Global Advanced Research Journal of Environmental Science and Toxicology (ISSN: 2315-5140) Vol. 2(4) pp. 119-127, April, 2013
Available online http://garj.org/garjest/index.htm

Full Length Research Paper

Disposal of effluent waste from machining process among small and medium scale industries in Malaysia

Punnose Kovoor[1]*, Mohd. Razif Idris[2] and Mazjuki H. H.[3]

[1]Institute of Product Design and Manufacturing, IPROM, Universiti Kuala Lumpur, Malaysia,
[2]Institute of Product Design and Manufacturing, IPROM, Universiti Kuala Lumpur, Malaysia,
[3]Department of Mechanical Engineering, University of Malaya, Kuala Lumpur, Malaysia,

Accepted April 15, 2013

The small and medium scale enterprises in Malaysia face a problem in disposing the industrial waste. According to publications from United Nations, most of the small and medium scale enterprises do not have any environmental management program. They lack expertise and facilities to recycle the effluent waste from the machining operations and moreover they are not in a good financial predicament to invest on such investments. This may result in not disposing the effluent waste in an appropriate manner, thus causing an environmental pollution to soil, water and air. This research aims to bring out the most preferred mode of effluent waste disposal among the small and medium scale enterprises in Malaysia and also intends to identify the reasons that contribute to the inappropriate disposal of the machining waste among them. A descriptive survey is conducted as the primary mode of data collection for this research. The target population for the survey comprises of the small and medium scale industries which are specialized in metal removal operations using the lathe, drilling, milling or grinding machines. The data collected from the SMEs are compiled and analyzed using Statistical Package for Social Sciences (SPSS) software. The survey revealed that most of the SMEs in Malaysia do not have any Environmental management program and that they do not follow any proper method in disposing the effluent waste from their companies.

Keywords: Small and medium scale enterprises, Effluent waste, Descriptive survey, Environmental management program

INTRODUCTION

Small and medium sized enterprises are rapidly growing in different parts of the world especially in Malaysia and have made significant contribution to the development of the economy of the country. At the same time, they have created many pressing and thorny issues related to environment. Small and medium sized enterprises have the highest pollution intensity among enterprises of all ownership types and have caused visible damage to the environment according to UNEP (2003). These damages have caused the world's environment to deteriorate rapidly. Many small and medium sized enterprises consider their own environmental impact as negligible, comparing themselves with large firms and not recognizing their cumulative impacts. Indeed most of these enterprises perceive environmental improvement as a costly burden. As they are concerned more with the short term economic survival, they are not much motivated to spend for large scale recycling or re-treatment facilities within their establishments. The

*Corresponding Author E-mail: punnose@iprom.unikl.edu.my
Tel: +603-91795000; Fax: +603-91795001

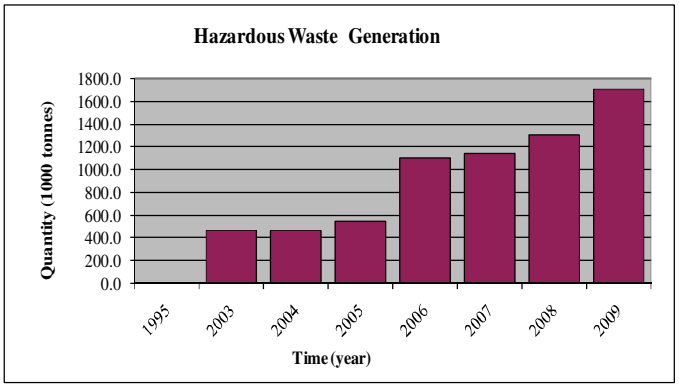

Figure 1. Hazardous waste generation in Malaysia

Source: UNSD/UNEP Questionnaires on environment statistics, waste section

hazardous waste in Malaysia has been gradually increasing over the years as shown in Figure 1 in response to a survey from UNSD/UNEP (2011).

