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MONGOLIAN UNIVERSITY OF SCIENCE AND TECHNOLOGY

TU Delft
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FINAL REPORT

Economic feasibility study of the public construction and demolition waste (CDW) based product

Ulaanbaatar 2019

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Acronyms and Abbreviations

BEP	Break Even Point
CCR	Caritas Czech Republic
CDW	Construction and Demolition Waste
EU	European Union
MNRA	Mongolian National Recycling Association
MUST	Mongolia University of Science and Technology
SA	Substation Airline
SMEs	Small and Medium-sized Enterprises
TUD	Delft University of Technology
VAT	Value Added Tax

Glossary

Gravel - A loose aggregation of rock fragments, which is extracted from the river basin. Mongolian name is khairga.

Crushed stone - A form of construction aggregate, typically produced by mining a suitable rock deposit/mountain and breaking the removed rock down to the desired size using crushers. Mongolian name is dairga.

Quarry - A quarry is a type of open-pit mine in which dimension stone, rock, construction aggregate, riprap, sand, gravel, or slate is excavated from the ground.

1. Introduction

1.1. Background

Caritas Czech Republic (CCR) in Mongolia is implementing the EU-funded project "Improving Resource-Efficiency and Cleaner Production in Mongolian Construction Sector through Materials Recovery" for 2016-2020 in partnership with the Mongolian National Recycling Association (MNRA), Mongolia University of Science and Technology (MUST) and the Delft University of Technology in the Netherlands (TUD). The main goal of the project is to contribute to poverty reduction and the mitigation of climate change in Mongolia with the specific objective to promote sustainable production and consumption in the construction sector through supporting SMEs to switch to a more resource-efficient product.

The construction industry has expanded rapidly in recent years in Mongolia and demand for all types of construction products (from concrete to metals) is set to increase in the coming years. Currently, however, **more than 50% of construction materials are imported**. Such imports continue to increase (in spite of the government's policy to increase local production) due to the lack of affordable local products. **Additionally, the lack of research and development, innovations, quality control procedures, and standards hamper the expansion of recycled construction and demolition waste (CDW).**

Therefore, the priority of the project is to explore the use of recycled CDW. In this regard, a CDW-based product has been tested at the laboratory of the School of Civil Engineering and Architecture of MUST. The next step is to verify the CDW-based product in terms of its economic feasibility. Therefore, the CCR commissioned MIRIM Consultant to conduct this economic feasibility study of CDW-based product.

This report is unique in providing information on market supply and demand and cost-effectiveness analysis of the CDW-based product based on empirical data collection from potential participants in the market.

1.2. Objectives

The primary aim of this study is to verify the economic profitability of the CDW-based product. The study will assist Caritas Czech Republic in introducing CDW-based product to the market. The specific objectives are (i) conduct market readiness research-overall market environment, market demand, supply analysis, and competitor analysis; (ii) determine the awareness of CDW-based product among the main players of the market, and (iii) verify the economic feasibility and profitability of CDW-based product.

As such, the key research questions of the study are the following:

Market environment:

1. What is the general state of the market, market capacity, and market segmentation?
2. What is the cost of the raw material resources of conventional products and CDW-based product?
3. What are the barriers to the market in terms of competitiveness?

Market demand for CDW-based product:

4. Who are the consumers of CDW-based product?
5. How much do consumers demand CDW-based product?

6. What about consumers' purchasing power?

Raw material's supply of the CDW-based product:

7. Who are the potential suppliers of CDW-based product?
8. How great is the supply of raw materials from demolished buildings and waste from new buildings?
9. What about the suppliers' behavior during the demolition of buildings?

Competitors of CDW-based product:

10. Who are the competitors of CDW-based product?
11. What are their features and how are they competitive?
12. Is there any interest in competitors in producing CDW-based product?
13. What are the costs of producing competitive products?

Awareness of CDW-based product:

14. How about the awareness of CDW-based product among the main players on the market?

Cost-effectiveness analysis:

15. How much investment is required for the production of the CDW-based product?
16. What is the production plan?
17. What are the costs for each production stage?
18. Is CDW-based products feasible and profitable?

1.3. Methodology

Research design

This study used a mixed-method approach to generate an accurate and comprehensive picture of the market for CDW-based product and its economic feasibility. Mixing qualitative and quantitative approaches, while ensuring the inclusion of different stakeholders, it offers a wide variety of perspectives and a more reliable picture of reality.

To achieve the identified objectives, the research team adopted a sequential mixed-method design where the quantitative approach is dominant. The study began with qualitative data collection and analysis followed by quantitative data collection and analysis to construct a typology of respondents which was followed by further quantitative analysis.

Research framework

To answer the above-mentioned research questions, the study's analytical framework was developed to construct the economic feasibility of CDW-based product. Assessment criteria with corresponding sub-criteria were developed in the table below. The sub-criteria were assessed using the questionnaire and interview responses. The assessment of the criteria was done using three methods - analyzing collected data, asking direct questions (questionnaires) and semi-structured questions, and by conducting economic and financial analysis.

Table 1. Criteria and sub-criteria used in the study

Dimension	Criteria	Sub-criteria	Methods[1]
Market readiness	The overall market environment	ABOUT THE MARKET o The overview of the target market, including market mapping, main players, external influencing factors o Raw material's recourse of conventional products and CDW-based product o Segmentation of the market based on its specific characteristics COMPETITION ENVIRONMENT OF TARGET MARKET o Entry barriers to the market o The product differentiation based on the quality and technical capacity o The threat of substitution (ease of substitution, the relative price performance of substitutes, number of substitute products available in the market) o The threat of complements of CDW-based product o Availability and accessibility to distribution channels	DR+II+Q II+DR II+DR Q+DR+II Q+DR+II Q+DR+II Q+DR Q+DA
	Market demand	CONSUMERS AND THEIR SEGMENTATION o Total number of consumers and their segments o General characteristics o Capacity (production and technology) and sales income of the consumers CONSUMERS' DEMAND AND THEIR PURCHASING BEHAVIOR o Demand for raw materials (gravel and crushed stone, CDW-based product) o Consumers' purchasing behavior o The market price of raw materials, changes in prices, and influencing factors in prices CONSUMERS' PURCHASING POWER o Income o Costs of the current raw materials vs their price (vs income)	DR+II Q+DA Q+DA Q+DA Q+DA Q+DA Q+DA Q+DA
	Raw material's supply	POTENTIAL SUPPLIERS OF RAW MATERIAL o Type of potential suppliers, the total number of suppliers o General characteristics o Capacity (production and technology) and sales income of the suppliers (by segments) POTENTIAL SUPPLY OF RAW MATERIAL AND SUPPLIERS' BEHAVIOR o Potential amount of raw material supply from demolished buildings and the waste of new buildings o Demolition techniques used for concrete buildings o Whether they classify debris after demolishing o Whether they have an interest in supplying waste from constructing a new building to construction companies	DR+II Q+DA Q+DA Q+DA Q+DA Q+DA Q+DA Q+DA
	Competitors of CDW-based product	COMPETITORS o General characteristics o Capacity (resources and extraction) COMPETITIVE PRODUCTS	Q+DA Q+DA

[1] Q-Questionnaire, DA-data analysis, DR-desk review, and II-In-depth interview

		○ Features of the products and competitiveness ○ Sales and price (change in price, and influencing factors in price) ○ Distribution of the products ○ Interest in producing CDW-based product COSTS ○ Production costs of competitive products	
Awareness of CDW-based product		○ By the types of main players in the market	Q+DA
Cost-effectiveness analysis	Production process	○ Mapping of the production process of CDW-based product	II
	Price study	○ Price study on substitutions (gravel and crushed stone) ○ Price study on concrete batching ○ Price study on the complements of CDW-based product ○ Analysis of factors influencing in prices of raw materials and final goods	Q+DR+DA
	Project efficiency	○ Initial investment plan ○ Production plan ○ Cost budget (production and operation costs) ○ Sales revenue plan ○ Profit forecasting	Methods of financial analysis
	Analysis of economic efficiency	○ Social benefits of the project ○ Analysis of economic efficiency	Methods of financial analysis

Data collection

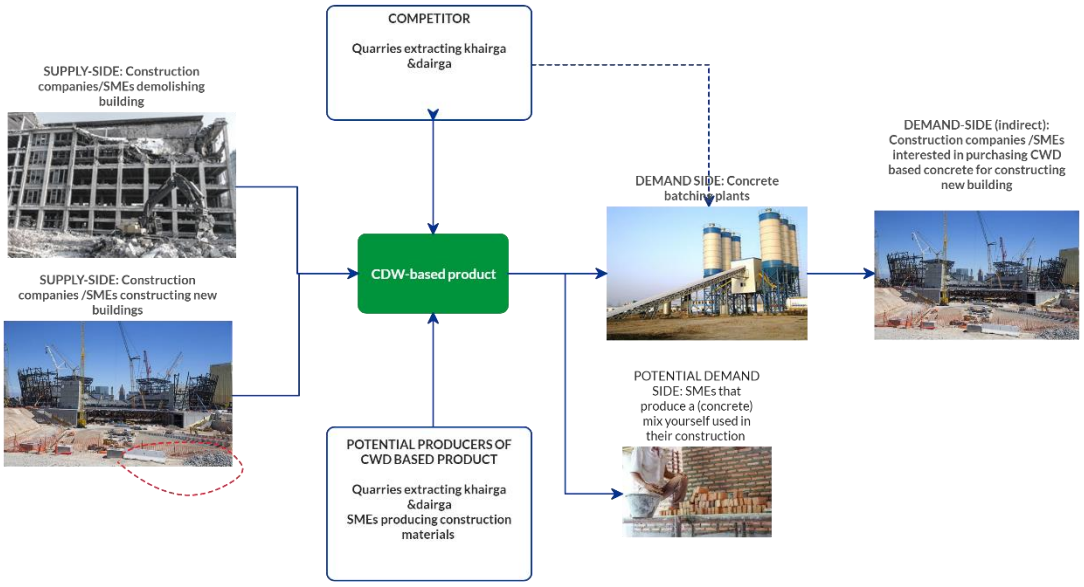
As this study focused on exploring the SMEs in the construction sector, i.e. producers and potential consumers of CDW-based product, it did not consider the general public. The key participants of the study were:

- Demand-side: Concrete batching plants, SMEs that produce a mix themselves in constructing new buildings, and Construction companies/SMEs
- Supply-side of raw materials: Construction companies /SMEs such as
    - Construction companies/SMEs which demolish old buildings;
    - SMEs contracted with construction companies to demolish an old building; and
    - Companies/SMEs that construct new buildings- concrete waste from constructing a new building is also the raw material of the CDW-based product.
- Competitors and potential producers of the CDW-based product: Quarries extracting gravel and crushed stone.

The demand for CDW-based products in the market can include direct and indirect demands. Concrete batching plants and SMEs that produce a mix by themselves in constructing new buildings can generate direct demand for CDW-based products. Construction companies/SMEs will generate demand in the market indirectly.

The picture below illustrates the mapping of participants involved in the study.

Figure 1. Participants involved in the study



The primary data of the study was collected using questionnaires. In this framework, three types of questionnaires were developed for suppliers, consumers, and competitors. Moreover, the secondary data of official sources and expert interviews were used as supplementary data.

Sampling size and composition

In total, there are of 54 concrete batching plants, 87 construction companies that are actively working, and 26 quarries that are extracting gravel and crushed stones are present in Ulaanbaatar[2]. A total of 92 companies out of 177 in the construction sector were sampled in the survey. The sample size was determined by the margin of error[3] and the confidence level[4] that we chose. The formula below was used to calculate the sample sizes.

$$n = \frac{Z^2 p(1-p)}{C^2}$$

Where: n-sample size, Z-confidence level (1.96 for 95% confidence level), the p-estimated prevalence of the variable of interest, C-margin of error (confidence interval). The total sample size is chosen with a ±7% margin of error and 95% confidence level.

