Excavated soil management from road construction in rural part of Nepal.

Case: Kusum Nirman Sewa

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Abstract

Globalization has narrowed the world with astonishing technology. With this, construction projects have been continuously exercising at high speed in the world. Consequently, threatening issues are observed, and management of excavated soil is one of them. Tremendous volume of soil is excavated during the construction project and hence some percentage of the amount is being reused. There are no guidelines and regulations for these issues besides reuse and recycling.

The project of upgrading road from Bandipur to Thumka has estimated excavated 89000 m^3 of soil of which only an ignorable amount is used for backfilling. This project comprises of the practical solutions applicable based on geographical status. The company objectives are to maximize the reuse of the excavated soil. This research work was conducted based on case studies, journals, and European case history. The data collection follows qualitative research guidelines. The study is based on semi-structured interviews followed by secondary data.

Traditional trends such as reuse, recycling, land reclamation, embankment utility are the techniques for managing the excavated soil. Mainly reuse and embankment are generally used solutions.

The case company had successfully achieved 85 % of the excavated soil reusing in different areas using the resources and information. All the techniques and ideas applied were discussed and analyzed with the company chiefs as well as expertise. Some amount of soil was planned to be disposed of in the landfill site around the center. The case had not been completed since the uncertainty of the permit to dispose. The department was looking for a concrete solution for the disposal of the remaining soil. Due to the Pandemic (Covid-19), the project faced some restrictive challenges.

Keywords/tags (subjects)

Soil management, logistics in construction, Excavation soil management

Miscellaneous (Confidential information)

N/a

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Abbreviations

WFD - Waste Framework Directive

Co_2 - Carbon Dioxide

MD- Managing Director

UN- United Nation

RMP - Remediation Management Plan

OSHA- Occupation Safety and Health Association

CDW- Construction and Demolition Waste

EU- European Union

EC- European Commission

ELGIP- European Large Geotechnical Institutes Platform

M^3- Cubic meter

M^2- Square meter

KM- kilo meter

1 Introduction

Logistics in the construction industry has been overlooked in many big projects and countries. The case is even apparent in developing countries. For example, one of the countries having logistical challenges is Nepal. Nepal is a developing country in Asia, located between two powerful countries, China and India. Nepal is landlocked but diversified in different geographical areas, Terai (plain), mountainous and Himalayas. Mountains and Himalayas are covered with forest and snow, thus there are more expenses and difficulties in constructing roads from the beginning. The country itself is under geographical limitations and barriers, and the prime factor is budget. Companies cannot afford a proper logistics consultant to solve important aims of the projects.

Road construction has been considered as a primary step for the development of any place. In the case of Nepal, especially, road construction is a major need in rural areas. The reason being that a proper road facilitates the other developmental works. For example, connected areas bring developmental projects in that, other development sectors are subsequently initiated. Construction projects require large budgets to operate successfully. The budgeting process follows immense biding, thereafter the initial phase of the survey, designing, estimation, testing, etc. is carried out.

There are several reasons for road construction projects failure in Nepal. Among them, Nepal being a landlocked is one of the major limitations. This geographic limitation increases the cost of transportation and delays the shipment of goods. Nepal lies between China in the north and India in the south. Nepal is fully dependent on these two powerful nations for the importation of raw materials including fuel. Most of the rural areas are in hilly areas which brings about unique problems in roadway design and construction. The geological features of the hilly and mountain region present difficulties in the design, construction, alignment, and maintenance of the roads. The irregular terrain, fast flowing rivers, and deep gorges in the mountain region require multiple short or long bridges to connect the roads, which is another barrier in road construction.

During road construction, management of excavated materials like soil has become one of the major hindrances. Construction projects and roads often lead to production of a large quantity of excavated soil (both clean and contaminated). Most of the excavated soil ends up in landfills, uncontrollable sites or in other inappropriate areas. These kinds of practices cause negative impact on nature which include air pollution, water pollution, underground water pollution, risks in public health and many others.

Soil management is the most challenging issues in Nepal. There have not been distinct solutions provided by the concerned authorities whenever the construction bid is published. Most of the soil is disposed of not using any methods and no concern is taken by the company before starting the projects. It is mishandled and disposed of in the most unfriendly way to avoid interruption during the entire process. According to the engineer Rajiv Subedi, the soil is disposed of or thrown away from the high hills without observing the negative consequences. They are bound to perform so because the solution has not been indicated from initial stages. Although they are aware of the consequences, the company act according to their comfort.

The research question of the thesis was developed in consideration of the company’s regular concern over the management of soil. The main question of the thesis is ‘*What can be the solution of management of excavated soil having large volume?*’ The main theme of this project is also that how assigning a logistical engineer can be profitable to a company in problem solving issues regarding construction.

This thesis comprises the viable solutions for the huge amount of unmanaged excavated soil that has been estimated from the project of upgrading road ‘Bandipur to Thumka.’ Approximately, 89528.8 cubic meters soil is an estimated amount of excavation, which needs proper solution for allocation from the site. 6589.53 m^3 soil undergoes in the earth work of foundation of structure including construction of shoring and bracing as well as backfilling. The remaining amount requires proper management balancing economically and logistically. Although there are not sufficient details regarding the disposal of the waste soil from the authorities, the bidding company is irresponsible for the solutions. Even though some amount of soil could be disposed of in dumping areas as directed by the government, the logistics department plans for alternative methods.

Figure 1 shows the current situation and condition of the earthen road before the project of upgrading.

Figure 1. Condition of the gravel road before the upgrading project

Logistically, the company requires a practical solution for the unwanted soil. This thesis is based on the practical work experience of coordinating with all the workforce working on this project. Regardless of proper rules and agenda from the government and guideless, the company tends to emphasize the amendment of traditional methods of disposal excavated soil.

Er. Rajiv Subedi (MD of the company) initiated first green road waste management in Nepal considering plastics and other waste materials into bitumen mixture reducing asphalt concentrate cheaper and environmentally friendly road. The company focuses on reducing, recycling, and reuse strategies in ongoing projects whereas possible. This demonstrates the enthusiasm for friendly environmental solutions (Lamichhane, 2018).

Theoritcal basis

Next section pursues to provide theoretical background of excavation soil management. It assists the primary introduction of soil and waste management including case studies in Europe and its theoretical solutions. Basically, reviewing the history of soil management, the contexts are combined with economic and environmental perception. The aim of this part was to provide information about the logistical barriers that are part of the process and the ways to overcome them.

2 Road management

Road system is a fundamental component of economic and social development, which absorbs huge portion of National Budget (Robinson et al., 1998). Road management can be observed as a progressing process that attempts the optimizing the performance of road networks. Road management has objective to maintain and improvise the existing road network to ensure the quality and safety manner (Robinson et al., 1998). Roads have both positive and negative influences on people. On the positive side roads provide the opportunity of mobility and transport for people and goods. On the negative side roads occupy land resources and cause adverse impacts on natural resources and discharge areas. Also, roads form barriers to animals. The three most damaging effects of road construction and management are noise, dust, vibrations (Ullberg, 2021). Additionally, road management must also prioritize the issues regarding effectiveness and environment (Robinson et al., 1998).

