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GREEN MANUFACTURING AND ENVIRONMENTAL SUSTAINABILITY IN SELECTED MANUFACTURING ENTITIES IN KAMPALA DISTRICT, UGANDA

Rugasira Jack[1], Agaba Moses[2], Jotham Mbiito Byarugaba[3],Rita Makumbi[4], Kyatuheire Jill[5] and Asiimwe Jane[6].

[1,3,4] Ndejje University, Department of Procurement and Logistics Management

[2]Kabale University, Department of Management Science

[3]USAID Freedom House

[4]United Nations High Commission for Refugees

Abstract: *The purpose of this study was to empirically establish the relationship between green manufacturing and environmental sustainability in the Kampala district. The study employed a cross-sectional design. The study also used quantitative approaches in collecting and analysing the data both descriptively and inferentially. The study population was 675 manufacturing entities. Using the purposive sampling technique, the study took a sample of 248. Data were obtained from 186 usable questionnaires. The researcher applied Statistical Package for Social Scientists (SPSS) to test all four hypotheses. The results are presented in terms of descriptive statistics and inferential statistics in terms of correlation analysis, simple regression and multiple regression analysis models. Results indicate that Pearson's correlation results indicate a relatively moderate, positive and significant association between Green manufacturing and Environmental Sustainability in Kampala industries The findings show that there was a low but significant positive correlation (r= 0.323, sig 000, p< .01) between green manufacturing and environmental sustainability. This implies that any improvements made in Green manufacturing can be associated positively with changes in Environmental Sustainability in Kampala. The study results concluded that green manufacturing contributed very little to environmental sustainability. The study, therefore, concludes that findings are not supportive of The National Environment Act, 2019; specifically concerning control of pollution and environmental emergency preparedness and management of waste. It also has a limited effect on environmental sustainability.*

Keywords: *Green Manufacturing Environmental Sustainability, Manufacturing Entities, Kampala distric*

1 Introduction

Green manufacturing is the process of production in especially factories while protecting the environment by eliminating or reducing emissions of toxic gases and also reducing the amount of energy used (Seibel, et al., 2019). This leads to an ecological balance whereby animals, plants, and human beings won't be negatively affected since no toxic fumes are being emitted.

This is a process of mechanically using a combination of different resources aligned together with each having a unique job but working towards one objective of producing a preset output. Energy is used to process and turn raw materials into desired finished goods. This must be done in a manner that avoids polluting the environment through production and emitting toxic fumes into the air, using energy-efficient systems, using renewable energy and not dumping toxic industrial waste into the environment, wetland, and water bodies. These are part of what a green manufacturing system must uphold.

Green manufacturing is still under-researched, especially in Africa (Jalil, et al, 2016). This itself self is a big problem and calls for serious interventions cut the effects of environmental sustainability caused by manufacturing. Green manufacturing is the process of turning raw materials into finished goods with systems prior designed to reduce the negative impact caused to the environment. Green manufacturing usually insists on the following as a means of reducing the negative impact on the environment during operation avoiding air pollution, reducing energy spent on running machines, using renewable energy to run/operate machines and s, and using lean manufacturing systems that reduce waste production during manufacturing, using machines that output quality products, recycle the waste raw materials instead of buying whenever they are in need, reusing products that are returned from the market but can still be reused, repairing and using broken down manufacturing, refurbishing, and many more different ways of protecting the environment during manufacturing (Ata, 2015). In green manufacturing, toxic fumes can also be captured and treated before clean fumes are to go into the atmosphere, that is by the use of industrial fume extractors which are systems designed to channel the dust and toxic some produced to points of treatment and removal of dust particles before finally letting the clean air into the environment. The other system is called backwashing or filtering which is also used to capture toxic industrial fumes within the chimney and try them before final release them into the atmosphere. Toxic industrial liquid can also be captured and treated before being introduced into water bodies when it is safe and can't harm living things. According to Oguntoye & Evans, (2017), critical issues of environmental sustainability in manufacturing supply chains like reverse logistics and circular economy aren't sufficient practised

in Npracticedhis leaves a big gap on how to effectively clear the environment of waste produced by manufacturers and it also leads to quick depletion of nonrenewable raw materials. In their paper titled green industrialization sub-Saharanran Africa, Luken & Smith, (2019), insist on strict measures to be adopted in sub-Saharan Africa if environmental sustainability is to be adhered to in the industrial sector.

Uganda for example is focusing on a green economy by 2030 (National Environmental Management Authority, 2018). This is way too far and something must be done now since pollution from manufacturing entities is clearly causing environmental sustainability problems. Coca-Cola Uganda and a few other businesses a reverse logistics specifically to collect and recycle plastic waste. The business seems lucrative and much as it is growing, the plastic waste collected is still very little compared to what accesses the environment, leaving the rest to either be taken to landfills or poorly disposed into water bodies and the general environment (Ministry of Water and Environment, 2018). Most of the green manufacturing activities aren't being practised in Uganda, this leaves a big gap in line with educating supply chain manufacturers on what to do and how to do it. There are some manufacturers that are using simple systems like back flashing to treat fumes which is a good starting point. That shows that they are willing to go the whole way in improving their systems to much more green but they need more knowledge and better infrastructure to help them achieve that. Efforts must be made by the government to get all plastic waste cleared from the environment.

Sustainability is a wide principle, it means a process of mainly carrying out activities in a manner that upholds the well-being of three aspects, environmental, social, and economic (Cousins, Lawson, Petersen & Fugate, 2019). Environmental sustainability is the effort made by human beings to save the planet from total destruction by voiding climate change such that it is a better place for us and future generations to enjoy their stay on. Supply chains have contributed the most to global warming, especially through manufacturing that pollutes the air, water bodies, and land, and the fast depletion of raw materials.

Such occurrences don't support environmental sustainability, which is a critical prerequisite to a life-supporting planet. Just like (Chathurani,2020), mentions the lack of environmental sustainability has over time become a critical concern in the manufacturing sector globally and an immediate remedy is required if the world is to survive the foreseen ramifications. Protecting the environment may be a costly venture but the dangers of not proactively protecting it are worse with situations like deaths occurring (Seyed, Ahmad, Mohammad, & Vahdat, 2018).

