

Preliminary Survey of Industrial Perception On Using Immobilised Microalgae, *Botryococcus* sp. For Wastewater Bioremediation

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Abstract: The water pollution is a serious threat all over the world in the light of limited fresh water availability and increasing generation of wastewater being discharged prior to the environment. This study is to investigate the perception and to analyze the knowledge of people from different industries on the usage of microalgae *Botryococcus* sp. for wastewater bioremediation. There are various manufacturing industries in Malaysia which use high amount of water. Palm oil industries, textile industry, fiberboard industry, automotive industry and food industry were selected for this survey. Based on the data, food factory industry has more knowledge compare with others industry. However, it is pleasing to note that the industries are willing to contribute to this study that would reduce the risk of contamination of wastewater. It is therefore recommended that the industrial should adopt the concept of wastewater bioremediation to emphasize institutional effectiveness and promote awareness campaign for better wastewater management.

Keywords: Bioremediation, Microalgae, *Botryococcus* sp., Wastewater

1. Introduction

In this era of globalization, the rate of water pollution becoming grievous and worse year by year. Earth is covered by 70.00 % of water, and it is undeniably becoming one of our greatest water resources. In Malaysia, about 95.00 % of water sources comes from the inland river systems [1]. Growth of urban-industries, industrialization and civilization in Malaysia had also led to the water pollution around the regions of the country [2]. Pollution of water occurs when substances that will modify the water particles when a negatively charged molecules are discharged in it. Malaysia has lot of manufacturing industry which using much of water. Some companies treat the wastewater with high cost, but still other companies directly or indirectly discharged wastewater into the environment [3]. It gives out negative impacts on the sustainability of water resource and it also affects the quality and lifespan of plants and

organisms and also damages the health of humans. It reduces the amount of total water availability considerably, as the cost of treating polluted waters is too high and, in some cases, polluted waters are not treatable for consumption. Water is polluted by natural events and human activities, and in most cases, it's not only polluted on the surface but also in the subsurface water [4]. Bioremediation is a process used to treat contaminated water, by altering environmental conditions to stimulate growth of microorganisms and degrade the target pollutants. . In bioremediation process, it uses various microorganisms including fungi, microalgae and bacteria. In this survey, microalgae were selected for bioremediation because it is an essential competitive advantage over fungi and bacteria to degrade organic pollutants. The application of bioremediation is accepted as an environmental design and economical measure for the decontamination of polluted environments [5]. There are two types of bioremediation method, which is the ex-situ and in situ bioremediation. Contaminants are treated at the same location employing biological systems is in situ bioremediation. In ex situ bioremediation, contaminants are treated in some other place from the original site. Bioremediation processes more often employ immobilization methods, in recent times. Immobilization is defined as a process of cell attachment and cell inclusion to or into a carrier volume as a support. Cell immobilization has a number of advantages over suspended cells [6]. Immobilized systems have been applied in various applications such as the production of no contaminant energy, wastewater bioremediation, toxicity measurement, metabolite production, and stock culture management [7]. The process of microorganism immobilization can be done by various mechanisms, including adsorption, covalent bonding, cross-linking, encapsulation, and entrapment in a matrix. The most common immobilization methods are cell attachment and cell entrapment [8]. In immobilization via adsorption, the attachment is done without using intermediate molecules while, in the covalent attachment, the "bridge-molecule" is used for functionalization of the support [9]. Since no previous research on human perceptions about the bioremediation process have been conducted. Therefore, it is necessary to conduct preliminary investigations to gather the necessary data before undertaking a nationwide survey. Knowledge about bioremediation is low among the industries. This questionnaire helps to identify the level of knowledge of industries on process of bioremediation as a wastewater treatment process. Other than that, if there is no knowledge about this process of bioremediation in the industry, this questionnaire can be a starting point for the industries to learn more on a low cost and natural water treatment process. Hence it allows a detailed on the knowledge level by industries and provides necessary tools for engineer technologist to implement microalgae bioremediation of wastewater.

2. Materials and Methods

This chapter will describe clearly the methods used to achieve the objectives of this research. The survey was carried out in 5 companies to get preliminary findings on their perceptions towards the study. Since no studies have been conducted before on the human's perceptions, it is important to conduct a preliminary investigation to get all the necessary data before conducting a survey nationwide or to the related industries involved in your subject matter. Then, the research design and analysis were executed during this research followed by the descriptive analysis was used to examine the data collection. Finally, the deduction of the findings was done with the recommendations for future research being recommended. All data collection were assembled from various industries in Malaysia. The following Figure 2.1 illustrates the planning flow chart for this project. The respondents were selected based on company which use lots of water and doing water treatment process. The selected respondents from food factory, textile industry, palm oil company, automotive industry, and fiber board industry. Engineers, managers and department heads were selected as respondents because they are well aware about the water treatment process used at their company. For the data collection procedure for this study, a set of questionnaires were distributed. The respondents were chosen to answer a set of questionnaires that relevant to the objectives. The number of questions was based on the knowledge achieved from the literature review in order to accomplish the research objectives. The questionnaires that were contributed is composed of multiple answer questions.