3 Basic of soil management

On the entire planet daily 11 tons of solid waste adds up to 1.4 tons for everyone on the planet. Construction and demolition hold 36% of this total solid waste which is the largest share. The increasing amounts of waste and poor waste management is not only a major environmental problem, but it also has a high economic cost. According to UN, the cost of not addressing waste management problems in developing countries exceeds the cost of proper waste management by a factor of 5-10. Not only cost, but solid waste also adds to global warming. When solid waste is burned, it adds further to CO_2 emissions which is responsible for about 5% of global greenhouse gas emissions (Tons of Resources Extracted from Earth, 2021).

Ongoing urbanization and growth of cities will lead to an increase in road construction and many other developmental infrastructures. This will significantly increase excavated waste materials as well. Together with this, there will be an increment in the demand for natural resources such as water, land, energy, and mineral resources. Urban areas are responsible for emitting of about 80% of global CO_2 and is also responsible for about 80% of global energy consumption. To reduce climate impact from construction waste, there should be improvement in resource efficiency and an increase in reuse of construction materials (Magnusson et al., 2015). Rapid development and attraction of people toward easy and comfortable life, the flow of population to cities is increasing or the development of rural places is necessary. Many developing countries are in the phase of accessing roads to rural areas.

The European Waste framework directive (WFD) has declared all waste which is excavated soil and cannot be reused in site from which it was excavated. Thus, municipal management is responsible for addressing these issues with remedial methods, licensed landfilling with all waste management requirements (Darmendrail et al., 2012).

A unique method was introduced in French contaminated soil management framework revised in 2007 is based on the site-specific risk assessment linked to the current use (predefine allocation of the site) and does not specify the generic guidelines values (Darmendrail et al., 2012). It aims for high protection of humans and the environment. This method works sorting out the area before or in future use. If there is uncertainty to utilize then Remediation management plan (RMP) restores the compatibility between public health and the environment. Provided that the decision has already been made to use the area, compatibility with the state of the environment should be determined.

This results in a large amount of soil that is not recycled or reused as a burden on the environment. This is taken as a serious threat in near future without a distinguishing solution. The situation has established to underdeveloped strategy for practical but secure way to reuse the contaminated soil, decreasing the adverse effect to public health and environment (Darmendrail et al., 2012).

According to remediation technique, that if the contaminated soil is reused in the ongoing site, then it is a part of soil management plan. Wherever the reuse is not possible, the contaminated soil is disposed of in a licensed landfill site. The Waste Framework Directive also prevents the re-use of such contaminated soil in Europe (Darmendrail et al., 2012).

3.1 Excavation soil

While referring to construction and demolition waste group excavation soil is one of them. Excavated soil is generated through excavation activities and can be classified into vegetable soil, sand, gravel, rock, clay etc. Excavation is the cardinal pace in most infrastructure development. Occupation Safety and Health Association (OSHA) defines an excavation as any "man-made cut, cavity, trench, or depression in the earth's surface as formed by earth removal" covering buildings to dams and highways (OSHA Publication 2226, 2015). Earthwork, trenching, construction of wall shafts, ditch and fill of inclined grounds and tunneling etc. comes under Excavation (Kibowen, 2018).

3.2 Introduction and Method of excavation

Excavation waste can be defined as "material that arises from excavation and site clearance works, and chiefly consists of topsoil and subsoil" (Kibowen, 2018). In 2012 in Japan, it was estimated that the excavation waste amounted to approx. 140 million cubic meters. Thus, this waste must be managed (Kibowen, 2018). Excavation waste emitting from civil and site works is classified into two types, they are 1) Rock and stone and 2) Soil/Sand (Kibowen, 2018).

Mostly, excavation is done using mechanical means, but the technique used to depend on the factors such as nature of the soil, size of excavation, scale of work, underground water condition, environment condition, budget, construction time, available equipment, neighboring excavations and foundation types of neighboring buildings and their conditions and control over the job (Kibowen, 2018; Wong, 2010). According to (Ou, 2006), some commonly used methods for excavation are the "full open cut method, braced excavation, the island excavation, the anchored excavation method, the top-down construction method and the zoned excavation method". The removal of the excavation waste can be as different as manual e.g., using wheelbarrow, bucket and lift, hoist rack, gantry crane, conveyor belt and use of dump truck (Kibowen, 2018; Wong, 2010).

3.3 Determining the types of soil

According to (Hale, Jos, et al., 2021), the excavated soils can be contaminated depending on their origin and historic age. Therefore, as a first step of reuse, their level of contamination must be well examined and characterized. After this, the soil should be geotechnically evaluated and characterized according to as they may have geotechnical variations, to solve the questions like is the soil ready for the next reuse for the specific purpose or not. In many countries there are still not any guidelines about the steps that must be followed while testing and evaluating the soil which may lead to any risks while improvising the quality of soil. The authors have said about the Brazilian situation where a flowchart to cover excavated soil for several reuse strategies based on their current geotechnical and environmental properties has been proposed which is suggested to be fitting for the worldwide use. Till date there are not any specific rules in any country which guides about the documentation that is needed to show an excavated soil meets the geotechnical and geo environmental properties that allow reuse. Facing all these documentation challenges, as well as other barriers, the use of virgin material with well-known properties is far easiest way to satisfy geotechnical and geo environmental requirements than to reusing excavated soils which may be harmful with low quality (Hale, Roque, et al., 2021).

In the article, the clean or lightly contaminated soils are defined as those exhibit an acceptable risk for public health or environment (i.e., insignificant risk) and could be reused directly with or without geotechnical improvement (but without geotechnical treatment, pollution level may increase) for other buildings and constructing projects. In Japanese legal system, these soils are not even categorized as waste, but do require proper management (Hale, Roque, et al., 2021).

3.4 Economical perspectives

Apart from this, management of waste materials during construction is the foremost. Depending on local geographical conditions excavated materials can be rock, stones, gravel, sand, clay, and organic material. The quantities of excavated soil and rock can be huge, making the cost of hauling and handling significantly high. Around 30% of the project cost is used for the on-site handling and hauling of the excavated materials (soil and rock) and earthworks in infrastructure projects. The optimization of waste management in projects not only reduces the cost of construction but contributes to environmental sustainability. This could be accomplished by significantly reducing the carbon footprint for a total project based on both financial and non-financial factors of construction (Kenley et al., 2000; Kenley & Harfield, 2011).

3.5 Theoretical solutions for excavated soil.

The management of excavated soil and rock vary between construction projects. The possible management alternatives for excavated soil and rock are 1) use on-site 2) use in other projects 3) pretreated before use in other projects 4) store for later use, 5) use as landfill cover or dispose at landfill. Other parameters affecting the possibilities of soil management are geotechnical properties, geo environmental properties, availability of recycling facilities, landfills, and quarry materials. The geotechnical properties are the basis for what functions to be accomplished and the geo environmental properties are for what material can be acceptable at the construction site. Particle size, water absorption, density, deformation properties and bearing capacity are crucial aspects that need to be considered boosting with PH value, organic content, total concentration (Magnusson et al., 2015).