The world is under threat of being destroyed by poor environment-related disasters than ever before, and entities are compelled to align activities that promote green supply chain practices in order to reverse the situation (Tseng, Chiu, & Liang, 2017). This is due to the continued warming of the planet by carbon emissions, especially from manufacturing-based supply chains (Hendriks, et al., 2017). In addition, for example, the wildfires that raved the Amazon rainforest in Brazil destroyed forestry and animal species (San-Miguel-Ayanz, Durrant, Boca, Maianti, Alberta, Artes, Jacome, Branco, De Rigo, Ferrari, Pfeiffer, Grecchi, Nuijten, Onida, & Loffler. 2020). The wildfires in California USA, South Wales and Victoria in Australia killed people and animal species, destroyed properties worth billions of dollars and many more storms in Asia and the USA (Food and Agricultural Organization & United Nations Environment Programme, 2020). In Africa, a study on environmental sustainability focusing on health hazards espoused by poor environmental sustainability found that much as poor environmental sustainability and its effects were taking a toll on Zimbabweans, the local communities in the Mount Darwin district of Zimbabwe still believed that environmental adverseness isn't real and simply not existing (Ncube & Tawodzera, 2019). Zimbabwe experienced a series of heat waves and storms which left a lot of devastation (Ncube et al., 2019).

In Uganda, continued occurrences related to poor environmental sustainability include increased drought spells, air and water pollution, poor wetland management which has seen many wetlands being claimed for construction of industries with impunity, inadequate waste management, continued flooding incidences, not to mention the multiple loss of human life and food in the regions affected (Akiyode, Katongole, & Tumushabe, 2018). These are alleged to be caused by inadequate resource use resulting in the continuous search for the depleting key raw materials. Tendencies that suggest an ecological imbalance are noticeable through drought spells mostly evidenced in the central and northeastern parts of the country. In addition, continuous wetland misuse is evidenced through relentless human activity and poor waste disposal tendencies that have a potent effect on the environment (NEMA Report, 2017/2018). Efforts like educating the masses on environmentally safe operations have been made by a number of autonomous bodies in Uganda to counter the situation but no significant results have been registered. This could be due to the fact that the organizations haven't elaborated on how manufacturing entities in Uganda should practically go green. Enough incentives are not in the place that will enable manufacturers to acquire the necessary resources that enable green supply chain practices, i.e. machinery which may be expensive to acquire, also tough laws that prohibit manufacturers from continuing to operate traditionally haven't been put in place.

Uganda has encouraged industrialization in order to improve earnings through the value addition of agricultural products which is a key economic activity therein. This is with the aim to bolster economic growth and development in the country. However, this has a negative impact in the form of averting environmental sustainability (National Environment Management Authority Annual

Corporate Report for FY 2017/2018). Carbon emissions produced during manufacturing processes are a threat to the environment if not controlled well in time.

Globally, the challenge of environmental sustainability is evident, disasters are on the rise and still manifesting with a potential of more deaths and devastation occurring (Choudhary, Nayak, Dora, Mishra, Ghadge, 2019). This is all due to the continued warming of the planet by carbon emissions from especially manufacturing-based supply chains.

Supply chains have for a very long time been operating in total disregard for environmental sustainability and actually focusing on their own continued prosperity which isn't sustainable anyway. In reference are the wildfires that raved the Amazon rain forest in Brazil in 2019 destroying many trees and animal species, the wildfires in California USA, and in South Wales and Victoria in Australia that killed people and animal species, destroyed properties worth billions of dollars and many more storms in Asia and the USA in 2018 and 2019 (United Nations Environment Programme, 2015).

Green supply chain management is the process of handling all activities on the supply chain that chronologically flow as, planning, sourcing, transportation, manufacturing, distributing and returning in a manner that protects the natural environment such that the planet remains a better place for us in it now and future generations to live in (Yawar & Seuring, 2019). Green supply chain management and practices are closed-looped efforts by all supply chain actors to protect the natural environment with no hesitation at all times. This can be done by insisting on the following environmental for green processes, green designs, green sourcing, green transportation, green manufacturing, green distribution, reverse logistics, and green disposal where disposal cannot be avoided (Maleki, Minbashrazgah, & Shabani, 2019). Green supply chain practices are the processes of being environmentally conscious when carrying out any activities right from service provision to commodity production, distribution, and disposal of goods that have reached the end-of-life stage, meaning they cannot be reused or recycled. For that matter, unlike the traditional supply chain activities that are responsible for polluting the environment, and causing climate change, green and modern supply chains consider environmental sustainability by avoiding any activities that pollute the natural environment. There are many tried and approved ways in which green supply chain operations can be conducted and the most mentioned are green designs, green sourcing/procurement, green transportation, green manufacturing, reverse logistics, closed-loop logistics, circular economy, and others (Sarkis, et al., 2017).

Supply chain operations especially in manufacturing entities have produced a lot of environmental pollutants which in turn overwhelm the environment leading to a challenge in environmental sustainability (Govindan, Sarkis, Jabbour, Zhu, & Geng, 2014).

The study was carried out in Kampala Uganda specifically in the Kampala manufacturing industries. The impact of environmental management is still insignificant, in Uganda, there is evidence of poor environmental sustainability which manifests through droughts, floods, and diseases like cholera that kill people, especially in Kampala, and air and water pollution that is caused by the high concentration of manufacturing industries, reclamation of wetlands for the construction of manufacturing industries and harvest of raw materials which has led to the fast depletion of un renewable raw materials, congestion by the huge number of vehicles on the roads that also pollute the air and make it very unhealthy for human consumption. (Budget Monitoring and Accountability Unit, 2018).

Environmental sustainability is very important, without having a sustainable environment, humankind, animals and plant species will be destroyed (Sarkis, 2017). Uganda is facing unprecedented environmental sustainability challenges caused by traditional supply chain practices which operate in total disregard for environmental protection (BMAU, 2018). Supply chains must continue to operate since they improve economic sustainability which is much needed, but the main challenge is that as they continue operating, they jeopardize environmental sustainability which threatens our existence and the existence of future generations (UGGDS, 2017/18). This is the main gap since without solving the current challenge, it would lead to a serious situation which threatens the extinction of all living things on the planet (Tesfaye & Kitaw, 2020). The state of affairs if not addressed expeditiously, it would also lead to adverse situations like raw materials depletion, perpetual flooding which destroys lives and properties, wetland abuse, water and air pollution, and ecological challenges (National Environment Management Authority, 2018). Organizations like NEMA, KCCA, Ministry of water and environment, have educated the country on how to uphold environmental sustainability but all efforts haven't yielded enough (National Environment Management Authority, 2018). They have encouraged green sourcing, green manufacturing, green transportation, and reverse logistics among others (Ministerial Policy Statement, Ministry of Water and Environment; FY 2020-2021). Despite all these efforts, environmental sustainability has continued to be a challenge in Kampala and this is due to supply chains not operating consistent with environmental sustainability (BMAU briefing paper, 2018). If environmental sustainability in Kampala is to be improved, certain aspects that negatively impact it must be effectively identified and consequently addressed. Green supply chain practices in the manufacturing sector have been identified as a critical way of improving environmental sustainability Sarkis, (2017), and that is what compelled this study.

