

# Challenges in Adopting 3R Concept in the Heritage Building Restoration

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**Abstract**—Malaysia is rich with historic buildings, particularly in Penang and Malacca states. Restoration activities are increasingly important as these states are recognized under UNESCO World Heritage Sites. Restoration activities help to maintain the uniqueness and value of a heritage building. However, increasing in restoration activities has resulted in large quantities of waste. To cope with this problem, the 3R concept (reduce, reuse and recycle) is introduced. The 3R concept is one of the waste management hierarchies. This concept is still yet to apply in the building restoration industry compared to the construction industry. Therefore, this study aims to promote the 3R concept in the heritage building restoration industry. This study aims to examine the importance of 3R concept and to identify challenges in applying the 3R concept in the heritage building restoration industry. This study focused on contractors and consultants who are involved in heritage restoration projects in Penang. Literature review and interviews helps to reach the research objective. Data that obtained is analyzed by using content analysis. For the research, application of 3R concept is important to conserve natural resources and reduce pollution problems. However, limited space to organise waste is the obstruction during the implementation of this concept. In conclusion, the 3R concept plays an important role in promoting environmental conservation and helping in reducing the construction waste.

**Keywords**—3R Concept, Heritage building, Restoration activities.

## I. INTRODUCTION

**M**ALAYSIA is rich with historic building featuring traditional Malay, Chinese, Indian and colonial reaches hundreds of years. Unfortunately, most of this historic building is not well conserved and most of them are in poor condition due to the factor of damage to buildings [1]. Indirectly, it drives the trend restoration of historic buildings in Malaysia especially in Penang [3]–[8]. Georgetown Grants Program (GTGP) has approved the projects will involve the work of restoration, maintenance and rehabilitation in renewing its historical building in Penang [12]–[35]. Nevertheless, the activities of the growing building improvements will result in a large waste where it will jeopardize the environment. Landfill is the most common method used to dispose of waste because is simple, cheap and most cost-effective [4]. Due to the limited space problem,

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Malaysia is now using combustion technique to overcome the problem of waste disposal. Although combustion method of choice to defeat the rising problem of waste disposal, but this method would require high costs and pose environmental problems. Thus, 3R concept was introduced to replace the method.

Today, the regime is promoting the 3R concept in solid waste management and tries to reduce the usage of natural raw materials and introduced the Solid Waste and Public Cleansing Act [10]. According to [29], the restoration project Hotel Penaga has used recycled materials. This is one of the 3R concept where it apart to minimize the raw material used to also directly minimize waste. In fact, agreeing to a survey conducted by the Technology Information, Forecasting and Assessment Council (TIFAC) found that there are 70% of the construction industry does not sensitize the use of recycling techniques. Not all building restoration projects applying this concept, although this concept has been promoted by the government [31]. Some agencies have indicated that upwards to 90% of the waste stream have the potential to be recycled or recycled if due consideration is paid to the potential benefits [17]. In Portland, Oregon, there are 76% of construction waste from a new restaurant with 5,000 square feet has been recycled. 61% of the waste timber can be reused or recycled, 11% recycled cardboard, and 4% are gypsum wallboard that can be recycled. Expected to exceed 90% of the waste is a potential to be reused and recycled, where it depends on the material and the type of project [34]. Therefore, based on factors such as the potential for waste reuse and recycling, the 3R concept should be advertised among the construction industry particularly the restoration of the historic building in Penang. This is because, systematic waste management in renovated building not only reduces the cost of the project, and it also gives people a secure environment.

## II. LITERATURE REVIEW

### A. Restoration of Historic Buildings

In Malaysia, a private body, such as the Penang Heritage Trust and Heritage of Malaysia Trust and government bodies such as national and state museums have directly classify buildings as memorials to be preserved. However, since the late 1980s in Malaysia was held conservation of monuments in the various categories of buildings that includes institutional, commercial and residential. Heritage buildings more than a hundred years old accounted for by the National Museum as a historic monument [28]. This incident has raised awareness that historic buildings should be maintained in the best possible chance to make it from the mainstream of

development. Restoration involves building maintenance and upkeep of historic buildings is done to prolong the life of the building. In addition, it seeks to ensure that historic buildings be preserved free from any damage to the building and preserved in terms of architectural design and material building.

Repair of buildings is to better the standard of an existing edifice, or change it to suit the new user, or to fill new equipment, fixings and fittings making [5]. Building repair work growing produce a lot of waste and residues usually will be managed by using the existing landfill and incineration. Because both these methods lead to a negative impact on the environment and humans, 3R concept was introduced. But in introducing the concept of 3R, there are challenges that inhibit the use of this concept.