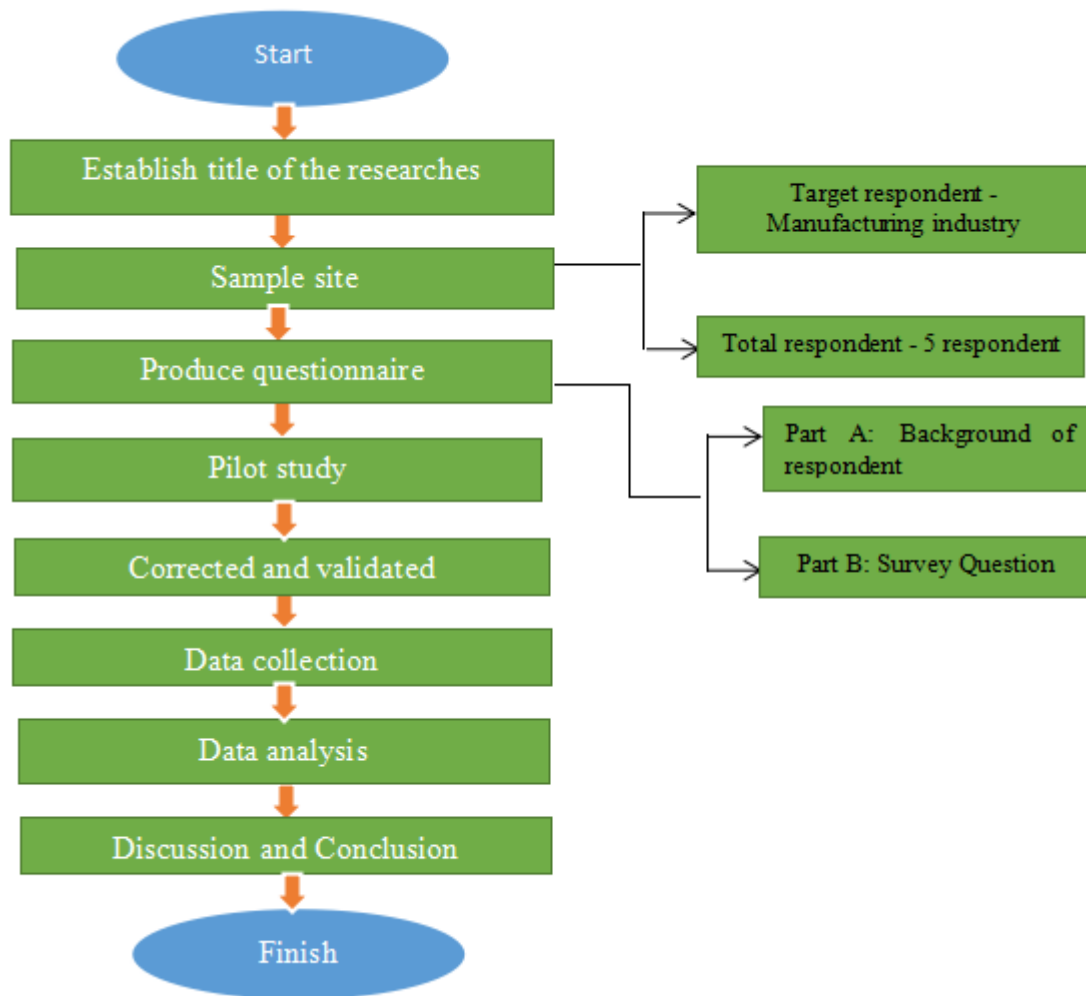


Figure 1: Flow chart of Methodology

3. Results and Discussion

The results of the survey will be discussed in this section. This research is to explore the proficiency on bioremediation of industrial wastewater treatment using immobilised freshwater green microalgae, *Botryococcus*.sp. The data helps to analyse the knowledge of people from different industries on the usage of microalgae *Botryococcus* sp. for bioremediation. The purpose of the research is to investigate the perception of respondents on usage of microalgae, *Botryococcus* sp. for bioremediation in industries. The respondents selected from 5 companies had responded for the survey. The survey explored about the use of living microorganism in Bioremediation. Bioremediation is a process that uses microorganisms to degrade pollutants. This shows that equivalent percentage of the respondents which is 40.00 % respondent have answered the question correctly (Figure 2). Other than that, 20.00 % respondent answered wrongly.

In other words, bioremediation employs the living microorganisms, to degrade the pollutants and convert them into less toxic or nontoxic form. Majority of respondent which 60.00 % respondent, they lack awareness about usage of living microorganism in wastewater treatment. This clearly shows that the industries do not really possess the knowledge on bioremediation. Industries must provide the knowledge on microorganism usage on bioremediation technique.