25 concrete batching plants, 12 quarries extracting gravel and crushed stone, 51 construction companies, and 4 companies demolishing buildings are included in the survey. The aim of the data collection was not to make statistical generalizations or include all companies that are actively working in Ulaanbaatar city. The aim was to select the companies that can represent the players of the market at different levels. The table below presents the number of informants that will be involved in the survey.

[2] Sources: the list provided by the Caritas Czech Republic, www.barilga.mn, the yellow book, telephone directory such as 1900-1950.

[3] It is a statistic expressing the amount of random sampling error in a survey's results. It asserts a likelihood (not a certainty) that the result from a sample is close to the number one would get if the whole population had been queried. The likelihood of a result being "within the margin of error" is itself a probability, commonly 95%, though other values are sometimes used. The larger the margin of error, the less confidence one should have that the poll's reported results are close to the true figures; that is, the figures for the whole population. The margin of error applies whenever a population is incompletely sampled

[4] The confidence level tells you how sure you can be. It is expressed as a percentage and represents how often the true percentage of the population who would pick an answer lies within the confidence interval (margins of error)

Table 2. Sample size and composition

#	Types of Informants	Ulaanbaatar	
		Total entities	Sample
1	Concrete batching plants	54	25
2	Quarries extracting gravel and crushed stone	26	12
3	Construction companies/SMEs	87	51[5]
4	Companies/SMEs demolishing buildings	10	4+3
	Total	177	92

1.4 Report structure

The report has five chapters. Chapter 1 is the introduction to the study. It summarizes the background of the project, outlines of key objectives, the methodology used for this study; including research design, framework, data collection, and sampling.

Chapter 2 provides the market readiness of CDW-based products. It begins with the overall market environment, it continues with the market demand and supply, and it finishes with the competitors' analysis. Chapter 3 considers the awareness of CDW-based products among players in the construction sector.

Chapter 4 provides a detailed analysis of cost-effectiveness for CDW-based products. It includes the price, cost and profit analysis. The final chapter summarizes the findings of the study.

[5] Three of them operate demolition activities besides construction.

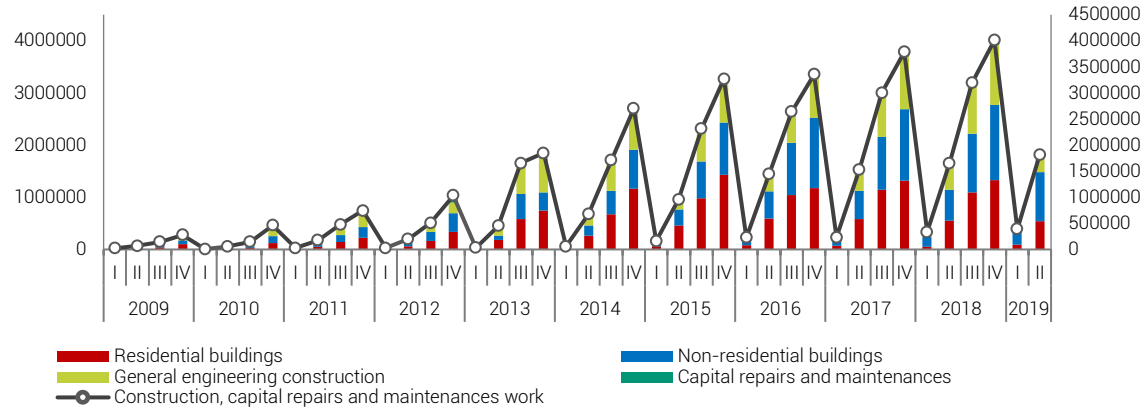
2. Market Readiness of CDW-based products

2.1 The Market Environment

About the market

During the last decade, the construction industry has boomed in Mongolia, particularly in Ulaanbaatar. Major changes have been made to settlement patterns through the dramatic migration of the population towards urban areas. Since 2018, about 72 percent of the population lives in the capital city, provincial centers, soum centers, and other urban areas, with 45 percent of the population residing in, and 70 percent of enterprises and organizations concentrated in Ulaanbaatar city.[6]

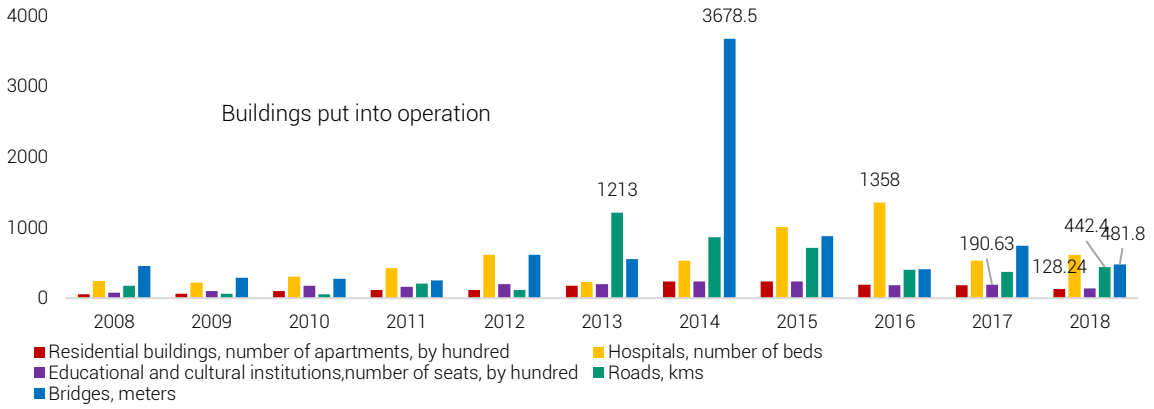
Figure 2. Construction, capital repairs and maintenances work, MNT million



Source: Mongolian Statistical Information Service, 1212.mn

From Figure 2 which shows construction maintenance work done over the last decade, measured quarterly, it can be seen that construction, capital repairs, and maintenance work is steadily increasing year by year, and it appears to be dependent on the season.

Figure 3. Finished construction and capital repairs done, by type of construction and capacity of buildings, at the end of the selected years



Source: Mongolian Statistical Information Service, 1212.mn

[6] http://en.investmongolia.gov.mn/40.html

Figure 3 illustrates the finished construction and capital repairs, and a large number of of meters bridges were built during the "Gudamj Project" in 2014. Residential buildings (number of apartments) were built in large numbers in 2013-2017, many hospital buildings were completed in 2011, 2015-2016, and many bridges & roads had been commissioned in 2013-2014.

Urbanization and industrialization have been increasing as the population of Mongolia has grown in recent years. This has resulted in an overall increase in solid waste generation and air pollution, especially in Ulaanbaatar city. In 2010, the total amount of solid waste generation in the country was 840,000 tonnes. By 2015, in just five years, a solid waste generation had increased three-fold to 2,900,000 tonnes, which means that the total amount of solid waste generated has increased at the rate of 500,000 tonnes per year.[7]

Out of the total solid waste disposed of in landfills, municipal solid waste (from households, commercial and institutional areas) covers 51% of the total waste, while construction and demolition, and hospital waste accounts for 3% each.

Figure 4. Percentage composition of various waste streams in Mongolia

Source: Mongolia National Waste Management Improvement Strategy and Action Plan /2017-2030/

Apart from new construction, the Municipality of Ulaanbaatar is planning to demolish a considerable number of old buildings. It is estimated that debris from demolished buildings accounts for 20–25 percent of all solid waste produced in Mongolia. A large amount of this debris from demolished buildings was dumped and still is being dumped illegally. Construction companies do not have any proper inventory systems to classify the different types of waste or waste-separation arrangements. However, the amount of debris from demolished buildings delivered to disposal sites is growing.[8]

Table 3. Debris from demolished buildings 2006-2016, tonnes per year

Year	Mongolia	Ulaanbaatar
2009	48,236	11,306
2010	38,637	7,455
2011	98,072	15,150
2012	77,943	...
2013	182,249	92,831
2014	93,508	...
2015	133,107	87,467
2016	119,187	80,800

Source: Ministry of Environment and Tourism, 2017

[7] Ministry of Environment and Tourism of Mongolia, (2017 July), p.2
[8] United Nations Economic Commission for Europe, 2018, p.276

Activity report 2018[9] the Office of Capital City Planning and General Planning noted that the State Professional Inspection Agency has evaluated earthquake resistance, strength, and reliability of 629 public housing buildings around the Ulaanbaatar city area, during 2011-2017.

The standard norm for a building is different depending on the location of which can withstand the 7-9 magnitude of the earthquake. According to the decisions from the state senior inspector of the State Professional Inspection Agency in 2014-2017, a total of 238 residential buildings had been prohibited for use as they do not meet the requirements of usage and are not able to tolerate earthquakes. There was a decision to demolish and re-plan to construct again 143 buildings in the districts of Bayangol, Bayanzurkh, Chingeltei, Khan-Uul, Songinokhairkhan, Sukhbaatar, and Nalaikh due to 13 orders from the Ulaanbaatar City Governor's Office.

By announcing an open invitation to select the project implementer for 49 blocks, bundled from 143 buildings, project implementers selected for reconstructing 25 blocks and started their work accordingly to the rules (Office of Capital City Planning and General Planning , 2018).

Table 4. Number of buildings demolished and planned to demolish by 2018

#	Work progress	Number of buildings	Explanation
1	Project is in process	74	6 apartments of 614 households have been newly built
2	Project was rejected	4	The project was refused by request of residents
3	Project implementer needs to be selected	65	Selection is going on according to the rules
	Total	**143**	

Source: Urban Planning and Development Agency (http://uda.ub.gov.mn/?p=4370), Implementing Agency under the Ulaanbaatar City Governor's Office

The project implementer has demolished a total of 27 apartments/households with 531 households and commissioned 6 apartments with 614 households according to the activity of 'The demolition and replanning 74 residential buildings they do not meet requirements of usage'. Here is:

- In 2016, the apartment of 18 households was demolished and 1 apartment of 64 households was commissioned
- In 2017, an apartment of 20 households was demolished and 2 apartments of 237 households were commissioned
- In 2018, 5 apartments of 70 households were demolished, 1 apartment of 140 households and 2 apartments of 173 households were commissioned.

According to the 2018 activity report from the Office of Capital City Planning and General Planning, the number of buildings planned to be demolished will grow in the future, and hereupon the volume of waste generated by these buildings is expected to increase as well.

Besides increasing concentration and construction in Ulaanbaatar city, the number of non-qualified buildings is increasing. In addition to this, construction companies are still doing

[9] http://uda.ub.gov.mn/?p=4370

environmentally harmful activities by using river and mountain gravel and crushed stone as the main material for concrete.

Furthermore, even though there are policy documents on waste management, such as on the recycling of waste from buildings and separating garbage, few of these are implemented in practice.

Most of the factories of gravel and crushed stone are concentrated in Khan-Uul district of Ulaanbaatar city, while most of the concrete factories are located in Bayangol district. These factories, which are located near the city, are a source of pollution for the living environment of citizens and are affecting the degradation of the urban environment. The Municipality of Ulaanbaatar regularly monitors their activities, places requirements on them, and even limits their activities.

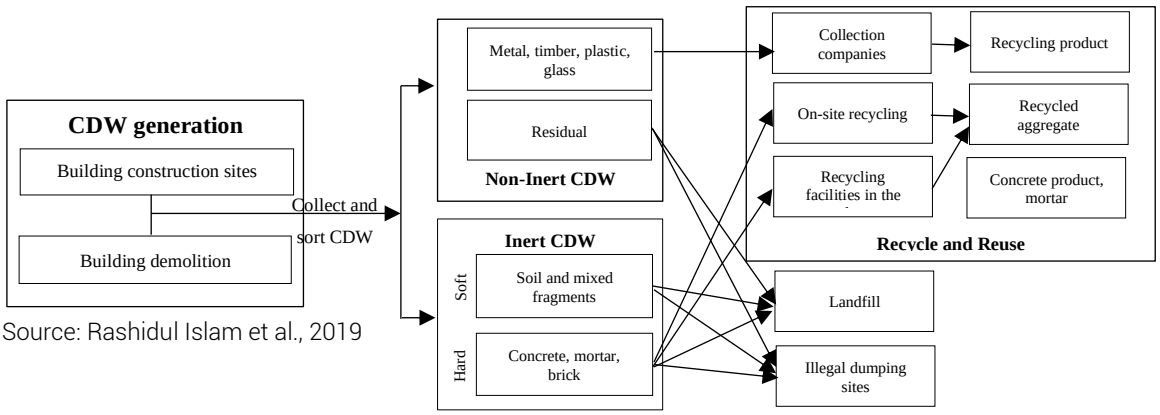
In these circumstances, the recycling and production of waste materials will be beneficial to all stakeholders. For example:

- Environmental benefits of reducing debris from demolished buildings (less waste going to landfills)
- Environmental benefits of declining river and mountain gravel mining (less use of natural resources)
- The social benefit of lower risk of pollution incidents
- Citizens will live in a healthy and comfortable environment.
- Construction and demolition companies will transform waste into revenue.