### *B. The Concept of 3R*

Waste reduction can be accomplished by using the 3R concept of reduce, reuse and recycle, referring to the reduction, reuse and recycling. The main goal of this concept is to reduce the amount of waste sent to landfill in order to create a safer and healthier [22].

#### 1. Reduction

To reduce the amount, number, toxicity and other quantities [36]. The most effective method is to avoid the waste material at an early stage to limit the amount of materials used [21]. Reduction involves actions to eliminate or reduce the amount of materials used in the construction site, before it entered into the solid waste stream [20]. The amount of waste is reduced by increasing the efficiency of resource use and extending the life of the product [23]. Component in reducing is a modification in practice and design principles that architects possess the power to design a module-based construction that can accommodate the role of standard-sized materials in order to avoid wastage of materials [20]. Waste reduction can be achieved by reducing the consumption and purchase of new materials [21]. With this, the key to the reduction is careful planning of the construction process so that waste reduction can be avoided in the early phases.

#### 2. Reuse

Reuse is the reuse of materials in the same function on the same site or on other sites that use a product more than once. This includes conventional reuse where it is used again with the same function or use of the new functionality [18]. According to [36], reuse is to extend the life of an item in order to use it again to include repair, modification or creation of new uses. Reusing does not require reprocessing and therefore, it has a lower energy requirement than recycling [16]. Reuse of materials also occur when the product has been employed for its original intention is then employed to wield the same parts or new role based on the power of these materials [21]. In conclusion, reuse is the reuse of materials that can be used more than once to have the recurring without making major changes to the design and ultimately reduce waste.

#### 3. Recycling

According to [22], recycling is the separation and distribution of waste that cannot be reduced or used in appropriate facilities so that they can be used to produce new products. Recycling is the process of acquiring or separation, purification and processing of waste materials for reuse or produce new product [15]. Reference [9] stipulates that recycling is the separation and recycling of waste materials that can be recovered generated during construction and renovation. Recycling plays an important role in the formation of new policies and proactive environment, at the same time it creates a market for materials that can be used as a new product [21]. In conclusion, recycling can be used in building restoration industry because it can help to reduce the amount of waste generated and will directly reduce the cost of waste disposal and to prevent environment pollution at the same time.

### *C. The Importance of 3R*

The importance of the 3R concept in the restoration of historic buildings are saving energy and costs, conserve natural resources, and reduce environmental problems.

#### 1. The Cost Savings

Use the 3R concept in building improvements can save costs in terms of waste management, waste disposal and the cost of buying new materials. Restoration activities will produce a lot of waste and where waste is not reused or recycled; it would involve substantial management costs [25].

#### 2. Conservation of Natural Resources

Waste disposal rate has resulted in the involvement of high raw material digging activities regularly to produce new products. Digging process raw materials from underground has damaged the natural habitat for wildlife. But, with the re-use and recycling of waste materials, activities excavate raw materials can be reduced and indirect natural resources can be saved [37].

#### 3. Conservation of Energy Resources

Saving energy through the 3R concept is important because the energy from non-renewable resources can be protected and saved for future generations and the cost will be saved when the source of energy used is less. Reference [24] found that recycling is more energy efficient than the combustion method. This is because recycling can save a large amount of energy which does not require the extraction of raw materials from nature to produce new materials.

#### 4. Reduction of Environmental Pollution Problems

With the re-use and recycling of waste materials would reduce greenhouse gas emissions and avoid the emission of methane from the breakdown of wood, paper, and organic waste [26]. Recycling also reduces waste from landfill where it can produce methane gas and dissolve into the groundwater to contaminate soil [14]. In the long run, dependence on natural resources such as trees, oil and minerals can be reduced and the rate of environmental pollution will be

decreased by reducing emissions from manufacturing and transportation.

#### *D. Barriers Use of the 3R*

3R concept is rarely used among industrial refurbishment of historic buildings may be caused by a number of the factors. Among the factors is the cost of waste management, pollution, lack of information about the 3R concept, slow work and removal of distribution space.

##### 1. The Cost of Waste Management

Most of the waste disposal contractor assumes the overhead in construction projects. But it is not calculated directly in the offering of a project [11]. This means that contractors have their own alternative of choosing the cheapest cost as burning and illegal dumping to dispose of the waste. Furthermore, some of the cost of waste management is not funded by the client or agency to finance a project [27]. So, the cost of disposal will be borne by the contractor himself. Thus, this event will be a barrier to recycling waste materials from implemented.

