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SMART RAINWATER DOWNPIPE

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ABSTRACT

Abstract: Rainwater downpipe acts as a collector from the roof to the building and diverts the water away from the building. However, there are issues that arise from the gutters and rainwater downpipe. These issues include water accumulation in the gutter that prevents water from flowing smoothly which then leads to blockage and clogging. Gutters become source of breeding ground for *Aedes* habitat. The aim of this research is to develop a smart rainwater downpipe that can enhance a better water flow in the pipeline. This innovation project is important for the building so that it can distribute the water smoothly without any disturbance. The research methodology involved document review, research process and also simulation. The collected data shows the performance of conventional rainwater downpipe, and how it affects the flows of the water in the pipeline. The findings from this study provide insights for optimizing rainwater downpipe design. By implementing the improved rainwater downpipe, it can improve the rainwater flow efficiency and maximize the functionality. In conclusion, this study emphasizes the importance of using and having a good system of rainwater downpipe and gutter. By adopting this finding, good water management can be achieved and there will be lesser maintenance and works for humans.

Keywords: Blockage, gutter, innovation, rainwater downpipe, water

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INTRODUCTION

Water and water resources are critical for ensuring a sufficient food supply and a fruitful environment for all living species. Global freshwater demand has been quickly growing as human populations and economies have grown. Water scarcity reduces biodiversity in both aquatic and terrestrial ecosystems (Kilic, 2020). Water is one of the largest constituents of the Earth (Boyd, 2019). As the human population has grown, this basic necessity in producing goods and services for the population has increased which led to the greater water usage (Boyd, 2019). That is because, water quality has become main topic as water quantity often cannot be assessed independently of its quality (Boyd, 2019). However, with a proper treatment water can be treat and reuse (Bobek, 2020). One of the ways to preserve the quality of the water is by starting with a good water harvesting system in residential building (Bobek, 2020). Rainwater harvesting is the effective in collecting and storing the rainwater (Bobek, 2020). According to (Bobek, 2020), there are two basic ways of collecting water, surface runoff and rooftop runoff. He also adds, the rooftop surface harvesting consists of conveyance that consists of gutter and rainwater downpipe or downspouts which deliver the water from roof the other pipe. However, there are problems in some parts of the rainwater harvesting, specifically the rainwater downpipe. In this research, there will be more in-depth research and studies about the rainwater downpipe, specifically the gutters. The aim of this research is to develop a smart rainwater downpipe that can enhance its workability. This innovation project is important for the building so that it can distribute the water smoothly without any disturbance.

LITERATURE REVIEW

As the number of human populations is increasing, supplying sufficient water of good quality is one of the most urgent and significant challenges faced by decision-makers (Okhravi et al., 2015). There are prevention and solutions to ensure there is no water shortages in water supply, which include rainwater harvesting (Okhravi et al., 2015). Rainwater harvesting systems are independent systems, which means that users have the responsibility of operation and maintenance (Okhravi et al., 2015). By using the rainwater harvesting, it can avoid many environmental problems that can cause a larger scale of conventional water supply (Okhravi et al., 2015). However, there are some components in the rainwater harvesting which is the rainwater downpipe that may cause problems. Problems that usually occur in the rainwater downpipe is blockage. So, for this chapter it will mainly discuss about the general view of rainwater harvesting, the elements in it which consist of rainwater downpipe, how the rainwater flows in the system and some of innovation that can be used for improvement in future

study. The basic elements in the rainwater system which include three basic components will be introduced in the first sub-topic. Then the latest sub-topic will be explaining about how the water flows from the roof to the other rainwater harvesting element. From there, it can highlight which part of the rainwater system is crucial in delivering the water and why there are problems occur in the part. The chapter will be concluded with the various innovation existed so that the problems can be encountered, and the old innovation can be improvised.

The Basic Element and Importance of The Rainwater Downpipe

According to (Patrick, 2020) the rainwater downpipe acts as a conveyor to direct rainwater away from buildings. He adds, the rainwater downpipe serves as drainage channel which is situated near to drainage system that functions to remove water from the gutter out to the drain.



Figure 1 : The Gutter and Rainwater Downpipe

The rainwater downpipe is an important part of the building which was mentioned in the Building Regulations (Patrick, 2020). In the Building Regulations, it is stated that a sufficient provision should be made for the proper carrying and removal of the rainwater from the roof of buildings which can be solved by sloping the roof towards the water collector and providing a gutter so that surface water can run into the rainwater downpipe (Patrick, 2020). While according to (Superstar, 2017), rainwater downpipe function to serve as a motorway of sorts which should be evenly distributed around that particular house or a building. He adds, a better distribution of water will ensure safe disposal of rain, able to avoid damage to the building and the downpipe itself and also including neighboring properties (Superstar, 2017).

Issues Caused by Gutter and Rainwater Downpipe.

Despite the importance of the downpipe, there are also issues that arise from the gutters and rainwater downpipe in maintaining the downpipe. According to the (The

Most Common Issues Caused by Clogged Gutters, 2019), one of the problems is the damages of foundation that occurs when the water sits and accumulate in the gutter after rain, which then causes the water to rot because it does not go anywhere then started to rot and decaying which then lead to foundation cracks.