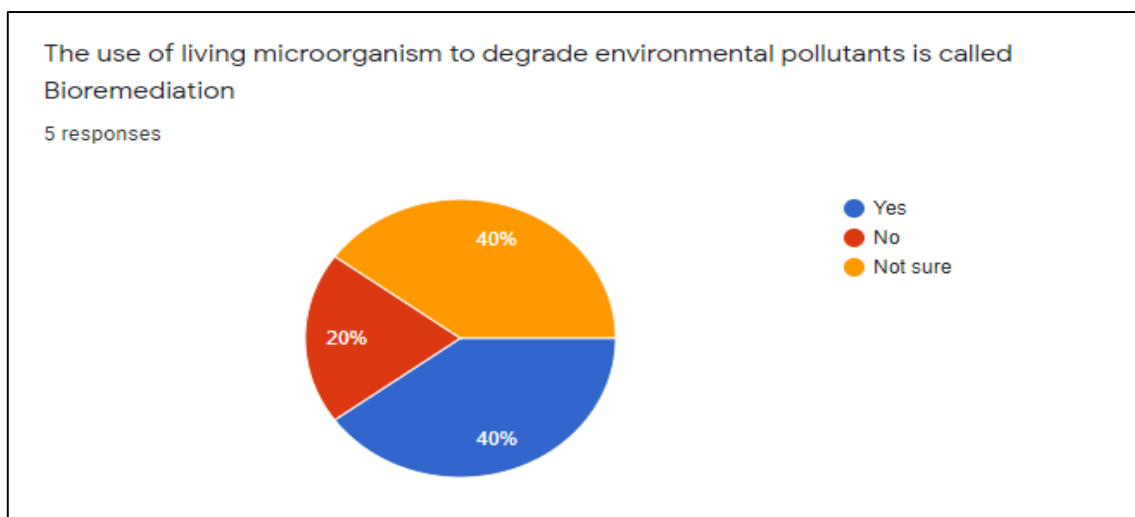


Figure 2: Respondent’s knowledge on living microorganism usage in bioremediation

Bioremediation is the process of using microorganism to clean up pollution. According to the data obtained, 40.00 % (2) of respondents have answered the question correctly while 60.00 % (3) of respondents have no idea about the bioremediation process. Bioremediation is a natural technique, because in this technique only use living organism, notably living microorganism and has capacity to clean up the pollutant. Figure 3 clearly shows that only 40.00 % (2) of respondents have explored the bioremediation process while rest of respondent have high rate of ignorance on bioremediation process.

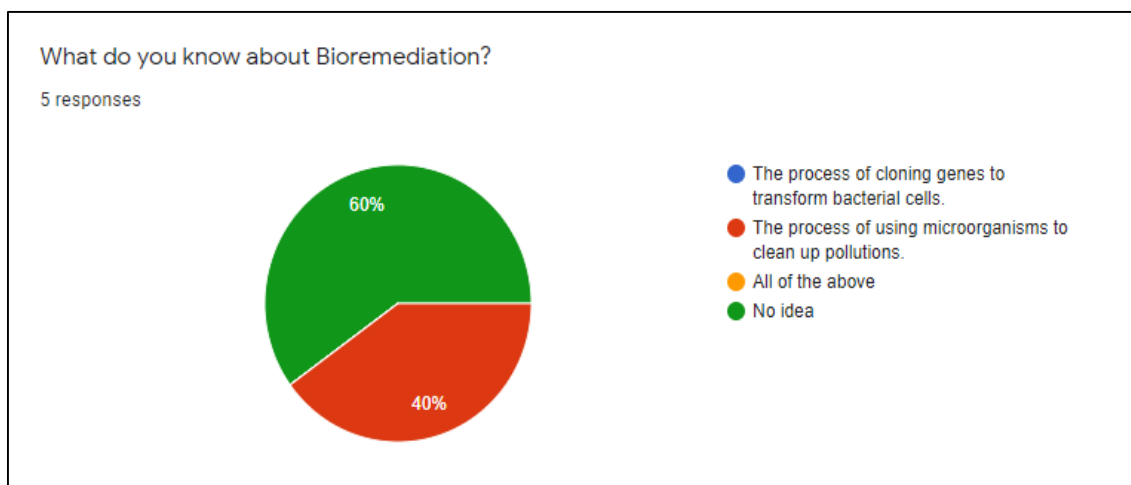


Figure 3: Respondents knowledge on bioremediation process

Most of the respondents, 60.00 % (3 respondents) were dubious if living organisms are used in bioremediation to rid of toxic waste. This clearly shows that the knowledge of bioremediation is not sufficient among the industries because only 40.00 % (2) of the respondents were confident that bioremediation is a process of using living organism to get rid of toxic waste. The living organism function in is to remove toxic during wastewater treatment process. According to the Figure 4, 60.00 % (3) of respondents are skeptical on the bioremediation process while 40.00 % (2) of respondents have awareness on bioremediation technique. Majority of respondent are unaware on how does the process of bioremediation works.