##### 2. Contamination of Hazardous Materials

According to [11], usually, a single container is used for the collection of waste at the construction site. Commingled waste is difficult to be separated unless the separation is done by hand or by special machinery. Some materials, such as treated wood can alter the characteristics of other waste until the waste cannot be used as a raw material for recycled materials. Hazardous materials such as asbestos contaminating construction debris and cause it cannot be recycled or reused [33]. If the flow of hazardous waste is mixed with non-hazardous waste streams, whole mixture shall be recognized as a hazardous waste and cannot be used again [11]. By referring to [25], the authors show that in the course of the recycling process, the content of pollutants such as lime plaster, soil, wood, gypsum, asphalt and paint in recycled aggregate will result in a reduction of 15% in compressive strength compared with the control concrete. This has resulted in many contractors do not confident with recycled materials so they are willing to spend a lot of money in the use of new building materials.

##### 3. Lack of Information About the 3R

The potential of waste materials for recycling and reuse are shipped and disposed of in landfills due to the inability to identify a market for the material when it is presented [30]. Lack of investment in research on recycling technology has led to a lack of sophisticated equipment to purify or isolate waste. From [11], the authors state that the limitations of the materials testing and approval of the code is also a major obstacle for the contractor, client and designer using recycled materials. This is because they are unable to bear the high risks. Due to lack of education and technical information, this has led to related parties do not understand the potential use of waste materials to dispose of waste in landfills [30].

##### 4. Delaying Work

Use the 3R concept will slow down the work because in the process of recycling, waste separation process is the most important process underway [27]. In this process, the waste will be separated at the construction site, stored and transmitted to the processing center. This operation is not only burdensome but contractors working with the involvement of many steps have been indirectly delaying the work [11].

##### 5. Space Allocation Removal

After separation techniques recycling, waste should be stored on site in a given period of time until it reaches a level that is appropriate to be sent to a processing center. Some waste, such as wood and gypsum, take up much space because it is usually transported in large pieces. There is sufficient space on the site to store waste and put the container waste separation [11]. Crushed concrete on site to produce recycled aggregate can reduce transportation costs and low value but it requires a large space to put a temporary plant [13]. This poses a problem of lack of space because space is limited at the construction site.

### III. METHODOLOGY

This study utilizes quantitative research because this research is flexible. This is because it enables researchers to modify the design of the research at any time [2]. Moreover, this research enables the achievement of a better understanding. It also enables researchers to obtain the data which is not designed in this research and to improve the quality of data collected [7].

#### *A. Interviews*

Interview method was chosen as the instrument for this research. The interview is a systematic way in a conversation between researcher and respondent. It allows for the involvement of the respondent and the respondent the opportunity to give their views. Through these interviews, the perception and interpretation of the respondents in the matter can be discussed [19]. Semi-structured interviews were used in the study. Semi-structured questions focus the contractors and consultants involved in restoration projects of historic buildings in Penang. It aims to examine the importance of and barriers to the use of the 3R concept in the field.

#### *B. Population and Sample*

The study population consisted of contractors and consultants involved in building restoration projects in Penang. Based on the list of names from Georgetown World Heritage Office (GTWH), there were 12 contractors and consultants to 6 people involved in restoration projects of historic buildings in Penang. This is the number of contractors and consultants introduced by GTWH to clients who wish to carry out repair work.

After contacted with all contractors and consultants who are on the list, it was found that only 6 of the contractors and consultants able to participate the interview sessions. So, the sample of this study is 6 contractors and consultants involved

in restoration projects of historic buildings in Penang. During the interviews, only senior managers were asked because these people have a wider experience and highly involved in restoration projects of historical buildings in Penang.

#### *C. Data Analysis Method*

Content analysis method is done after the data collection process [6]. Moreover, this method allows researchers to understand more about the issues and topics studied because it is systematic. Moreover, this method allows conclusions to be made and then supported using other data collection methods [32]. This situation can facilitate researchers in data collection and analysis of data.

After data collection, all data from the interviews were recorded and transcribed into the computer in the form of transcript. Data analysis was carried out verbatim transcript produced. To facilitate data analysis, all questions and answer from the interview have been translated into other forms of expression. During the process of data analysis, an analysis was made based on the evidence collected to ensure that whether the evidence supports or does not support the findings of the research. Finally, this analysis is important to enable researchers cite the actual expression used as proof to the respondent and the answer sought by the research questions.

### IV. DATA ANALYSIS & RESULTS

#### *A. Background of the Respondents*

There are six contractors and consultants who have been selected to participate in the study. They were chosen because of involvement in restoration activities that directly and this group has a long and professional experience in this field. Through interviews conducted, it was found that all contractors and consultants have experience of more than 5 years and the most experienced of 15 years. This experience shows the reliability of the information provided. All of them are involved in this restoration project old shop houses and restaurants. Only two of them have been involved in the restoration project and the old town hall.