As such this study sets out to investigate the relationship between green supply chain practices and environmental sustainability, establish the relationship between green sourcing and resource use efficiency, examine the impact of green manufacturing on ecological balance, to assess the relationship between green transportation and air and water pollution and to investigate the

relationship between reverse logistics and wetland management. Since they are key to environmental sustainability, embracing green supply chain activities, and this would allow sustainable solutions to environmental sustainability challenges

The objective of the study was to evaluate the relationship between green manufacturing and environmental sustainability in Uganda, focusing on selected manufacturing entities in the Kampala district.

2 Brief Review of Empirical Literature

Relationship between green manufacturing and environmental sustainability

A number of studies were available on green manufacturing and environmental sustainability. For instance, AuYong et al. (2019) point out that green manufacturing is the production of commodities in a manner that protects the natural environment from abuse which makes its life un-sustaining. Ecological balance is a situation where all living species like people, plants, animals, and all others are living in harmony with nature. This is usually achieved by avoidance of activities like traditional manufacturing which pollutes the environment and kills many species. Green manufacturing can lead to ecological balance in the sense that if the pollution in manufacturing is reduced, there won't be severe global warming which destroys many living species hence jeopardizing ecological balance and environmental sustainability at large.

Green manufacturing focuses on several processes that support environmental sustainability. Some of them are, reducing energy spent when manufacturing, reducing or eliminating air pollution by emissions, reducing or eliminating water pollution, reducing energy spent on running machines, using renewable energy to run/operate machines, and using lean manufacturing systems that reduce waste production during manufacturing, using machines that output quality products, recycling the waste to get more raw materials instead of buying whenever they are in need, reusing products that are returned from the market but can still be reused, repairing and using broken-down items, remanufacturing, refurbishing, and other activities that lead to ecological balance. All the above ways of manufacturing in a manner consistent with environmental sustainability are scientifically proven and actionable if necessary assistance is rendered to the industrialists most of who aren't aware of them. According to Tricoire, resources four times the size of the earth are likely to be consumed by man's activities by 2050. Such levels of activity contribute to the carbon emissions reported by a United Nations report which warns that if the emissions aren't reduced by 50%, there are likely to be adverse situations ahead (Tricoire, 2019).

In this research, green manufacturing is defined as the process of production that aims at eliminating or at worst reducing pollution, using energy-efficient systems, using systems that ensure overall resource use efficiency for their production, hence leading to ecological balance. This can be achieved through the following ways, eliminating or reducing greenhouse gas emissions during production, eliminating or reducing water pollution, reducing the amount of energy spent during operations, using environmentally friendly raw materials in manufacturing, recycling goods, reducing unnecessary use of materials, avoiding landfills which lead to land pollution, and repairing items for reuse such that their life cycle is elongated as much as possible (Rebeca, Sara, Samantha, & Carlos. 2020). Wildfires have ravaged Australia, the USA and the Amazon rainforest which have led to the demise of irreplaceable species that balance the ecosystem, all these are direct life-threatening events that must be addressed immediately instead of taking climate change for a myth like many are doing (Zaman, 2015).

A study titled "The role of green attributes in production processes as well as their impact on operational, commercial, and economic benefits". conducted by Jose, Jorge, Roberto, Emilio & Julio. (2018). They used partial least squares and the results obtained portrayed that greening the manufacturing process has positive results both before and after the production processes. However, they didn't clearly show how the positive results would be obtained since they never narrated the process of achieving the positive results. That leaves a major knowledge gap that urgently needs to be addressed.

New advances like the Industrial Internet of Things (IIoT) have introduced new ways of operating that promote innovations which effectively counter carbon emissions. But it is still not applied in most African countries because it is ambiguous. Some cities like Shanghai are models of green manufacturing, the city brings together stakeholders, public and private for the advanced manufacturing in the municipality (Hing, Rachel, Jing, & Ming. 2015). This is the way to go especially in Africa where we still lag behind in environmental pro and sustainability and still don't have sufficient scientific ways of uniformly going green. A related study on general environment-sensitive practices was carried out in Uganda to establish its impact on the community's sustainability. It was found that green supply chains like manufacturing would not only lead to ecological balance and environmental sustainability but also enhance economic sustainability (Akiyode, et al., 2018). This has been highlighted in many studies before, green manufacturing contributes to economic improvement at the organization level by improving the overall cost of operations by significantly reducing it. It has also improved household incomes in Kampala's suburbs by availing plastic waste collectors with an

income. This wasn't the case and actually, there are groups of former street children who have been mobilized by KCCA to collect and sell plastic waste to manufacturers who recycle and reuse the waste as raw materials. However, much as they insist on educating Ugandans on how to go green, they also negate the aspect of availing enabling items like environmentally friendly fuels, air pollution control equipment, electric vehicles, and other things, these are mainly the gaps that need to be addressed.

Some research findings indicate that 65% of consumers prefer to buy and consume products from organizations practising green operations (Carol practising, Amaia, Covers, 2017). This shouldn't be the basis to go green, it can only be an added advantage since the primary reason for green manufacturing is to have a planet that supports life for today and future generations and not to only have goodwill amongst consumers.

According to the World Health Organization (WHO), at least 4.2 million deaths are recorded every year due to poor manufacturing which causes air pollution (Aslam, Muhammad, Waseem, & Khurram, 2019). The figure portrayed by WHO may seem small, but questions must be asked in a bid to decide on the way forward. Where are these deaths occurring exactly? Are all deaths caused by air pollution being recorded? How many more deaths are expected if the status quo is maintained? What can be done to improve the situation?

Manufacturers and other production firms need to know that 91% of the world's population is living in areas with air pollution above acceptable levels (World Health Organization, 2019). This calls for the world to stand in unison against anything that jeopardizes the environment.