Generally, CDW is defined as the solid waste, which is generated from the construction, renovation, and demolition activities. CDW is the leftover, damaged or on-site temporarily used material during the sequence of the construction process (Lu, W., Yuan, H., Li, J., Hao, J.J., Mi, X., Ding, Z.,, 2011).

Structures comprise all types (both non-residential and residential) of buildings as well as bridges and roads. Construction and demolition debris or components generally include asphalt, wood, concrete, metals, wallboard gypsum and roofing materials. The composition of CDW is broadly categorized as, inert and non-inert waste. The inert waste materials include soft and hard inert materials, while the non-inert waste includes residual waste and other materials like metals, timber, plastic, and glass (Zheng, L., Wu, H., Zhang, H., Song, Q.,, 2017). The typical life cycle flowchart of different types of CDW is shown in Figure 5.

Figure 5. Life cycle flowchart of different categories of CDW



Source: Rashidul Islam et al., 2019

Competition environment of target market

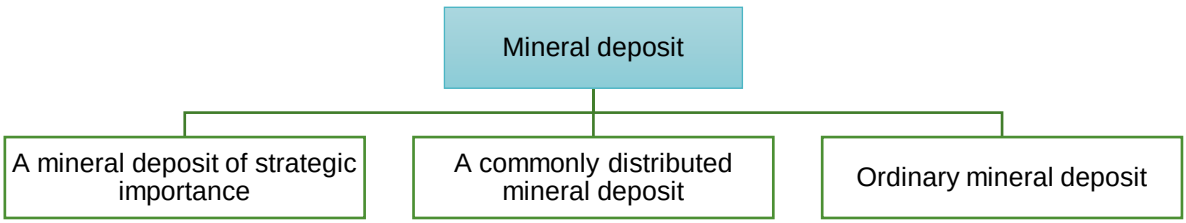
Entry barriers to the gravel (khairga) and crushed stone (dairga) market

In this section, we consider what barriers can occur while entering and performing operations in competitive products market of gravel and crushed stone, where CDW-based products are construction-filling materials and are able to replace gravel and crushed stone.

Cost of entry to the market

The Law of Mongolia on Minerals has classified mineral deposits described in Figure 6. In general, sand, gravel, brick clay, granite, and crushed stone are classified into common mineral resources (The State Great Hural, 2014).

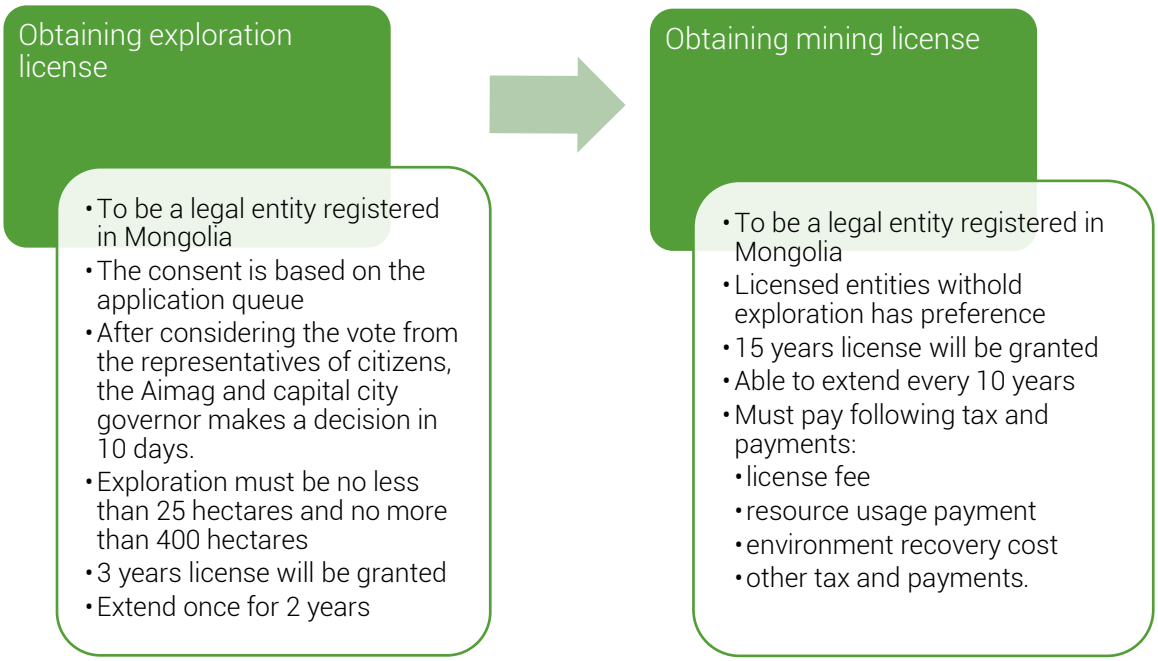
Figure 6. Classification of Mineral deposits



Source: Law of Mongolia on Minerals (The State Great Hural, 2006)

Exploration and mining of commonly distributed minerals can only be conducted by licensed entities. "Law of Mongolia on Commonly distributed minerals" was approved and has been implemented since 2014, and by this law, province and Capital city governors shall be responsible for licensing, cancellation and monitoring of licensee payment performance.

Figure 7. Information on obtaining permission for commonly distributed minerals exploration and mining



Licenses for the exploration and mining of commonly distributed minerals are only allowed for entities established, registered and operating under the law of Mongolia. This is a barrier for foreign

companies to enter the market. All gravel and crushed stone companies that participated in our questionnaire and research were domestic investment companies.

According to the Law of Mongolia on State Stamp Duties, license holders of commonly distributed minerals exploration and mining shall pay the following payments:

- Exploration license fees for commonly distributed minerals – per a hectare of exploration area – MNT 100 in the first year, MNT 200 in the second year, MNT 300 in the third year, and MNT 1000 for fourth and fifth years each.
- Mining license fees for commonly distributed minerals are MNT 5000 for 0-20 hectares of the area granted by the license, MNT 8,000 for up to 30 hectares, MNT 10,000 for up to 50 hectares, MNT 15,000 for up to 100 hectares, MNT 20,000 for more than 200 hectares.

The Law of Mongolia on commonly distributed minerals states that resource usage payment is equal to 2.5% of the commonly distributed mineral sales revenue from all mined, sold, loaded, and used minerals.

As a result of the survey conducted by the quarry companies, the respondents concluded that the process of obtaining a license for exploration and mining is difficult. Many times, due to the inspections from professional agencies, high requirements for their operation and policy volatility, there are some barriers to operate in the market. Some respondents also said that resource scarcity and limited location permits were the main obstacles facing the market.

However, if gravel and crushed stone companies do not fulfil their legal obligations, do not make recovery and pollute the environment, the government will impose penalties or even stop their activity. For example, on the 20th of June in 2019, https://newspress.mn reported that "Extracting licenses of 94 gravel and crushed stone companies around the place named Chicken factory (Shuvuun fabric) were cancelled. They hadn't done any recovery and produced a lot of environmental dust, furthermore, they polluted residents' healthy living environment and dried two rivers named Bohog and Turgen that resulted in people having no drinking water."[10]

Need for skilled and experienced workers

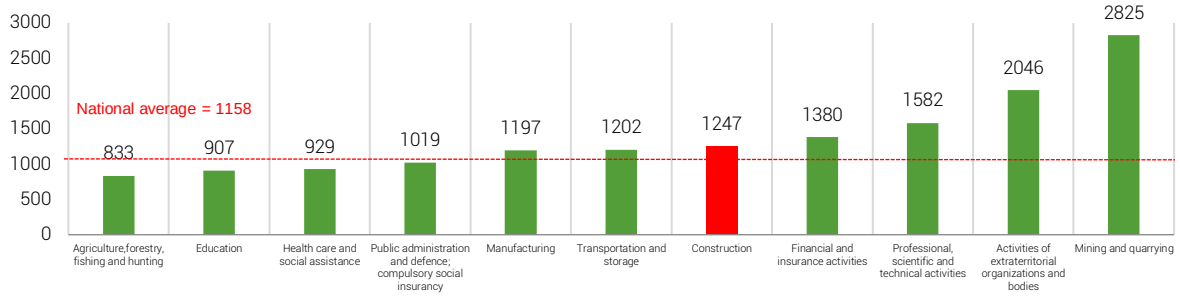
Another barrier and limitation to enter the market is the need to hire excellent, skilled, and experienced employees. Let us clarify whether such a barrier may occur in the construction sector using the following two analyses.

1. To compare wage levels in the construction sector with wage levels in other sectors.

The level of wages based on employee productivity reflects how capable employees are. Figure 8 shows that the average wage level of the construction sector in the first quarter of 2019 is MNT 1,247,000, which is approximate to the average salary of Mongolia at MNT 1,158,000. Thus, the construction sector may not require highly capable employees, but it is shown that the mining and quarrying sector employee wage level is higher than others. It means the mining and quarrying sector requires more capable employees.

[10] https://newspress.mn/v1/p/news/10743

Figure 8. Monthly average wages and salaries, 2019-I, by the division of economic activities, MNT thousand



Source: Mongolian Statistical Information Service, 1212.mn

2. To compare the classification of age groups in the construction sector with other sectors

Because of the lack of statistical data on the employee experience in each sector, the experience of employees is represented using their age group classification. The following figure shows that most of the employed people in Mongolia are relatively young, 30-44 years old. Figure 12 shows an interesting fact that 25-34-year-old young people mostly dominate in the professional, scientific and technical activities sectors. Furthermore, the construction sector and the mining and quarrying sector tend to employ relatively young employees rather than those who have many years of experience.

Figure 9. Classification of age groups in total Mongolian employees

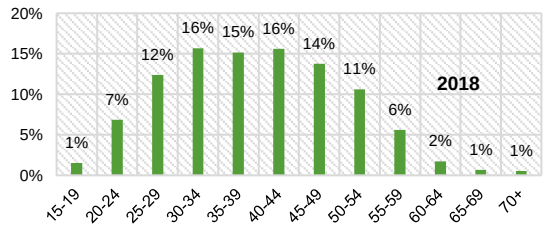


Figure 10. Classification of age groups in the construction sector

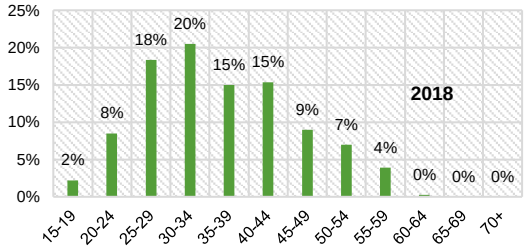


Figure 11. Classification of age groups in the mining and quarrying sector

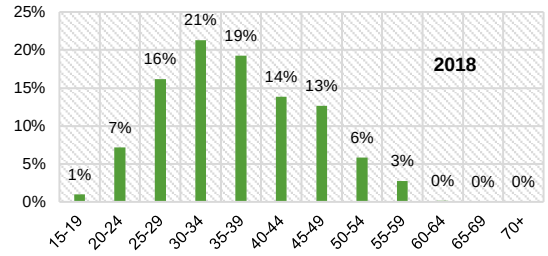
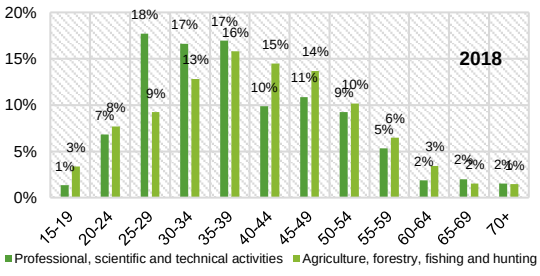


Figure 12. Classification of age groups in professional, scientific and technical activities, agriculture, forestry, fishing, and hunting sectors



Source: Mongolian Statistical Information Service, 1212.mn

Technology protection

Generally, heavy equipment and high technologies are used in the construction, mining and quarrying sectors. So, it is costly, and innovation and new technology tend to be more robust than in other sectors. If the production requires new technology and becomes costlier, this might be a barrier for a new company to enter the market.