#### *B. The Level of Understanding of the Concept of 3R*

Through interviews, we found that most of the respondents in this study were not aware of the term 3R concept. After the explanation of the term 3R concept, then they understand that 3R is intended to reduce, reuse and recycle. Two of the respondents are of the opinion that the concept of 3R is a method of re-use of waste materials that are still in good condition and worth. Thus, this method can also preserve the environment. Meanwhile, one of them argued that the concept of 3R is one purpose of the conservation of historic buildings.

Established along the consideration given, it indicates the degree of understanding of the term 3R is still really depressed. However, in terms of understanding the function of the 3R concept, they have a good understanding and found that some of them have applied the concept in building restoration projects.

#### *C. Waste Management in Historic Building Restoration Activities*

##### 1. Types of Waste, the Waste and the Quantity of Waste

Based on information provided by the respondent, usual building restoration activities will be channeled for the integral edifice. While there are some projects that only involve restoration of part of the building and this situation is dependent on the needs of the building owner. It was found that most types of waste generated from the activity are the same historic building restoration. Residues were obtained from the roof to the floor. For example, roof tiles, limestone, wood (stairs, window frames, doors, floor boards), bricks, floor tiles, cast iron, and historical souvenir (house number plates, lamps, decorative items).

Conditions and the quantity of waste are dependent on the severity of the condition of the building. In fact, the respondent argued that during the current conservation activities, restoration of historic buildings, the quantity of waste will be minimized as best as possible. On the other hand, one of the respondents is of the opinion that the old buildings are not occupied by people, most of the waste is in a terrible state because there is no maintenance done on the building. Meanwhile, the old building has a building owner; the waste is in a state that still can be reused as maintenance of the building.

In conclusion, waste generated from restoration of historic buildings is suitable for reuse if the waste material is in good condition. This situation reflects the fact that this waste could either be recycled is dependent on the waste. The quantity of waste will not affect. Thus, this statement shows that the 3R concept is very suitable to be applied in the field.

##### 2. Methods of Waste Management

During building restoration, the contractor is responsible for waste management. Only the toxic waste requires external experts to carry out the waste management. Through interviews conducted, it was found that most of the respondents segregated all waste by type and state of repair of the waste in the course of activities.

Residues such as sawdust, porous limestone and brick pieces are wastes that cannot be reused. Found that the three of the respondents will use the waste for leveling roads. Meanwhile, for other respondents, they will remove all the waste that cannot be reused or recycled to the landfill. Methods of managing waste are dependent on the value of the waste. Waste that is in good condition will be reused while the waste is in a terrible state to be disposed of to landfill.

Granting to the two respondents, the waste management process is costly. This is due to the current waste management requires a lot of labor and transportation costs. Meanwhile, four of them argued that these costs are dependent on the method used. Overall the chosen method of managing waste is dependent on the type of waste and the waste. Furthermore, the method chosen will affect the operational costs indirectly.

### 3. The Views of Respondents on Landfill and Incineration Methods

This section describes the view given by the respondents to the method of landfill and incineration methods. Based on the respondents, it was found that most of the respondents are of the opinion that the landfill is the most traditional method of waste management. This method is fast and secure while waste management for all waste to a waste disposal site. However, they argued that the burning is not allowed in Penang and it is not only costly but also a method that will cause environmental pollution problems.

In ratiocination, the prospects of all respondents have indicated that both methods have a problem and weaknesses of its own. Landfill site will face shortages, while open burning is costly and causing environmental pollution. Therefore, this situation reflects the fact that the 3R concept is crucial to be implemented to minimize the problems faced by both methods.

### 4. The Government's Efforts in Waste Management

To know the efforts given by the government for waste management in the building restoration industry, the question of the guidelines and policies have been asked of the respondent. All of the respondents in this study felt that the government and the relevant agencies do not have guidelines and policies set forth in the waste management contractor. This situation is explained that the government and the agencies give less emphasis on efforts to improve waste management.

#### *D. The Importance of the 3R Concept in the Work of Restoration of Historic Buildings*

There are several factors of interest in the application of the 3R concept in the work of restoration of historic buildings as has been shown in the literature review. Among the factors are the cost savings, energy savings, preservation of natural resources, and reduction of environmental pollution problems. Preservation of natural resources and reduction of environmental problems is the most important factor in applying the concept of 3R. Based on the reply given by the respondent, all respondents in this study felt that these two factors are very important.

