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Solid Waste Generation from Construction of Office Building with Special Reference to Nepal Telecom, Nepal

[1]Khet Raj Dahal. [2]Sushmita Sharma, [3]Madan Sharma, [4]Bikash Adhikari
[1]*Head of Department (Civil), Kantipur Engineering College, Nepal*
[2]*Architect, Civil Department, Nepal Telecom, Nepal*
[3]*Manager, Civil Department, Nepal Telecom, Nepal*
[4]*PhD Scholar, Kathmandu University, Nepal.*

Abstract: *The study was carried out during the period of August 2012 to December 2013. Three sites were selected for the study viz. Rupandehi, Kaski and Kathmandu districts. Construction industry is one of the booming industries in Nepal, contributing to infrastructure development and the main objective of this study was to understand the construction wastes generated by newly constructed buildings undertaken by renowned contractors. The study revealed that the construction industry followed orthodox construction methods and major construction wastes were concrete, reinforcement bars, wood and bricks. The use of new technology and prefabricated elements, though desired by Nepal Telecom were not being adopted due to construction constraints. The haste to complete design and construction works often created flaws which resulted in waste. The lack of proper managerial planning, the hesitation to invest in training and learning procedures, lack of monitoring and non-stringent rules from the government were seen as dominant causes of haphazard construction waste management. Presence of theoretical understanding of waste management in all studied facets and lack of pragmatic approach in its implementation could be seen. The principal wastes identified could either be reused or recycled. Partial reuse and recycling techniques using scrap dealers were being practiced in all the studied sites. Potential for waste reduction was less addressed. This study can be considered as a baseline for formulating government policies and may be used to attract attention of concerned construction industry.*

Key words: *Construction waste, Contractor, Kaski, Rupandehi, Kathmandu, Nepal Telecom, Municipality*

I. Introduction

An old Chinese proverb defines waste as a resource in the wrong place [1]. Any substance or object the holder discards, intends to discard or is required to discard is waste (under the Waste Framework Directive) [2].According to Environmental Protection Department (EPD) of Hong Kong, construction waste is anything generated as a result of construction and then abandoned haphazardly without any regards to possibility of its future use. It comprises surplus materials from construction, demolition and renovation. Construction wastes can be non-inert or inert. Non-inert construction waste is around 20% of the total and usually comprises of bamboo, timber, vegetation, packaging and other organic materials, not suitable for land reclamation. Hence such wastes are disposed at landfills. In contrast, inert waste - otherwise known as public fill - mainly includes construction debris, rubble, earth, bitumen and concrete, which can be used for land formation. Materials like concrete and asphalt can also be recovered for construction use [3].

Any waste, once generated, if not reused or explored for energy extraction will always be in its state of waste with potential to hamper the environment and human health.

In the same manner, construction waste is byproduct of construction works and tends to pose some degree of threat to the environment and human alike.

Construction works are among the vital components to judge the development of any nation and developing countries like Nepal see major construction works being undertaken in various sectors. All these works generate by-products commonly termed as construction waste and these wastes till date have not been considered adequately to be properly managed. In Nepal, the construction works are usually manually done and can result in direct wastages like the waste of concrete which is prepared more than necessary and indirect like the ones generated from the packaging of materials. Usually construction wastes are considered as the part of Municipal Solid Waste (MSW) and no considerable efforts have been made to react to this problem seriously. Though construction waste is not a threatening scenario in Nepal at the present, its proper management needs to be considered soon to avoid problems in the future.

Inadequate data also hinders in the proper management of construction wastes in Nepal. Few studies have been done and among them the study of [4] demonstrates that about 5% of the municipal solid waste in Kathmandu is construction waste. Typical studies are lacking in this field which is why the issue of construction

waste is still vague. However since the process of all building construction is similar, the waste type and the cause of waste generation is also similar. Thus this study has taken specific buildings of Nepal Telecom (NT) constructed between 2010 and 2013 to understand the construction waste generation and their management in office buildings of NT. Relevant data from municipalities was also studied to further understand the scenario of construction waste management from state level.

Ekanayake and Ofori [5] define waste as "any materials apart from earth materials, which needed to be transported elsewhere from the construction site itself other than the intended specific purpose of the project due to damage, excess or non-use or which cannot be used due to noncompliance with the specification, or which is a by-product of the construction process". According to Macozoma [6], the construction industry has been found to be quite wasteful with construction process waste being categorized into equipment, labor, process and material waste. Construction materials extractions indirectly have their toll on environment in the form of cost externalization even before they are processed and used. A study conducted by Dahal, et al. [7] shows that extraction of materials like sand and gravel from river beds imbalances the ecological harmony and creates environmental problems, ultimately increasing the external cost.

Though the definition of construction wastes vary among different individuals and institutions, this research has considered construction wastes as the materials other than earth materials from excavation, obtained solely during construction of the building which can be used within the site or need to be transported outside for disposal. Legal provisions for sub-contracting works are not present in the contract document of NT despite the contractor achieving most of his works through sub-contracting with various bodies. Hence, for the purpose of this study, such workforce which has been deployed by the contractor but bear no direct legal obligations with the client are termed as outsourced workforce.

Construction waste management has been of high priority in developed countries. In United Kingdom, NSCC had committed to a 50% reduction to the amount of waste it sends to landfill by 2012. They believe that a change in the understanding of waste is required and regarding waste as something dirty and unwanted needs to transform into a realization that it has potential to be used and reused again rather than discarding it after being used once [8].

II. Methodology

Study Area

The study areas selected were in Kathmandu, Kaski and Rupandehi districts (Fig. 1). In Kathmandu district, two specific buildings at Sundhara and Babarmahal were taken up as case studies; in Kaski district, the building chosen was in Ranipauwa, Pokhara and in Rupandehi, the building was located at Padsari, Bhairahawa.

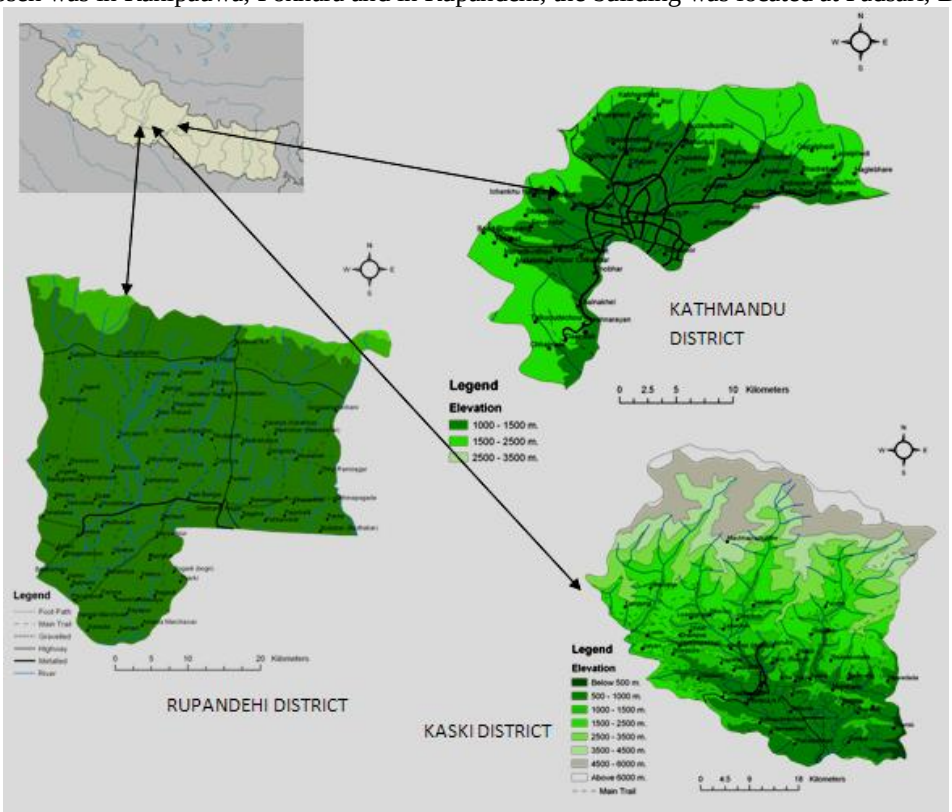

Figure 1: Study areas (Source of map: Digital Himalaya)

The study was carried out during the period of August 2012 to December 2013. The four project sites were selected for this study along with their relevant parameters have been tabulated in table 1 and details of site conditions have been presented in table 2.