More productive workers can use the highest technology and can earn higher wages and salaries. Figure 8 shows that wages in the construction, mining, and quarrying sector is not poor. The surveyed quarry companies conclude that skilled labour, high capital costs, heavy equipment and more investment need to enter and operate in the market.

The product differentiation based on the quality and technical capacity

In the Mongolian context, gravel and crushed stone, which can be the main competitors of CDW-based products, are usually extracted from mountains. Around 60 quarries are operating in Mongolia and they can produce 1,200,000 m^3 of concrete annually. The typical production process starts with full crushing and grading technology where a mixture of mined mountain and river-basin sand and gravel (raw gravel) pass through two crushing phases, through a jaw crusher and cone crusher with a conveyor belt connected to a sieve with 3-4 circles. The plant is equipped with a drum washer for sand washing. (Tommaso Troiani, 2017) Although many companies are operating in the market, all of them are located near Ulaanbaatar. Thus, their products are almost identical and there isn't any product differentiation based on the quality and technical capacity.

The threat of substitution (ease of substitution, the relative price performance of substitutes, number of substitute products available in the market)

Because the construction companies are using natural resources, such as gravel and crushed stone, as building raw materials, they are not harmful to the health of residents and have the advantage of being sturdy. Gravel and crushed stone are non-renewable natural resources (once used, they are no longer available), so their supply is likely to depend on the season, the environmental policy decision of the authorities, and the citizens' concepts related to environmental protection.

Production of CDW-based products doesn't depend on the season and is environment-friendly. This is the advantage of CDW-based products compared with natural resources. But their price may be more expensive than gravel and crushed stone because CDW-based products are more value-added and there are more stages in their production.

Availability and accessibility to distribution channel

It might be difficult to find distribution channels in the gravel and crushed stone market for new entry companies. 88% of the surveyed concrete batching plants purchase their raw materials under agreements with suppliers of gravel and crushed stone. All the quarries sell their products in bulk amount and 25% of quarries answered that customers reach the quarries themselves because they had already heard of them from the market. Besides, the quarries' other important ways of reaching customers are introducing products by meeting with customers in person, working as a subcontractor of bigger companies, and working with long term agreements with customers.

According to the survey results, there are cash shortages and barter exchange commonly among the quarries extracting gravel and crushed stone market. Barter exchange generates more opportunity cost and takes a longer time to reach customers than exchange using cash. Also, the

respondents said that companies have higher marketing costs because competitors are engaged in various marketing products.

2.2 Market demand for the CDW-based product

This section aims to determine the potential consumers of the CDW-based product and their behavior, purchasing power and how much construction fill material can be demanded. The CDW-based product can demand in producing the construction fill materials, such as concrete batches.

There can be three types of consumers of the CDW-based production. The potential consumers are:

1. Concrete batching plants
2. SMEs that produce a mix themselves in constructing new buildings
3. Construction companies / SMEs interested in purchasing the CDW-based concrete for constructing new building.

Consumers and their segments

A total of 54[11] concrete batching plants and 87 construction companies/SMEs are actively working; 26 quarries are extracting gravel and crushed stone in Ulaanbaatar. In our sample survey, 25 concrete batch companies were involved, two of them joint ventures with China and Korea, others with domestic investment. 52% and 40% of the 25 concrete batch companies are located in Songinokhairkhan district and Bayangol district, respectively.

The market demand is segmented as shown in the following table depending on the number of employees because the number of employees is the best indicator of a company's capacity.

Table 5. The market segmentation

Name of the segment	Number of employees
Small enterprises	Less than 17
Medium enterprises	18-32
Large enterprises	More than 33

Figure 13 and Figure 14 illustrate the frequency of the number of employees and the duration of activity of the surveyed companies. 64% of them have less than 32 employees, and 52% of them have been established since 2010. The average number of employees is 32. Although the number of companies has been increasing since 2006, there is no correlation between the number of employees and the duration of activity.

[11] Sources: the list provided by Caritas Czech Republic, www.barilga.mn, the yellow book, telephone directory such as 1900-1950.

Figure 13. Histogram of the number of employees

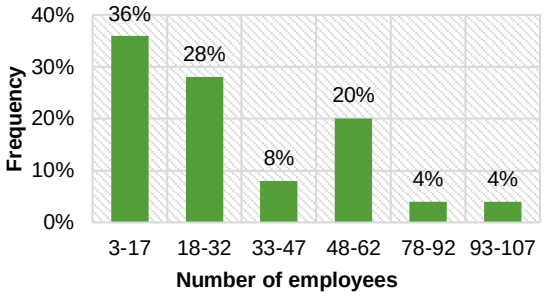
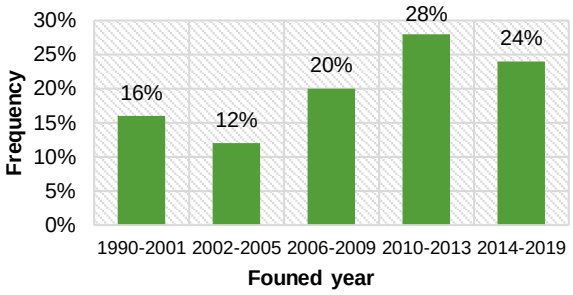


Figure 14. Histogram of the duration of activity



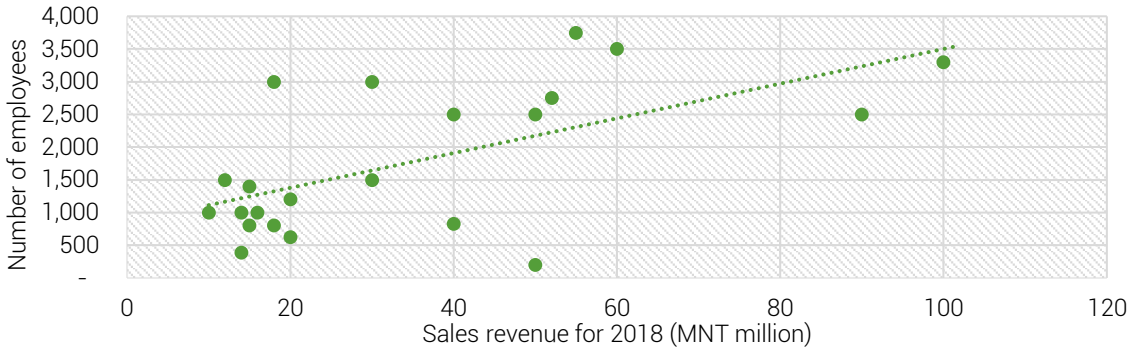
Source: Survey results

Let's now analyze the production capacity and sales income based on the market segment or/and the number of employees.

The main activity of the companies involved in the survey was the manufacturing of concrete batches, and they have been working on this subject for an average of 10 years, with a maximum of 29 years and a minimum of 2 months.

20% of them owe the quarries where they extract gravel and crushed stone, the remaining 80% buy gravel and crushed stone from other companies. 32% of the companies surveyed use conventional and common technology, with the other 68% using modern and new technology. 65% of the companies with modern & new technology were originally from China, the remaining were from South Korea. Unfortunately, there was no significant correlation between the number of employees and the type of technology used or whether or not they own quarries.

Figure 15. The relationship between the number of employees and sales revenue, n=25



Source: Survey results

The correlation coefficient between the sales income and the number of employees was 0.61. From here, we can conclude that a company's income generally increases as the number of employees increases. (Figure 15) According to the calculation of the average sales revenue for each segment, the average sales income was MNT 1,013 million for a small enterprise, MNT 1,688 million for a medium enterprise, and MNT 2,426 million for a large enterprise in 2018.

Consumers demand and their purchasing behavior

Concrete batching plants and SMEs that produce a mix themselves in constructing new buildings can generate demand for the CDW-based product directly, while construction companies / SMEs will create the demand for the CDW-based product indirectly.

Based on the survey data, we calculated the quantity of the direct and indirect demand for the CDW-based product using the Cobb-Douglas[12] production function, the empirical rule[13], and the norm of ingredients of 1 m^3 concrete. Detailed calculations are shown in Appendix A. All variables used in the calculation are expressed in terms of per employee. Because the number of employees is the most significant indicator of the production capacity and the key indicator for the market segmentation in our survey.

In order to calculate direct demand for the CDW-based product, we used the survey data of the average quantity of gravel and crushed stone per employee, which is the raw material for concrete batching plants and can substitute into CDW. Therefore, we calculated that the average quantity of gravel and crushed stone per employee is 317 m^3, the demanded quantity of gravel and crushed stone for a company with 32 workers is 10,132 m^3, and the quantity of market gravel and crushed stone demand with 54 active companies is 547, 128 m^3 a year.

Then we estimated the supplied quantity of concrete batching in the total market based on the calculated quantity of market demand for the gravel and crushed stone and the norm of $1m^3$ concrete batch ingredient. The $1m^3$ of M300 type concrete batch includes approximately $0.369m^3$ gravel / crushed stone. Hence, we assessed that the supplied quantity of concrete batching is 1.48 million m^3 per year in the market. It means that the potential quantity of market direct demand for the CDW-based product (because the gravel and crushed stone is a substitution for the CDW-based product) is 547,128 m^3 in a year and the market supplied the quantity of the concrete batching plants (they can generate the direct demand for the CDW-based product) is 1.48 million m^3 per year.

The demand for concrete batch created by construction companies will generate indirect demand on gravel and crushed stone, which can substitute CDW-based products. Hence, construction companies/SMEs will generate demand in the market indirectly. We projected the indirect demand on gravel and crushed stone by the inverse step of the method for the direct demand. Detailed calculations are shown in Appendix A.

There are 87 construction companies with 77 employees on average in Ulaanbaatar. The average demanded quantity of concrete batch per employee for the construction company is 101.9 in the survey. Based on this piece of information, we assessed that the construction companies generate the indirect demand for 682, 776 m^3 concrete batching and 251,944 m^3 gravel and crushed stone per a year.

The main findings of these calculations are that the total market demand for concrete batches equals approximately 2.17 million m^3 and the total demand for gravel and crushed stone for construction equals 799 thousand m^3 in a year. These numbers are consistent with the available

[12] Particular functional form of the production function, widely used to represent the technological relationship between the amounts of two or more inputs and the amount of output that can be produced by those inputs.