Stakeholders shouldn't simply be convinced, established green supply chain practices like pollution control and stoppage of wetland encroachment for manufacturing must be enforced for the planet to be preserved for today and future generations. Manufacturing entities have led to the depletion of many different kinds of raw materials and very soon, there shall be either no or quite limited amounts left which would lead to global price surges. Today, global fuel prices are rising and destabilizing commerce in general because transportation is a big cost driver. This is all due to the fact that the world is because fuels much more than any other kind of clean fuel to run vehicles, what even hurts more is that the use of fossil fuels like diesel and petrol isn't only environmentally dangerous but expensive too. Well-developed and designed green manufacturing systems don't leave anything to waste. They produce items whose waste can be recycled and reused as raw materials again and again meaning that most of the products produced through green systems don't easily get to their end-of-life point. Green manufacturing has enabled many factories to refurbish electronics like phones and computers in the developed world. This is done through people who had bought the items taking them back when they feel like having better ones, and those that had been returned are either repaired and resold, recycled and the materials used to produce better models of phones which gets phones on the market at a much lower price than the ones that weren't made from recycled materials.

In their study, Sucheta, Vivek, Jitendra. (2020), assert that green manufacturing will not only contribute to environmental sustainability y will also contribute to economic sustainability at household and organizational level. Given the increased surge in global fuel prices, technologies like solar energy, wind energy, geothermal, and biomass, shall inevitably become the next source of industrial energy.

According to the global trends, manufacturing has been a critical economic growth driver in Africa and developing countries for over three decades (Munch, Ogallo & Lourenco. 2021). Reports indicate that, during the 20th century, Africa and other parts of the developing world realized over double in GDP growth due to manufacturing activities, world steel production grew between 1950 and 2000 to over r 1.2billion metric tons. Aluminium Production was unscaled between 1980 and aluminium which is a good development but requires serious checks and balances if Africa is to continue benefitting from that good work (United Nations Environment Program, 2011). This hasn't come without challenges; the UNEP report alludes that these manufacturing activities have a large negative impact on materials depletion. Manufacturing consumes approximately 35% of global electricity produced, 20% and above global carbon emissions, and 25% and above of natural resources extractions. Africa and the world at large cannot simply think or even opt to stop manufacturing as an economic development and sustainability activity (Dini, Yudi, Ende, & Zulkifli. 2020). But the other challenge is that if we continue manufacturing the way we are doing, we shall harm the planet to a point of no return and there won't be life on it. This calls for a more scientific way of harmonizing a critical way of livelihood with environmental sustainability and the solution amongst others is green manufacturing.

In Uganda, the president is always attracting investors to bring their manufacturing businesses into the country, this has seen a proliferation in the number of manufacturing units which are mostly concentrated in the capital city Kampala and the surrounding areas for definite reasons which are, access to expected big makes, access to the airport, fairly reliable power supply, better information and communication technology access, skilled labour access and many others. This has gotten Kampala to endure multiple signs and indicators of continued environmental challenges caused by the heat and other challenges like pollution by the manufacturing entities that have accelerated global warming and climate change in Kampala.

If we continue in the direction of traditional production, we shall be sorry for ending life on this planet which is very disappointing. There is s a need for strict regulation in manufacturing processes by global leaders such that the discrepancy and disharmony between manufacturing and ecological balance come to a logical conclusion. While the above-related studies were on green manufacturing and environmental sustainability; they presented a number of gaps. Several studies were locatedseveralanda creating contextual gaps. Many studies were several years out of date creating temporal gaps and few of the studies utilized the institutional theory thus creating a theoretical gap; prompting this study to test the null hypothesis that from the aforementioned, it can be hypothesized thus:

H1: There is a statistically significant relationship between green manufacturing and environmental sustainability in selected manufacturing entities in the Kampala district

3 Methodology and Ethical Consideration

3.1 Methodology

The study adopted Positivism Philosophical orientation and Positivism is mainly associated with the philosophical stance of the natural scientist, which entails working with an observable social reality to produce law-like generalizations (Saunders, 2019). This philosophy was found to be sufficient for the study because it establishes the truth about what's exactly happening in supply chains thereby helping to develop a scientific model to enforce green supply chain practices (Crowther & Lancaster, 2008).

The study employed both a survey and phenomenological design. The survey encompassed a cross-sectional approach whereby data was collected at a particular point in time. The study chose only a few illustrative sample essentials of a cross-section of manufacturing entities in Kampala. The researcher was not obliged to have further interactions with the study respondents.

In regard to the nature of the study objectives, a cross sectional survey design was the most suitable to gather quantitative data and make statistical predictions and correlations of factors associated with green supply chain practices and environmental sustainability.

The phenomenological approach was also adopted for this study, this was applied to establish inner most qualitative data using an open-ended question appended to the survey tool at the end of each objective, this open-ended question sought to establish the respondent's view on how green supply chain practices could be improved in order to have them contribute to environmental susto. The use of two methodological designs aimed at detailed information gathering from respondents is highly recommended and supported due to its nature of helping the study to obtain more insight into what is happening in the area (Ntayi,2005; Mafabi; 2012).

The study area was environmental sustainability in selected manufacturing entities in the Kampala district. This geographical area has many high scale manufacturing facilities, many of them being concentrated in close proximity, making accessibility easy (BMAU Briefing Paper 2018) the target population was all the manufacturing entities in the Kampala district. Kampala has 675 manufacturing entities (www.Uma.or.ug).
The unit of analysis was the manufacturing entities and units of inquiry included top management like managing directors, general managers, operations managers, production managers, and procurement managers of these entities because they were well positioned to provide information on green supply chain practices and environmental sustainability in manufacturing entities in Kampala district.

Table Showing Sample size

Category of Population	Total Number (N)	Sample (S)	Sampling Technique
Top Managers	225	83	Purposive
Production and Operations	225	83	Purposive
Procurement Managers	225	82	Purposive
Total	**675**	**248**	

The sample size constituted 248 entities from a population of 675 entities; This was decided upon using Krejcie and Morgan's table of sample size determination. The research considered a more targeted way to select units of analysis and units of inquiry from whom to collect primary data. After determining the sample size of 248 manufacturing entities, they were categorized according to their level of activity and those with higher operations that were likely producing more waste were purposively selected. From these manufacturing entities and top management, production and operations managers, and procurement managers were selected. Purposive sampling from the categorized population was chosen as the method was fit for the purpose as only the managers of entities that produced a lot of waste were targeted as study participants. The study collected and analyzed primary data.

Data were collected at a single point in time since the study was a cross-sectional study. The cross-sectional kind of study was used due to its adequacy in fully exhausting the avenues of such a study and this method has been used in many more studies (Walugembe, 2018). Data was collected from one source and that is primary data which was collected through direct interviews with respondents.