According to respondents, the factor of preservation of natural resources essential for the re-use of waste materials such as wood, purchase of new timber will be less. This is due to the many historic buildings use a lot of wood volume during repair work. Where to reuse some of the waste material (wood), it can reduce the use of new wood and indirectly reduce logging activities. Finally, natural resources can be preserved.

Reduction factor for the problem of environmental pollution, respondents felt that it is important for the application of the 3R concept, the raw material used to produce new products or materials will be reduced. Thus, the release of gases from processing and transportation declined. Moreover, the problem of air pollution can be reduced because the gases methane and carbon dioxides produced in the landfill

can be minimized. The remnants of the building can be minimized by applying the concept of 3R. This helps to reduce the amount of waste disposed of in landfills.

Three of the six respondents in this study felt that the use of the 3R concept is important to save the energy. Sources of energy used to produce new products from natural materials can be saved by applying the concept of 3R. Meanwhile, two of them argue that this factor is not important because it is less associated with the use of the 3R concept and reuse of waste materials with no significant impact on the conservation of energy resources. So, this factor has been shown that energy can be saved by reusing or recycling of waste materials a lot.

Cost savings is the least important factor in applying the concept of 3R. Four of the six respondents are of the opinion that the cost of purchasing new materials will be reduced with the use of the 3R concept, but the cost of management is still required. When handling waste for reuse or recycling, the process will involve a lot of labor and time. The process will involve high costs. So, cost savings in applying the concept of 3R is less effective. However, two of them argue that the cost savings are effective as using the 3R concept; the cost can be saved in terms of management, waste disposal and purchase of new materials. Transportation costs are not required to send waste to landfill and large numbers of workers are not required to waste management.

Apart from the factors mentioned above, four respondents have suggested that the use of the 3R concept, it can preserve the history of a building. This is due to the originality of the materials is the most important aspect in maintaining a building. Building materials considered worth is important because it has historical value. All element buildings were constructed based on the traditional techniques and technologies that will not exist in modern times. So, the arrangement of ideas and ideals of historic buildings should be preserved. Thus, the re-use of building materials, it can preserve the authenticity of heritage buildings and historical buildings can be maintained.

#### *E. The Use of the Concept of the 3R in the Repair of Historic Buildings*

To understand whether the 3R concept was applied in the building restoration industry, questions about the use of the 3R concept in the industry have asked. Based on the reviews given by four respondents, it was found that the 3R concept has long been used in the restoration of historic buildings. However, two of them emphasize that this concept is still at an intermediate level in the hierarchy. This is because some of them still do not understand the importance of recycling waste valuable.

Clearly, this concept is applied either during repair work is dependent on the contractor. Perception and knowledge of the contractor is an important factor in the application of the 3R concept because even if they have knowledge of these concepts, but they have the perception of commercial, this concept will not be applied.

*F. Barriers in Applying the Concept of the 3R in the Repair of Historic Buildings*

TABLE I  
DIFFERENT BARRIERS IN APPLYING THE CONCEPT OF THE 3R IN THE REPAIR OF HISTORIC BUILDINGS

Limiting Factor	Comments from respondents
Disposal costs incurred by the contractor	<p>"Nothing to do with the concept of the 3R...." (R5)</p> <p>"The use of the 3R concept is dependent on the behaviour, a second thought whether the contractor himself has a green concept..." (R2)</p> <p>"Contractors do not have to bear the cost that..." (R3)</p> <p>"Cost of disposal is borne by the contractor itself..." (R6)</p>
Not suitable for recycling or reused due to contamination during the waste management	<p>"This problem is very rare..." (R2, R5)</p> <p>"Not all the waste will be tarnished..." (R3, R4)</p>
Lack of knowledge on the 3R	<p>"Not necessarily due to a lack of knowledge because, although some contractors have the knowledge, but they still did not apply the 3R concept. It is dependent on the desire of the contractor whether or quality-conscious living..." (R1, R3, R5)</p> <p>"Lack of professionals in the field in giving teachings on the contractor..." (R2)</p> <p>"In terms of information, the term 3R concept is not clear, the concept of only focus on the management of garbage in residential areas..." (R4)</p> <p>"The lack of publicity about the 3R concept..." (R6)</p>
Separation process waste delaying work	<p>"The purchase of the new material is more easily compared with reuse of materials that would involve a lot of processes..." (R2)</p> <p>"Job separation process could produce a more effective job..." (R3, R4)</p> <p>"Although it will slow down the work at the beginning but it is worth it to do so..." (R1)</p> <p>"Allow separation process work faster, systematic, neat and clean..." (R6)</p>
Separation of materials waste requires large spaces, it troublesome because space actually is limited	<p>"Requires a large space to store waste such as wood..." (R2)</p> <p>"Depending on site conditions..." (R3)</p> <p>"Space is limited causing difficult waste materials separated until jobs be systematic and effective..." (R4)</p>
Others	<p>"Troublesome work as a door or window must be in pairs, sometimes do not have a complete pair of size may not fit with the structure of the part..." (R2)</p> <p>"Require skilled workers to update the waste material (wood) is. Long time and high cost of skilled workers to practice..." (R2)</p> <p>"Preparation of BQ contract is not clear..." (R3)</p> <p>"Taking a long and difficult process..." (R5)</p>