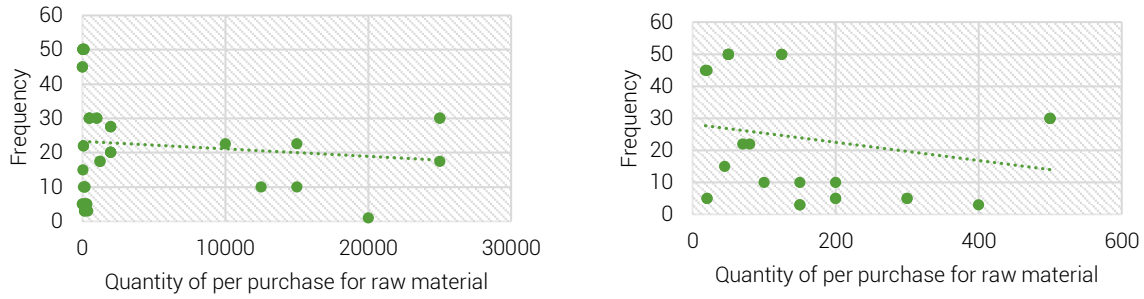
[13] When the data is believed to approximate this distribution, the empirical rule can be used to determine the percentage of data values that must be within a specified number of standard deviations of the mean. Specially,

- Approximately 68% of the data values will be within one standard deviation of the mean.
- Approximately 95% of the data values will be within two standard deviations of the mean.
- Almost all of the data values will be within three standard deviations of the mean.

information, that "in Mongolia, the total supplied quantity for concrete batch per year is less than 2 million cubic meters".[14]

64% of the total of 25 respondents that participated in the survey mainly used gravel in their production while the other 36% used crushed stone. Among the concrete batching plants, the 10-20 mm crushed stone, 0-5 mm gravel, and 10-20 mm gravel are most commonly used, and other types of raw materials are rarely used in overall concrete production.

Figure 16. The relationship between the frequency and quantity of per purchase for raw material, n=25



Source: Survey results

The average amount of one-time purchases of raw material for concrete production is 3826 m^3 and there is an average of 23 purchases per month in summer.

Figure 16 shows the weak negative correlation (correlation coefficient is -0.1) between the average amount of one-time purchases and the frequency of inventory for raw materials. If we remove the one-time purchase of more than 1000 m^3 from the sample, this negative correlation is more likely to occur (correlation coefficient is -0.23).

About 60% of companies surveyed usually buy their raw materials in terms of bulk purchase, while 16% buy using retailing. Also, 88% of the respondents purchase their raw materials under contracting with suppliers of gravel and crushed stone. They said that the contract has many advantages and several disadvantages (Table 6).

Table 6. Advantages and disadvantages of contracting, n=22

Advantages	Disadvantages
• Payments are made according to contract and keep their quality at the required level • It is possible to accumulate stock for raw materials and does not become scarce • Positive impact on concrete quality • No more time to search for a quarry • Reliability, stability • Lower price and favorable payment terms	• There is no legal regulation • Sometimes there is a conflict between the companies • It is difficult to solve a problem based on a contract • They don't find new technology and innovation • Sometimes the supplier behaves irresponsibly, and wastes consumer's time.

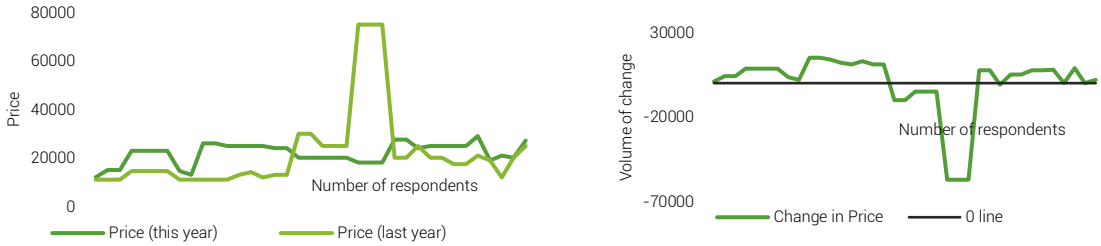
[14] http://www.premiumconcrete.mn/content/395

All respondents answered "No" to the question, "Does your company make additional production lines for recycling, re-screening, and crushing when using gravel and crushed stone of your suppliers?".

The most important requirement for the quality of gravel and crushed stone is its relative humidity and durability. 56% of surveyed concrete batch companies test the chemical composition and other ingredients of the inventory in their laboratory, while 36% of them take samples and test them in permitted laboratories. Unfortunately, 4% of them haven't tested their raw materials, and the remaining companies test them using mechanical methods.

In 2019, 27% of the companies involved in the survey pay MNT 17,000-22,000 per m^3 of gravel and crushed stone, 46% of them pay MNT 22,000-27,000 per m^3 of gravel and crushed stone.

Figure 17. Change of raw material prices, n=25



Source: Survey results

The average price of raw materials this year rose by 1.23 percent to MNT 22,280 from the same period of last year. The increase in average price is very low, but Figure 17 shows that there is a significant difference between the previous year and the current year's price. To identify the increase in price, the median price for every two years is calculated. The median price rose from MNT 17,500 last year to MNT 23,000 this year and the price difference between two years is MNT 5,500, reflecting the median price increase of 31.4 percent.

Respondents described the most significant factors that affect change in the price of raw materials as the self-cost of raw materials (40%) and transportation cost (40%). Following that, the location of suppliers (32%), the availability of raw materials (32%) and the state's policy (28%) influence the change in raw material prices.

The cost of transportation of the concrete batching plants is different depending on the type of transport, and in some cases, the transportation cost is determined by the sum of 2-3 types of costs. The majority of the concrete batching plants, which were 64.29% of the total respondents, transport raw materials using their vehicles, and their transportation costs consist of transport costs and quality control costs. Two other types of transportation account for 28.5% each. Costs of loading and unloading raw materials are also incurred when they are transported by other individuals or organizations. However, the loading costs are mostly in the shipping price.

The cost of loading and unloading per month is the highest while the quality control cost is the lowest, which is MNT 339,625. On average, concrete batching plants spend MNT 650,500 per month on transport only. If the quality control costs are added, MNT 990,125 will be used for transportation.

Consumers' purchasing power

On average, the surveyed concrete batching plants revenue MNT 1,775 million in 2018. 14%, 27%, and 14% of them have revenue below 699 million, 700-1199 million, and more than 3200 million, respectively (Figure 18).

Figure 18. Sales revenue for 2018, n=25

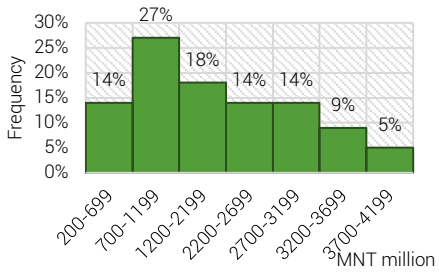
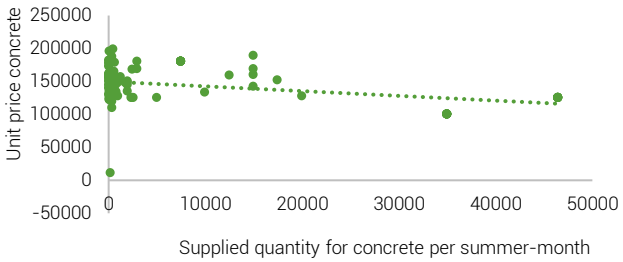


Figure 19. Correlation between the supplied quantity of concrete and its price

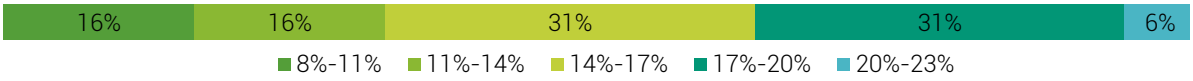


Source: Survey results

Figure 19 shows the correlation between the unit price and volume of concrete in summer months using product output and price information supplied to the market. There is a weak negative correlation between production volume and price per month and the correlation coefficient of two variables is -0.39. If we sort the batch supply by type, then the M550 type batch supply is the highest while its price is relatively low. On the other hand, the M500-650 type batch supply is the lowest while its price is the highest.

The average price of 1 m^3 of concrete is MNT 115,000 and on average 16% of the unit price includes the cost for the gravel and crushed stone. 16% of the respondents answered that 8%-11% of the unit price includes the cost for gravel and crushed stone, while 6% of them said that 20%-23% of the unit price includes the cost for gravel and crushed stone.

Figure 20. The share of raw materials cost in the unit price, n=25



Source: Survey result

2.3 Raw material's supply of the CDW-based product

This section aims to determine the potential suppliers of raw material and their behavior, and how much raw material can be supplied. The raw material of the CDW-based product that will be considered in this section is the concrete debris from demolished buildings and construction of new buildings.

Potential suppliers and their characteristics

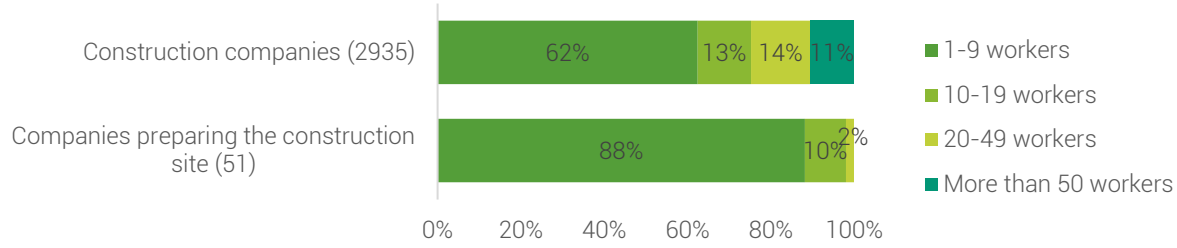
There can be three types of suppliers of the CDW-based production. The potential suppliers are:

1. Construction companies/SMEs demolishing old buildings,
2. SMEs that are contracted with construction companies to demolish an old building

3. Construction companies/SMEs constructing new buildings- concrete waste from constructing new buildings is also a source of raw materials for the CDW-based product.

As of the first quarter of 2019, 2.935 construction companies and 51 companies preparing the construction site are actively working at the national level.[15] The majority of the construction companies and companies preparing the construction sites are SMEs. Namely, 89% of construction companies have up to 49 workers, while all companies preparing the construction sites[16] have up to 49 workers.

Figure 21. Construction companies and companies preparing the construction site at the national level, by number of workers



Source: Survey result

According to the integrated portal system of construction (www.barilga.mn), the list provided by the CCR, the yellow book, directory telephones, a total of 87 construction companies and 10 demolition companies have actively worked in Ulaanbaatar. It, therefore, can be concluded that the potential suppliers of the CDW-based product are around 97 companies.

A total of 55 companies were involved in the supply side survey, which are chosen with ±8% margin of error and 95% confidence level. 51 out of 55 companies are the construction companies, and 4 out of 55 are companies that demolish old buildings. Moreover, 3 out of 51 construction companies operate in both construction and demolition. Therefore, information regarding the demolition is based on the 7 companies. Most of the respondents are engineers, managers, and directors.

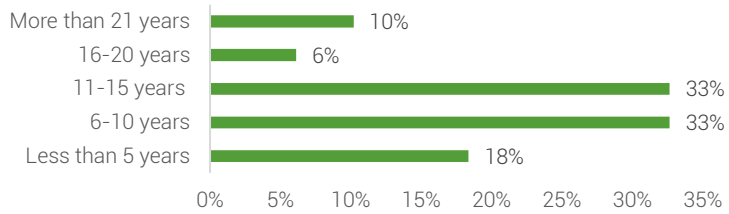
Over half of the construction companies involved in the survey were established within the last 10 years, while the rest (41%) were founded more than 10 years ago. The average age of construction companies is 11 years. The oldest construction company was established 30 years ago, while the youngest was established a few months ago.

As for the demolition companies, the average age is 9.6 years. The oldest was founded in 2000, the youngest was founded in 2015.

[15] Business register database of National Statistical Office

[16] They are the companies that prepare the construction site before constructing a new building.

Figure 22. Age of the construction companies, n=51



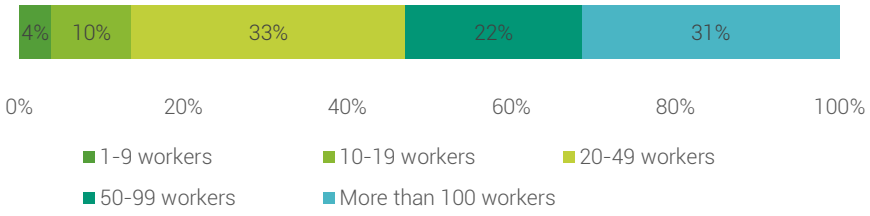
Age of demolition companies, n=4

Average age	9.6 years
Oldest age	19 years
Youngest age	4 years

Source: Survey results

47% of the construction companies have up to 49 workers, whereas 53% have more than 50 workers. The average number of workers in construction companies is 81 workers. Three of the demolition companies have ten workers, while the rest has a hundred workers, which is a relatively large company specialized in demolition activities.