Table 1: Details of buildings of studied sites

Location	Total area	Major materials used	Constructed by	Supervised by
Sundhara	6122.35 sq.m.	Concrete, Brick, Metal, Aluminium, Glass	Contractor chosen through pre-qualification process	Consultant
Babarmahal	9398.30 sq.m.	Concrete, Brick, Metal, Aluminium, Glass and Wood		In house team at Nepal Telecom
Pokhara	4514.51 sq.m.	Concrete, Brick, Metal, Aluminium, Glass and Wood		
Bhairahawa	4514.51 sq.m.	Concrete, Brick, Metal, Aluminium, Glass and Wood		

Table 2: Details of site conditions of studied sites

Location	Access	Storage space availability	Construction practice
Sundhara	Adjacent to vehicular road	Very less storage space	'Labor outsourcing' for structural works and 'Material and labor outsourcing' for finishing works.
Babarmahal	Adjacent to vehicular road	Very less storage space. ROW of road used for storing and batching plant.	'Labor outsourcing' for all works except aluminium works which were' Material and labor outsourced'.
Pokhara	Adjacent to vehicular road	Very less storage space	'Material and labor outsourced'
Bhairahawa	Adjacent to vehicular road	Ample storage space	'Labor outsourced'.

For this survey, client's representative, site engineer, store keeper, outsourced workforce and main contractor were selected, as and when necessary. Officers dealing with municipal waste from Kathmandu and Lalitpur Municipality offices were also chosen to get an overview of the state's practices on construction waste management.

For this research, the population was building construction companies chosen from the contractors who are actively building four major buildings of Nepal Telecom. Furthermore technical staffs of construction sector within Nepal Telecom and municipal staffs associated with waste management, in totality, comprise the research population.

Purposive sampling was done since the research assumed that these respondents would be able to give the answers to the research questions. Questionnaires and observations were the main tools used in generating the data for this study. In order to collect primary data questionnaire survey and field observation were exercised. The questionnaires were provided to the respondents personally or via email and any confusion were made clear before commencement of process of obtaining answers. Secondary data have also been used in few areas in an attempt to understand the scenario of construction waste management in context of Nepal.

Descriptive case study approach was followed in this research endeavor, describing the current practices in construction companies operational within certain projects of Nepal Telecom, the perspective of waste and its management in Nepal Telecom and the system of construction waste management in different municipalities. The quantitative data relating to volumetric aspects were analyzed using simple methods pertaining to calculation of volumes and percentages. Likert scale was used for qualitative issues, in which respondents were asked to respond to statements. Likert scale was chosen due to its ability to get views to the statements provided and to identify ambiguous responses irrelevant to the scope of the research.

III. Results And Discussions

Nepal Telecom, being a semi government entity needs to follow national procurement rules and procedures for the construction activities it undertakes. Though in-house design is done, construction is done mandatorily through national or international competitive building.

3.1. Analysis of Data Obtained From Studied Construction Sites

The total sample size of the study from the construction site was fourteen. The data from the construction sites were collected from various people whose designation distribution has been shown (Fig. 2)

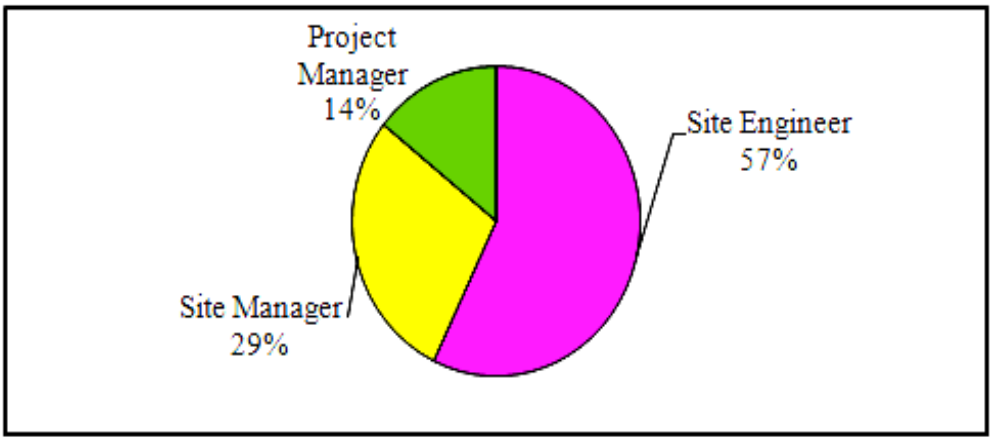

Figure 2: Designation distribution at construction sites

Site engineers were involved in the projects from start of construction till the end and no replacements were found to have been made in any of the studied buildings. The contractors were directly/ indirectly involved in all works since they acted as coordinators between NT and the engineers in major decision making works, except in case of Sundhara where the engineer from consultant came forward. The procurement managers were chosen as respondents to identify how materials were procured, stored, utilized and managed. In order to find out the categories of waste present in site, the respondents were provided a table to fill in the questionnaire The rank of the nine most probable waste categories in the construction. The respondents ticked the ones they believed ranked the highest in the waste production.

Figure 3 reflects the categories of waste present in site. Bricks were found to be the highest ranking waste scoring 50% of the total responses in rank 1 category followed by reinforcement bars (20%), concrete and masonry (20%) and wood (10%).All categories in rank 2 also consisted of bricks, reinforcement bars, concrete and masonry, and wood. Aluminum wastes were recognized majorly in the rank 4 but since aluminum works were pre-measured at site and cut at workshop, the work at site included fittings only. Hence such waste wasn't found to have been given much importance by the respondents. Packaging and plastics were found to have been acknowledged only in rank 5 and after. Similarly tiles and painting also ranked low in the data. These data were obtained as responses to question number thirteen in the questionnaire distributed in the construction. This response depicts that the works with superior value of money were considered important in case of wastes and they were acknowledged and observed due course of construction by the personnel involved. Also these wastes were bulky in nature and occupied space and hence were more prominent.