In today's world, there is growing interest in the probabilities of reusing and recycling excavated materials like soil and rock for construction purposes. When focusing on reusing, typically on- and off- site options include embankments, roads, landfills, railways, or landscaping. On-site reuse is preferred to meet sustainability goals only when these options are supported by the national guidelines, legislation, technical specifications, and standards. Even in the European countries, the Waste Framework Directive (WDF) is the initiative point for the reuse of excavated soils. This directive attempts to help move the EU closer to a recycling society, by reducing waste production and using waste as a resource. Also, WFD expresses that 70% of construction and demolition waste (CDW), which is the main source of excavated soil, should be recycled by 2020 (Hale, Roque, et al., 2021).

"Closing the loop" was the action plan introduced by the European Commission (EC) supporting the circular economy, in December 2015. Following this action plan the "EC Construction and demolition Waste Management protocol" and "Guidelines for the Waste Management audits before the demolition and renovation works of the buildings" were made, however this plan could not address clean and lightly contaminated excavated soil. Later in 2020, EC published a report: "Circular Economy plan for cleaner and more competitive Europe " with a new scheme for a sustainable built environment. Promoting initiatives to diminish soil sealing, rehabilitate abandoned and contaminated brownfields and improve the safe sustainable and circular use of excavated soils is the primary target (Hale, Roque, et al., 2021).

From this, reuse of excavated soils is the mainstay of sustainable built environment but that must start with the sustainability ideas at the planning and design stages of an infrastructure construction project. At the same time, so far only very few countries have developed principles and guidelines of practice to support this for instance (France, Australia, Canada, Switzerland). These principles or guidelines documents not only address the legal model for reuse of excavated soils but give best emphasis on the practices for their sustainable management along with forethought, especially in cases of contaminated soils. The objective of this work is to present the status of reuse of excavated soils, of which the majority are clean or lightly contaminated (Hale, Roque, et al., 2021).

4 European case studies

In 2012, a large amount of soil (140 million cubic meters) was generated from construction sites, and 43 million cubic meters of it was reused at construction sites. New soil materials (26 million cubic meters) were collected from mountains or riverbeds, which should be reduced to minimize the environmental impact. Further utilization of these soils is required. Standardization of excavated soil is an important task to improvise the use of excavated soil. The Ministry of Construction in 1994 proposed the standardization of excavated soil. This standardization includes a five-level classification system of excavated soils (1st to 4th class soils and muddy soils), as well as the matching of classified soils and their application. The classification is based on the state of soils such as soil type, strength, and water content and the application include road base, backfill, elevated land construction, reclamation etc. Some of the muddy soil can be categorized into waste while the excavated soil (which is clean and lightly contaminated) are not categorized as waste as said above. Before reusing the excavated soil, it is necessary to find out or discuss its contamination whether it can be use in geotechnical application or not so that it can be carried out using needed treatments which may further helps in cost and pollution reduction as well (Katsumi & Katsumi, 2015).

Several countries like (Australia, Canada, England/Wales, France, Norway, Portugal, Slovenia, Sweden, and Switzerland) are members of the working group "Reuse of urban soils and sites" which with other EU countries and leading EU geotechnical engineering research organizations constitutes the European Large Geotechnical Institutes Platform (ELGIP). ELGIP aims to promote best practice of the professions, its networking and its societal relevance and its working group. "Reuse of Urban soils and sites" work for a safe and resource efficient reuse which directly helps for sustainable and wastage free environment. The starting point for the reuse of excavated soil is to find out whether they are classified as waste or not. As mentioned above the excavated soil should be identified first as clean, contaminated or waste. WFD also clearly defines and classifies the excavated soils and addresses how the soil should be treated according to its type. In some countries (such as Norway, Sweden) the obtained excavated soil from construction sites is automatically considered as waste. As a result, the large amount of excavated soil ends up in landfill (Hale, Roque, et al., 2021).

The above selected countries of the ELGIP working group have some common practices for the reuse of excavated soil. Appendix 1 clearly shows how the countries in ELIGP working group have carried out the reuse of copious amounts of excavated soil.

Also, Appendix 1 provides the details of the amount of excavated soil that is landfilled and reused in the ELGIP working group countries. From the data available, we can see an enormous difference in the amount of excavated soil generated throughout the countries. Among the given countries France is the country with the largest amount of excavated soil i.e., 7 million – 10 million tons per year whereas Portugal is the country with the smallest amount of excavated soil i.e., 339,386 in 2017. The countries have classified the excavated soil into hazardous and non-hazardous. After this, the soil is landfilled, black filled and recycled. Norway in 2017, sent 98% of non – hazardous excavated soil to landfill in contrast Portugal sent only 17% of non – hazardous excavated soil to landfill. However, this varies among the countries according to their social, political, and economic status. The best practice promotes to reuse of excavated soil and emphasis the facts that reusing excavated soil has actual economic, environmental, and social benefits in comparison to traditional disposal alternatives (Hale, Jos, et al., 2021). But this detailed data gives other developing countries an idea to develop rules on soil management and implement rules which will drag the world into a sustainably managed and a pollution free environment.

4.1 Benefits and advantages in environmentally friendly

Reusing excavated soil and rock along with management also has a lot of environmental and economic benefits. Myriad studies demonstrate the environmental benefits of reusing the excavated soil at the construction site (Magnusson et al., 2015). In their journal, 44% of the excavated materials is possible to reuse and relocate by planning for huge balance of earthworks in an industrial construction site as a result it reduces earthworks and transports to landfill as well as the production and use of quarry materials. The overall climatic damage done by transport with the release of CO_2 be reduced from fuel savings and hence further cost could be reduced. The increased reuse minimized the material management costs and climate impact by about 85%. These benefits can be obtained by reusing excavated soil and rocks on-site. They also have mentioned about the technology 'Stabilization' which improves geotechnical properties in terms of increased strength, reduced permeability and compressibility of soil which makes it possible to use low quality materials in construction, such as soft soil that are mostly landfilled. If the excess soft soil from excavation is stabilized and used in construction, it will automatically reduce the use of new construction materials and help to save resources. The author describes that on-site reusing of excavated soil and rock is possible only when there is enough availability of space at the construction site. In the cities where there is not enough space at the construction site, the on- site reusing of excavated soil has less possibility.