Environmental management in Malaysia is still at its infancy, especially among the small and medium scale sectors. An empirical research on small and medium scale accommodations was conducted in Kuala Lumpur, Malaysia, which showed that despite the availability of tools and approaches to help business become environmentally friendly, the problem has been to persuade the small and medium scaled accommodations to adopt them according to Kassim and Dzakiria, (2009).

The SME's awareness of the importance of the environment is also often limited, and there is little pressure from the market to improve environmental management The lack of strong external drivers from government, non governmental organizations, consumers or trade associations promotes complacency and ignorance among the SMEs.

According to Malaysia's Environmental Quality, Industrial Effluent Regulations 2009, (Department of Environment Malaysia, 2010), which is applicable to any premises which discharge or release any industrial effluent or mixed effluent onto or into any soil, or into inland waters or Malaysian waters, the SMEs should monitor the concentration of Chemical oxygen demand (COD) and any other parameters of the effluent waste as specified in the fifth schedule of the Act. They should also install flow meters, sampling, monitoring and recording equipment and should maintain a record of industrial effluent or mixed effluent discharge monitoring data in the form as specified in the tenth schedule. The record of all industrial effluent or mixed effluent discharge should be made available for inspection for any authorized officer.

With the emergence of new manufacturing industries and establishments among the small and medium scale sector, large quantities of sheet metals are used every month for various sectors of the industries such as automotive, furniture, electrical items, mechanical items, body parts for consumables, body building for coaches, lorries, trucks, buses etc. Most of these items are subjected to some form of machining process for material removal operations. Various forms of wastes are generated in the form of effluent discharge, solid waste, atmospheric emission and energy emissions as shown in Figure 2.

Due to lack of finance and resources within the companies, the small and medium scale enterprises do not give adequate importance to the recycling of manufacturing waste in their organization. If these wastes are disposed into the environment before adequate treatment, there is a possibility that it can pollute the environment. This can cause an adverse effect on the people and the living organisms present in that place.

In the past, various researches have been carried out on the environment performance assessment among the small and medium scale enterprises in different parts of the world. One such research was conducted by McLoone et al (2008) among the small and medium scale enterprises in the Mid-west region of Ireland to identify the ecological footprints of their specific activities. This was to determine the environmental "hotspots" of each small and medium scale enterprise's activities and to use as an indicator to monitor their progress towards sustainability. The contribution of each small and medium scale enterprise towards achieving sustainable development is measured quantitatively using ecological footprint. According to another survey conducted by Melynk et al (1999) to assess the impact of ISO14000 on corporate effectiveness and efficiency, successful attainment of ISO14000 certification program has a large positive impact on the perceived efficiency and effectiveness of the environmental management system except for lead time, costs and quality. According to O' Regan et al (2008), the formation of Eco-industrial networks can enhance the environmental performance and cost savings made by companies operating in partnership with other companies. The follow up process