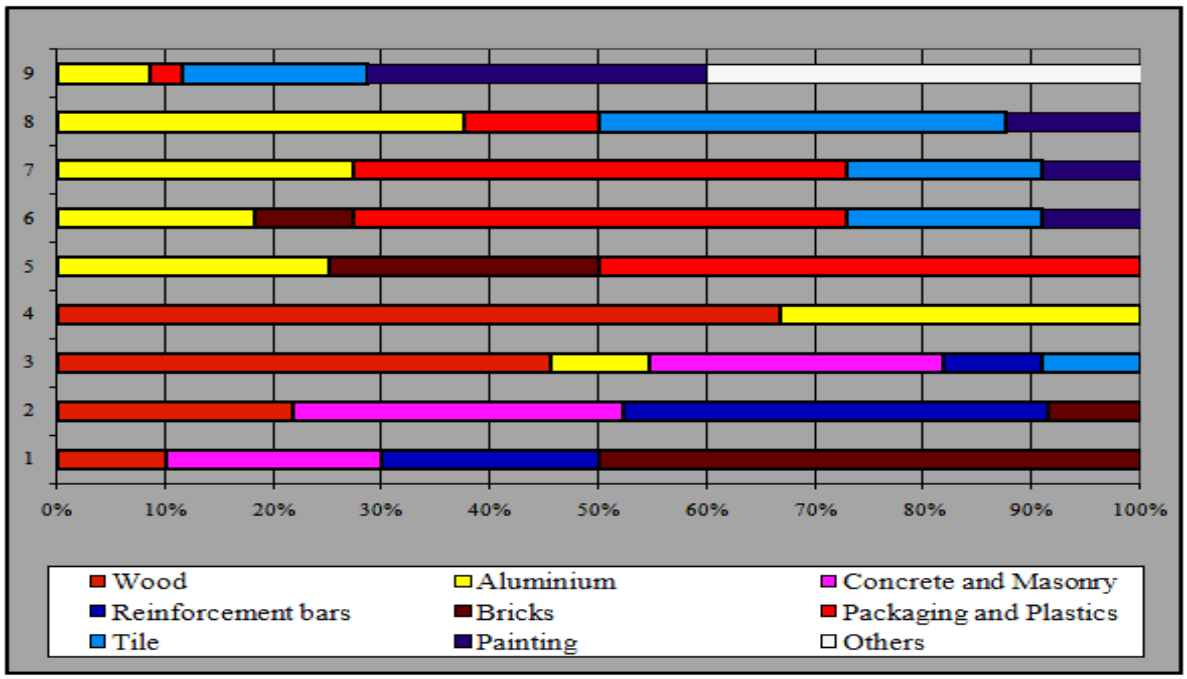

Figure 3: Waste rank and their occurrence

From the data obtained the quantitative ratio of prominent construction wastes in all the four studies sites were identified. The quantitative data obtained in the categories of wastes ranking 1 in the figure 3 are presented in figure 4. The percentages depict the percentage that occurred in 100% of the materials procured for construction.

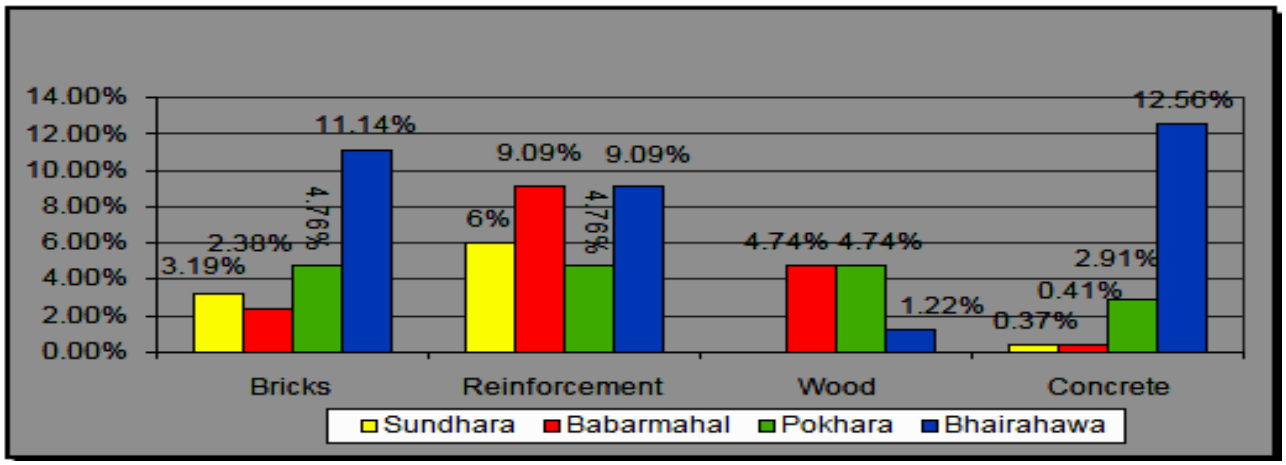

Figure 4: Percentage of waste generation in NT buildings

Analysis of the data showed that the reasons of waste could be identified as follows:

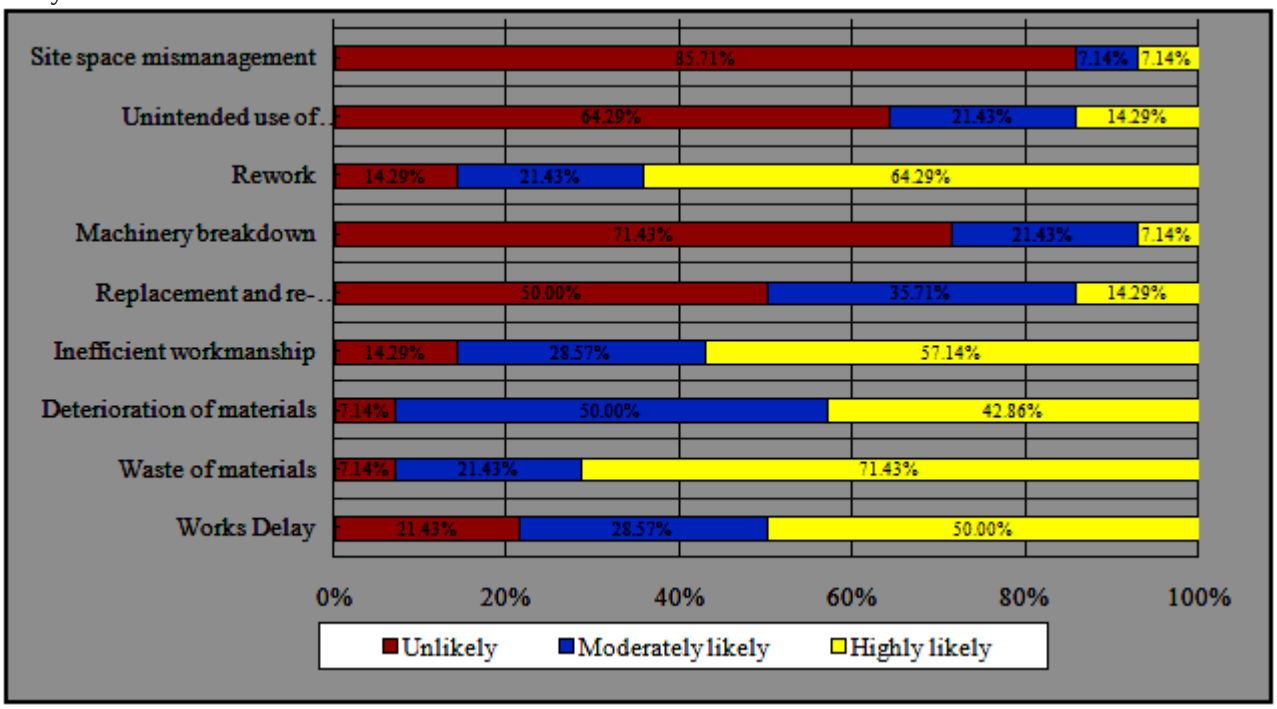

Figure 5: Reasons of waste in NT sites

Five causes were found to be prominent than others since the response in their part was 40% or higher in the highly likely scale. Those major reasons identified were; work delays (50%), waste of materials (71.43%), rework (64.29%), inefficient workmanship (57.14%) and deterioration of materials (42.86%).