Not only that, (The Most Common Issues Caused by Clogged Gutters, 2019) also add that roof and other element in building also can lead to damage. Roofs can also rot and fall apart from the accumulation of water in the gutter. Besides, it can also cause erosion that leads to falling of roof or crumbling.

Blockage and Clogging in Water Pipeline.

Water accumulation happens when there are foreign matters preventing the water from flowing, this will result in blockage and clogging. According to (Tu & Traver, 2018), clogging is caused by substances such as leaves and other trash accumulating in pipes. They add, clogging in pipe also was influenced by the weather. For example, in a heavy rain or larger storm, the weather might move the debris and substances that cause clog and blockage of the water pipeline. Figure 2 below shows the rain gutters were clogged by foreign matters which is the dried leaves.



Figure 2: Dried leaves Clogged in the Gutter

According to (Zainon et al., 2016), checking and cleaning for clogged gutters are impossible because it is designed with unreachable rain gutters. They add, clogging may give effects to human, this include poor drainage and piping system has found to be source for breeding ground the Aedes habitats, for Aedes to breed, thus can cause and spread harmful disease. This is shown on figure 3 down below.

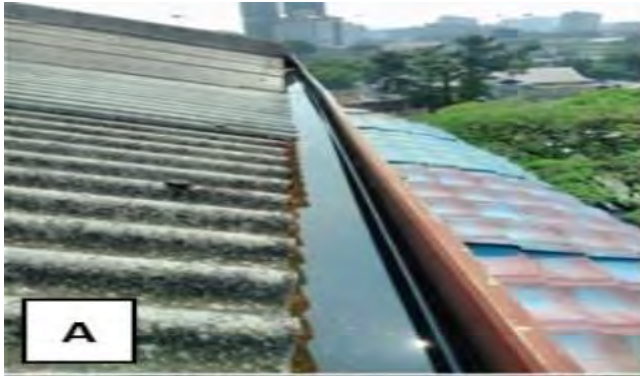


Figure 3: Breeding Aedes in Accumulated Water

Various Existing Innovation

There are three existing innovations that have been used, this consist of gutter helmet, automated gutter cleaning system and gutter cleaning robot. Follows are the details of each:

Gutter helmet

The gutter helmet is one of the existing innovations that people have come out to solve issues like blockage and clogging. Figure 2.6 below shows the gutter helmet. According to (Barbour et al. ,2006) the gutter helmet is an innovation system that capable of capturing rainwater from roofs, which then stop the gutters while reducing the seizure of debris. This gutter helmet also has been found practical in capturing storm water because of the 'Coanda' effect. This innovation also claims that it can catch any organic matter (Barbour et al. ,2006). However, not all of the gutter helmets provide a complete safeguard against debris from entering the gutters (Barbour et al. ,2006), gutter helmets work only certain of time. He adds, contaminants or debris will still get stuck at the top of the cover of the gutter helmet leaving no place for water to flow in the gutter.

Gutter Guard

According to (Charlie, 2020) gutter guard is a material that use to cover the gutters which prevent any debris or contaminants from getting in and allow the water to flow smoothly. He adds, installing gutter guards consist various of advantages this include lesser time and money spend on the maintenance of gutters because of the gutter downspouts are protected from contaminants so lesser time and money spend to clean the gutters, prevent from animal infestation such as pest insects or birds making the gutter as nesting areas and reduce the chances of likelihood of fire. The gutter comes with various quality, sizes, and types. Figure 2.6 below shows one of the types of gutter guards.

Gutter Cleaning Robot

Robotics is also an innovation that people created to counter any problems and help human being doing works. According to (Todd, 2012), robotics is a part in engineering which the subject is the robots but there is no general agreement on what makes up a robot. For this innovation, they are people that came up with a Gutter Cleaning Robot. Cleaning the gutters may be harmful and dangerous, thus the idea of gutter cleaning robot has appeared on the market (Hudy et al., 2021). The robot can easily pass- through the gutters to remove debris and dirt which include leaves, pieces of soil and moss (Hudy et al., 2021). The robot will be control that will be placed inside the gutter. The cleaning tool will be track inside of the gutter. The ascend paddles allows the device to break leaf blockages and remove impurities with a screw. Rotating blades at the front of the dirt, while brushes located behind the blades will remove debris and contaminants (Hudy et al., 2021). Figure 2.7 shows the gutter cleaning robot. The gutter cleaning robot may be harmful as it is not secured enough. This gutter cleaning robot will be used to improve for the next innovation. There will be improvement in every aspect so that it can function efficiently.

METHODOLOGY

Methodology will be focusing on how the methods and materials for the smart rainwater downpipe are collected. According to Acadia University, Methods and materials are highlight oh what was done and how the research was done. In addition, (Materials and Methods - Biology, n.d.) stated that the processes that are employed as well as all the materials that were used to conduct the study are described in detail in the materials and methods section. The materials in each of its subsections should be presented logically since research writing should be ordered and organized.