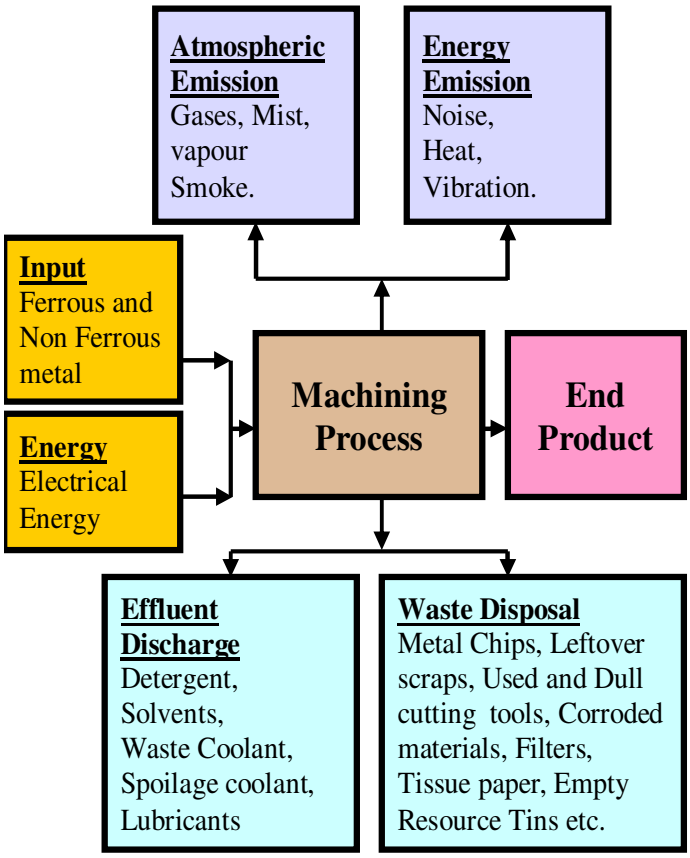

Figure 2. Schematic representation of machining process

is very important to ensure that the control measures which were recommended in the environmental impact assessment are implemented as claimed by Hammer (2006). According to Williamson et al (2006), an eighteen month study of 66 small and medium scale enterprises in four European member states revealed that these enterprises are governed by the need to comply with and that their actions were frequently a response to environmental regulations. It also showed that the small and medium scale enterprises in each member state exhibited similar patterns of behaviour as they all tend to respond in the same manner as claimed by Willimson (2006). There were similar studies that were undertaken in Malaysia to find the effectiveness of the environmental management system. Ann et al (2006) claimed that the ISO14001 certification has a positive impact on firm's performance, specifically on perceived economic impact, perceived environmental impact and perceived customer satisfaction.

A survey was used as the main data collection tool for most of the above researches as well as for the current research. The Survey involved the collection of information from a large group of people through mailed, postal questionnaires, telephone calls and personal interviews. Validity and a reliability test were conducted to ensure that the questionnaire was appropriate to be used to obtain the data. Validity of the questions were tested with content validity and reliability with internal consistency coefficient Cronbach's alfa. The Cronbach's alpha values range from 0 to 1, higher values indicated higher levels of internal consistency. The generally agreed upon lower limit for Cronbach's alpha is 0.70, although it may decrease to 0.60 in an exploratory research as claimed by Saraph et al (1989).

The survey was launched upon completion of the Pilot study. As the target participants were from the metal manufacturing sector, the best available directory to be used as a basis for choosing respondents was the Federation of Malaysian Manufacturers (FMM) Directory (2008).

METHODOLOGY

A Positivism philosophy is adopted behind the development of this research. A deductive approach is taken to develop the project and to come out with the appropriate strategies to conduct the survey. This research utilizes the collection of quantitative data to test the hypothesis. Controls are applied to ensure the

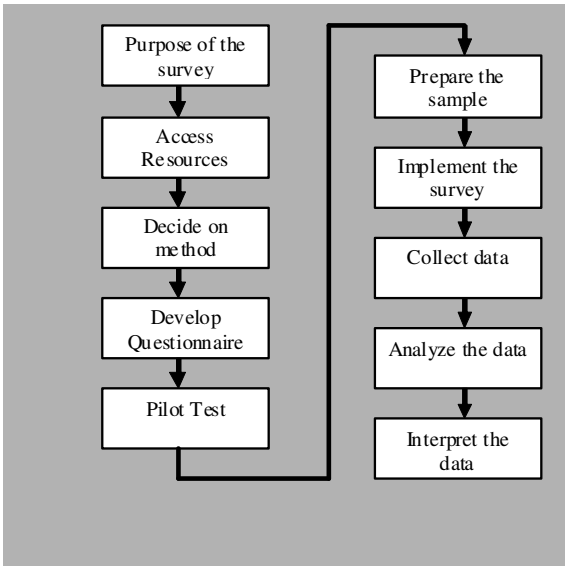

Figure 3. Methodology of the Survey

validity of the data. Survey is used as the main research strategy to obtain the data and it is conducted on a cross sectional basis over a period of six months. The methodology of the survey is as shown in Figure 3.