To further understand the causes behind each of the reasons for waste occurrence, the respondents were provided with numerous probable causes. From the data obtained if one particular cause stood out in majority, it was termed as 'Yes' for charting purpose while all the others not in majority and non responses were termed as a cumulative 'No' (Fig. 6 to 10).

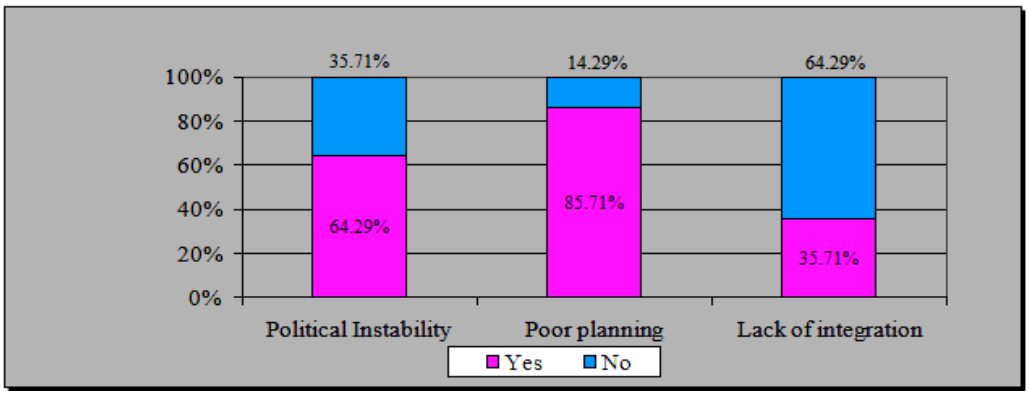

Figure 6: Main causes of work delays

Political instability and poor planning were identified as the major causes of work delays. These fell in the managerial practice category.

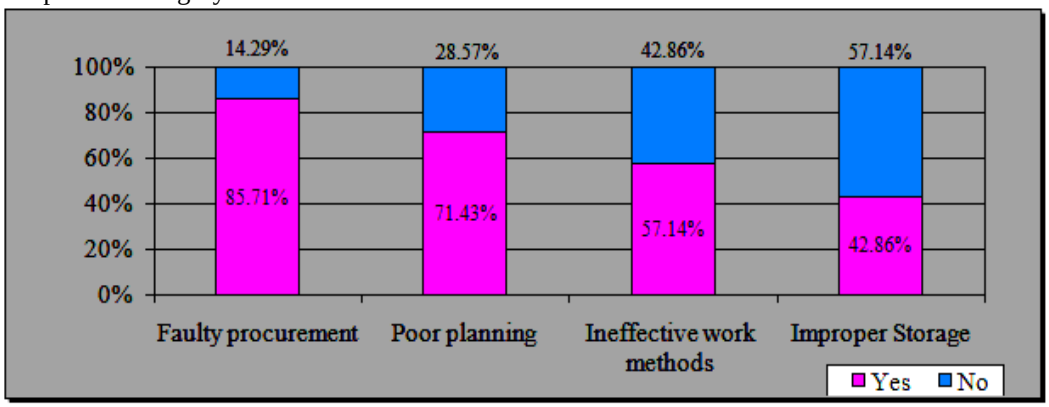

Figure 7: Main causes of waste of materials

'Faulty procurement' and 'Poor planning' were identified as the major causes of waste of material. These fell in the use of materials and managerial practice category.

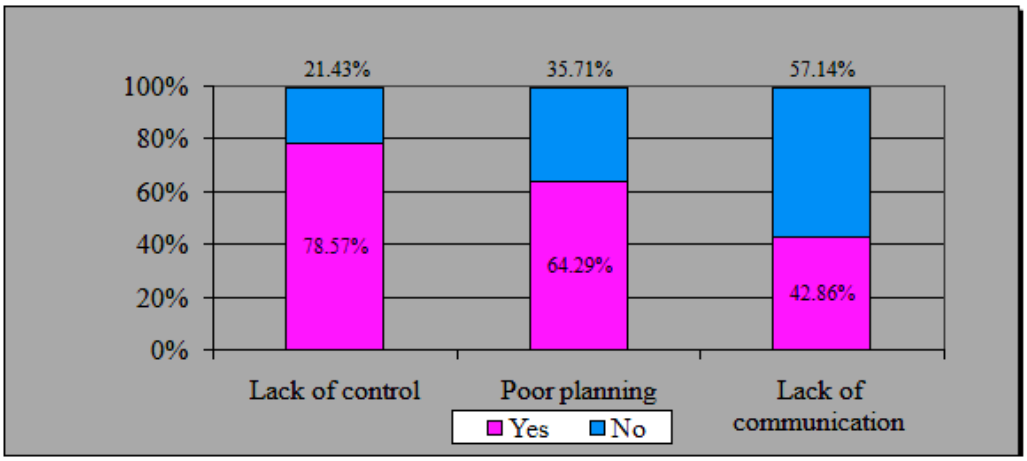

Figure 8: Main causes of rework

'Lack of control' and 'Poor planning' were identified as the major causes of rework. These fell in the management category. Lack of communication was also identified as the cause of rework.

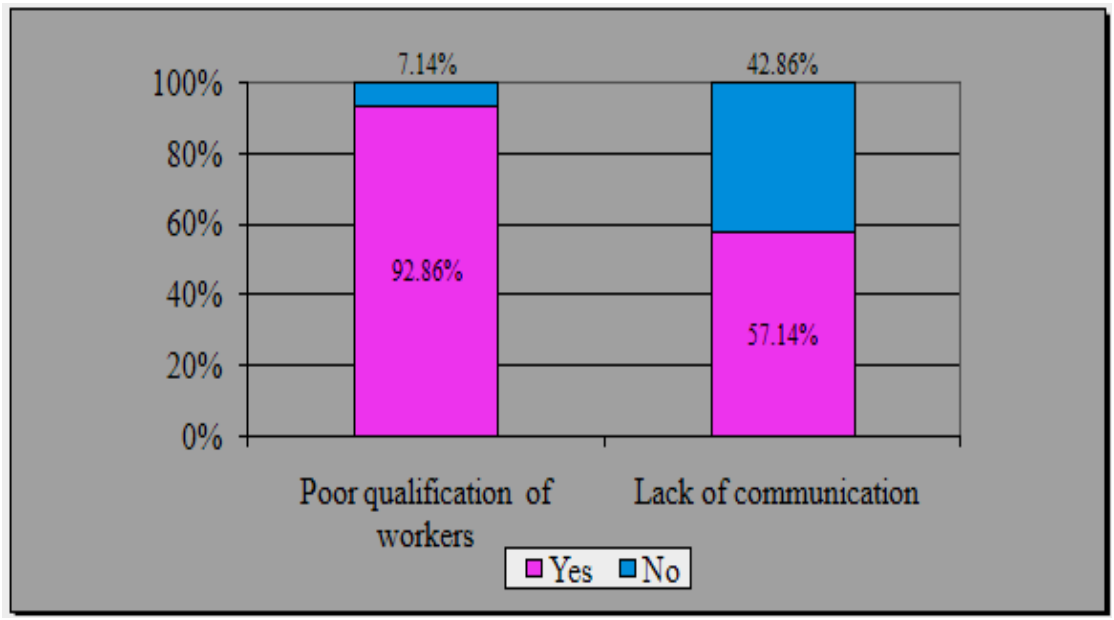

Figure 9: Main causes of inefficient workmanship

'Poor qualification of workers' was identified as the major cause of inefficient workmanship.