3.2. Validity of Research Instrument

The researcher used the judgment of different experts to verify the content validity of the instruments. To assess this, judges were contacted to evaluate the relevance of each item in the instruments in relation to the objectives. The experts rated each item as either relevaboutevant. The questionnaire was developed based on already used questionnaires which makes it appropriate enough for the exercise. Biases and inaccuracies were reduced through the creation of rapport between the interviewer and interviewee, and explanations to make statements and questions well understood were also emphasized. Validity was determined using the Content Validity Index (C.V.I). C.V.I = Items rated relevant by both judges divided by the total number of items in the questionnaire.

$$CVI = \frac{\text{No. of items rated relevant}}{\text{Total no. of items}} \geq 0.5$$

In case less than the projected number of respondents had participated due to different reasons that caused failure to participate, a mathematical formula to establish a sufficient number like the one below was provided to ensure that the number of respondents is sufficient.

The CVI for the questionnaire was valid at above 0.5 because the least CVI recommended in a survey study should be 0.5 (Amin, 2005). CVI results were as presented in Table 3.2.

Content Validity Index

Items	Number of Items	Items Deleted	Items Retained	Content Validity Index
Green Sourcing	12	2	10	0.833
Green Manufacturing	7	1	6	0.857
Green Transportation	6	2	4	0.667
Reverse logistics	6	1	5	0.833
Resource use efficiency	7	2	5	0.714
Ecological balance	8	3	5	0.625
Clean air and water	6	1	5	0.833
Wetland Management	7	2	5	0.714
Total Items	59	14	45	0.76 (AVG CVI)

Source: Primary Data 2021

Instrument Reliability

Reliability is the extent to which a research instrument yields consistent results across the various items when it is administered again at a different point in time (Sekaran, 2016). To establish reliability, the instruments were pilot tested in areas with designated industrial parks in Namanve, Jinja and Gulu industries. Reliability was assessed using an intra-class reliability measure. The intra-class correlation coefficient is computed to measure agreement between two or more raters

Intra-class Correlation Coefficient

	Intraclass Correlation	95% Confidence Interval		F Test with True Value 0		
		Lower Bound	Upper Bound	Value	df1	df2
Single Measures	.703[b]	.622	.769	5.728	185	185
Average Measures	.825[c]	.767	.869	5.728	185	185

Source: Primary Data

The intra-class correlation coefficient values less than 0.5 are indicative of poor reliability. Values between 0.5 and 0.75 indicate moderate reliability; values between 0.75 and 0.9 indicate good reliability and values greater than 0.9 indicate excellent reliability (Sekaran, 2011). This study scored an intra-class correlation coefficient of 0.825 which is indicative of a tool with good reliability.

3.3 Data Analysis and Presentation

The data collected was analyzed using a computerized analysis application called Statistical Package for Social Scientists (SPSS). This included descriptive and inferential analysis. The descriptive analysis gives data structures in form of frequency tables, standard deviation, and percentages. The inferential analysis gives correlations, Regression, and ANOVA tables. These were used to determine the relationship between the independent variables and the dependent variable. The results from the statistical analysis were presented in tables. This kind of analysis was done for each objective in the study.

3.4 Ethical Consideration

The ethics were handled with utmost care since any divergence or neglect of the ethical considerations would lead to a dispute regarding the study outcomes. In this regard, all necessary ethical guidelines were considered. Ethical approval was sought from Mengo Hospital Research Ethics Committee (MHREC) and Uganda National Council for Science and Technology (UNCST) was consulted for guidance on the ethical aspect of the study. prior consent from the respondents was sought and all data collected from respondents was handled in a way prior agreed upon between the researcher and respondent. Exposing the respondent's identity and publishing sensitive material without permission wasn't and won't be done too. Environmental sustainability is quite a sensitive area that is fast affecting the world and we all have to participate in countering the trajectory. In doing so, all of us who decide to make an input in the quest to find a solution should do it with the best of ethics and integrity. Things like reporting falsehoods must at all times be avoided.

4. RESULTS

Response rate

This study involved 248 respondents to enable the researcher to come up with conclusive results about the relationship between green resourcing and environmental sustainability in the Kampala district. Only 186 of the respondents that were set for the study or research were able to respond to the study. This reflected a 75 percent response rate

Table showing a response rate

Instrument	Distributed	Per cent	Response Rate
Questionnaire	248	186	75%

Source: Primary data (2021)

Background of the Respondents

This theme handles the background information on the respondents that participated in the study. The study identifies characteristics of the respondents that help judge their aptitude in expressing views about the relationship between supply chain practices and invites the entire environmental sustainability the in Kampala district. These characteristics include gender, age, the highest levf the education job description and tenure in the current docket.

Gender of the respondents

To take into consideration the gender of the respondents, the researcher recorded the results in figure 4.1.

Figure 4.1: Gender of the respondents

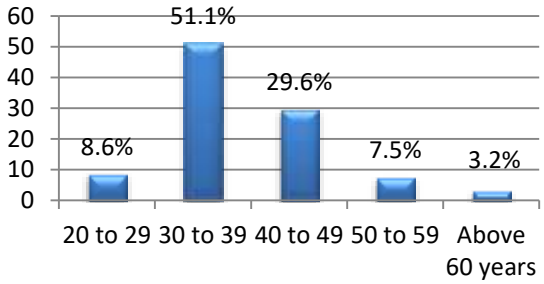
Primary Data 2022

From Figure 4.1 above, the study was conducted with mainly male respondents who constituted 74.7%. Female respondents, on the other hand, were 25.3%. The implication of such gender percentages in the study was that all genders were reproduce gender percentages in the study implied between green supply chain practices and environmental sustainability in the Kampala district were captured in the study in a legitimate manner. The responses were however male dominated.

Age of the Respondents

To ascertain their respective age distribution, the respondents were asked to provide the study with their ages. Information presented in figure 4.3 below:

Figure 4.2: Age of the Respondents



Primary Data 2022

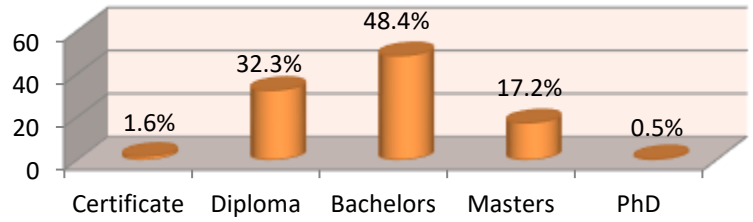
Figure 4.2 above indicated that of the respondents who participated in the study, 8.6%, were in the range of 20 to 29, 51.1% were in the range of 30 to 39, 29.6%, were in the range of 40 to 49 years, 7.5% were in the range of 50 to 59 and 3.2% were Above 60 Years of age respectively.