The purpose of the survey was to collect the quantitative information on the current practice of operation of the machines at the respondent's workplace, a combination of mailed questionnaires, telephone interviews, face-to-face interviews and on line feedbacks were adopted as the means to obtain the survey research. The face to face interviews presented the advantage of obtaining a deeper understanding of the constraints and difficulties faced by the small and medium scale enterprises to dispose the machining wastes. The questionnaire was drafted with clarity and simplicity, keeping in view of the target audience and the objectives of the survey. The questions were designed mostly with a combination of multiple choice, rating scales and dichotomous type of response format for ease of understanding and answering. Upon completion of the questionnaire, a validity test was conducted to check out on the extent of which the questionnaire was measuring its objectives and how much the questions represented the domain under study. Corrections were made upon feedback from a panel which constituted of two academicians, an expert from the industry and a language authority. A reliability test was also conducted by circulating the questionnaire to ten workers from the small and medium scale industry who are currently using the machines in their workplace. An overall Cronbach's Alpha of 0.709 was obtained for the ten items measured using the SPSS software. Sampling was conducted to cut costs and effort while still obtaining information from a representative sample of the target population. A stratified random sampling was employed to identify the target respondents among the metal working sector of the small and medium scale industry. The sample size was statistically calculated to be around 274 respondents for a 95% confidence level and ±5% precision for the metal working industry among the small and medium scale enterprises. The total respondent rate was around 76.64% at the conclusion of the survey. The data obtained from the survey was compiled and analysed using the SPSS software.

RESULTS

This section presents the statistical analysis of the data collected from the survey that was conducted among the metal working sector of the small and medium scale industries in Malaysia. The research consisted of three hypotheses which was centered around the objectives of the research.

Hypothesis 1 was to identify whether there was at least 60% of the companies which practiced any environmental management program to identify, monitor and control the industrial waste. It was measured using a dichotomous question and the response was to reject the null hypothesis as the z value was -11.27 and the p value was less than 0 for 95% confidence interval. The rejection of the null hypothesis showed that a majority of the small and medium scale enterprises do not practice any form of environmental management program and that they do not have any procedures to identify, monitor or control the waste from the machining process.

Hypothesis 2 was to identify whether finance and resources were a significant concern in implementing an environmental management program. The response from the survey was to reject the null

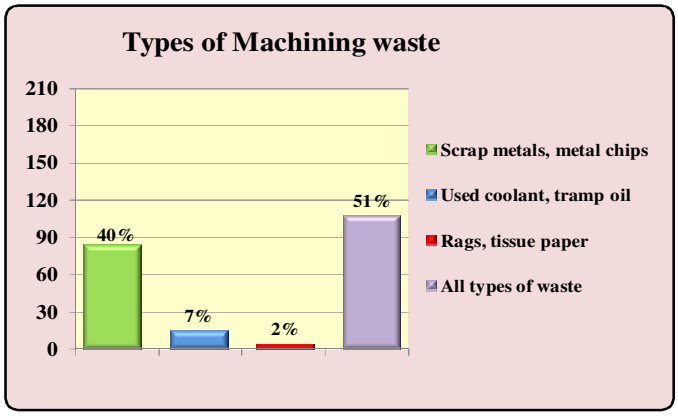

Figure 4. Types of machining waste disposed from SME's premises

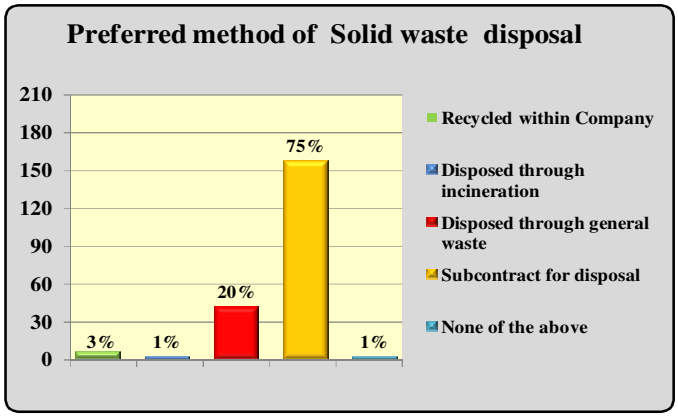

Figure 5. Preferred method of solid waste disposal among the SMEs

hypothesis as $X^2 = 35.934 > X^2_{0.05,6} = 12.592$. This would place the chi squared value in the critical region and hence the null hypothesis was rejected. The rejection of the null hypothesis showed that there are other issues which are more significant than finance and resources as shown in the radar charts in Figure 10.