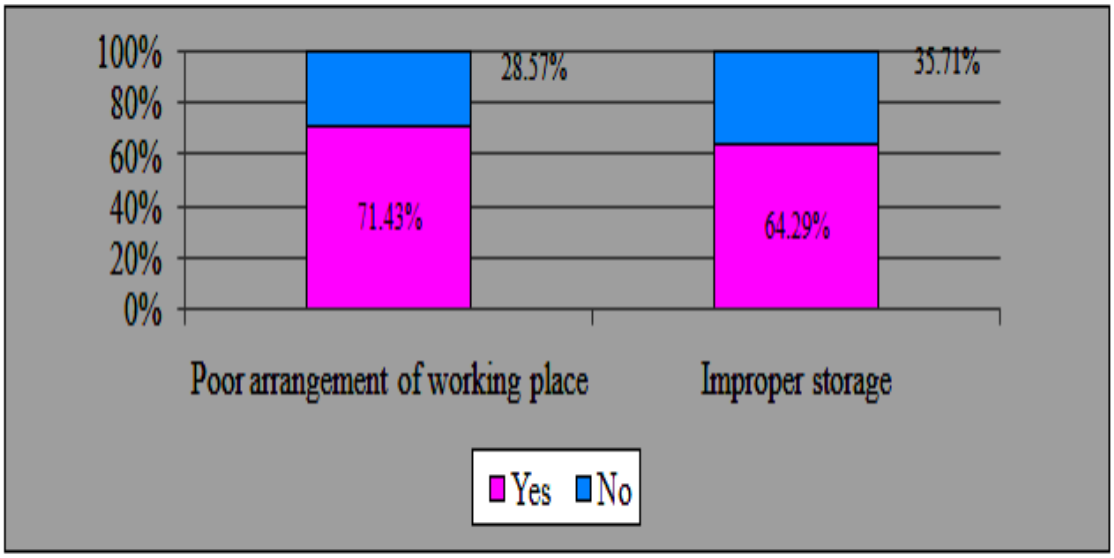

Figure 10 Main causes of deterioration of materials

Inadequate / Poor storage and Poor arrangement of materials, both were believed to be prime causes of deterioration of materials.

Hence from the data collected, the major reasons of waste generation on site were: work delays, rework, and waste of materials, inefficient workmanship and deterioration of materials. These were due to; lack of coordination, poor planning, political instability, improper storage, ineffective work methods, faulty procurement, lack of communication, lack of control and poor qualification of workers.

From the data, it was observed that 'Poor planning' was the main cause of construction waste. Poor planning referred to the overall management of the project and basically targeted the management aspect which included the project handling, material procurement, coordination and decision making. In all the sites, the decision making power during construction was inherently with the main contractor and they were not involved to the extent desirable to understand the scenario of the work place. This resulted in scheduling as per the reports given by the site engineer or the outsourced workforce and hence created loopholes and flaws.

Nearly eighty six percent of the respondent termed that site space mismanagement was not a highly likely factor in the construction waste occurrence. The inadequate space in the site in Sundhara and Pokhara and the adequate space in Babarmahal did not seem to create much difference in the waste and deterioration of materials. In Bhairahawa, higher waste percentages of bricks and concrete were seen because of ample space and placement of materials as and where desired. This also showed indifference of the management team in

practice of methods that could make difference in the reduction of waste in the first place. Storage containers to store materials were not put into practice by any of the sites. Orthodox methods of storage and use seemed to have resulted in more waste which could have been prevented.

Construction sites under this research seemed to lack proper information systems to dissipate work plan, methodology and desired output. Lack of communication, control and lack of coordination seemed to be the causes of different types of waste. Poor qualification of workers also seemed to contribute waste and this is and all sites have suffered with this problem because the labor force in the country is usually scarce and untrained. The working environment has different facets and the political stability that creates an environment of ease in procurement and execution certainly seemed to be missing in all the sites studied. Political turmoil during the research period or during the construction period created delay that had subsequent effects on overall execution and waste. Use of new methodology seemed to decrease the percentage of waste as found in Babarmahal site. The use of batching plant decreased the volume of concrete waste. However, waste due to poor storage of materials were not remissible.

Furthermore the contractors and the authorized site personnel didn't seem to pay much heed to the festivals of the nation and to plan the work schedule accordingly. Though not explicitly stated in any of the responses, during local festivals, the local labor took leave and usually returned in a span of one week or more. This resulted in delay of works and associated waste and deterioration of materials. All the responses were affirmative towards a waste specification and believed that such specification will provide alternate techniques, material salvation and reuse options along with specific dos and don'ts that would serve as guidelines.

In an attempt to find out the attitude of workforce in the construction site towards waste management, a comprehensive statement chart was included in the questionnaire. This involved 21 statements relating to site, contractor, outsourced workforce, government and practices that could be used in waste management.
With respect to the attitude of the construction work force from the conducted research, the following analogies can be drawn from this research:

- Site management is the key to ensuring reduction in construction waste
- Close interaction with construction team helps to avoid unnecessary waste
- Main contractors should be fully responsible to segregate waste on site
- Poorly offloaded and incorrectly stored materials are the major cause of wastage on site
- A waste level of 5% is not an acceptable level for the construction process.
- The government should not increase landfill tax to force waste reduction on site
- Waste reduction / minimization need not be mandatory for outsourced workforce and they should not price for costs involved in waste reduction
- Lack of care by outsourced workforce is not the major cause of waste on site
- Education of outsourced workforce is not the preferred method of reducing the wastage
- A financial incentive with financial benefits for outsourced workforce will not reduce waste

The construction team members in charge were not found to be too keen regarding interactions with the labor / outsourced workforce. Outsourced workforce was not taken as important facet in construction waste management. Either apathy or disagreement was observed regarding their involvement in waste management, especially if it involved finances. Educating outsourced workforce was not preferred by majority of respondents. These responses shed light on the short term planning of the respondents and a lack of broad view towards construction waste. They were only focused on the running project and calculated investments and returns. Since no study was found regarding how much saving can be done through education of outsourced workforce and how much can be saved if they manage the waste themselves, the respondents seemed skeptical. Also since skill is qualitative issue, respondents could not agree on how much skill improvement can be obtained through training and how it can benefit the waste reduction / management.

Majority of respondents desired to see the main contractor as fully responsible to segregate waste whereas no definitive response was observed in regards to whether the contactor should employ operatives for that. Hence a sense of attributing responsibility to the main contractor and not trying to play a part in helping the contractor manage the waste was seen. As the major contractors had project based engineers and supervisors, the lack of concern seemed more evident.

Waste reduction was responded to be understood as high priority and majority believed that control is needed in construction stage. This subtly depicts that the construction team knows that there is lack of control during construction that subsequently leads to waste. However the construction team accustomed to disposing less bulky wastes without segregation into the municipal waste stream did not believe in increment of landfill tax to control construction waste. Lack of municipal rules for construction waste landfill tax has created a sense of easiness among the contractors to dispose the wastes as suitable and feasible without much concern.

Interactions regarding waste reduction through design changes were not favored mainly due to pre finalized design and variation clauses in contract. The disagreement to accept 5% waste as acceptable level of

waste showed that it was understood that waste should be minimized but strong steps to bring it into realization was not found.