Another way of reusing excavated soil and rock is to the other projects. When the materials are transported between construction sites, they are directly reused but it is only possible when many constructions site are running at the same time (Magnusson et al., 2015). Authors illustrate that the benefits of using excavated soil and rock in other projects have been studied by the English non- profit organization CLAIRE. They claimed to conduct a study of a cluster project which consisted of four remediation projects located close to each other in Northwest England. In these projects, substantial amounts of contaminated soil were excavated and transported to a temporary hub located at one of the construction sites where the materials were treated and thereafter transported to construction sites for reuse. This group approach resulted in an increased reuse of excavated soils of a total of 30,000 m3 and reduction in discharge of about 100 tons of CO_2. In addition, use of new materials, transportation, landfilling was reduced which saved the cost to about

30%. To make the above-mentioned way of reusing excavated soil possible there should be coordination between the construction sites, there should be a shared planning and the planning should include how the joint coordination is benefitting all the sites involved(Magnusson et al., 2015).

(Magnusson et al., 2015) describes excavated soil and rock which is classified as waste can be transported to a recycling facility where it is treated and prepared for use in other construction projects. This process is called recycling at a facility. They have revealed that, from different studies there are numerous benefits when using recycled C &D waste including excavated soils and rock produce at recycling facility than to use quarry materials. The CO_2 emissions were decreased in good amount when using C & D waste compared to quarry materials. Though it is difficult while transporting recycled materials than the natural ones but still has a positive impact on the environment. There is also a dramatic difference in climatic impact while producing natural aggregates than the recycled one. The authors have described about the numerous examples of studies which focus on the economic benefits for recycling other C & D waste than the excavated soils and rock. From all the studies it is concluded that for the recycling facility an appropriate location needs to be selected as transportation hinders the economic and environment aspect. Apart from this, through the studies recycled C &D waste including excavated soils and rock is risky economically but may be beneficial for environment. CO_2 saving is the most significant benefit from all the reusing strategies.

4.2 Barriers

Regardless of increased concern in reusing excavated soils, there are still many hindrances that bound the practice. (Hale, Roque, et al., 2021) have described the barriers that limits the reusing of excavated soils in their article. They have divided the barriers into dissimilar categories like 1) regulatory 2) organizational 3) logistical 4) material quality. They also have characterized and summarized the barriers as follows:

The authors have defined regulatory barriers as those problems which arise from the consequences of different regulative bodies and authorities from the environment. Under regulatory barriers, complicated legislation frameworks with both local, regional, and national government are included. There is a lack of guidelines for reuse in most countries. The process time and long applications are the problems when reuse is the possible choice. The authors have concluded different studies from other references as well which show different cases on regulatory barriers. For instance, the WFD must be followed when the soil is removed from a site as waste, also when reusing it the planning and building act and the pollution act must be followed. When reusing the excavated soil, permission from the environmental authorities is mostly needed and there must be a risk judgement which shows that the process does not harm any human health or the environment. The permission and application process sometimes may be exceedingly long, which may be a barrier to a project within a brief time span. There is also limitation on the ownership of the materials needed to be reused as the owner should be responsible for the future consequences and impacts of the new construction. But if the owner disposes of the soil at a landfill, they do not have to answer any questions which makes reuse of excavated soil a less appealing choice(Hale, Jos, et al., 2021).

Organizational barriers come with the lack of planning policy and its application during construction works. The project planning process plays a vital role in reuse of excavated soils. With the traditional solutions for reuse of excavated soil it is difficult to say whether they are best, or the new option should be introduced. The overall planning and its implementation, which include the handling of the excavated soil of the project, is done by the developers or the owners, with less involvement of the contractors as they are assigned to construction only. As a result, the responsibility of making the most of reusing the excavated soil falls within only specific criteria excluding all the parties. The lack of holistic and early planning of reuse (for e.g., preparation of application, coordination with other projects etc.). also hampers the reuse of excavated soil. The articles say that in recent times, different countries in the world have increased the use of design build contract form. In this form the contractor is responsible for both construction and design, they are the decision maker about the management and material flow. Then the contractor begins the design later which is vastly different than the traditional build contract where the developer designs the plans before the involvement of the contractor. In this form, an application of reuse of excavated soil is prepared in design stage by the contractor and may postpone construction work which is a plus point to prepare application as early as possible for reusing(Hale, Jos, et al., 2021)

Thus, when the responsibility of designing, planning, and implementing includes all the parties as possible it may reduce organizational barriers in reusing the excavated soil. Not only the owners or developers but the contractor also must be included and given equal responsibility and power to handle the materials which may shorten the time limits as well for the reusing of excavated soil. Comparing the traditional building method, the modern design build contract form is effective in case of organizational barriers (Hale, Roque, et al., 2021)

4.3 Logistical barriers

Logistic and economic barriers occur when the supply and demand for excavated soil is not always inline. It results in the problem of storage space required for excavated soils before it is used. In most dense cities, the construction sites have limited space so they may need a temporary storage site for the excavated soils. Not only the space, but time is also another problem as excavated soil is permitted to store on and off site for a limited time before it is used in another construction projects. The authors(Hale, Jos, et al., 2021) says, according to European landfill Directive, the excavated waste can only be stored for 1 year as immediate storage and for 3 years before recycling. For further storage than 1 year it requires permission from the authorities, so it creates problems in the projects which need to store excavated materials for more than a year for its reuse. Transportation is another factor that enlarges the logistics barriers. When the materials must be transported to and from storage sites or to the recycle facility where it is treated before using in the construction sites, it increases transport and loading costs. It also introduces other indirect problems such as emission of greenhouse gases which results in negative environmental and financial impacts. If the tax for using virgin soil and landfill is low, then there will not be any interest in reusing the soil it can be counted as a financial barrier. The economic barrier is felt depending on the country as the positive and negative effects of reuse of the excavated soil varies according to the respective countries (Hale, Roque, et al., 2021).

4.4 Guidelines

From the above-mentioned barriers, we can conclude that the management of excavated soil has many hindrances. As reusing and recycling is one of the best ways to manage excavated soil, it has also many negative aspects along with positive. It is easier to use virgin materials than the reused and recycled one as the properties are well known but considering other facts of environmental pollution the use of reused excavated soil must be emphasis it needed more guidelines(Hale, Jos, et al., 2021).

Further in this literature review we are discussing different possibilities where reusing of excavated soil can be increased. (Hale, Roque, et al., 2021) have talked about diverse ways to increase the reuse of excavated soil in their article. It is important to increase the reuse of excavated soil to move towards the goal of UN Sustainability Development. By reducing the transportation, landfilling, and use of virgin materials, it helps in the reduction of costs and climatic impact. Reusing excavated soil can lead to monetary as well as non-monetary benefits. As the authors say in different studies it is possible to reduce the emission of CO_2 by reusing the excavated soil on site, off site and recycling. Therefore, considering all these things the ways to increase the reuse of excavated soil are as follows:

1. Rules, guidelines, and regulation should be improved or developed to provide the projects planners and constructors with the tools they need to consider reuse of excavated soils.
2. Agreed management systems within the same countries or the countries across the world may provide greater understanding for reuse of excavated soil.
3. The local bodies within the same country should have the same set of conclusions, which could help in joint work to increase the reuse of excavated soil.
4. The simpler the guidelines and instruction, the easier the reuse of excavated soil and its practical achievement.
5. When the cost difference of using virgin materials and reused materials does not work, the tax on landfill can be imposed which may motivate towards the reusing of excavated soil.
6. Rewarding the one who proposes proficient level of reuse and emphasizes less environmental impact may increase reuse of excavated soils.
7. A great evaluation system on how the soil is being managed and reused can also be a factor to increase the reuse of soil.
8. A well-managed planning process and design of the construction is needed.
9. The demand of excavated soil in the construction and demolition projects should be identified early in the planning process to increase reuse.
10. If the national reuse projects could target the individuals, this would give something to them to be focused on when designing solutions.
11. The tenders for major construction projects can be organized in such a way that their requirements can be how much excavated soil can be reused, may increase reuse.
12. Traceability and quality control of excavated soil with clear responsibilities are crucial for the increment of reuse.
13. To address the problem of storage, more soil hubs could be helpful which may provide a transparent market that circulates the supply and demand for excavated soil.
14. Documentation is the crucial factor to increase the reuse of excavated soil. Suitable material quality should be documented as per the intended reuse.
15. The suggestions above are only the view of the authors and not any stakeholders. These mentioned suggestions are based on the references, literature, and other experiences.

Waste generated by the construction sites is increasing worldwide. The construction waste includes excavated soil and rock. Hence, excavated soil management has become one of the topics of discussion in today's era. The above review through different references, articles, journals, studies, has endorse about management of excavated soil. The review has investigated unusual ways for managing soil which emphasize its reuse. Furthermore, there was investigation into how different countries in the world are reusing the soil. The barriers while reusing the soil and the ways to increase the reuse of soil are discussed. The soil can be professionally managed, and the environment can be pollution free(Hale, Jos, et al., 2021).

5 Methodology and Implementation of the project

5.1 Qualitative and quantitative methods:

Both the methods provide effective conclusions to analyses data and concrete the results accordingly. (Daniel, 2016) emphasizes, qualitative research utilizes the data outputs from methods such as discussions, conversations, interviews, case studies and observations. It has its criteria to assist in primary and secondary data and functions as a key role in detailing the research. Whereas quantitative research methods are usually tested hypotheses based on statistical evaluations and numbers(Newman et al., 1998). Carrying a few barriers on each side, qualitative methods are physically practiced by the researcher (Newman and Benz 1998, 18-19). Also, additionally it generates more expenses on digging out the data on the procedure (Joy Frechtling et al., 2002). Quantitative methods push the research slightly less deep into the subjects and is dependent on quality and uniformity of analyzed data. Since quantitative research produces more hypothetical analysis and comparison, resulting in large volumes of processing data which may be stressful as well as inflexible to handle(Daniel, 2016).

5.2 Primary and secondary data:

These two types of data define the characteristics and nature of the research activities and way of obtaining different methods (Joy Frechtling et al., 2002). According to the writer, primary data refers to the information gathered from the prime sources like interviews, surveys, inspections, observations, discussions, experiments, case studies varying the cost according to required quality and investment. Whereas, Secondary data is considered from the original article, journals, books, records, anything that has been already published.(Muhammad & Kabir, 2018) supports primary data can be more trustful and genuine since it cannot be altered or manipulated.

5.3 Interview

Interviews are taken as the tool to obtain exciting hypothesis with elevated level of information power with minimum contestant available (Malterud et al., 2016). This statement elaborates the advantages of the method interview study. The author also describes that the quality dialogue determines the quality of the information from the participants. Strong and clear communication can be more fruitful than study with ambiguous and unfocused dialogue (Malterud et al., 2016). Interview can be unstructured, open-ended question on one topic and the interviewer can adapt to response accordingly, so they are called semi – structure interview (Tenny et al., 2020). The authors also describe that survey, interview, observation, and discussion are best source of obtaining qualitative information for getting more deeper insight solution.

5.4 Implementation of the project:

The current trends regarding solid waste management are waste reduction, reuse, recycle and response (Hao et al., 2007). The excavated soil is disposed into landfill sites and the ratio of the reusable soil is comparatively low (Magnusson et al., 2015). Wise contractor, engineer or client must resemble the concepts that with the proper material handling, the cost of recycling and reusing the material could be less than that of buying and disposing the excavated material (Rahimzadeh et al., 2018)

The research was based on mostly case studies and journals regarding soil management, due to less adequate defined solutions being published through construction project management. With consulting with the M.D of the company Er. Rajiv Subedi, the conclusion was pointed into more practical and usable solutions. So, for further research it was based on mostly case studies with vast amount of soil management in global scenarios.

The primary research method was the solution was implemented focusing interview, survey, and discussions. Information is required to be an impactable factor for decisions to be executed during the process. Implementation requires correct and reliable resources which could be directly from the authorities or from the community people. Since the road construction was in rural areas, the committee was interested and committed to providing aid as much as possible. Reusing soil in self project was mentioned from the estimation and bill of quantities. For alternative solutions, information needs to be gathered from reliable sources and analyses it.

The interviews were taken specially with the project engineer Rajiv Subedi, village development committee, forest department, road department, machine operator, heavy truck drivers. The concept of evolving logics or ideas for the solutions requires numerous communications with most of the crews revolving round the projects. Interviews or consultation did not depend on the limited questions to limited people, it was also short discussions or short and multiple meetings, and discussions were also made as required to obtain the information and approvals.

Obtaining the primary data as well as secondary data, the company team started to discuss the possible applicable treatment and analyze the consequences, also cost calculations. When the maximal criteria are crossed, the company steps into the initial steps of the process. In the pre implementation stage the team was advised to focus more on safety and accept the fact that a small mistake could get a huge price tag. Er Rajiv Subedi stands on the side that it is important to manage traffic while working in rural areas because of the narrow and single lane road because it is difficult for two vehicles to pass by. It increases the risk of accidents while using them frequently.

6 Research results

This project was based on qualitative methodology. The questionnaires were prepared in advance and followed the semi-structure format. The questionnaire respondents include the head of the village committee, head of school, community people and locals. The interview was divided into two phases. In the initial phase, the question was about the landslide history of the village, to know particularly the adverse effect of excavation in several places. Some of the questions are follows:

1. How often does a landslide occur in this area of the construction site?
2. What range of effects is? Highly dangerous/ medium / ignorable.
3. What endangered species have been spotted around the site?
4. Any special conditions or suggestions before starting the project?
5. Open participation for the local workers to support local empowerment and materials.

As per the interview and data analysis from the village committee, nonmajor landslides occurred in the upgrading road track. Ignorable landslides were observed due to rainwater causing minor damage. The questions about landslides are to detect extra filling up cases of excavated soil from the site to the damaged area. The management team and the villagers suggested areas that are suitable for storage and restroom and safe preventing from landslides or natural disasters. Road construction in geographically hilly and rocky foundation are supposed to be examined properly about the history of landslides as per the suggestion of Er. Rajiv Subedi. To avoid major accidents or loss in rainy season, such a survey is necessary to keep in record. Infrastructural imbursements have been recorded multiple times in recent years facing natural disasters.