Hypothesis 3 was to identify whether awareness training in Malaysian environmental legislation can help the small and medium scale enterprises to reduce the environmental pollution. The measurement was done on a seven point Likert scale and the response obtained from the survey was to reject the null hypothesis which showed that awareness training in Malaysian environmental legislation can help the small and medium scale enterprises to reduce the environmental pollution. This was shown from the survey by conducting a Chi squared analysis on the data as

$X^2 = 30.907 > X^2_{0.05,6} = 12.592$.

Besides the hypothesis, this survey was also targeted to identify the current practice of operation of the machines at the respondent's workplace, the preferred mode of waste disposal and the existing facilities to dispose the machining waste. The feedback obtained for the different types of machining wastes that were disposed from the small and medium scale enterprises are as shown in Figure 4. 40% of the waste is in the form of scrap metals and metal chips. Another 7% comprises of used coolants, tramp oils and lubricants. The remaining 51% comprised of a mix of all the waste given in the questionnaire. The intriguing question of what the small and medium scale enterprises would do with the solid waste that was generated within their company proves vital in the investigation towards the cause of environmental pollution.

Figure 5 shows the response obtained from the survey on the preferred method of solid waste disposal among the small and medium scale enterprises. 75% of the respondents disposed the solid waste through contractors and around 20% through the general waste. 3% of the respondents claimed to recycle the waste within their company

Figure 6 shows how the small and medium scale enterprises preferred to dispose the effluent waste from the machining process. The effluent wastes from a

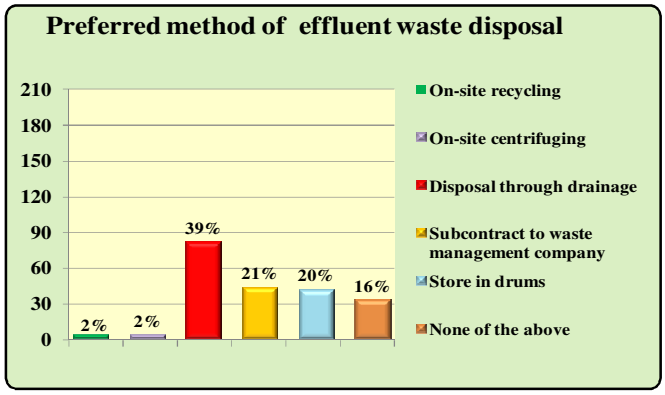

Figure 6. Preferred method of effluent waste disposal among the SMEs

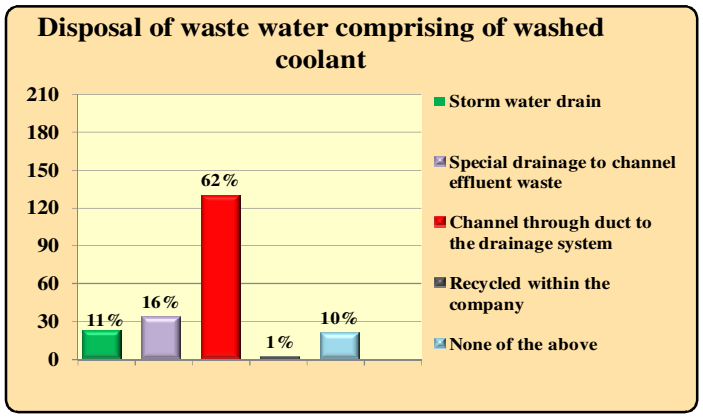

Figure 7. Disposal of effluent waste from the SME's premises

machining process comprises of the spent coolant, tramp oil, lubricants and solvents. 39% of the respondents disposed it through the drainage system where it entered into the waterways leading to a river or the sea. This can cause water pollution to the aquatic organism. About 21% claimed that they subcontracted the waste management company to dispose the effluent waste from their premises