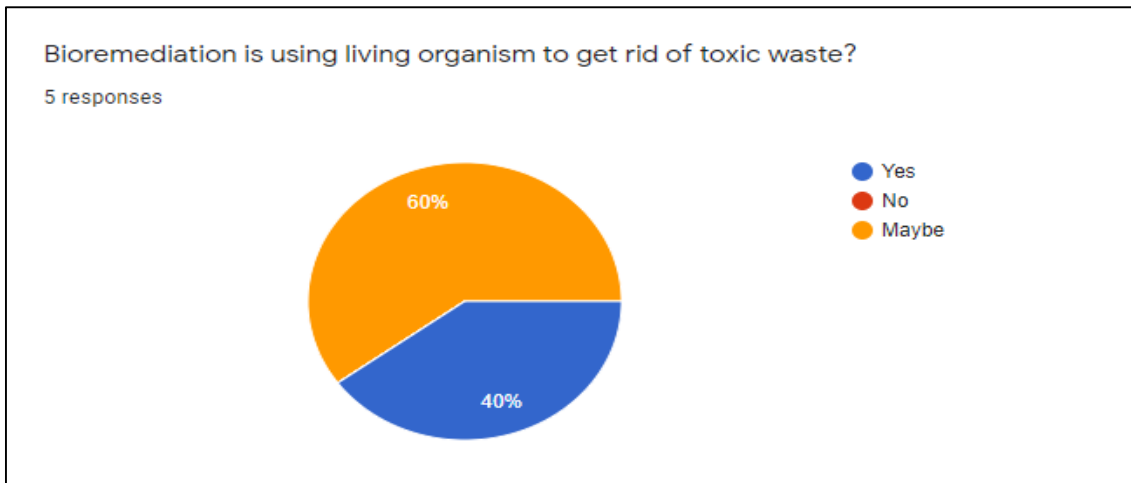


Figure 4: Respondent response on usage of living organisms to get rid of toxic waste on bioremediation

From the data obtained, ultimate number of respondents from various industries retains a very low level of knowledge on process of bioremediation. This is because only 40.00 % (2) of the respondents answered the question correctly which is bioremediation technique is a pollution free and better water treatment method while a great number of respondents which is 60.00 % (3) respondent were indecisive this method. In bioremediation process, use living microorganism only and completely avoid chemical uses in this process and less energy consumption According to the Figure 5, majority of people has less perception about advantages of bioremediation technique.

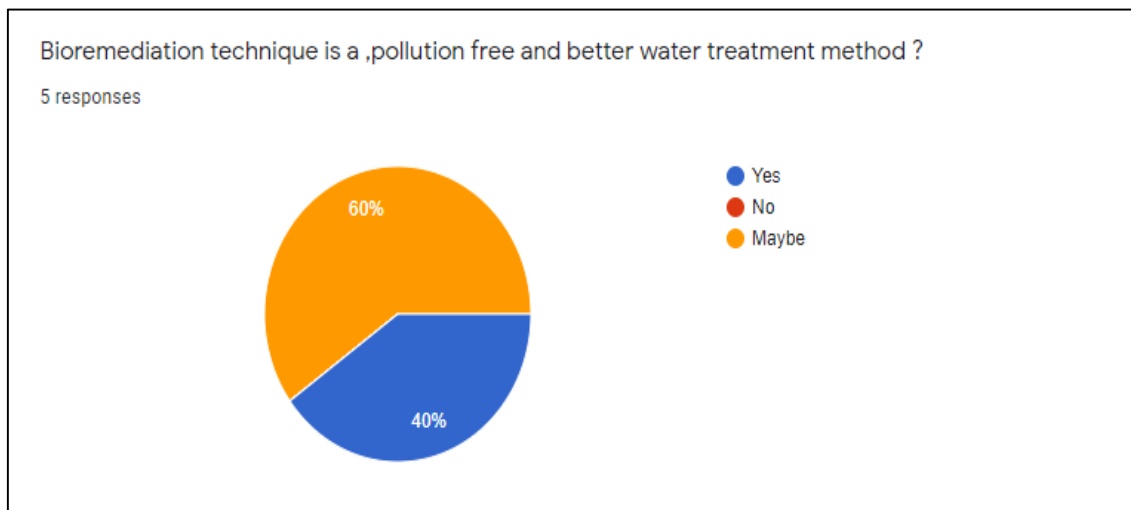


Figure 5: Respondent’s knowledge on advantages of bioremediation technique

Botryococcus sp. is a type of microalgae has the capacity to remove heavy metals [10]. The 40.00 % (2) of the respondents have answered the question wrongly. One of the respondents (20.00 %) respondent answered bioremediation removes hydrocarbon and another 20.00 % (1) of respondent picked organic waste as the answer. According to Figure 6, vast of the respondents which is 60.00 % (3) respondent were uncertain of the type of microalgae are used in bioremediation. The data clearly show, all the respondent are be clueless because the awareness about *Botryococcus* sp is very poor. This situation is due to lack of the awareness on this treatment.