Figure 23. Number of workers of construction companies, n=51



Average workers 81

Max workers 500

Min workers 3

Figure 24. Number of workers of demolition companies, n=4

Average workers 33

Max workers 100

Min workers 10

Source: Survey results

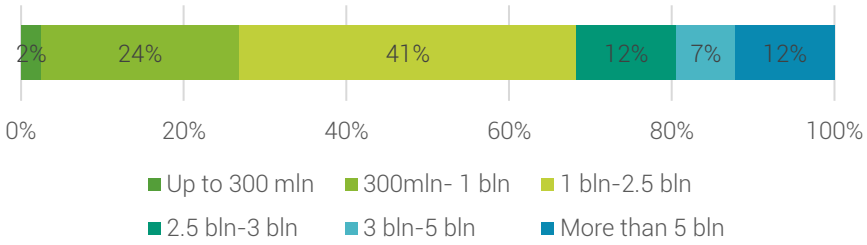
2% of the construction companies that gave their income information[17] earned up to MNT 300 million, 24% earned from MNT 300 million to MNT 1 billion, 41% earned from MNT 1 billion to MNT 2 billion, and 32% earned more than MNT 2.5 billion in 2018. Therefore, that 2% (1 construction company) is classified as a micro-enterprise, 24% (11 construction companies) are small enterprises, and 41% (17 construction companies) are in medium companies according to the amendment of the Law on Support of Small and Medium Enterprises.[18] On the contrary, 32% (13 companies) are big companies. The average sales income of construction companies is MNT 3.1 billion.

[17] 10 out of 51 construction companies refused to give information about sales income.

[18] Enterprises with 10 workers and sales income of up to MNT 300 million are regarded as micro-enterprises; enterprises with 10-50 workers and sales income from MNT 300 million to MNT 1 billion are regarded as small-enterprises, and enterprises with 50-200 workers and sales income from MNT 1 billion to MNT 2.5 billion are regarded as medium-enterprises.

As for the demolition companies, 1 out of 4 companies earned MNT 800 million, 2 companies earned MNT 1 billion, and 1 company earned in MNT 2 billion in 2018. Therefore, 3 of them are small enterprises and the rest are the medium enterprises.

Figure 25. Sales income of construction companies in 2018, MNT, n=41

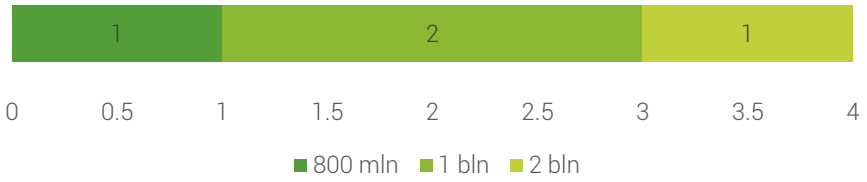


Average sales income MNT 3.1billion

Max sales income MNT 25 billion

Min sales income MNT 100 million

Figure 26. Sales income of demolition companies in 2018, MNT, n=4



Average sales income MNT 1.2 billion

Max sales income MNT 2 billion

Min sales income MNT 800 million

Source: Survey results

The majority of construction and demolition companies are Mongolian companies. Nearly half (45%) of the construction companies can construct up to 5000m^2 per year, 40% can construct from 5,001m^2 to 10,000m^2 per year, and 14% can construct more than 20,0001 m^2 per year.

Figure 27. Ownership of companies, n=55

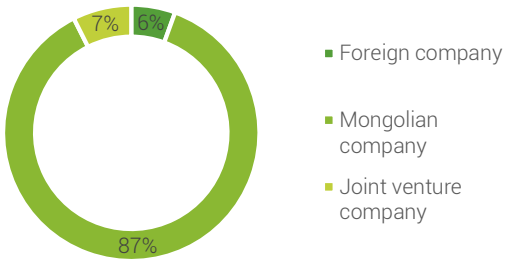
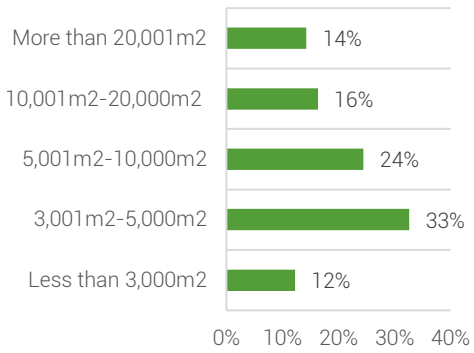


Figure 28. The production capacity of construction companies, n=51



Source: Survey results

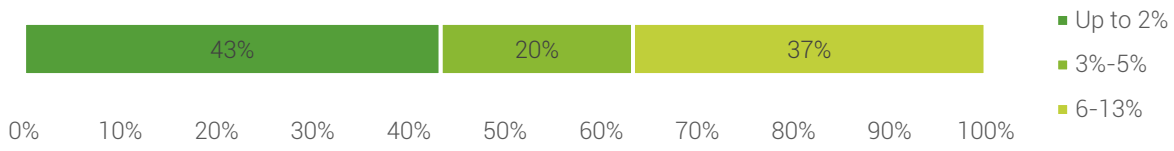
The potential amount of supply of the raw material and suppliers' behavior

On average, the demolition companies demolish 4-5 large residential and non-residential buildings per year. However, a company responded that it demolishes around 100 small buildings per year. Nearly 80%-85% of debris from the concrete buildings is concrete waste, including gravel, crushed stone, sand, reinforced concrete cement, etc. On average, the demolition price of 1m^3 building is MNT 121,000.

37% of the construction companies constructed their buildings on land where old buildings existed before, and they have constructed around 47 buildings on these lands. It, therefore, is concluded that there is demand for the demolition of old buildings in Ulaanbaatar. Furthermore, 68% of the construction companies responded that concrete waste is generated when constructing a new building. 5% per ton of concrete is wasted on average. The main reasons for wasting concrete are the following:

- Concrete remains regarding the operations with concrete pump;
- Wrong calculation and planning; and
- Technical issues.

Figure 29. The amount wasted from a ton of concrete, n=30



Source: Survey results

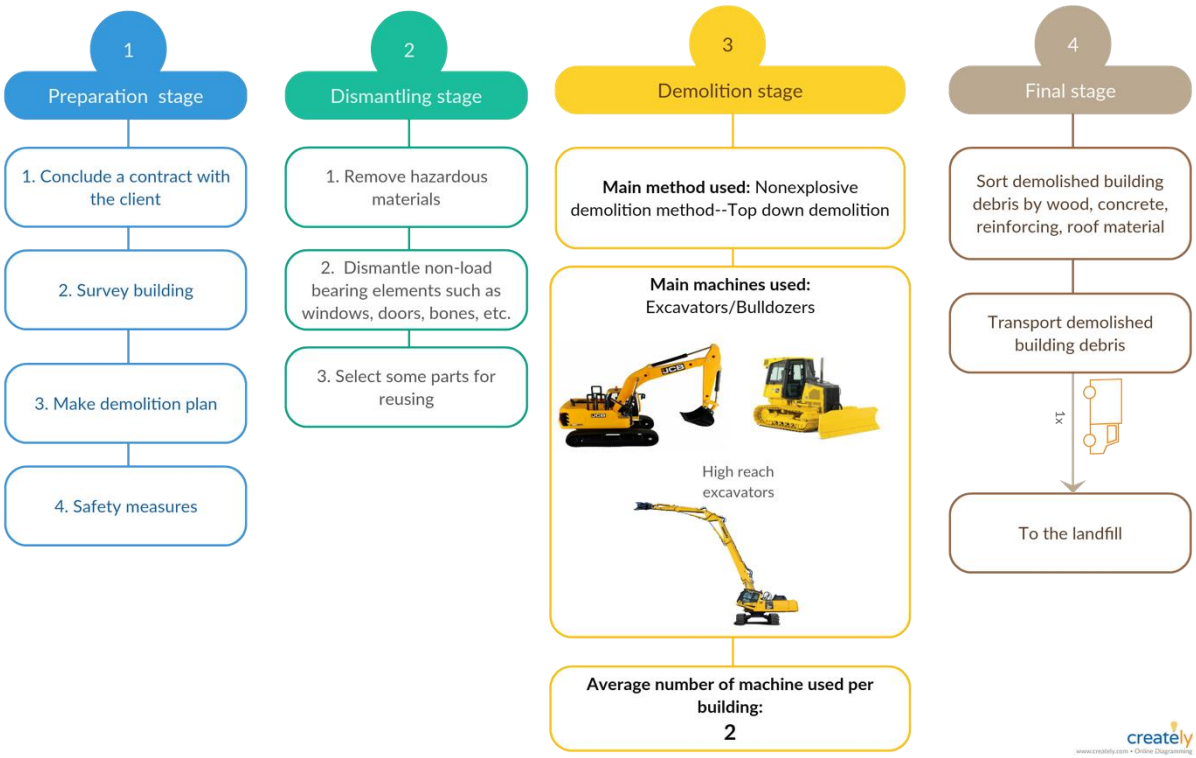
On average, they paid around MNT 230,000 per truck to remove waste from the construction site.

Demolition process and techniques: The demolition companies mainly demolish buildings in four steps. The process of demolition of buildings is illustrated in the figure below. In the preparation stage, the demolition companies make an agreement with the client, survey a building in terms of the structure and its surroundings, make the demolition plan, and implement safety measures. The next step is to dismantle the building. In this step, hazardous materials will be removed if they are found in the investigation of the site. After that, the dismantling process begins with the removal of non-load bearing materials such as windows, doors, bones, hanging ceiling, etc. The majority of the demolition companies said that they select those parts for reuse if they are not broken.

All companies use non-explosive demolition methods, and they all perform top-down demolitions. The process of top-down demolition involves the deconstruction of the property, floor by floor, from the top down to the bottom. This method is the safest method in which to undertake the demolition of high and medium-rise properties. The key machines used in demolition are excavators, bulldozers, and high reach excavators. Each demolition company has 2-3 machines. Only one company said that they use small handheld equipment for demolition of a building, and they have around 25-30 pieces of equipment.

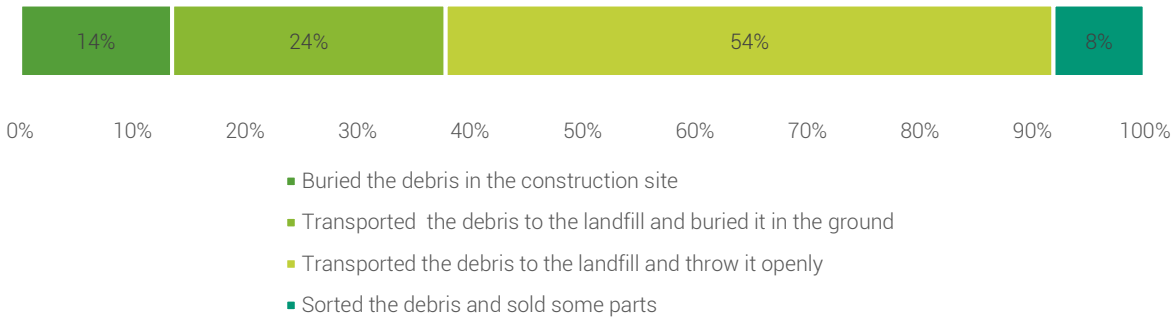
In the final step, 6 out of 7 demolition companies sort demolished building debris. Two of them pick only wood from the debris, while the others sort the debris by wood, concrete, reinforcing, and roof material. After sorting, they transfer the remained debris to the landfill. In doing so, two of them transport demolished building debris to the landfill themselves and throw it in the open and 1 company transports the debris to the landfill themselves and buries it in the ground. The other four companies pay money for handling demolished building debris.