Figure 7 shows the response graph from the small and medium scale enterprises on how they channeled the effluent waste from their premises. 62% admitted that they channeled the waste water comprising of washed coolant and other solvents into the nearby drainage system. When this water reaches the waterways leading to streams and rivers, it can cause water pollution. 16% claimed that they channeled the effluent waste through special ducts to the drainage system while a meager 1% claimed that they recycle the effluent waste within the company

The survey also wanted to identify the number of times the machine operators cleaned up the machining waste from their premises. Figure 8 showed the graph of their response, according to which, 45% of the respondents claimed that they cleaned up the facilities once a week

This survey also captured the opinions of the respondents on the importance of certain factors which included awareness on Malaysian Environmental Law and legislation, Attitude of Top management, Capital and Resource management, Standard operating procedures and Environmental management program in reducing the environmental pollution as shown in Figure 9. The opinions of the respondents were captured using the seven point Likert scale and mapped on a Radar chart. The respondents were organized into three categories, respondents from Kuala Lumpur, Selangor and from other states.

The respondents from Kuala Lumpur and Selangor claimed that Capital and resource investment is considered as a major factor in reducing the environmental pollution in their company. They also claimed that the environmental pollution can be reduced by drafting and implementing standard operating procedures to monitor and control the waste disposal from their companies. The small and medium scale enterprises from other locations maintained a balanced

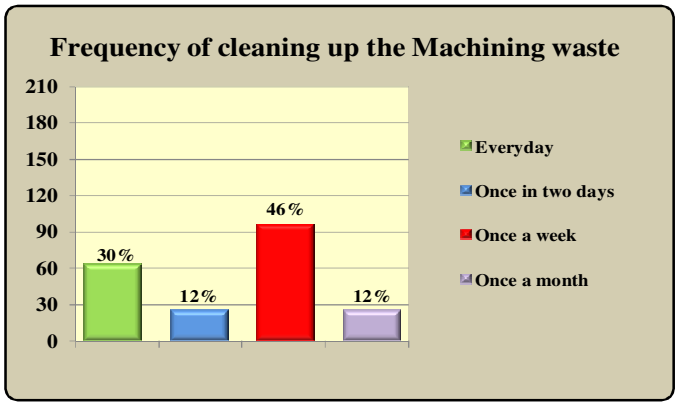

Figure 8. Frequency of cleaning up the facilities

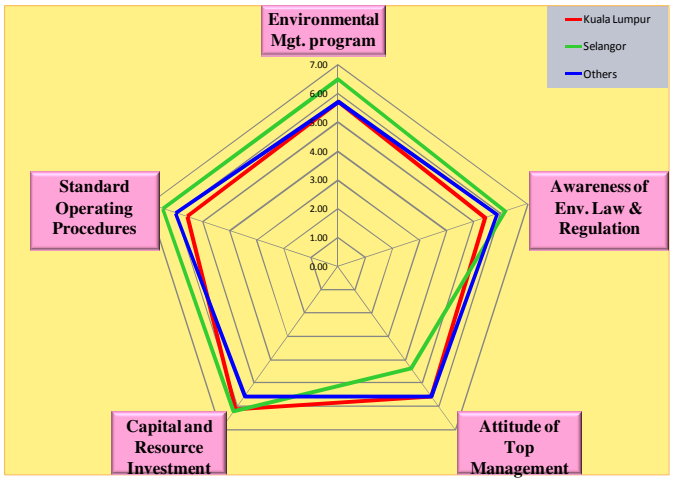

Figure 9. Opinions of respondents in reducing the environmental pollution.