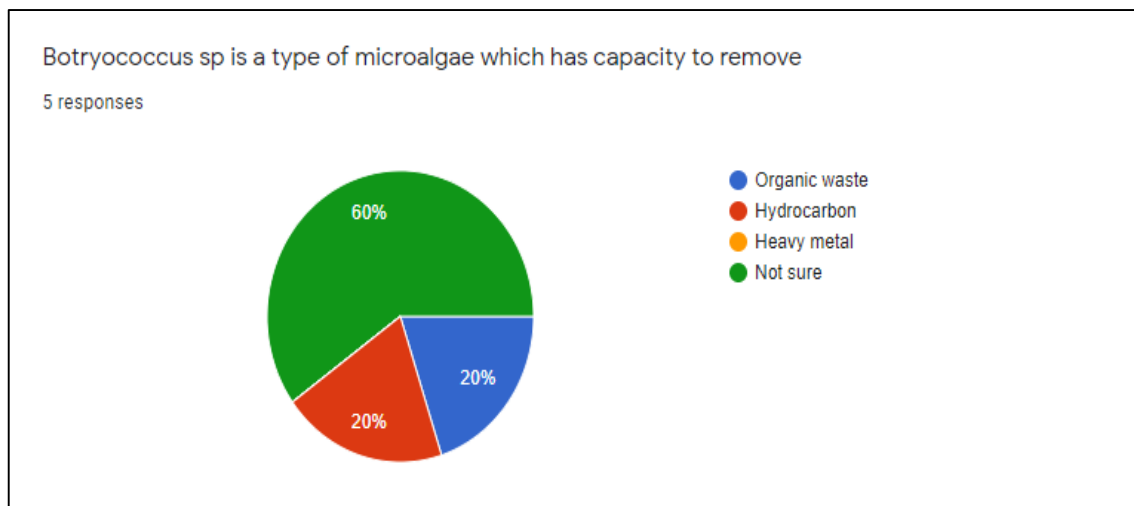


Figure 6: Respondent' awareness data on the capacity of *Botryococcus* sp

In wastewater treatment process, microorganisms are the most important element used during sludge digestion [11]. According to Figure 7, 20.00 % (1) of respondent answered the question correctly, which is sludge digestion. A sum of 40.00 % (2) respondents have placed a wrong answer for the question. Primary treatment was selected as an answer by 20.00 % (1) of respondent and 20.00 % (1) of respondent selected secondary treatment as the answer. Most of the respondents, which is 40.00 % (2) respondent, were not sure about the important stage of bioremediation where microorganisms are used. According to the data, 80.00 % of respondent does not have a clue, which stage microorganism are important during wastewater treatment. Due to lack of knowledge on microorganism for wastewater treatment most of respondent answered wrongly (40.00 %) respondents and not sure (20.00 %) respondents.

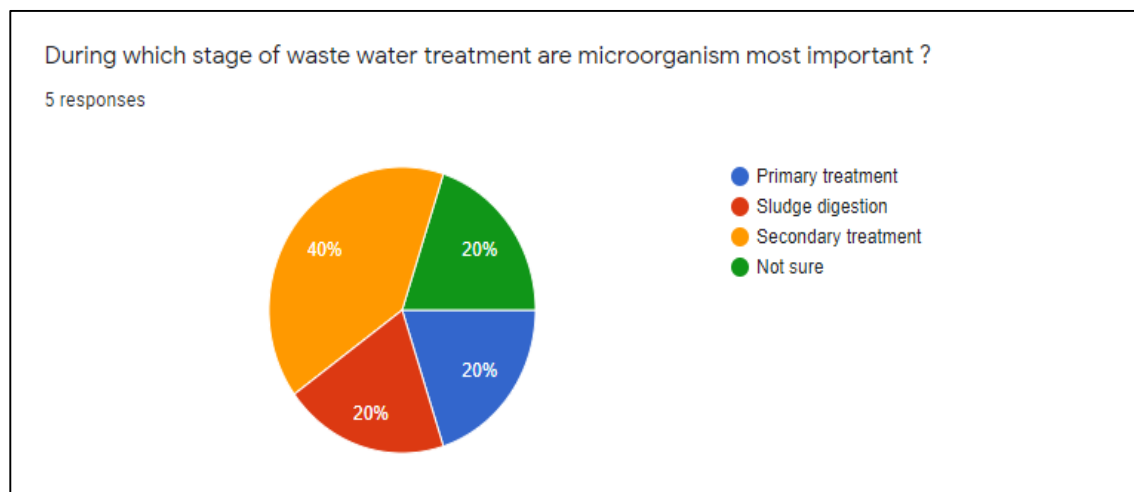


Figure 7: Respondent answer on important stage of microorganism on wastewater treatment