### 1. The Cost of Waste Management

Based on the data collected, it was found that 17% of respondents agreed with a factor of six, while 83% are not agree with this factor. Only one respondent agree with this factor. This is because the cost of waste management is strongly related to the use of the 3R concept. The contractor will select the cheapest cost management in managing the waste generated. Methods of disposal sites will be chosen because it is fast and involves procedures that less than re-use of waste materials that will involve a lot of labor and complex procedures.

While some of the respondents did not agree with these factor because they felt that this factor is not related to the use of the 3R concept. In their opinion, the use of the 3R concept is dependent on the initiative of a contractor in the production of a repair job. Overall, whether the cost of disposal is borne by the contractor himself obstacles in applying the concept of 3R is dependent on the contractor.

### 2. Contamination of Hazardous Materials

All respondents in this study do not agree with this factor because they are of the opinion that the activities of restoration of historic buildings rarely have hazardous materials such as asbestos waste will contaminate the construction. This is because most of the old buildings do not use asbestos or other hazardous materials. So, the problem of contamination is rare. Furthermore, despite the pollution waste, all waste materials are not necessarily to be contaminated and are usually

remnants of restoration activities are not the type who easily contaminated waste.

### 3. Lack of Information About the 3R

Based on the comments given by the respondents, it was found that there were 50% of respondents agreed with a factor of six, while the remaining 50% is not agreed. Four of the six respondents stated that lack of knowledge on the 3R concept has made one of the obstacles in applying this concept because of publicity about the 3R concept in the industry is less. This concept is not widely introduced. The professionals in this field are limited to assist contractors in applying this concept.

According to the one respondent, term 3R concept is still confusing. This is because the government is introducing this concept in the management of garbage in residential areas and not in the building restoration industry. So, the contractor or consultants will not understand the importance, usefulness and advantages of this concept in the course of restoration activities.

But, other respondent emphasize that although some contractors have knowledge, they did not apply this concept during repair work because they want a fortune exceeding quality. They understand that some of the waste material has a higher value event is sold to third parties compared to their reuse of waste materials.

### 4. Delaying Work

The analysis made has shown that only 17% of respondents agreed that the six barriers use the 3R concept is slow work. Meanwhile, 83% of respondents are not agreeing with this

factor. According to the respondent, the process of waste segregation is not only slow but also burdensome work contractors. This situation is caused by the purchase of the new material is faster than with the use of materials. The recycling of materials will involve a lot of steps up to slow down the work. It has been a barrier in the application of the 3R concept.

Meanwhile, four of the six respondents argued that although the waste separation process will slow down the work at the beginning, but they think it is worth it because after the waste is separated following types of materials, job site will be clean, neat and systematic. This will not only speed up the next, but also enable more effective work produced.

There is no doubt that the separation process will slow down the work at the beginning but with the separation process, it can speed up work on. Thus, for contractors who want a pleasant work, this factor will be the obstacles in applying in the concept of 3R. However, for contractors who are willing to sacrifice their time in segregation of waste materials, this factor will not be as their obstacles.

#### 5. Space Allocation Removal

This factor is the factor that has the highest percentage of agreement 83% and 17% are not agreed. According to the two of the respondents, a large space for storing waste is required at the 3R concept. For example, a large and long timber requires a relatively large space, but in fact the space available at the site is limited and this is directly created obstacles in applying the concept of 3R. Some contractors want to reuse waste, but due to insufficient space have resulted in the waste material they had to sell to someone else. In fact, not all sites have limited space and it is dependent on the condition of the site. For example, shop houses usually have a small space, while the old city hall or have a larger space. Limited space on site is inevitable and this problem is not directly caused contractors to apply the 3R concept. This is because the small space would be inconvenient separation of work and cause the work to be unsystematic.