Endangered animals in rare cases were spotted in the site, though there is dense forest around, no human attack was reported. This first phase of interview verified certain issues of the projects including no human attack by dangerous animals that confirms security for the workers staying for the night in the camp (store/camp/rest).

The first phase interview was taken to measure the mentality of the community people and locals for this project to ensure less discomfort during the period. Crucial responsibility of the logistic engineer is to ensure minimum risk of project collapse or delaying the project completion. After this interview, we were able to percept the local’s concept regarding the disintegration or problem that may arise during the project. We were able to conclude that there will not be adverse disagreement by the community during the project.

Results from the survey were convincing as people were actively participating in the pre implementation programs and discussions. One of the primary agendas of the first phase survey is also to mention local employment through this project. As this project is running through uneven pandemic (economically unstable) situation, it is also major concern to employ local workforce in the project. Labor is highly affected in this political phase, especially in the underdeveloped country as insurance companies, labor unions or any sort of organization has not been established. 15 skilled workers have ensured their presence as workers, which was informed to our representatives via local people and chiefs.

The company and worker have reached a fair salary agreement, allowances, and benefits. Locals have granted permission as companies can use roadside huts and other private land (currently not in personal use). Storge unit, rest room or bitumen heating machine as per the required necessary will be carried out in those granted areas.

In this road upgrading project, soil excavation with all types of soil including disposal is higher than 89520.8 m3. As per the (Rahimzadeh et al., 2018) , solution of the excavated material can be reuse and recycling in industrial production, aggregates for embankment, back filling in the road construction, voids, and land reclamation. The Gotthard and Loetschberg base Tunnel projects in Switzerland were the first projects to reuse and recycle the use of maximum amount of excavated material from the tunnel. 35% of the material were recycled as replacement as aggregates that also requires proper classification of materials.

Figure 2 describes the excavation of soil and rock in the site, where the operator was performing the process with excavator.

Figure 2. Excavation of rocks and soils from the road construction

According to (Katsumi & Katsumi, 2015) in 2012 total sum of 140million m3 soil was generated from the construction site of which 43 million m3 was reused in other construction site. These theories drive the conclusion of the excavated soil of our project to classify the soil to reuse with high amount of possibility, which also is defined as healthier for environmental impact.

As a conclusion, 6589.53 cubic meters soil requires in back filling and embankment in this upgrading project. Only 7% of the soil is reused in this project, thus remaining quantity requires a proper solution. Reuse of the soil requires the perfect placement of the site to manage, this requires definite information regarding the process of reuse or transfer.

Company approves the second survey primarily for the concrete resolution of unsettled 93% of soil excavated. The second phase of the survey has been conducted in a wider range within criteria in state level forest department and authorities. Since there is no major landslide area or non-needed backfilling area of soil nearby, this conducted survey aids the required outcome solution for the embankment.

The second phase of the survey includes the authorities within the member of states that supplies the information of landslides and construction data within another district. The questions are listed below:

1. Any major landslides near Bandipur district?
2. Distance specification if the affected area is mentioned?
3. Requirement of soil for personal use that have be notified to regional road headquarters of village development committee.
4. Road construction sites that are parallelly running along with company?
5. Information about construction of houses near highways.

This survey leads to the information of the recent heavy monsoon rainfall triggered heavy flood and landslides in 26 districts of Nepal. The major disaster was seen in Bandipur rural municipality but also more than 70 incidents were recorded in authorities from floods and landslides in the month of June 2021(Khabar, n.d.). Though a distinct major accident was not Bandipur area, but 26 families were displaced from their residence affected by the flood and the number of human losses was 2. The following accident was seen in another village from the site approximately 30 km distance from the upgrading site.

Given information of affected areas provoked a team to calculate the volume of excavated soil that can be conveyed. A site visit with additional support of local authorities determined to reuse 35% of the soil to support the backfilling, land filling also for the house construction. In addition to the demand, the committee also offers to bear half of the expenses on trasportation.35% of soil is equivalent to approximately 32000 m3.

Absoils project (Ollila, n.d.) reports that 20 to 30 million tons of excavated soil is generated in Finland annually. Most of the soil is not usable before stabilization. 340 000 m3 of contaminated soil is transported for landfilling and 400 000 m3 aggregate rocks are imported to Helsinki for replacement. This concludes the strong connection among the construction companies to exchange the material in turn. However, we can assume economic interest is a major benefit of this project although unspecified data has never been released.

It requires pre-planning and coordination with the representatives locally or administratively to perform such a type of exchange program (Magnusson et al., 2015). The financial burden is overcome, and the workload is reduced with such a joint venture with mutual interest and benefits.

Population growth and rapid urbanization decreases the possibility of acquiring space to store the excavated waste in city areas. It is inappropriate to store waste in city area health wise also, because after drying, soil turns into dirt and causes dirt pollution hampering the environment. Sorting and reuse in less and congested space increase the risk of negativity among the local community. (Hao et al., 2007) describes the problem of finding the land to sort the construction and demolition (C&D) waste in Hong Kong and the consequences of the storing waste in urban area. Thus, to prevent such risk and issues from gathering, Rajiv Subedi has suggested the logistics department to distribute maximum volume of soil outside urban areas. The strategy behind the disposal of excavated soil within close range to the site is also to reduce the transportation cost, which minimizes the aggregate amount, triggering profitability for the company.

Similarly, using this method we have conducted the second phase of the interview and survey as mentioned above, number four questions in the set figures out the possibilities of the existence of any other Parallel running projects around the site. 4 road construction projects running, and 2 private land plotting projects are under consideration and very soon, the project will resume after the lockdown of the pandemic as per the information given by the rural development project committee.

With alliance of various government authorities, local representatives and company contact, we managed to deal with those companies about the possible use of excavated soil. 2 projects require an adequate sum of soil for landfilling in the road construction also informed the amount of the soil needed in near future. Total sum of approximately 25000 m3 of soil is their primary requirement for the project, in which the company is constructing large backfilling in projects.

Plotting company had a minor quantity of soil demand of estimated 10000m3 volume, in addition to brace transportation cost which we agreed. The second survey was more applicable and convenient also effective to squeeze the details of projects in accessible range. Escorted consultation with board members and local authorities assists soil waste management in proper direction supporting sustainable waste management and financial aspects.

The priority of the company was to reuse and recycle the excavated soil with the required system. The company and the logistics department have agreed for the planning of the disposal site for the remaining approximately 14932.27 m3. Throughout the disposal site selection process, it is highly recommended for the company to cover both qualitative and quantitative aspects (Meethom & Triwong, 2016). As the authors recommend, site selection is appropriate when it reduces the transportation costs, and the risk of any casualties during the process. Additionally, the authors also suggest to defines the criteria for the selection of the site which may vary unconditionally. These uncertainty decisions are also handled with the expertise, who has gained experience in such a field (Meethom & Triwong, 2016). The researcher suggests some criteria to check like transportation cost, area infrastructure, area terrain, Stress of driver, Liquidity of traffic.