Microalgae used in water treatment process as a direct uptake for the transformation of water contaminants. This shows that only 20.00 % (1) of the respondent has answered the question correctly, while a great number of respondents which is 80.00 % (4) respondents had no idea on the intake of microalgae and the usage of microalgae (Figure 8). From the data obtained, it clearly shows that minority of respondents from various industries which is 20.00 % (1) respondent has knowledge on usage of microalgae in wastewater treatment process. The usage of microalgae in wastewater treatment plants is the direct uptake or transformation of water contaminants and improving the purification

performance of bacterial systems (microalgae). Most of respondent be clueless on how microalgae perform in wastewater and how extract the pollutant.

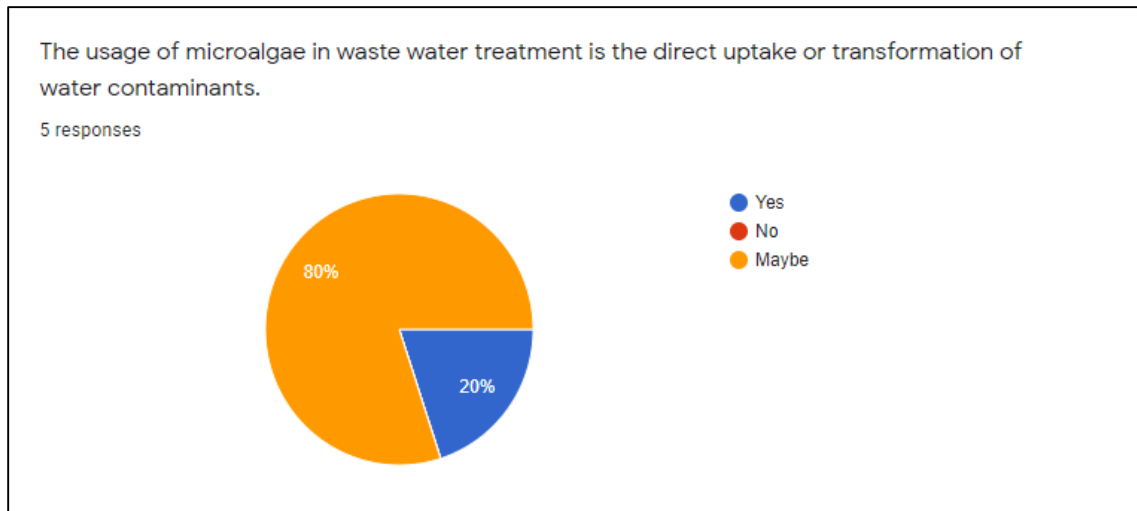


Figure 8: Respondent’s response on usage of microalgae in wastewater treatment process

A vast group of respondents which is 80.00 % (4) respondents are not sure about bioremediation is harmful technique or not when applied at industries. Meanwhile, 20.00 % (1) respondent (Figure 9) have placed an accurate answer for the question. Bioremediation technique is completely natural process with almost no harmful side effects and very cost effective. Due to lack of awareness from the industries, bioremediation method should be introduced. Industries learn and provide bioremediation technique to employee for work in secure environment. It is a great advantage of bioremediation.

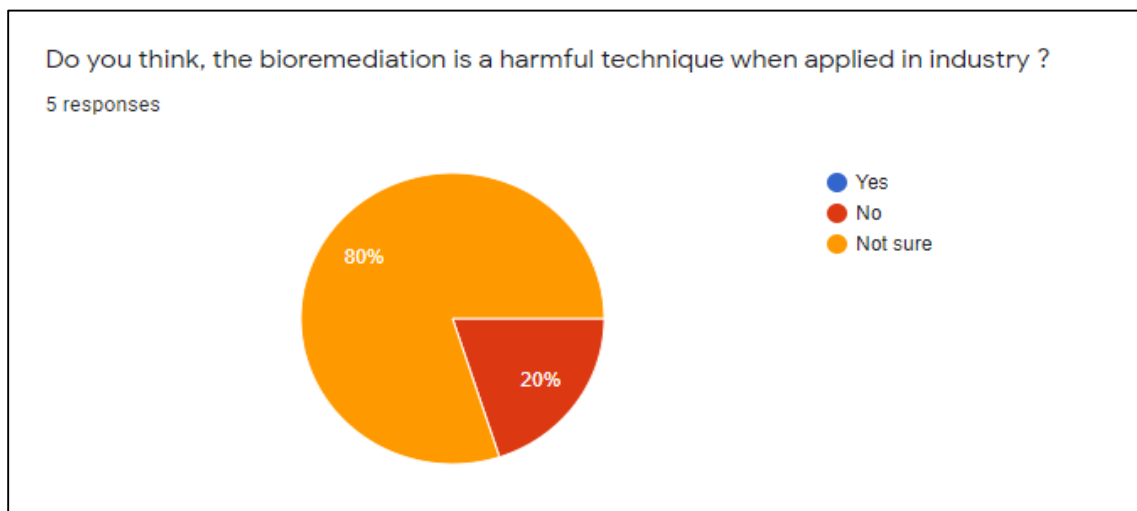


Figure 9: Knowledge on benefit by applying bioremediation technique at industries