In the light of 3R(Reduce, Reuse and Recycle), since design was pre-finalized during contract agreement and changes meant variation issues, waste reduction attempts through design changes was not present. However waste reduction that could have been obtained through proper offloading and storage was also lacking. Reduction that could have been attained by educating outsourced workforce, labors and involving them in waste management was not considered important due to the tendency of the main contractor to have minimum association with the outsourced workforce. Proper planning and coordination seemed to be lacking since usable length reinforcement bars were also sold off. Inadequate monitoring hence led to indirect wastage and consequent loss. Reusing was found to be optimum. Recycling basically covered the metal and plastic wastes and these were sold to the scrap dealers. A comparative analysis showing how reduce, reuse and recycle practices were carried out in the site has been presented in table 3.

Table 3: 3R practices observed in site

Site	Reduce	Reuse	Recycle
Sundhara	No effort	Bricks and concrete used in landscaping.	Reinforcement bars sold to scrap dealers
Babarmahal	No effort	Bricks and reinforcement bars used in landscaping.	Reinforcement bars, plastics and packaging sold to scrap dealers
Pokhara	No effort	Bricks and reinforcement bars used in landscaping. Wood used to make storage platform for finishing materials	No effort
Bhairahawa	No effort	Bricks, concrete and leftover aggregates and sand used in landscaping	No effort

3.2 Analysis of Data Obtained From Nt Personnel

Information was collected from selected personnel from Nepal Telecom to obtain their views regarding construction waste and its management. NT had a good qualified technical team able to undertake building projects from inception to completion. Designs, estimates, tender proposals, evaluation, awarding and supervisions along with billing were done by the team. Apart from the building at Sundhara, in other studied buildings, the respondents were directly or indirectly involved and were aware of the construction practices. From NT, the designations of the respondents have been identified as presented in figure 11.

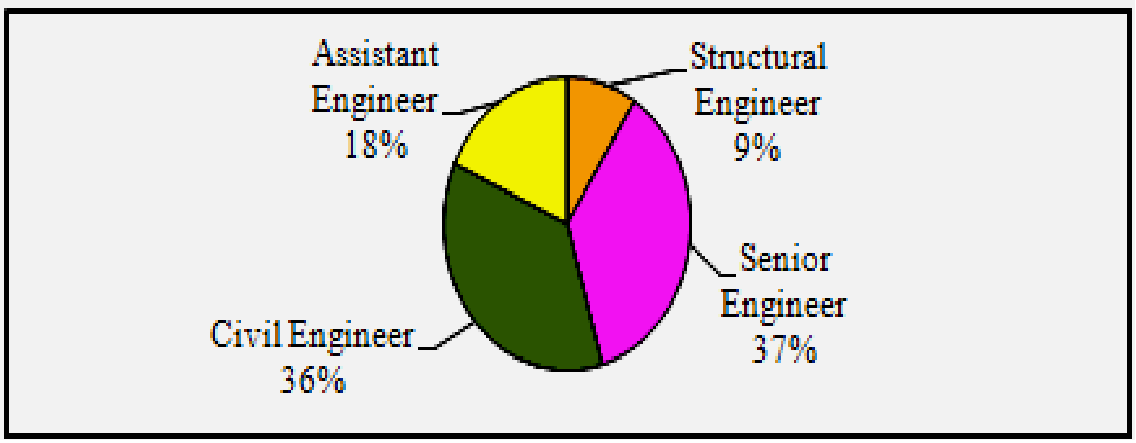

Figure 11: Designation distributions at NT

The responses obtained in questions or statements put forward to understand the attitudes and/or perceptions of the NT personnel regarding construction waste has been graphically depicted in figure 12.

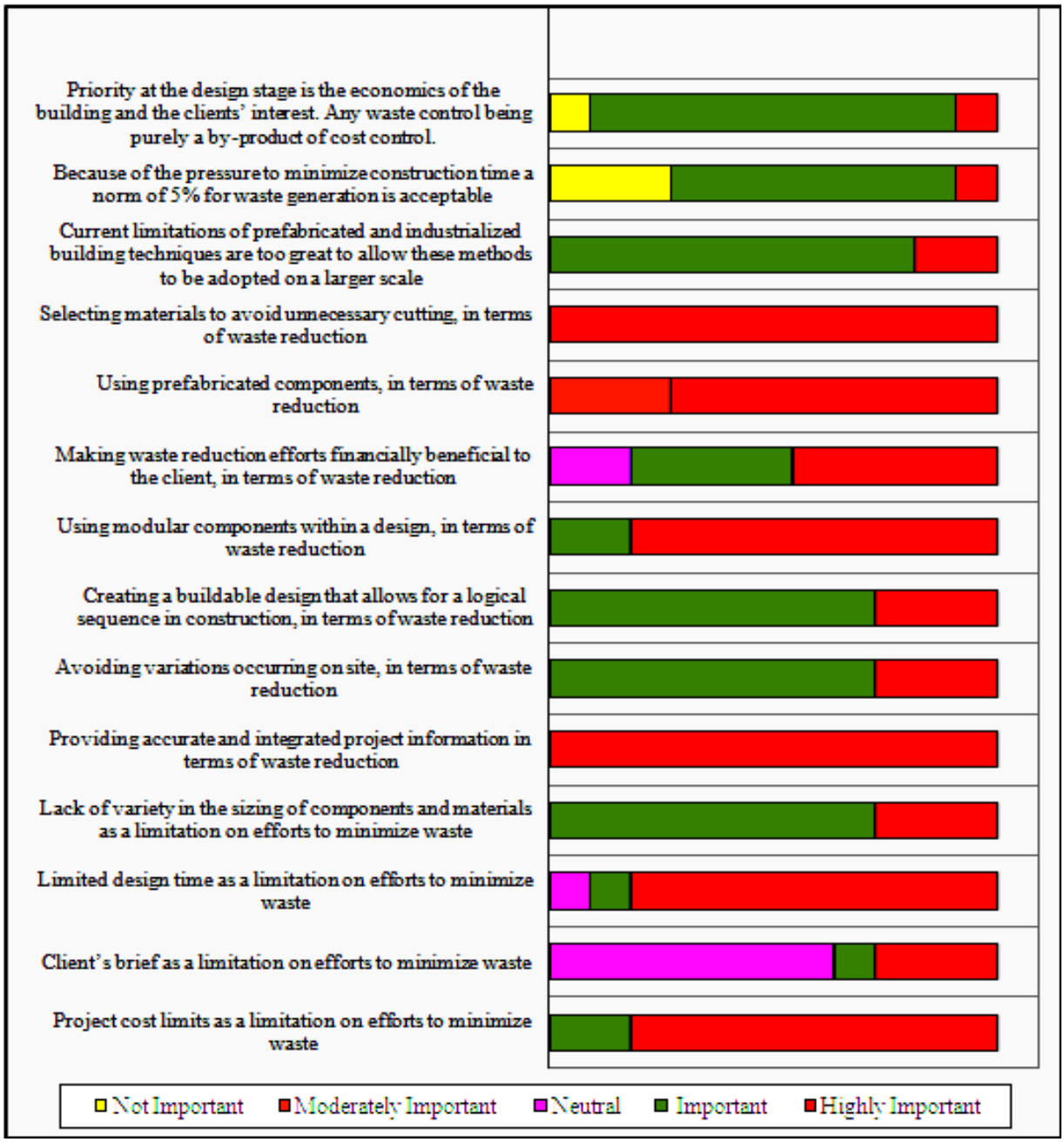

Figure 12: NT personnel's general perception toward construction waste

Responses showed that adopting new techniques of modular design and encouraging new methods like prefabricated elements were desired by NT. Further proper selection of materials and proper dissipation of information was also termed important to minimize construction waste. Limited design time, cost and profit issues seemed to be the hindrances for proper construction waste minimization as per the respondents.

