، وتركز الدراسة على قضية مياه الصرف الصحي الناتجة عن المصانع، وآلية تطبيق استراتيجية الإنتاج النظيف، للحد من الأضرار العديدة الناتجة عن هذه المياه.

تتكون هذه الاستبانة من قسمين:

-القسم الأول: يهدف إلى جمع معلومات عامة عن المصانع.

-القسم الثاني: يتكون من ستة أجزاء تهدف إلى تقييم مدى إمكانية تطبيق استراتيجية الإنتاج النظيف في هذه المصانع.

سوف تستغرق الإجابة على هذا الاستبيان عشر دقائق بالحد الاقصى، يرجى قراءة جميع الأجزاء بعناية، واختيار الإجابة المناسبة بدقة وحيادية مع التقدير الكامل لمشاركتك.

ولكونك متخذ قرار في إحدى مصانع قص الحجر والاسمنت في فلسطين، فإن رأيك يعد في غاية الأهمية. لذا أقدر كثيراً تطوعك ببضع دقائق من وقتك الثمين لتعبئة هذه الاستبانة، و كن على ثقة بأن مشاركتك في هذه الاستبانة هي لأغراض البحث العلمي فقط.

الباحث: مؤمن نائل القب
ماجستير إدارة هندسية
ايميل: Alqub119981@gmail.com
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القسم الأول: معلومات عامة

يرجى التكرم بالإجابة على الأسئلة التالية:

1- نوع المصنع

(   ) قص حجر   (   ) أسمنت   (   ) طوب

2- اسم المصنع (اختياري): ______________________________

3- ما هي آلية التخلص من المياه العادمة الناتجة من المصنع؟

(   ) إلى الوادي مباشرة   (   ) في شبكة الصرف الصحي   (   ) من خلال تنكات نضح

4- معدل استهلاك المياه اليومي في المصنع: ____

5- عدد سنوات عمل المصنع

(   ) أقل من 5 سنوات   (   ) 5-10 سنوات   (   ) 11-15 سنة   (   ) اكثر من 15 سنة

القسم الثاني:

<u>الجزء الأول: الآثار البيئية والاقتصادية على الفلسطينيين والناتجة من إلقاء مياه الصرف الصحي الصناعية في الأودية</u>

(ملاحظة مهمة: إن استراتيجية الإنتاج النظيف في هذه الدراسة تشمل اتخاذ العديد من الإجراءات للحد من الملوثات الناتجة من مصانع قص الحجر في وادي الزومر مثل تركيب محطة معالجة داخلية، بالإضافة الى تشغيلها او وضع فلاتر او عمل برك تجميع وما يلزم من نقل داخل وخارج المصنع لتطبيق إعادة الاستخدام).

البعد		**الاثار البيئية والاقتصادية**				
الرقم	الوصف	بدرجة كبيرة جدا (5)	بدرجة كبيرة (4)	بدرجة متوسطة (3)	بدرجة قليلة (2)	بدرجة قليلة جدا (1)
1	يؤثر إلقاء مياه الصرف الصحي الصناعية في الأودية على الجوانب ***<u>الاقتصادية</u>*** للفلسطينيين					
2	يؤثر إلقاء مياه الصرف الصحي الصناعية في الأودية على الجوانب ***<u>البيئية</u>*** للفلسطينيين					

الجزء الثاني: تقييم مدى توجه أصحاب مصانع الأسمنت والطوب وقص الحجر لتبني استراتيجية الإنتاج النظيف.

الرقم	البعد	تبني استراتيجية الإنتاج النظيف				
الرقم	الوصف	بدرجة كبيرة جدا (5)	بدرجة كبيرة (4)	بدرجة متوسطة (3)	بدرجة قليلة (2)	بدرجة قليلة جدا (1)
1	مقدار التوجه العام لديكم تجاه محطات المعالجة للمياه الصناعية					
2	المساحة المتوفرة في المصنع لتبني استراتيجية الإنتاج النظيف					
3	قابلية تبنيك لاستراتيجية الإنتاج النظيف في حال توفير دعم مادي كامل					
4	قابلية تبنيك لاستراتيجية الإنتاج النظيف في حال توفير دعم مادي جزئي					