Bioremediation is popular technique that being conducted globally, mostly overseas. Majority of the respondents which is 60.00 % (3) (Figure 10) respondent has no idea that if bioremediation techniques are being conducted globally. Another 20.00 % (1) of the respondent has placed the wrong answer for the question. Only 20.00 % (1) of the respondent possess the knowledge on conductivity of bioremediation process. Bioremediation is a cost effectiveness water treatment process. Least of the respondents which is 40.00 % (2) were very sure that the process of water treatment using bioremediation will be not costly and 60.00 % (3) (Figure 11) respondents were not sure if the process of water treatment will be costly.

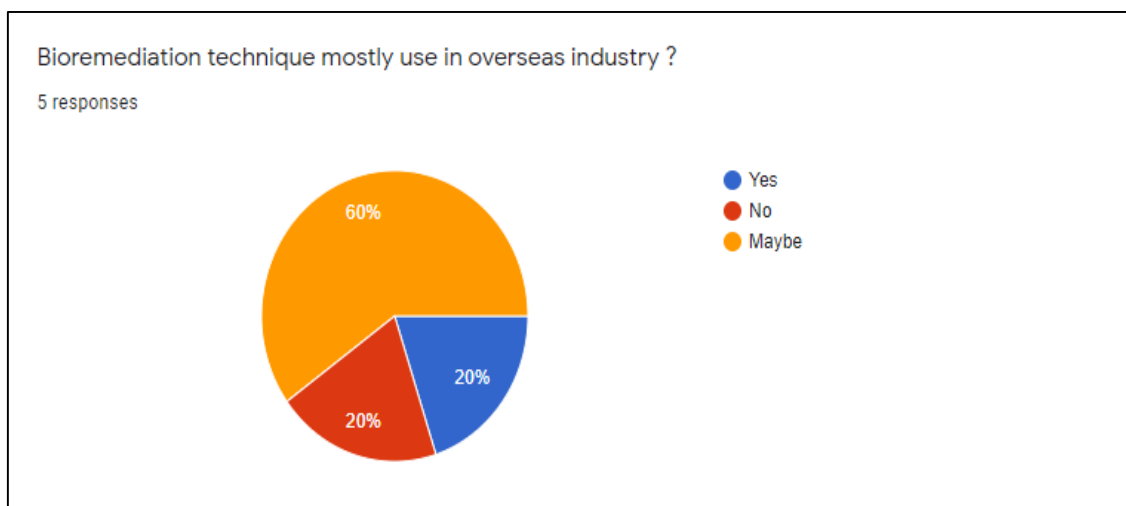


Figure 10: Responses on conductivity of bioremediation technique globally

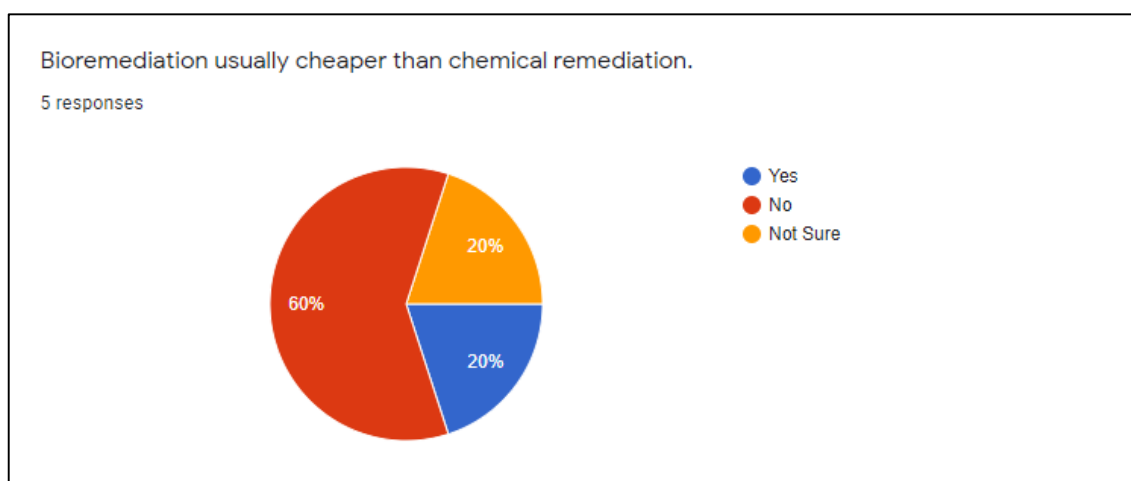


Figure 11: Respondents knowledge on cost of bioremediation compared to chemical remediation

From the data, it clearly shows that majority 80.00 % (4) of the respondents are ready to accept bioremediation for a cost effective, harm free and environmentally friendly wastewater treatment system at their company. It is also stated that 20.00 % (1) of the respondent (Figure 11) was totally decline on switching to bioremediation technique for the industries. This shows that the knowledge on bioremediation on the specific respondent's company is not up to satisfactorily level.