It was observed that there was no strategy for minimizing waste in the design phase. NT had land ownership in many parts of the country and buildings were constructed depending upon the needs of the organization. Standard sizing of the column grids were followed in the design process but the building size and planning were governed by the need to adjust human resource and equipment alike. To the queries regarding the factors as limitations on an architect's efforts to minimize design waste, the following was observed.

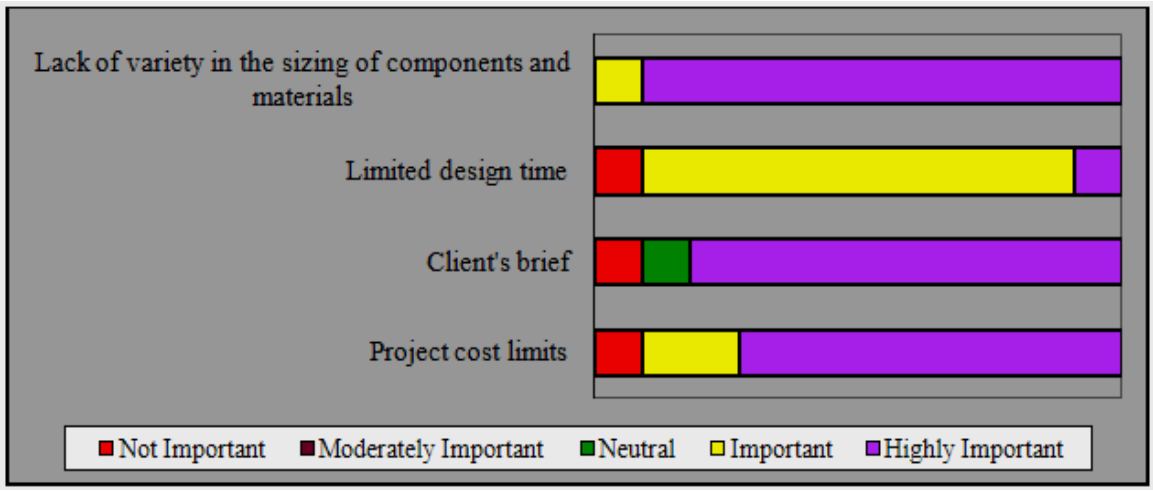

Figure 13: NT personnel's views regarding limitation to architect's efforts to minimize waste

From the queries regarding the factors on limitations on an architect's efforts to minimize waste, lack of variety of components and materials along with limited design time, client's brief and project cost limits, all were termed important. Similarly, regarding the approaches in terms of waste minimization, the following data was obtained (Fig. 14).

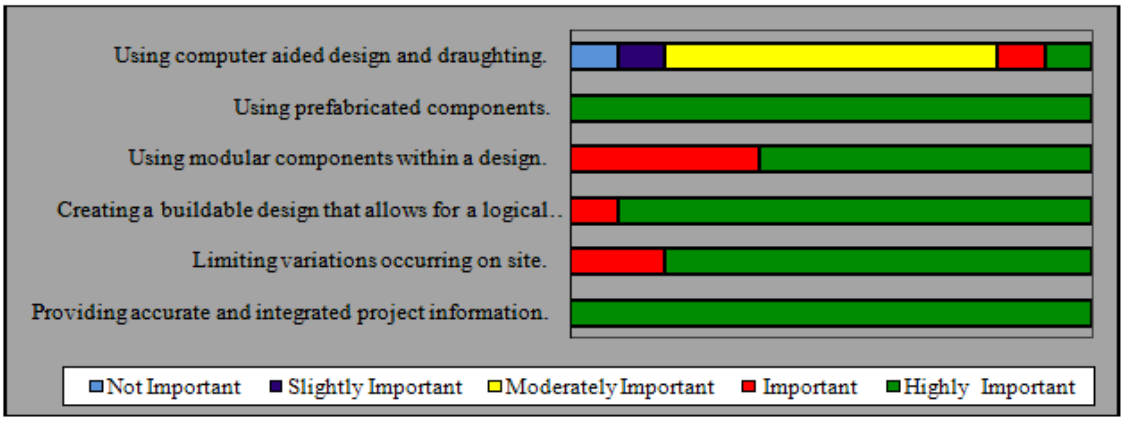

Figure 14: NT personnel's approaches towards waste minimization

It was observed from the analysis that though pre fabricated components were desirable, the lack of variety of the components and the need of the organization guided the design along with limited design time and project cost limits. NT personnel seemed to be well aware of chances of waste minimization through modular design, through prefabricated elements and by limiting variations through proper and buildable design.

It was obtained from the data that the type of contracts used in NT was 'Unit price / rate contract', where a client fully designs the project and prepares tender documents upon which competitive bids are received from main contractors and the client pays a fixed sum for each completed unit of work. It was commented that 'Adopting design and build' will put the party concerned to make effective design and reduce waste management by adopting standard sizes of available materials'. The following were the measures provided by the respondents that could be most effectively taken at the design stage to reduce waste occurring on site:

- Market study and using the available components and designing as per the standard sizes available
- Using pre-fabricated non-structural components
- Avoiding variety of sizes of structural components
- Accurate site survey depicting exact lengths, levels etc so that no adjustments have to be made during construction stage.

With respect to the attitude of the NT workforce towards waste management, the following analogies can be drawn from this research in regards to construction waste management:

- Providing accurate and integrated project information
- Using prefabricated components

- Selecting suitable materials to avoid necessary cutting to reduce waste
- Project cost and time limits creates limitation to minimize waste
- Because of the pressure to minimize construction time, a norm of 5% for waste generation is acceptable.

Responses from the NT personnel were highly inclined towards better communication, buildable design, adopting new technology of modular construction and avoiding variations. High positive response in regards to waste control being a by-product of cost control indicates that since the NT team does not deal with finances as the contractor does and relates all bills with estimates, which has the waste factor incorporated, they relate waste control to cost control. Due to the practices in Government rates, a waste level of 5% was acceptable since they were accustomed to provide that in the estimates.

Even though prefabricated components were desired, their limited market was shown as a limitation to reduce waste and at the same time though proper material selection was asserted, the limited design time and difficulty in changes after contract agreement had potential to create waste due to inappropriate sizing. A thorough market study to understand the nature of materials available and their sizes was seen necessary to plan on waste reduction from design stage.

The governance of equipment size, land shape and desired occupancy often tied the designer to a fixed form which may or may not match with the market available materials and result in waste. Ongoing practices in NT and analysis of responses showed that though changes were desired and new technology was eyed with interest, the government rules, the procurement rules, building sizes and shapes governed by office requirements and lack of market analysis seemed to be the hindrances to taking steps in creating a design that had the potential to create less construction waste.

Recycling practices were not observed in the tendering and constructing works undertaken by NT. Waste generation on site may occur due to one or a combination of many causes. Gavilan and Bernold (1994) as cited by Viljoen (2010) organized the sources of construction waste under six categories: (i) design; (ii) procurement; (iii) handling of materials; (iv) operation; (5) residual related; and (6) others. In this research, four major sources as shown in Table 4 : (i) design, (ii) operational, (iii) material handling and, (iv) procurement were found to be major contributors.