#### 6. Difficulties in Restoration Work

One of the respondents is of the opinion that the use of the 3R concept, it will be difficult work of building restoration. This is due to the replacement of doors or windows of the same type are rare pair. For example, in the event of damage to one of the windows, the windows cannot be reused because it is difficult to find the windows of the same size or have a similar design. So, the window had to be removed. Incompatibility problem with the size of the structure occurs. Therefore, this situation reflects the fact that the waste material is not necessarily good condition can be reused.

#### 7. Skilled

According to the respondents, waste materials such as wood require skilled workers to update that can be reused. Long time and high cost required for skilled workers to practice. This has indirectly restricted the use of the 3R concept because the contractor does not necessarily have the time or the cost of certain skilled workers to practice.

#### 8. The Time and Process Involved

One of the respondents holds that certain processes must be carried out before re-use waste. For example, prior to re-use timber, pull all the nails in the wood there is to be carried out. After that, the wood should be sanded with crab. The process will involve a long and difficult process. Moreover, the old wood is usually large and long. To get the desired size, the cut should be compared with the new wood was already cut to follow the desired size is time-consuming.

#### 9. Preparation of Contract "Bill of Quantity (BQ) Is Not Clear"

BQ contract is documentation that will specify how the building will be restored to a project. According to respondents, the provision of the contract which is not clearly stated will result in contractors to take their own decisions in the management of waste materials. For instance, a part of the state would be restored "to make good or to be dramatically improved." This statement indicates that the section should be reviewed and improved. In the event it is stated "to replace it", it means that the part will be removed and replaced with new material. Confusion this statement will result in the contractor chose a more economical means of disposal and fun work.

### V. CONCLUSION

In conclusion, the 3R concept in the restoration of historic buildings is growing important in preserving natural resources and reducing the environmental problems, followed by saving energy and ultimately is cost savings. However, apart from the factors that inhibit the use of the 3R concept, the respondents have proposed a new factor that is troublesome obstacles repair work requires skilled workers, involving a long and difficult process and preparation of contract and BQ remain unclear.

Based on the analysis, we found that the distribution of space is not enough waste has made a huge impact in the 3R concept. Process during the use of the 3R concept requires a large space, but space constraints have trouble contractor. High costs required for storage of waste materials to be reused or recycled. These costs are burdening contractors in a long time. Meanwhile, the cost of waste management, lack of information about the 3R concept, slow work, and difficulty in repair work requires skilled labor, time and processes involved, and the preparation of bill of quantity contract that is not clear is also a barrier in the application of the 3R concept. Through the findings of this study, the authorities can take appropriate measures to overcome the challenges of waste management in heritage buildings restoration.

### ACKNOWLEDGMENT

The authors express gratefully acknowledgment to the industry stakeholders for their valuable contributions towards the success of this research. This research is fully funded by Ministry of Education (Malaysia) Ministry of Science, Technology and Innovation, Malaysia (MOSTI), and the Office for Research, Innovation, Commercialization,

Consultancy Management (ORICC), Universiti Tun Hussein Onn Malaysia (UTHM) under the Fundamental Research Grant Scheme (FRGS) Vot. No.1417, Science Fund grant No.S023 and Multidisciplinary Research Grant (MDR) Phase 1/2012 Vot: 1106.