The above statistics imply that all respondents (100 %) covered by the study were above ≥20 years of age and considered mature enough to give responses that were consistent and legitimate. The statistics also imply that there was fair distribution in terms of respondents' ages, which provided the study with views of respondents from all ranges in terms of age, without bias.

Highest Level of Education of the Respondents

Respondents were also asked to state their level of education and most of them indicated that they had a bachelor's degree as shown in figure 4.4 in detail below.

Figure 4.3: Level of education of the respondents



Primary Data 2022

Figure 4.3 depicts the fact that the largest part of the respondents had attained a bachelor's degree which stood at 48.4%. Only 1.6% held certificates. Those who had attained a Diploma constituted 32.3% of the respondents and Master's Degree holders were 17.2% of the respondents. One PhD holder participated in the study. This implied that the respondents who took part in the study were adequately educated and could provide information that was pertinent to the study.

Job description held in Industry.

The research also sought to know the job description of the respondents. The findings are shown in table 4.4 below:

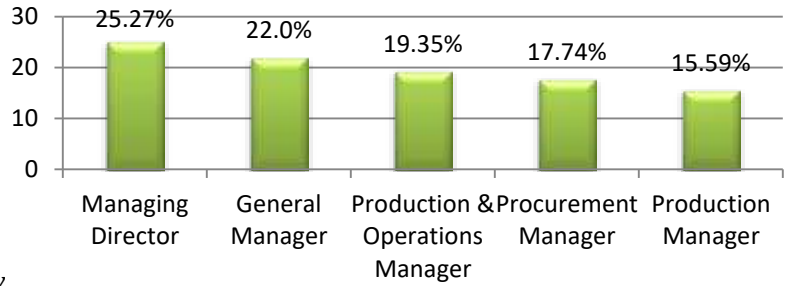


Figure 4.4: Showing Job description held in Industry

Primary Data 2022

Prominent from figure 4.4 above it is clear that 25.27% of respondents were managing directors, 22.04% were general managers, 19.35% were production and operation managers, 17.74% were procurement managers, and 15.59% were production managers. The implication was that the majority of respondents involved in the running of factories were the right people to give their opinion on the relationship between green supply chain practices and environmental sustainability in the Kampala district and their responses would be considered consistent and legitimate.

Descriptive statistics on Green Manufacturing

Independent variable two in this study was green manufacturing. The section avails a detailed presentation of the descriptive statistics; specifically measuring responses with the help of mean, standard deviation and t-values. To understand green manufacturing in Kampala industries, the respondents were introduced to different items to have their say. Their responses were computed by making an aggregate of responses given by respondents to the 5-point Likert scale (1= Strongly disagree, 2 =Disagree, 3 =Not sure, 4 =Agree, 5 =Strongly agree), which were categorized according to their means & standard deviations and were interpreted as per Appendix C. the results can be seen in the descriptive information table 5.1. To be significant, the t-value obtained from the data must be equal to or larger than the critical t-statistic values at the selected conventional significance levels of, for example, 10%, 5% or 1% (Amin,2005).

Table 5.1: Descriptive statistics on Green Manufacturing

Items on Green Manufacturing	Mean	S.D	t-Values
My organization is aware of what green manufacturing means	4.02	0.649	6.19
My organization fully protects against air pollution when manufacturing	3.71	1.096	3.39

Items on Green Manufacturing	Mean	S.D	t-Values
My organization doesn't dump waste in the environment	4.26	0.568	7.50
My organization uses renewable energy for its manufacturing activities	3.32	1.283	2.59
My organization reduces waste during manufacturing	4.18	0.538	7.77
My organization is periodically audited by the National Environmental Management Authority	3.81	1.132	3.37
Average Mean & Standard Deviation	**3.88**	**0.878**	**5.14**

Source: Primary Data 2021

Table 5.1 above illustrates descriptive statistics on Green Manufacturing in Kampala industries; the highest mean was 4.26 while the lowest was 3.32. The average mean value of 3.88 indicates a general agreement that organizations are aware of the effect of green manufacturing and its implications on environmental sustainability. The average standard deviation of 0.878 indicates that the means represent the data well. The overall t-value of 5.14 is higher than 2.51, with a significance level of 1%.

In the statement "*My organization is aware of what green manufacturing means"*. This statistic indicates strong agreement with the statement that organizations are aware of the essence of green manufacturing. This is reflected in the mean attained which stands at 4.02 which is over and above (3) revealing a strong agreement with the statement. The standard deviation obtained stands at 0.649, it shows how much variation or dispersion exists from the mean or expected value. Such a low standard deviation (0.649) is close to zero and indicates that the means data are clustered around and close to the mean. The t-value of 6.19 is higher than 2.51, with a significance level of 1%. This finding is partially in agreement with the study findings by Carola, Amaia & Anna Maria (2017) which affirm the value of consciousness of facts about green manufacturing in industries and the benefits that accrue to Industries when they are properly done are obvious.

In the statement "*My organization fully protects against air pollution when manufacturing*". This statistic designates robust agreement with the statement that organizations fully protect against air pollution when carrying out manufacturing. This is reflected in the mean attained which stands at 3.71which is above three (3) hence revealing agreement with the statement. The standard deviation obtained stands at 1.096 and shows how much variation or dispersion exists from the mean or expected value. Such a high standard deviation (1.096) is above one (1) indicating that the means data are widely spread out and not particularly close to the mean. The t-value of 3.39 is higher than 2.51, with a significance level of 1%. This finding is partly in agreement with findings in a study by Luthra & Mangla (2018) which stresses that manufacturing industries need to go about their activities mindfully of air pollutants and other harmful waste materials.

In the statement "*My organization doesn't dump waste in the environment*". This statistic indicates strong agreement with the statement that organizations desist from dumping waste in the environment. This is reflected in the mean attained which stands at 4.26 which is over and above three, thus revealing strong agreement with the statement. The standard deviation attained stands at 0.568, it shows how much variation or dispersion exists from the mean or expected value. Such a low standard deviation (0.568) is close to zero indicating that the means data are clustered around and close to the mean. The t-value of 7.50 is higher than 2.51, with a significance level of 1%. This finding is in strong agreement with findings in a study by Sarkis & Zhu (2017) which affirms that for environmental sustainability to be attained, firms must responsibly dispose of waste products because environmental enforcement agencies cannot be everywhere at once.