Table 4: Causes of construction waste with reference to studied sites

Design	• Lack of study of sizes in products to be used in the design • Minor Changes made to the design while construction is in progress • Use of alternate techniques as prefabricated products not explored adequately • Design misinterpreted due to lack of communication
Operational	• Errors by suppliers or labors • Strikes and riots halting works • Use of incorrect material, thus requiring replacement • Contractor's negligence in using the material as specified in the BOQ. • Festivals resulting in stoppage of work
Material handling	• Damages during transportation and offloading • Inappropriate storage leading to damage or deterioration • Unnecessary packaging
Procurement	• Ordering errors (over or under procurement) • Not paying attention to specification during procurement

3.3 Analysis of Data Obtained From Municipalities

The data obtained from both the offices (Kathmandu and Lalitpur) were similar in nature. It was observed that the legal definition of construction waste in municipality legislation was 'Discarded construction materials obtained from construction sites'. Furthermore, it was observed that no specific Act or Regulations existed that directed towards construction waste management specifically and it was dealt under Waste Management Act [10].

There was no record of volume of construction waste collected since it was not collected separately and was mixed in other solid wastes. These wastes were dumped in landfill sites. The municipal officers were of the view that the contractor should be responsible for the disposal of construction waste himself. However, if the municipality was requested for such removal, the contractor had to pay a fee specified. The municipalities till date have not researched adequately in the field of construction waste management and hence do not have sufficient data to show the volume of waste generation and forecast for the future. So far no actions have been put forward for management and possible reduction of construction waste generation. From the study of the three specific municipalities that were included in this study, the following data, tabulated in table 5 was obtained from the Baseline Study on Solid Waste Management in Municipalities in Nepal [11].

Table 5: Solid waste management practices in Kathmandu, Pokhara and Siddharthanagar (Bhairahawa) municipalities [11]

Municipality	Volume of non-organic waste (%)	Waste collection practice(s)	Disposal area	Private sectors involved in	Recycling practices through
Kathmandu	32%	Container	Landfill site	Street sweeping	Private group
		Roadside pickup		Waste collection	NGO
		Door to door service		Transportation	Scrap dealers
				Public Awareness	
				Composting	
				Recycling	
				Research	
Pokhara	44.6%	Roadside pickup	Landfill site	Street sweeping	Scavengers
		Door to door service		Community cleanup	
				Waste collection	
				Transportation	Scrap dealers
				Composting	
				Recycling	
Siddharthanagar	28.4%	Container	River bank	Waste collection	Scrap dealers
		Roadside pickup		Transportation	
		Door to door service		Street sweeping	

From the data obtained it was observed that municipality deals with all types of solid wastes in a common manner and there are no specific acts and regulations that could control the construction waste volume being dumped into the landfill site. No interventions have been used or planned for to reduce construction waste through municipal efforts.

The study conducted by SWMRMC in 2008 revealed that solid waste as a whole was discarded to the designated landfill or riverbank sites. The concept of 3R was seen in the Solid Waste Management Act but no specific guidelines were provided as how to use these. In Kathmandu and Pokhara municipality, composting and recycling were observed from Private Sector Participation. In recycling, scrap dealers and scavengers played major roles [11]. The concept of reduction and reuse of any type of waste generated is not seen in the Act. There, however, is provision of punishment in the case of breach of rules concerning throwing of wastes and misuse of waste collection containers and unauthorized use of the waste in the Act. Concept of segregation of waste at source and its practice was not observed.

The mode of waste collection and transportation didn't provide for separate category of waste to be transported and treated differently. The concept of roadside pickup was at large in all the studied municipalities.

From the research, it was seen that material waste can occur from the design stage to construction stage. However, as the proportion of the waste occurring during construction was quantitative in nature, it was seen to be more prominent and measurable. From the questionnaire, it was understood that waste is acknowledged by the design and construction team as an issue that needs to be dealt with properly. Responses mainly targeted the managerial aspect of the construction since all responses channeled to the management team, be it lack of coordination or faulty procurement or deterioration of materials. Only the political instability issue was out of control of all concerned. The conception of waste reduction was understood but not fully explored; reuse was practiced profusely on the site, mainly for bricks and concrete; and recycling was not intentional but indirectly observed through selling of unusable items. Municipal regulations were also not definitive towards construction waste management and hence proper waste management was not observed.

IV. Conclusions And Recommendation

The study concluded that the major construction wastes were Bricks, Reinforcement, Wood and Concrete. These waste categories fall in the reusable and recyclable categories. On site reuse of the wastes were observed to the extent possible. Recycling options were not explored. Management flaw was seen prominent in regards to improper waste management. All the major causes except political instability were issues that could have been handled with proper management. Management basically targeted the main contractor as he/she had the decisive and financial power over the works. The personnel at site were also found responsible for lack of coordination, communication and delegation of work related authority. The attitudes and/or perceptions of construction workforce, NT personnel and government entity varied in some issues while being similar in others.

It was unanimously agreed that waste management is essential. However, in actual work place, the workforce lacked positive attitude and behavior towards managing waste. Due to segregation of duties and least involvement of labor and outsourced workforce in overall work processes, priorities of each individual and the

associated team did not match. The aspects of time crunch, unexpected delays and unwillingness to invest in trainings and education also hampered the waste management processes. The responses from the construction team showed that 5% of waste is not an acceptable level.

NT personnel were well aware of the need for construction waste management and were willing to use prefabricated units that could reduce waste as well as to increase information flow. However the contractual obligations, the limited material rate that had to be used and the governance of time constraints had not allowed for adequate waste management strategies to be devised and implemented. Also NT did not have a waste specification that could have been a part of the contract in an endeavor to manage waste. The responses from the NT personnel showed that a norm of 5% for waste generation is acceptable in construction. Responses targeted that the main contractor should be responsible to segregate and manage waste. Municipal offices also agree that the main contractor should segregate waste before reusing or disposing it.

Municipality needs to be more proactive to manage construction waste. It was observed from the research that construction waste is not taken up by municipality as seriously as hospital and chemical waste. Though not hazardous as chemical or hospital waste, construction wastes do take up space in the landfill site. Lack of segregation of waste at the source also is the cause of haphazard collection of construction waste mixed with other municipal solid waste that reduces its potential for reuse and recycling. Construction Waste management must be started as a platform as soon as possible to ascertain less problems in the future regarding loss of space in landfills and to mitigate an even bigger scenario of sustainability and protection of human health. Some of the recommendations made from this study are presented below:

The client should focus on giving specifications for all kinds of construction wastes that can be reused or recycled during the time of contract. The specification should include methods to reduce waste at operational level, salvaging of reusable materials and also include a list of recycling markets for the contractor to take the recyclable wastes. A waste minimization and management plan should be incorporated in design and construction phase. Waste audits should be done to obtain a comparison of costs of waste management as opposed to waste disposal. For proper segregation of waste, the contractor should lay out separate bins and label them adequately so that reusable and recyclable materials get separated soon after they are generated.If outsourced workforces are deployed, they should be encouraged to manage their own waste and provided with financial benefits incorporated within their rates.

A separate branch should be established within SWM department to deal with construction waste only. To avoid roadside disposal of wastes, a compulsory requirement should be set by the municipality for the wastes at construction sites to be carted off by registered waste contractors from the Municipality. Since recyclable materials are also generated as wastes, government should put forward measures to establish recycling plants that can reduce the outflow of recyclable materials to neighboring countries.

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