After consulting with the local authorities and the company head, we finally conclude some sites to check. The logistics department analyses the different sites according to their useability and limitations. It is important to recommend the right locations for the allocations. Most of the municipalities urge to dump the waste near the riverbank or open places but with the support of the government landfill sites are being considered for 3R strategy (Thapa et al., 2009; Thapa & KC, 2011). Present context of landfill sites for operating sanitary in Nepal are numbered just three (Thapa et al., 2009).

Sisdole landfill site: Sisdole landfill consists of 15 hectares of land comprising 2 valleys. One has maximum capacity of 166085 m3 having 11200 m2 area and the second valley is 9501 m2 in size having maximum capacity of 108910 m3. This landfill site is 147km from the site (distance source extracted from the google map).

Pokhara sanitary landfill site: It has a limitation of 10 hectares of which 4 hectares provides landfill facility, 1.5 hectares has leachate treatment facilities, 3.75 hectares have buffer zone, and 0.75 hectares supports composition unit. The distance from the origin is 78 km (distance source extracted from the google map).

Karaute Danda sanitary landfill site: The distance from the origin is 336 km, moreover, out of 20 hectares of land only 1 hectare has accessible for management purposes (distance source extracted from the google map).

Figure 3 illustrates the clear comparison within the shortlisted sites based on the capacity available and distance from the site.

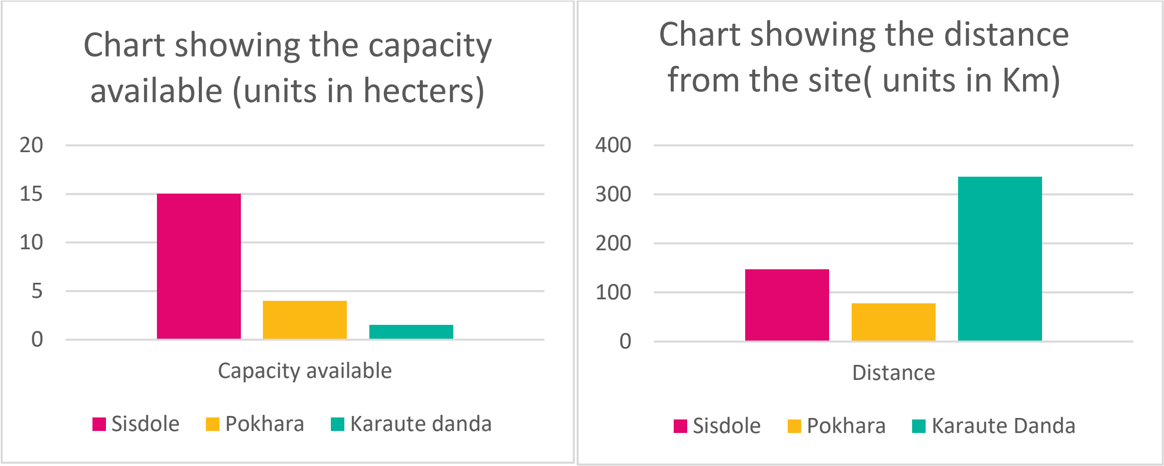

Figure 3. Chart comparison based on capacity and distance

Analyzing these data, Sisdole landfill site does not meet the criteria of transportation cost, drivers stress, time consumption and traffic liquidity. The team is not convinced only by the area and the capacity. Similarly, Karaute landfill site is not convenient option due to the large distance from the construction site. Therefore, we pinned to the idea of using Pokhara sanitary landfill site which satisfies all the criteria. Additionally, the company is also from same city ‘Pokhara’, which makes it easy for the arrangement and self-inspection.

A brief discussion and interview were taken with the drivers and the technical department of the company regarding the capacity of the load carrying tipper, drivers’ wages, fuel consumption and expenses. As per the driver of the tipper, 7.5m3 (volume of a storage unit) is the maximum capacity of the tipper and an estimated 60 liters fuel is consumed per day. With the information from the operator and drivers, averagely the truck can travel 200 km on the black top road whereas it goes normally 50 to 60 km on earthen road. It may depend upon the destination and station we planned since Nepal is not yet fully connected with road transportation. We interviewed some tipper drivers about the daily wages, we concluded that the average daily allowance is 25 euros, additionally monthly salary is 250 euros.

Figure 4 visualizes the image of the operating vehicle for the transportation of the excavated soil having 7.5m3 capacity.

Figure 4. Image showing the tipper/truck unloading the soil of capacity 7.5m3.

This is the most common transporting truck in Nepal. If the company intends to transport the soil to the above-mentioned landfill sites, the number of trucks shall increase to meet the pre-planned time. Depending upon the site confirmation, the salary, average fuel consumption and its expenses can be calculated using the rate.

7 Discussion

The management of waste in construction sites remains a perpetual problem. In this project, we have managed to find the solution of excavated soil through implementing various methods and techniques for the management of the soil. The foremost target is to use the maximum amount of soil in other areas as much as possible rather than disposing. In this project we have succeeded to manage about 85 % of the excavated soil in other field, which is satisfactory result overall even in the pandemic of covid. The project also faced many difficulties and restrictions, financial pressure during this period. Not all case studies and journals can be solutions for the construction issues as construction and technology has always been evolving. Although ideas and solutions are abstracted from history, it is not necessary to apply the same technique or methods. Methods vary according to geographical status, labor, and infrastructure. Though this thesis applied the methods from case studies, these solutions might not be applicable for other parts of the world. Reusing is not the only effective solution to such problem. There should be wide research and technological development in recycling the soil. Soil has its own characteristics, compositions and chemical impurities which restrict them from being recycled in another field.

Among other, one of the most undesignated and raw, yet to be discussed topic would be construction material handling. There are strongly urgences of specific method, study, planning, regarding the improvement in material handling. The company could save a significant amount of budget by solving the issues about handling materials and proper storage. There is no proper storge room for materials like sands, bitumen, cement, gravel stones, expensive machinery, and tools in rural areas. Equipements are particularly important to save throughout the project, especially in rural areas since the repairing center are hardly available nearby. In the rainy season, sand and other raw materials are wasted by water, which increases the expenses. Some materials require especial treatment in storage or during utilization like bitumen and cement. Logistics managers can be responsible for supply and demand dates of raw material and additionally, it is important to book the record of the quantity and quality. There are other huge factors and aspects in construction material handling, which still further studies should focus on.

During the project, the logistics engineer also observes other branches of their work field for future purposes. There are certain limits and flexibility for logistics operators in construction also, which was faced during the project. Some of them can be explained for the improvement of future concepts and preparation.

Land acquisition was the foremost thing before the projects began. After surveying the site, it is very necessary to determine which of the land is required and is acquired by government or private. In the case of private property, it is especially important to make a deal with the land client and give them proper compensation for the required land. If the construction site is rural then the important responsible authorities are the forest department. It is very necessary to have grant for the use of the forest and to deforest the necessary tress and other material. After the proper plan we must apply the same amount of plantation in other areas as a replacement. Another important case is the endangered animals' habitat. After all the inspections which are done by the logistics manager for the initial engineering implementation. The logistics manger must convince all the civil community to run the project without harming the community.