In the statement "*My organization uses renewable energy for its manufacturing activities*". This statistic indicates strong agreement with the statement that organizations use renewable energy for their manufacturing activities. This is reflected in the mean attained which stands at 3.32 which is over three (3) thus revealing strong agreement with the statement. The standard deviation obtained stands at 1.283 and shows how much variation or dispersion exists from the mean or expected value. Such a high standard deviation (1.283) is above one (1) indicating that the means data are widely spread out and not particularly close to the mean. The t-value of 2.59 is higher than 2.51, with a significance level of 1%. This finding is in partial agreement with findings in a study by Zaman (2015) that discussed the development of zero waste management and concluded that the use of renewable energy is the only viable option for environmental sustainability.

In the statement "*My organization reduces waste during manufacturing*". This statistic indicates strong agreement with the statement that organizations reduce waste during manufacturing. This is reflected in the mean attained which stands at 4.18 which is over and above three, thus revealing agreement with the statement. The standard deviation attained stands at 0.538 and shows how much variation or dispersion exists from the mean or expected value. Such a low standard deviation (0.538) is close to zero indicating that the means data are clustered around and close to the mean. The t-value of 7.77 is higher than 2.51, with a significance level of 1%. This finding is in partial agreement with findings in a study by Bai et al. (2020) which determined that efficient manufacturing processes cause less damage to the environment as wastage and by-products are minimal and manageable.

On the statement "*My organization is periodically audited by the National Environmental Management AutInrity*". This statistic indicates strong agreement with the statement that organizations that are periodically audited by the National Environmental Management Authority are aware of environmental sustainability. This is reflected in the mean attained which stands at 3.81 and is above three, thus revealing agreement with the statement. The standard deviation attained stands at 1.132 and shows how much variation or dispersion exists from the mean or expected value. Such a high standard deviation (1.132) is far from zero indicating that the data are more spread out. The t-value of 3.37 is higher than 2.51, with a significance level of 1%. This finding is in partial agreement with findings in a study by Hendriks, Slangen & Heugens (2018) that determined that environmental sustainability cannot be entrusted to manufacturers alone, but must be kept in check by the authorities.

Overall, the descriptive statistics represented by an average mean of 3.88 and standard deviation of 0.878 indicates an awareness of green manufacturing in Kampala industries; but manufacturing firms still need to put in more effort in order to obtain the fullest from green manufacturing.

Correlation Results

Objective two the to establish the relationship between Green Manufacturing and Environmental Sustainability in Kampala industries. This section delivers a detailed description of the inferential statistics obtained from the field of study based on the specific objectives of the study. It goes on to present and answer the research questions. These findings were thus obtained on the relationship between green manufacturing and Environmental Sustainability in Kampala industries in terms of green manufacturing and how it relates to Environmental Sustainability in Kampala industries.

In order to assess the association and direction between green manufacturing and Environmental Sustainability industries, the study computed Pearson product-moment Correlation (PPMC) between Green Manufacturing and Environmental Sustainability in Kampala industries. The bivariate Pearson Correlation produced a sample correlation coefficient, *r*, which measured the strength, association, and direction of linear relationships between pairs of the two continuous variables. The weights of the correlation were interpreted on the following basis: 1.00 perfect relationship; 0.90 – 0.99 very high; 0.70 to 0.89 high; 0.50 to 0.69 moderate; 0.30 to 0.49 low; 0.01 to 0.29 very low and 0.00 translates to a non-existent relationship. Results can be seen in Table 5.2 below:

Table 5.2: Correlations between Green Manufacturing and Environmental Sustainability in Kampala industries

		Green Manufacturing	Environmental Sustainability
Green Manufacturing	Pearson Correlation	1	.323**
	Sig. (2-tailed)		.000
	N	186	186
Environmental Sustainability	Pearson Correlation	.323**	1
	Sig. (2-tailed)	.000	
	N	186	186

**. Correlation is significant at the 0.01 level (2-tailed).

Source: Primary Data 2021

Results in Table 5.2 above show the results from the correlations computed. The findings show that there was a low but significant positive correlation (*r*= 0.323, sig 000, p< .01) between green manufacturing and environmental sustainability. This implies that any improvements made in Green manufacturing can be associated positively with changes in Environmental Sustainability in Kampala.

Regression results of Green Manufacturing on Environmental Sustainability in Kampala industries.

In order to derive the coefficient of determination and to also appreciate the predictive power of Green Tong on Environmental Sustainability in Kampala, a Linear Regression Analysis (LRA) was adopted. The findings are presented in table 5.3 below:

Table 5.3: Model Summary

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	The error	.104	.099	.34242

a. Predictors: (Constant), Green Manufacturing

Primary Data 2021

Results in Table 5.3 reveal an Adjusted R Square which indicates the variance in Environmental Sustainability due to changes in Green Manufacturing and Environmental Sustainability. The Adjusted R square value of 0.099 accounts for the variations noted in Environmental Sustainability in Kampala by 9.9% (at 100% test level). The remaining variations (90.1%) in Environmental Sustainability in Kampala are accounted for by other factors.

Table 5.4: Analysis of Variance

ANOVA

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	2.510	1	2.510	21.410	.000[a]
	Residual	21.575	184	.117		
	Total	24.085	185			

a. Predictors: (Constant), Green Manufacturing

b. Dependent Variable: Environmental Sustainability

Source Primary Data 2022

F-statistic shows variation within samples. Green Manufacturing reflects a small F statistic of 21.410 indicating that means of several independent samples are equal. Therefore, the model using Green Manufacturing as a predictor (independent variable) did a decent job of predicting the dependent variable and proves that there is a significant relationship between the predictor (Green Manufacturing) and the dependent variable (Environmental Sustainability).

Table 5.5: Regression Coefficients analysis

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	2.813	.197		14.284	.000
	Green Manufacturing	.233	.050	.323	4.627	.000

a. Dependent Variable: Environmental Sustainability

Primary Data 2021

The standardized Beta value of .323 (sig. 000, p<.05); means Green Manufacturing explains 32.3 % of the variance in the dependent variable, the remaining 67.7 % explained by other factors; and as such, the amount of unique variance Green Manufacturing accounts for is significant. Specifically, the Beta Value was positive, meaning that for managers to improve environmental sustainability, they need to adopt Green Manufacturing practices given that they are fair predictors of the variance in the dependent variable (at 32.3%)s.

The hypothesis stated that:

H_1: "There is a statistically significant relationship between Green Manufacturing and Environmental Sustainability in selected manufacturing entities in Kampala district"

A statistically significant positive relationship between "green manufacturing" and "environmental sustainability" The Standardized Coefficient (0.012) was positive (p = 0.878); (p>.05). H_2 is rejected. Therefore, the null hypothesis is accepted/confirmed. There is thus sufficient evidence at the 99 percent level of significance to support the null hypothesis.