الجزء الثالث: تقييم مدى قابلية إعادة استخدام نواتج عملية معالجة المياه الصناعية الناتجة من مقصات الحجر والباطون

الرقم	البعد	إعادة الاستخدام				
الرقم	الوصف	بدرجة كبيرة جدا (5)	بدرجة كبيرة (4)	بدرجة متوسطة (3)	بدرجة قليلة (2)	بدرجة قليلة جدا (1)
1	قابلية الاستفادة وإعادة استعمال الحمأة الناتجة من عملية معالجة المياه الصناعية الناتجة من مقصات الحجر.					
2	قابلية إعادة استعمال المياه المعالجة الناتجة من مصانع قص الحجر في عملية التبريد/ الصنع					

الجزء الرابع: الاستدامة البيئية الاقتصادية والاجتماعية

الرقم	البعد الوصف	الاستدامة بدرجة كبيرة جدا (5)	بدرجة كبيرة (4)	بدرجة متوسطة (3)	بدرجة قليلة (2)	بدرجة قليلة جدا (1)
1	وجود شكاوى من قبل المواطنين القاطنين بالقرب من المصانع والساكنين على جوانب الوادي بسبب الغبار					
2	التوفير في التكاليف على المصانع في حال تبني استراتيجية الإنتاج النظيف					
3	تطبيق استراتيجية الإنتاج النظيف ستعمل على زيادة الكفاءة التشغيلية					
4	تطبيق استراتيجية الإنتاج النظيف ستعمل على تقليل الآثار السلبية على البيئة					
5	تأثير مياه الصرف الصحي الصناعية على الاستدامة الاقتصادية للفلسطينيين بشكل عام من ناحية الاقتطاعات المالية الاسرائيلية					
6	تطبيق استراتيجية الإنتاج النظيف سيعمل على تقليل انتاج النفايات					

الجزء الخامس: الوعي ما بين أصحاب المصانع بالأضرار الناتجة عن مقصات الحجر وإمكانية تطبيق استراتيجية الإنتاج النظيف

الرقم	البعد	الوعي				
الرقم	الوصف	بدرجة كبيرة جدا (5)	بدرجة كبيرة (4)	بدرجة متوسطة (3)	بدرجة قليلة (2)	بدرجة قليلة جدا (1)
1	لا يوجد لدي معرفة سابقة عن إمكانية إعادة استعمال نواتج معالجة المياه الصناعية الناتجة من مقصات الحجر					
2	لا يوجد لدي المعرفة سابقة بالأضرار البيئية الناتجة من إلقاء مياه الصرف الصحي الصناعية في وادي الزومر					
3	لا يوجد لدي المعرفة سابقة بالأضرار الاقتصادية الناتجة من إلقاء مياه الصرف الصحي الصناعية في وادي الزومر					

الجزء السادس: توفر القوانين بخصوص إلقاء مياه الصرف الصحي في الأودية

الرقم	البعد	القانوني				
الرقم	الوصف	بدرجة كبيرة جدا (5)	بدرجة كبيرة (4)	بدرجة متوسطة (3)	بدرجة قليلة (2)	بدرجة قليلة جدا (1)
1	يوجد قوانين تمنع المصانع من القاء مياهها الصناعية في الاودية					
2	يوجد مؤسسات تعمل على توفير رقابة مستمرة للمصانع للحد من إلقاء مياه الصرف الصحي الصناعية في الأودية					

3	وجود تدابير قانونية تتخذها المؤسسات للحد من إلقاء المياه الصناعية في الاودية					
4	لا تسمح التراخيص التي تمتلكها المصانع بضخ المياه الصناعية في الأودية					

ملاحظات : ---

شكرا لتعاونكم

جامعة النجاح الوطنية

كلية الدراســـات العليا

استعداد مصانع الحجر والخرسانة الجاهزة لتبني استراتيجية إنتاج نظيفة، دراسة حالة: مياه الصرف الصناعي في وادي زمر، الضفة الغربية، فلسطين

إعداد

مؤمن نائل خالد القب

إشراف

د. عبد الحليم خضر

قدمت هذه الرسالة استكمالا لمتطلبات الحصول على درجة الماجستير في الإدارة الهندسية، من كلية الدراسات العليا، في جامعة النجاح الوطنية، نابلس فلسطين.