The engineering work begins with soil testing and possibilities of natural disasters after the excavation of the land. Because of the first excavation, natural disasters might occur like landslides during the projects as per Rajiv Subedi.

In the case of rural areas, then certainly there is no fuel availability nearby, so the problem may arise for the storage of the fuel and dealing with the availability of the fuel in emergency. The necessary materials, machines, trucks, crushers, etc. should be the focus of the logistics department to run the work smoothly. The logistics department decides whether the machine will be renting or buying, the cost of the renting and buying. The cost of the machine handlers is an important thing to consider while operating the machine. The daily wages of the Labor, per hour machine charge, the fuel importer in the site, these are the problems that have been seen in the projects.

A proper effective schedule for the worker and optimizing in the necessary section are the skills that must be applied. A legal contract with the workers, land clients, machine renting, operators, subcontractors should be a necessary matter to be handled. There are affairs that should be taken carefully for example, the project could be implemented with utilizing the local manpower. Local empowerment is emphasis through running projects. Following the process, we achieve the involvement of local people and crucial suggestions. The company is conceivable of margining profits when the laborers are not imported and do not have to bear the cost of transportation and accommodation also food, which decreases the expenses.

One of the possible risks that could occur in the disposal of soil in dumping sites is to get approval of the soil that is not tested in the laboratory. The authorities could question the composition of soil that can harm the nature around them. We also accept the fact that a permit of reusing the soil in various areas as the solutions given above would also be altered if any arsenic compounds are noticed during the initial process. The dumping sites may also have limited allowable volumes to provide. These solutions are based on research and experience having maximum probability that could function efficiently.

According to (Winch, 2009) construction management is a problem consist of lack of information or lack of information in decision making.

8 Conclusion

The list below gives the appropriate information on the management of the soil of the project.

1. Backfilling: 6589.2 m^3 soil have used in backfilling the same construction site which was mentioned in the estimation documents.
2. Flood landfill: 33000 m^3 soil have been used by the flood affected area near bandipur area.
3. Road construction: 25000 m^3 soil was reused in backfilling in 2 road nearby road construction.
4. Land plotting: 10000 m^3 soil was transferd to landplot company.
5. Disposal at landfill site: The remaining amount of soil was approximately 14931.27 m^3 which was planned to disposed.

Figure below illustrates the amount of excavated soil that has been distributed in different areas, which is the result of the entire project.

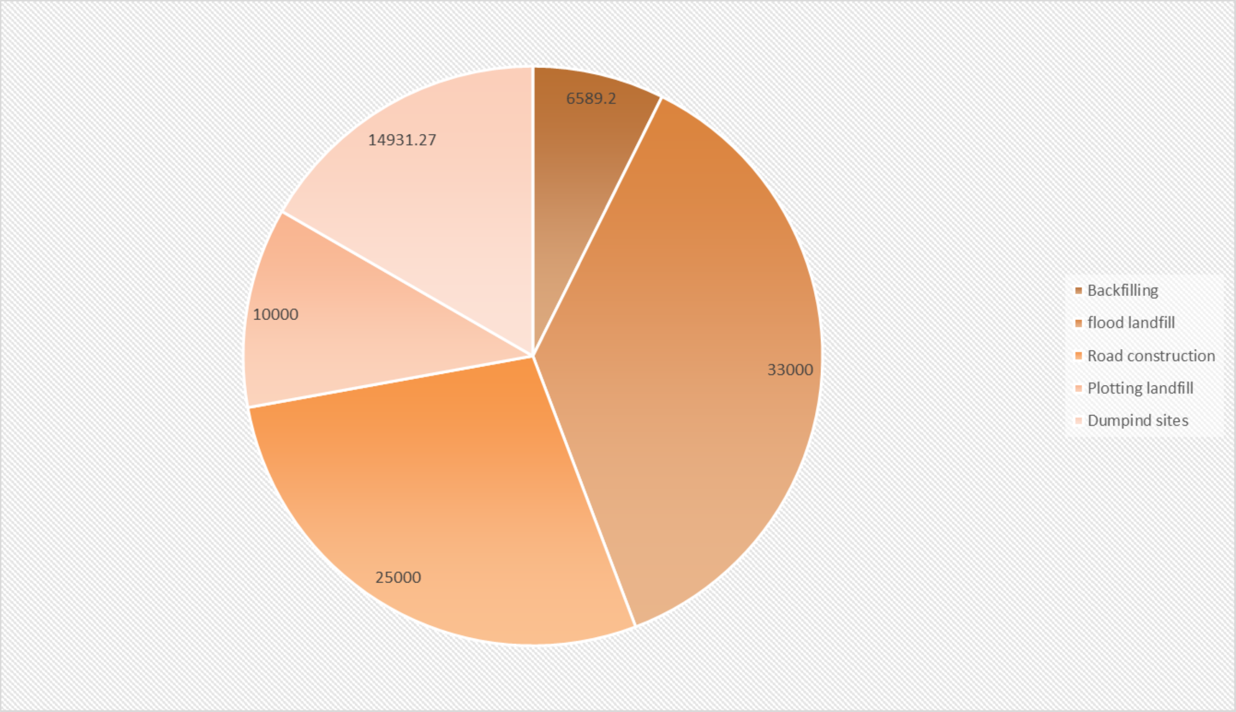

Figure 5. Showing classification of the excavated soil distribution (units in cu.m)

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Appendix 1. Quantities of excavated soil classified as hazardous and non-hazardous waste

	France	Norway		Portugal		Slovenia (Excavated soil used on-site are included)		Sweden (Excavated soil used on-site are not included)		
Year	2015	2017	2018	2016	2017	2017	2018	2012	2014	2016
Total volume (tons) hazardous and non-hazardous waste	7000000- 10000000	3010449		707810	339386	1938262	3849152	4220000	5690000	5447000
HAZARDOUS WASTE										
Total volume (tons)[6]		169449		12033	14933	4013	1917	720000	590000	347000
Backfilling										
% of total										
Recycling[5]				2768	2987			129000	110000	111000
% of total				23	20			181	19	32 %
Pre-treatment[4]						1725	169	285000	260000	322000
% of total						43	9	402	44	55
Landfill				9145	11946	2288	1748	30700	220000	362000
% of total				76	80	57	91	43	37	100
NON-HAZARDOUS WASTE										
Total volume		2841000	2993000	695777	333616	1934249	3847236	3500000	5100000	5100000
Backfilling		585000	44000						103000	156000
% of total		21	2						33	33
Recycling[5]				660988	276901	52	73418	103000	3300000	2400000
% of total				95	83	0	2	33	65	47
Pre-treatment[4]								2123000	170000	301000
% of total								611	3	6
Landfill		2256000	2549000	34789	56715	1934197	3773818	118000	1600000	2500000
% of total		79	98	5	17	100	98	33	32	49