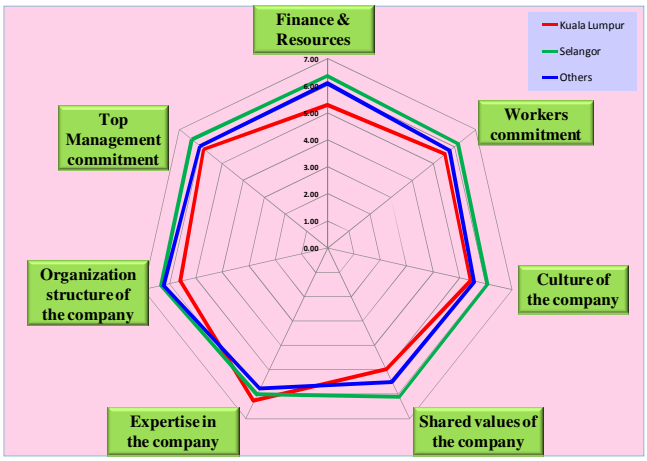

Figure 10. Opinions of respondents in implementing an EM program

opinion of all factors in the reduction of the environmental pollution.

The purpose of implementing an Environmental management program among the small and medium

scale enterprises was to identify, monitor and control the manner in which the waste is disposed. The survey was able to capture the opinions of the respondents on certain factors which were visible from the inside of an organization and are important in implementing an environmental management program. The opinions of the respondents were captured using the seven point Likert scale and mapped on a Radar chart for the small and medium scale enterprises in Kuala Lumpur, Selangor and from other states as shown in Figure 10.

Finance and resources are not the only factors that are significant in implementing an Environmental management program in the company but also other factors such as Top management's commitment and worker's commitment according to the small and medium scale enterprises from Selangor as revealed in hypothesis 2. The importance of not having relevant expertise in the company to implement an environmental management program is a major concern for the small and medium scale enterprises from Kuala Lumpur.

DISCUSSION

This survey has revealed the current practice of disposing the machining waste among the small and medium scale enterprises in Malaysia. As a majority of them do not have any recycling facilities, the effluent waste from the machining process is currently stored in the drums to be disposed through the contractors at a later date or is washed along with the waste water into the nearby drains, which can possibly enter into larger drains, streams or rivers. This can cause an impact on the aquatic beings which are present in the water. Besides capital and resources, there are other factors which include awareness of the Malaysian environmental regulation, awareness of environmental aspects and impacts, commitment and support from top management and support of workers that are essential in setting up an environmental management program in the company.

This survey has brought about an enhanced awareness on the current machining practice among the small and medium scale enterprises in Malaysia. In line with the Government's call for the small and medium scale enterprises to develop and adopt green technology in the production of goods and services, stricter and more rigid control measures must be drafted, enforced and audited from time to time.

In order to accomplish a cleaner production system within their organization, selection of appropriate lubrication process is important. Machinists can choose dry, wet or minimum quantity lubrication so that the amount of coolant can be controlled. The choice of applying the coolant can also be negotiated between flood and mist type so as to keep the use of the coolant to a minimum level. A coolant recycling system can be incorporated to the machines to keep the coolant clean. The small and medium scale enterprises can also hire hazard disposal contractors to dispose their used coolant on regular basis.

Abbreviations

SME: Small and medium scale enterprises,
IPROM: Institute of Product Design and M anufacturing
COD: Chemical Oxygen Demand
EM: Environmental Management
EMP: Environmental management program
EMS: Environmental management system
DOE: Department of Environment
UNSD: United Nations statistical Division
UNEP: United Nations Environment Program

Competing interests

The authors declared that they have no competing interests from the current research. Hence they have given their approval to publish this manuscript.

Authors' contributions

P. P. Kovoor was involved in the design of the study, guided the team to carry out the survey, performed graphical and statistical analysis and drafted the manuscript. MRI guided the whole study. MHH was involved in the design of the study. All authors read and approved the final manuscript.

Author's Information

P. P. Kovoor, is a senior Lecturer with Universiti Kuala Lumpur, Malaysia, currently doing his PhD in the same University. This research paper is a part of his PhD program.

ACKNOWLEDGEMENTS

The current research was funded by IPROM, as a part of the corporate social responsibility to reduce the environmental pollution due to machining wastes.

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