According to the data extracted, the respondents from various industry answered fifteen questions to state their knowledge and acceptance rate of bioremediation. The analyzed data clearly shows that most of the respondents has lack of knowledge on bioremediation by using microalgae, *Botryococcus*. sp for the water treatment process. The respondents clearly show the interest of learning and experiencing more on bioremediation process. With a proper guidance and knowledge on bioremediation, the acceptance rate and knowledge on bioremediation by using microalgae, *Botryococcus* sp. for the water treatment process will grow drastically. Most importantly, all the company are ready to accept the process of bioremediation at their company if Bioremediation process possess the characteristics of environmentally free, low on cost and has no side effects. It clearly shown that all the companies need a safe and cost-effective wastewater treatment process. Visit the selected company and get the detail on wastewater discharge. Most of respondent are interest to accept Bioremediation technique to treat the wastewater. Bioremediation technique has load of benefit which

cost effective, energy consumption and not harmful method. So, provide knowledge on bioremediation technique by using microalgae, *Botryococcus* sp. This shows that more campaigns and advertisement 43 should be conducted to make sure the knowledge of bioremediation reach to the industries which using more water

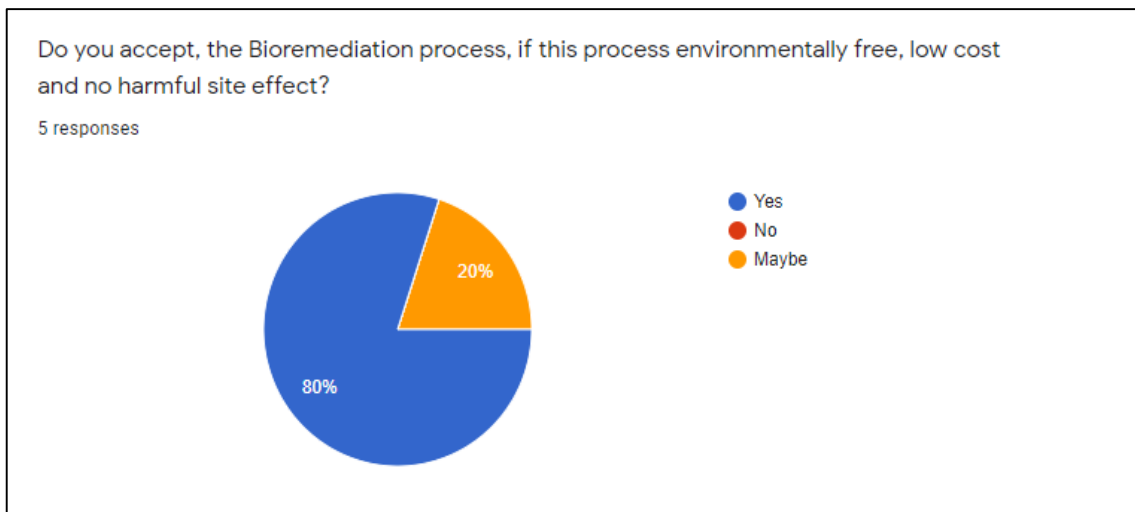


Figure 12: Respondents on the acceptance of bioremediation

4. Conclusion

A study to explore the usage of bioremediation processes at industries for treatment of water by using microalgae *Botryococcus* sp is carried out to achieve the following objectives (i) to investigate the perception usage of microalgae, *Botryococcus* sp. for bioremediation in industries; (ii) to analysis the knowledge of people from different industries on the usage of microalgae *Botryococcus* sp. for bioremediation A study to investigate the perception usage of microalgae, *Botryococcus* sp. for bioremediation in industries has achieved the objectives. The first objective concluded as achieved as most of the industries lack of perception on bioremediation technique by using immobilized freshwater green microalgae, *Botryococcus*.sp for wastewater treatment. Next, the second objective can be also be marked as achieved which analyze the knowledge of people from various industries on the usage of microalgae *Botryococcus* sp. for bioremediation. The level of knowledge on bioremediation among the respondent from various industry is very poor. The level of knowledge respondents possesses on bioremediation which using microalgae, *Botryococcus* sp. is disappointing. Thus, with proper guidance and the interest, the knowledge on bioremediation can be served to the industries because it is stated that majority of the respondents are accept bioremediation technique.

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