## REFERENCES

- [1] Ahmad, A. G. (2009) Treatment of rising damp and replastering at heritage buildings. Paper presented at the Bengkel Bersiri Konservasi Bangunan Warisan Siri 2: Lepatan Kapur.
- [2] Babbie, E. (2005) *The Basics of Social Research*. 3th ed. Thomson Wadsworth.
- [3] Balaras, C. A. (2002) TOBUS-A European method and software for office building refurbishment. *Energy and Buildings*. 34(2). 111-112.
- [4] Barret, A., & Lawlor, J. (1995) *The economic of waste management in Ireland*.
- [5] Burden, E. (2004) *Illustrated Dictionary of Architectural Preservation*. Mc Graw Hill, New York.
- [6] Burn, R. B. (1995) *Introduction to Research Methods*. 4th ed. Melbourne: Longman.
- [7] Carr, L. T. (2008) The strengths and weaknesses of quantitative and qualitative research: what method for nursing. *Journal of advanced nursing*. 20(4). 716-721.
- [8] CIDB (2007). *Construction Quarterly Statistical Bulletin-Fourth Quarter 2006*: CIDB, Malaysia.
- [9] City of Austin Green Building Program. (2003). *Sustainable building Sourcebook*. City of Austin.
- [10] DE, M. (2010). "Market Watch 2010" *The Environment Sector in Malaysia*: German Chamber of Commerce & Industry
- [11] Dolan, P. J., Lampo, R. G., & Dearborn, J. C. (1999). *Concepts for reuse and recycling of construction and demolition waste*: DTIC Document.
- [12] Emmanuel, M. (2011). Penang heritage zone 'refresh'. *Business Times*.
- [13] Ferguson, J. (1995). *Managing and minimizing construction waste: a practical guide*.
- [14] Gateway, E.-W. (2005). *Environmental Benefit of Recycling Study*. Paper presented at the St.Louis-Jefferson Solid Waste Management District.
- [15] Guide, C. (2003). *Save money and resources through job-site recycling and waste prevention*. Paper presented at the Business and Industry Resource Venture and King Country Solid Waste Division (2002-2003).
- [16] Heimlich, J. E., Hughes, K. L., & Christy, A. D. (1992). *Integrated solid waste management*. Publication-Louisiana Cooperative Extension Service.
- [17] Hill, R. C., & Bowen, P. A. (1997) *Sustainable construction: principles and a framework for attainment*. *Construction Management & Economics*. 15(3). 223-239.
- [18] Kajornboon, A. B. (2005). *Using interviews as research instruments*. *E-Journal for Research Teachers*. 2(1).
- [19] Khoramshahi, F., Dehghan, R., & Mortaheb, M. (2007). *Waste Management Practices in Construction Sites*.
- [20] Laustsen, G. (2007) *Reduce, recycle, reuse : guidelines for promoting perioperative waste management*. *AORN Journal*. 85(4). 717-722.
- [21] Memon, M. A. (2010) *Integrated solid waste management based on 3R approach*. *Journal of Material Cycles and Waste Management*. 12(1). 30-40.
- [22] M.O.E. (2005). *The 3R Initiative: Policy Planning Division, Waste Management and Recycling Department, Ministry of the Environment*
- [23] McTavish, D. G., & Loether, H. J. *Social Research*. 2nd ed. Allyn and Bacon. (2002). Merriem, S. B. *Qualitative Research and Case Study Applications in Education*. 2nd ed. San Francisco: Jossey-Bass. 1998. Morgan, R. 2002. *Waste management strategy*
- [24] Morris, J. (1996) *Recycling versus incineration: an energy conservation analysis*. *Journal of Hazardous Materials*. 47(1). 277-293.
- [25] Nisbet, M., & Ave, L. (2003) *Demolition and Deconstruction: Review of the Current Status of Reuse and Recycling of Building Materials*.
- [26] Ong, E. G. (2009) *Construction Waste Generated in Conventional method of Housing Construction degree of Master of Science (Construction Management)*. Universiti Teknologi Malaysia.
- [27] Saidi, S. B. (2007) *Pengurusan dan Potensi Kitar Semula Bahan Buangan Pembinaan*. Ijazah Sarjana Muda Kejuruteraan Awam. Universiti Teknologi Malaysia.
- [28] Samadi, Z. H., & Mahmud, S. A. M., M. (2008) *Pemuliharaan Warisan Senibina Rumah Kedai Bagi Kemakmuran Bandar: Isu dan Cabaran*. Jabatan Senibina Fakulti Senibina Perancangan dan ukur Univeristi teknologi MARA. .
- [29] SANYO. (2011). *Hotel Penaga partners with SANYO to receive Green Mark Certification in Malaysia*: SANYO Asia Pte Ltd.
- [30] Serpo, A. (2012). *Four Barriers to better C&D recovery: BEN Waste*.
- [31] Shah.R.A, & Pitroda, J.R. (2011) *Recycling of Construction Materials for sustainability*. Paper presented at the National Conference on Recent Trends in Engineering & Technology.
- [32] Stemler, S. (2001) *An overview of content analysis. Practical assessment, research & evaluation*. 7(17). 137-146.
- [33] Tey, J. S., Goh, K. C., Seow, T. W., & Goh, H. H. (2013) *Challenges in adopting sustainable materials in Malaysian construction industry*. 301-305.
- [34] Triangle, J., Kincaid, J. E., Walker, C., & Flynn, G. (1995). *WasteSpec: Model Specifications for Construction Waste Reduction, Reuse, and Recycling*: Triangle J Council of Governments.
- [35] Tye, T. (2008). *Introducing the World Heritage Site of George Town, George Town UNESCO World Heritage Site World heritage Site Home*.
- [36] Walther, R. *Builders' (1993) Guidebook to Reducing, Reusing and Recycling Residential Construction Waste in Wisconsin*.
- [37] *Zero Waste Explained (2010)*. Reduce, Reuse, Recycle and Recover: Edinburgh & Midlothian.