Figure 30. The process of demolition of the building



Over half of the construction companies that constructed their buildings on land used before transported demolished building debris to the landfill and threw it in the open.

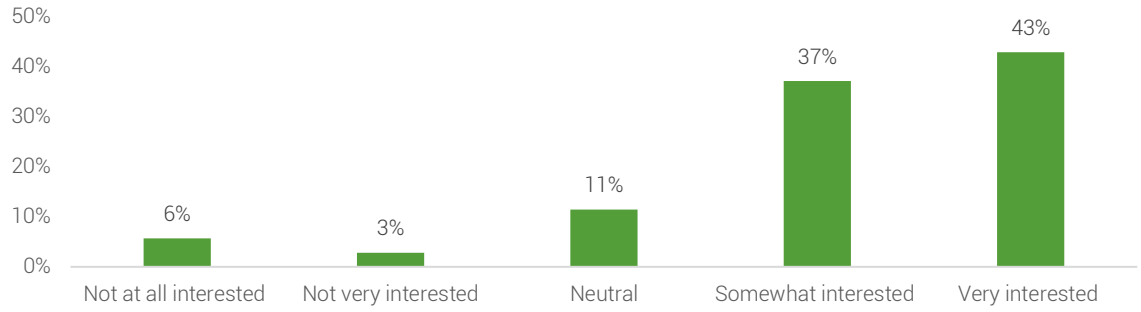
Figure 31. Handling demolished building debris for the construction companies that constructed buildings in the land used, n=19



Source: Survey results

All demolition companies involved in the survey have the interest to supply demolished building debris for recycling. The majority of construction companies generating concrete waste are interested in supplying their concrete waste from construction to new buildings for recycling.

Figure 32. Interest to supply concrete waste for recycling, n=35



Source: Survey results

2.4 Competitors of the CDW-based product

This section aims to define the main competitors of the CDW-based product, their features and competitiveness, the interest of quarries in producing the CDW-based product, and costs of producing competitive products. The competitive products or substitutes of the CDW-based product are gravel and crushed stone, and potential competitors are the quarries extracting gravel and crushed stone.

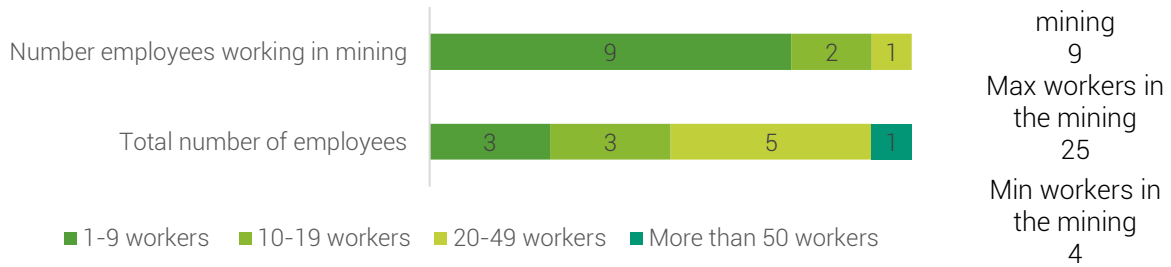
Quarries extracting gravel and crushed stone

A total of 26 quarries extracting gravel and crushed stone have actively worked in Ulaanbaatar according to the integrated portal system of construction (www.barilga.mn) and the list provided by CCR. Although the number of quarries has grown rapidly in the last few years, a number of quarries have been closed due to illegal operations. 12 out of 26 quarries in Ulaanbaatar are sampled with ±15% margin of error and 95% confidence level. 6 out of 12 quarries extract gravel and another 6 quarries extract crushed stone.

The quarries surveyed were founded during 1998-2019. The majority of the quarries involved in the survey were established within the last 10 years, and only two of them were founded more than 10 years ago. The average age of the quarries is 7.1 years.

The average number of total workers in the quarries is 24 employees, with 9 employees working in mining activities on average. 9 quarries have up to 9 workers, 2 quarries have 10-19 workers, and one quarry has 25 workers. In general, 3-4 persons work as administrative and managerial staff, and one person is responsible for sales in most quarries.

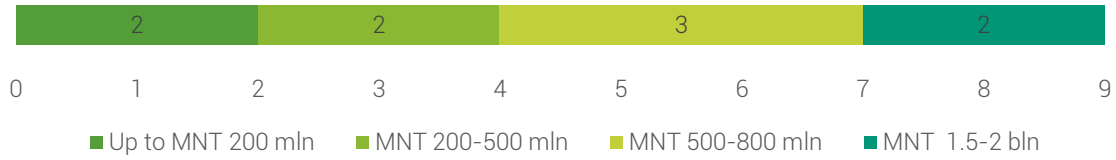
Figure 33. Number of workers in the quarries, n=12



Source: Survey results

Three quarries earned up to MNT 300 million, 4 quarries earned from MNT 300 million to MNT 1 billion, and 2 quarries earned from MNT 1 billion to MNT 2.5 billion in 2018. Therefore, 3 of them are classified as micro-enterprises, 4 are small enterprises, and the remaining two are medium companies according to the amendment of the Law on Support of Small and Medium Enterprises. Moreover, all quarries are Mongolian companies.

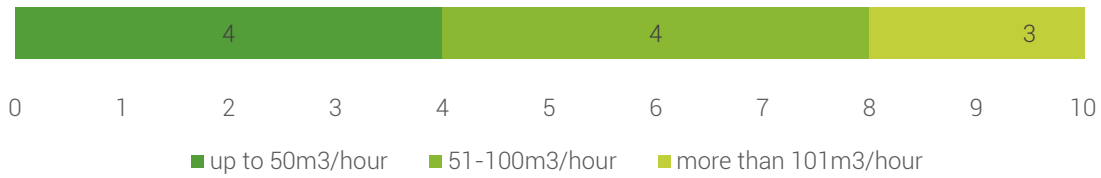
Figure 34. Sales income of the quarries in 2018, MNT, n=9[19]



Source: Survey results

Production capacity: The production capacities of the quarries are between 20-250m^3 gravel and crushed stone per hour. 4 out of 12 quarries can extract up to 50m^3 per hour, 4 quarries can extract 51m^3-100m^3 per hour, and 3 quarries can extract more than 100m^3 per hour. The average capacity of the quarries is 77m^3 per hour, the highest is 250m^3 per hour, and the lowest is 20m^3 per hour.

Figure 35. The production capacity of the quarries, MNT, n=11



Source: Survey results

All quarries have their factory building, production area, and storage area. The average sizes of areas used in production are 450m^2 for the factory building, 12 ha for the production area, and 1 ha for the storage area. All quarries are connected to the central electric power and water integrated system.

Table 7. Size of areas used in production

Type of areas	Average size	Maximum size	Minimum size
Factory building (m^2)	450	800	200
Production area (ha)	12	50	0.04
Storage area (ha)	1	5	0.3

Source: Survey results

Quarrying process and techniques: The process of quarries is illustrated in the figure below. Quarries are located in river basins and nearby mountains. The quarries extract gravel from rivers and crushed stone mostly from mountains. Only one quarry has extracted crushed stone from the open mining site.

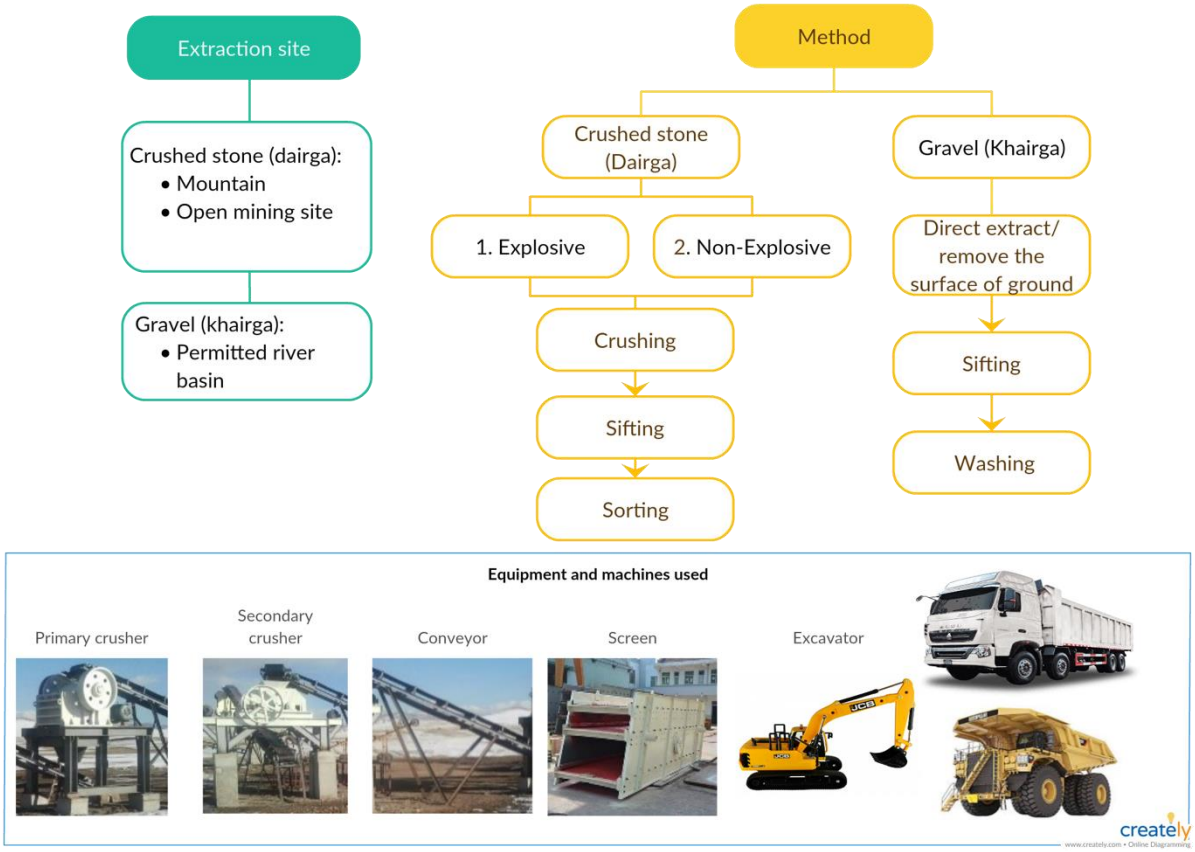
Quarrying is done either by fully automatic machines or semi-automatic machines. Namely, half of the quarries involved in the survey use fully automatic machines in the extraction, and the

[19] Three quarries refused to give sales information.

other half use semi-automatic machines. The quarries extract crushed stone using explosive and non-explosive methods. 4 quarries use explosive techniques in quarrying crushed-stone, while 2 quarries use non-explosive techniques. As for gravel, the main quarrying method is to remove the surface of the ground.

The main equipment used in production is primary crushers, secondary crushers, conveyors, and screens, while the main machines are excavators, and trucks. On average, a quarry uses four main devices in mining.

Figure 36. Quarrying process and techniques



Competitive products

Sales and prices: The annual average production of the quarries is very different due to production capacity and deposits. It was 26,700 tons in 2017 and 72,860 tons in 2018. The production had increased by 39% from 2017 to 2018.

The average monthly sales of gravel are 7200 m^3, while the average monthly sales of crushed stone are 15,700 m^3 in warm seasons. The demand for crushed stone is 2.1 times higher than gravel. Comparing sizes, smaller gravel tends to have higher demand than larger, while the bigger crushed stone has more demand than smaller. Namely, monthly sales of gravel with 0-5mm is higher than the other two sizes of 5-10mm and 10-20mm; and monthly sales of crushed stone with 10-30 mm is higher than others.