2023

استعداد مصانع الحجر والخرسانة الجاهزة لتبني استراتيجية إنتاج نظيفة، دراسة حالة: مياه الصرف الصناعي في وادي زمر، الضفة الغربية، فلسطين

إعداد

مؤمن نائل خالد القب

إشراف

د. عبد الحليم خضر

الملخص

تعد مياه الصرف الصحي الصناعية الناتجة من مقصات الحجر واحدة من أخطر المشاكل في منطقة وادي الزومر، حيث يوجد في منطقة وادي الزومر في طولكرم ونابلس العديد من مقصات الحجر التي تقوم بضخ أكثر من 2000 متر مكعب شهريا من مياهها الصناعية في الوادي مما يسبب اقتطاعات مالية من قبل الإسرائيليين على الأموال الفلسطينية بالإضافة الى اضرار بيئية ضخمة، لذلك يسعى هذا البحث للوصول الى خطة إدارية مستدامة لإدارة هذه المياه الصناعية بشكل يمكن الاستفادة منه واستغلاله.

أثبتت العديد من الدراسات والأبحاث السابقة إمكانية استخدام المياه الصناعية الناتجة من مقصات الحجر في صناعة الطوب والاسمنت كما انها تعمل على تحسين خواصهما، لذلك ركزت هذه الدراسة على إمكانية تطبيق استراتيجية الإنتاج النظيف في مقصات الحجر والطوب والباطون للحد من القاء المياه الصناعية الناتجة من المقصات في الوادي.

ومن أجل هذه الأهداف تم تطوير نموذج بحثي، وتم جمع البيانات من مصانع قص الحجر والطوب والاسمنت عبر الاستبيان. أما بالنسبة لتحليل البيانات وتقديمها فقد تم تقديم نموذج البحث من خلال نمذجة المعادلات الهيكلية للمربعات الصغرى الجزئية PLS-SEM باستخدام برنامج Smart PLS، من خلال 45 إجابة تم جمعها من مدراء هذه المصانع عبر الاستبيان.

وقد كشفت هذه الدراسة استعداد مدراء مصانع قص الحجر تبني استراتيجية الإنتاج النظيف لإدارة المياه الصناعية الناتجة لديهم وخاصة في حال توفير تمويل كامل او حتى تمويل جزئي لتطبيق هذه الاستراتيجية.

أما بخصوص مصانع الاسمنت والطوب فقد كان لهم توجه لتبني استراتيجية الإنتاج النظيف ولكن بوجود العديد من الملاحظات التي سيتم ادراجها في توصيات البحث منها الحصول على الموافقة من مؤسسة المواصفات الفلسطينية على الخلطة الخرسانية الجديدة، ان تكون هناك جهة رسمية تتابع وتشرف على هذه العملية، ان يكون سعر الكيك (المواد الصلبة الناتجة من تنقيه المياه الصناعية) من مصانع قص الحجر مقبول، توفير وسيلة نقل سهلة لنقل الكيك من مصانع قص الحجر الى مصانع الطوب والباطون.

هناك أيضا فوائد اقتصادية من الممكن تحقيقها لدى مصانع قص الحجر قد تصل الى 530 دولار امريكي شهريا من خلال التقليل من استهلاك المياه بالإضافة الى فوائد اقتصادية من خلال بيع الكيك الى مصانع الطوب والباطون.

لقد تم في هذه الدراسة إثبات كامل الفرضيات التي تم وضعها في هذا البحث حيث كان كافة قيم (t-value) أكبر من 1.96، يمكن لهذا البحث ان يفيد كافة الشعب الفلسطيني من خلال تقليل الاقتطاعات المالية الإسرائيلية بقيمة 5.26 مليون دولار امريكي سنويا وتقليل الاضرار البيئية في منطقة وادي الزومر بالإضافة الى تأثيرها الإيجابي على أصحاب المصانع من خلال تقليل التكاليف لديهم وتقليل انتاج النفايات السائلة الصناعية.

الكلمات المفتاحية: الإنتاج النظيف، الإدارة المستدامة، مصانع قص الحجر، مياه الصرف الصحي الصناعية، نمذجة المعادلات الهيكلية للمربعات الصغرى الجزئية.