The moper centitionally suggests that a unit increase in green manufacturing results in an 11.9% increase in environmental sustainability; while the remaining 88.1% of variations noted in the dependent variable are explained by other factors.

DISCUSSIONS

This study analyzed green manufacturing along with the following domains: whether manufacturing entities were aware of green manufacturing; whether they fully protect against air pollution when manufacturing; whether they don't dump waste in the environment; whether they use renewable energy for their manufacturing activities; whether they reduce waste during manufacturing; whether they are periodically audited by the National Environment Management Authority.

The study findings on Green Manufacturing and Environmental Sustainability in Kampala revealed that organizations are largely aware of the existing environmental sustainability standards. This statement can be supported by numerous submissions from other scholars. This is supported by Khan & Qianli (2017), who assert that comprehensive mindfulness of green manufacturing ethics eases the burden carried by environmental watchdogs because all stakeholders appreciate the benefits that accrue to the society as a whole due to their efforts in the perpetuation of tons of green manufacturing; while Lidia et al (2020) argued that green practices once widely publicized among factory employees would be respected and employees involved in manufacturing will not need close supervision to uphold them. Sarkis & Quingyun (2017), while examining environmental sustainability and production recognized that widespread awareness of the principles of green manufacturing is widely regarded as the first step towards the path leading to environmental sustainability. However, the study results obtained reveal inconsistencies in adherence to environmental sustainability standards as specified in the general obligation to prevent and mitigate pollution in the National Environment (Standards for Discharge of Effluent into Water or Land) Regulations, 2020 Part II (Standards for effluent) of regarding the general obligation to prevent and mitigate the pollution. The study finding partly conforms to the Institutional Theory which stipulates that organizations like manufacturing plants are duty-bound to follow institutional systems like the National Environment standards.

The study established that organizations fully protect against air pollution when manufacturing. These revelations are supported by Srivastava (2007) who established that for environmental sustainability to become reality, individual units emitting pollutants must take responsibility to put in place mitigating measures to stem the leakage of the same into the environment. Other scholars like Aslam, et al (2019), conducted an environmental sustainability study in Pakistan and argued that even in developing countries, measures can be undertaken like limiting emissions if at all treating waste proves costly and needs advanced technologies. De Carvalho et al. (2020), make a strong case for subsidized interventions for factories in third world countries paid for by rich countries that have done most of the environmental damage in the last century or so. However, the study results indicate that the control of

waste by the manufacturing sector that upholds environmental sustainability standards as specified in Part II General Provisions relating to Waste management found in The National Environment (Waste Management) Regulations, 2020 regarding compliance with environmental sustainability principles suggest that there has been very limited adherence to the laid down regulations. The study finding partly conforms to the Institutional Theory which requires individual members to offer cohesion to the institutional guidance through the support of key fundamentals that the institution stands for. Therefore, the deficiency of development in this part remains and needs further engagement by all concerned parties.

The study established that many organizations don't dump waste in the environment. This finding is in line with Chan, Yee & Lim (2015) who hold the view that manufacturing entities being the biggest active polluters should restrain and refrain from the practice of dumping; while Zhang et al (2018) argue strongly that just a fraction of manufacturers desisting from dumping waste materials waterways ways will tremendously repair the damage to the environment and lead to a drop in average temperatures worldwide and Diabat, et al (2013) put forward the view that the Automotive Industry could greatly contribute to environmental sustainability by turning to electric transmission systems. These study results are in agreement with part II of the general provisions relating to waste management contained in the National Environment (Waste Management) Regulations, 2020 regarding responsibility for waste management. The study funding partly conforms to the Institutional Theory which specifies that organizations have to make efforts to conform to the legislative powers and social claims of their environment. Manufacturing units desisting from dumping untreated waste into water bodies are in conformity with the theoretical framework. What is required is conform hanced adherence to environmental protection laws if environmental sustainability is to be achieved?

The study clarified that there was no widespread consensus that organizations use renewable energy for their manufacturing activities. This finding is only partly in line with Jambeck et al (2018) who while conducting a study on plastic waste inputs from land into the ocean argued that more factories switching to renewable energy for their manufacturing activities will make a huge difference in the fight to achieve environmental sustainability. Other scholars such as Govindan et al. (2014) largely agree. They postulate that given the alarming situation of global warming and the continued pollution situation and attendant carbon emissions; only a decisive switch to renewable energy for its manufacturing activities will actively improve the existing situation. However, the fact that the study was unable to identify a critical mass to form a firm foundation of firms that use renewable energy as a form of reduction in carbon emissions is a cause of concern. This is partly contrary to Part IV article 110 of domestic waste, municipal waste, and industrial waste contained in the National Environment (Waste Management) Regulations, 2020 concerning Waste generated at commercial premises or establishments. The study outcome is not fully synchronized with the Institutional Theory which advocates legislative powers and social rights alluding to a safe natural environment for the current and future generations.

6 Conclusion and recommendation

6.1 Conclusion

On objective two of the study *"To evaluate the relationship between green manufacturing and environmental sustainability in Kampala district"* The hypothesis that green manufacturing has a relationship with environmental sustainability was not rejected although it had a low significance which is confirmed by the low prediction of the variance in the dependent variable. The study results concluded that green manufacturing contributed very little to environmental sustainability. The study, therefore, concludes that findings are not supportive of The National Environment Act, 2019; specifically concerning control of pollution and environmental emergency preparedness and management of waste. It also has a limited effect on environmental sustainability.

6.2 RECOMMENDATIONS

Since the finding revealed that Green Manufacturing had a statistically insignificant relationship with Environmental Sustainability in the Kampala district highlighted the fact that manufacturing firms routinely ignore the laid down rules governing green manufacturing and have continued to emit fumes and dump untreated wastes in water bodies leading to the conclusion that green manufacturing when putting under consideration by National Environment Management Authority, have not had the expected effect on supporting environmental sustainability in Kampala district.

It is therefore recommended that National Environment Management Authority rethink its current strategies that are not registering positive adoption by manufacturing firms in Kampala; by possibly offering incentives like tax cuts and subsidies to compliant firms of green manufacturing. This is because the current approaches to enacting the relevant laws governing green manufacturing have remained unimplemented.

The findings further indicate that Green Manufacturing is a poor predictor of Environmental Sustainability and more work is needed before it can significantly contribute to environmental sustainability in Kampala.

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