Research design

According to (Creswell, 2009), study design is the planning and study procedure with decisions ranging from broad assumptions to detailed methods of data collection and analysis. The purpose of research design is to enable questions can be answered with concrete evidence as clear as possible (DeVaus, 2001). There are three types of research design which include quantitative, qualitative, and mixed method (Creswell, 2009). As for this study, the method used is quantitative method. Quantitative data used to determine whether the evidence existed are enough to support the existing hypothesis (Justin Dsouza, 2010).

Research Process

Research process is a multiple research step in organizing research (Singh, 2021). According to (Singh, 2021), the research process includes formulating the research question, conducting a comprehensive literature review, formulating hypotheses, preparing the study design, determining the sample design, and collecting data for the project, all of which are necessary to effectively conduct research. Consists of steps or actions, running, and analyzing data, test hypotheses, generalize and interpret, and write reports or present results.

LIMITATION OF STUDY

The study has several limitations that prevent the study from further research which are lack of previous research studies on the topic. There are very limited studies on the rainwater downpipe topic that limit the research to go further deep and most of the research is not statistically proof. Other than that, the assembly and performance of this innovation product only be demonstrated using SketchUp and did not have a real prototype due to cost and limited resources. In addition, due to limited time no surveys are done to find out how far the marketability potential for the products.

RESULTS AND DISCUSSION

Development of innovation idea

After making the comparison between previous innovation, gutter cleaning robot were chosen for some improvement and innovation. In this part of the ideation, improvement in terms of sizing and by applying some motor components were made in the SMART rainwater downpipe to improve the productivity of the products and reducing time and cost for maintenance.

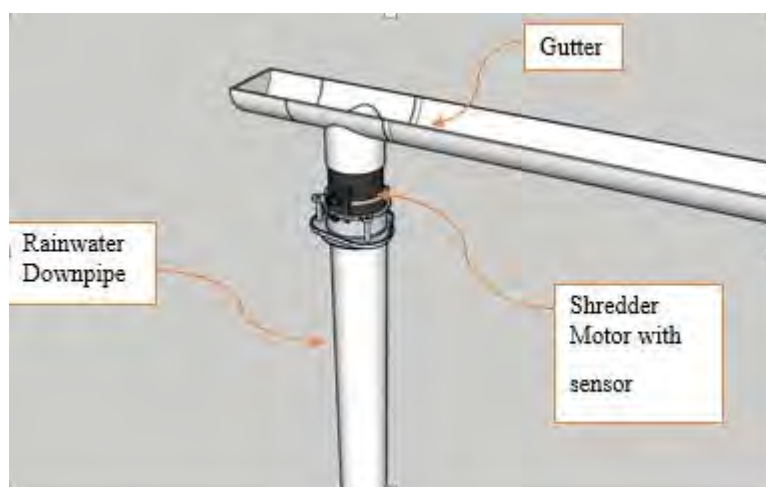


Figure 4: The Ideation of SMART Rainwater Downpipe

Development Performance

In this development performance, it will highlight the performance of the SMART Rainwater Downpipe. This includes being able to increase the productivity of the gutters making them require less maintenance. Other than that, SMART Rainwater Down is also able to prevent issues like mold, accumulation, water damage which lead to damaged landscaping, and flooded basements.

CONCLUSION

To recapitulate, this research aims to investigate and develop a smart rainwater downpipe that can enhance a better water flow in the pipeline. The primary objectives of this innovation were to identify the current issues of the rainwater downpipe, recognize what can be improved from the previous innovation of rainwater downpipe, demonstrate the assemble and performance of the smart rainwater downpipe and acknowledge the marketability of the innovations of SMART Rainwater downpipe for the potential users. Through a comprehensive research and findings, list of advantages has been observed associated with the adoption of SMART rainwater downpipes.

Findings found that the SMART rainwater downpipe offer various of solution of the problem stated above. These devices have a remarkable capacity to decrease water loss by accurately sensing rainfall patterns and optimising water flow, significantly aiding in water conservation efforts. Additionally, they considerably reduce maintenance needs and water damage hazards for building owners and tenants alike due to their ability to avoid blockages and clogging in gutters and downpipes. This innovation also helps in promoting sustainability of water usage.

Conversely, despite of the advantages of SMART rainwater downpipe, there are also certain limitation in the study which are are lack of previous research studies on the topic. There are very limited studies on the rainwater downpipe topic that limit the research to go further deep and most of the research is not statistically proof. Other than that, the assembly and performance of this innovation product only be demonstrated using SketchUp and did not have a real prototype due to cost and limited resources. In addition, due to limited time no surveys are done to find out how far the marketability potential for the products.

In conclusion, this study shows that SMART rainwater downpipes can make a big difference in managing water. By using this technology in buildings and cities, we can save water and take better care of our environment. Embracing SMART downpipes is a significant step towards a greener, more sustainable future, where we protect our valuable water resources and create strong, eco-friendly communities.

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