Figure 37. Annual production of the quarries, ton, n=5

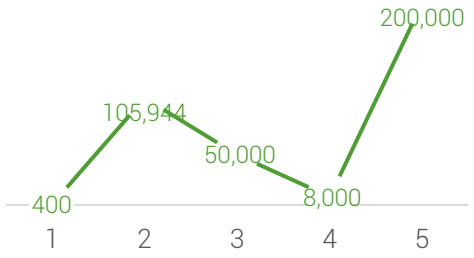
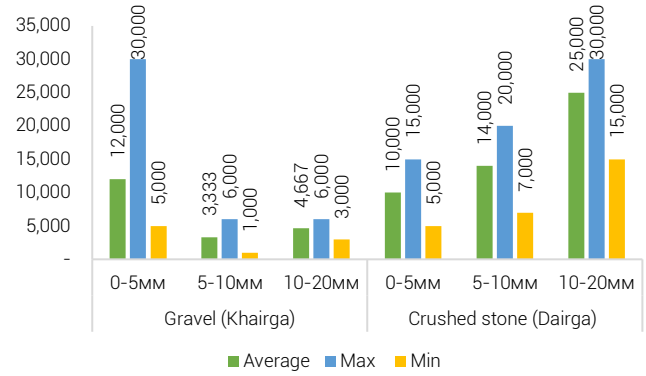


Figure 38. Monthly sales in warm seasons, m^3



Source: Survey results

In 2019, the quarries have sold MNT 11,730/m^3 of gravel on average, with the highest price being MNT 16,000/m^3, and the lowest price is being MNT 8,000/m^3. The price of gravel this year fell by 9 percent or MNT 1,625 from the same period of last year. The price of gravel sized 0-5 mm tends to be slightly higher than big sized gravel.

Crushed stone is sold for MNT 8,000-16,000 per cubic meter at the site. The average price of crushed stone is MNT 13,640/m^3. There is almost no change in the price of crushed stone, and only one quarry increased its price by MNT 2000 from last year, another quarry decreased its price by MNT 2,000 from the last year. The price of bigger crushed stone tends to be slightly higher than small-sized crushed stone.

Figure 39. Price of gravel at the site and its change

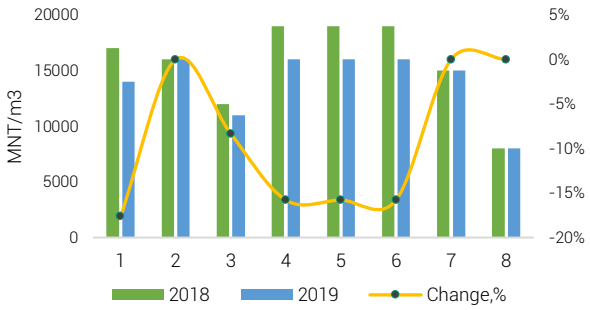
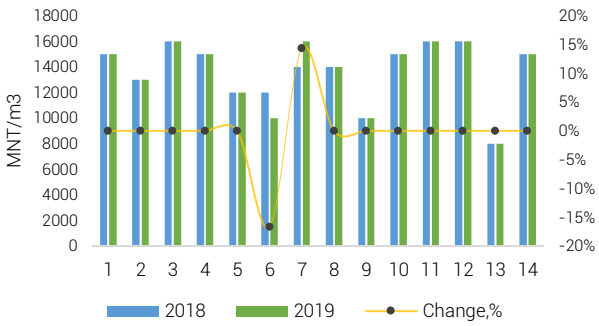


Figure 40. Price of crushed stone at the site and its change



Source: Survey results

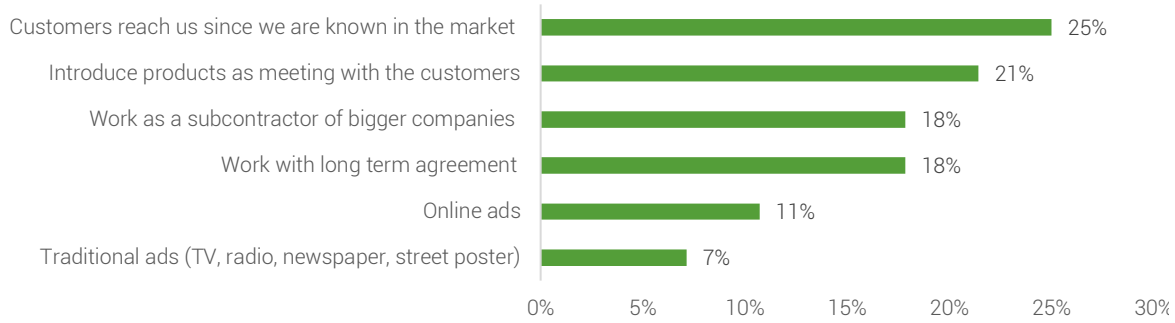
The most significant factors affecting change in prices of gravel and crushed stone are production costs of gravel and crushed stone (30%), taxes (19%), season effect (15%), and terms and conditions of agreement made with customers.

All of the quarries inspect the quality of their products through authorized laboratories. Five quarries valued their products as very good, and seven quarries valued their products as good.

Distribution: All the quarries sell their products in bulk amount, and three of them also sell their products in bulk amount in summer, and they retail their products in other seasons. Two ways are mainly used to deliver products to customers. One way is that the buyer is responsible for handling the transportation, and the other is that the quarries pay money for a transportation company/individual to deliver their product to customers.

Quarries use many ways to reach customers. A total of 28 answers were collected from 12 quarries, a quarter answered that customers reach the quarries themselves because they had already heard of them from the market. The next key ways of reaching customers are introducing products by meeting with customers in person, working as a subcontractor of bigger companies, and working with long-term agreements with customers.

Figure 41. The ways to reach customers, n=28



Source: Survey results

Customers regularly require quality assurance in gravel and crushed stone from all quarries. They also require meeting contract terms and stable prices.

Interest to produce the CDW-based product: When asked about their interest in producing the CDW-based product, 6 quarries expressed interest in producing the CDW-based product, 2 quarries had no interest, and 4 quarries hesitated in answering this question. The main reasons are listed below.

Have an interest	Hesitate	No interest
• Social responsibility (5) • Environmentally friendly (1)	• Social responsibilty (1) • Environmentally friendly (2) • Negative effect in product quality (1)	• Negative effect in profitability of company (2)

Source: Survey results

Production costs of competitive products

The costs associated with the extraction, production, transportation, maintenance of machinery and equipment, and marketing are the main costs of producing gravel and crushed stone. The table below summarizes the cost breakdown. On average, a quarry spends MNT 26.5 million per month for production and sales; the highest total cost is MNT 51 million per month, while the lowest is MNT 15 million per month.

Table 8. Cost breakdown

#	Costs	Amount (MNT, thousand)		
		Mean	Max	Min
1	Explosion per month	28,790	43,500	16,600
2	Production cost per month	26,000	30,000	22,000
3	Crushing cost per month	22,700	33,000	15,000
4	Quality inspection cost per month	2,080	2,250	2,000
5	Transportation cost, m^3	6,500	10	3
6	Maintenance of machinery and equipment per year	40,750	60,000	20,000
7	Sales and marketing expenses per year	7,500	10,000	5,000
	Total costs	26,504	51,066	15,000

Source: Survey results

The average monthly salary of employees is MNT 1,460,000 and workers are paid for salary incentives from MNT 200,000 to MNT 500,000 in a month.

Table 9. Salary information

#	Position	Monthly salary (MNT)	Incentives per month	Overtime
1	Executive officer	1,800,000	200,000-500,000	4,500
2	Operator, mechanic	1,300,000		
3	Engineer	1,720,000		
4	Accountant	1,300,000		
5	Salesman	1,180,000		

Source: Survey results

3. Awareness of the CDW-based product

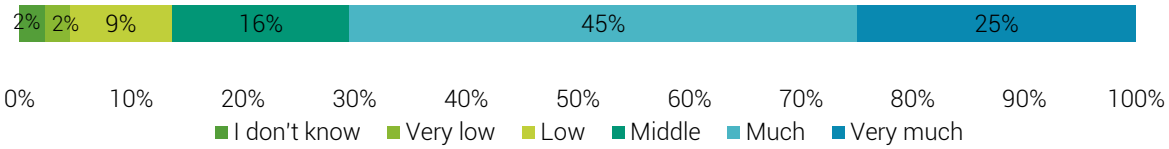
This section describes the interest, willingness, and awareness of the CDW-based product of the surveyed companies. A total of 92 companies involved in the survey, 60% of them were the construction and demolition companies/SMEs, 27% were the concrete batching plants and, the remaining were the quarries extracting gravel and crushed stone.

3.1 Construction companies

The absolute majority of them agree that debris from demolished buildings is a big source of environmental pollution (Figure 42) and 99% of all companies involved in the survey said the CDW-based product can be nature-oriented.

They answered that if the CDW-based product will be produced, (i) citizens and residents, (ii) construction companies (iii) concrete batch plants and (iv) project implementers will take benefit more than others.

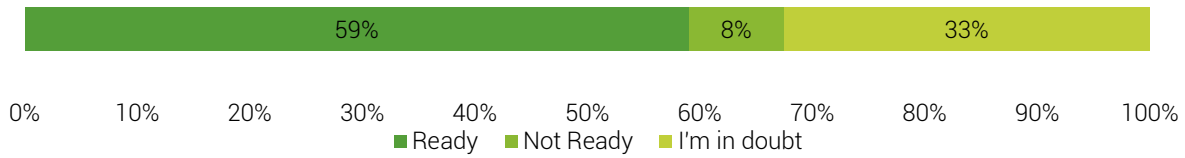
Figure 42. The idea of CDW is polluting the environment (n=88)



Source: The survey results

59% of the respondents expressed that they are ready to use the CDW-based product and the remaining of them were not ready or in doubt. However, 91% of them expressed their readiness to use the CDW-based product for their social responsibility.

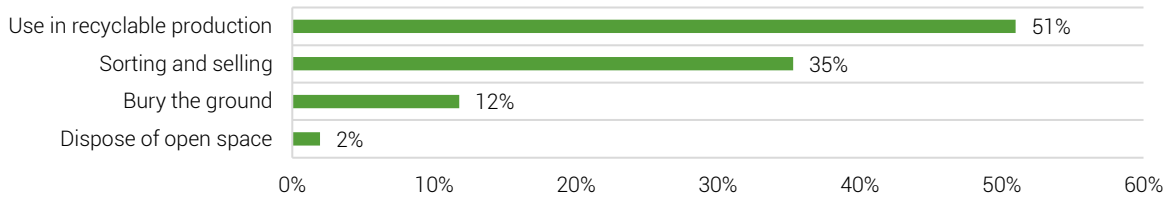
Figure 43. The willingness to use the CDW-based product (n=83)



Source: The survey results

As far as the attitude of the people towards how to deal with CDW, recyclable production is 51%, sorting and selling is 35%, bury in the ground is 12% and dispose of in and open space is 2%. This shows that use in recyclable production and sorting and selling are supported by most people.

Figure 44. How to decide on CDW (n=51)



59% believe that it is possible to replace the current product with the quality of the gravel and crushed stone with the CDW. 29% of them said that it is it might be possible and 12% said it was impossible. 12% that said it was impossible were b construction companies.

More than half are ready to use the CDW-based product (59%) and 31% answered that they are in doubt. But 10% or fewer of companies are not ready to use it.

Figure 45. Is the CDW-based product eligible for quality (n=51)

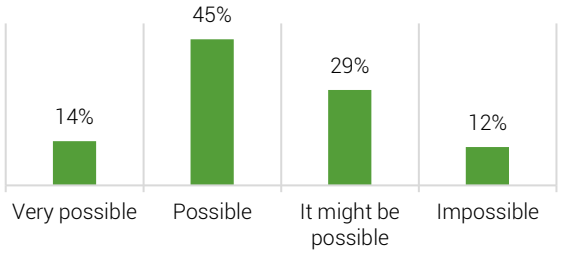
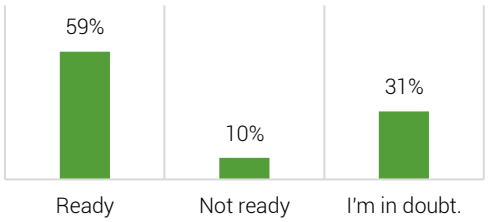


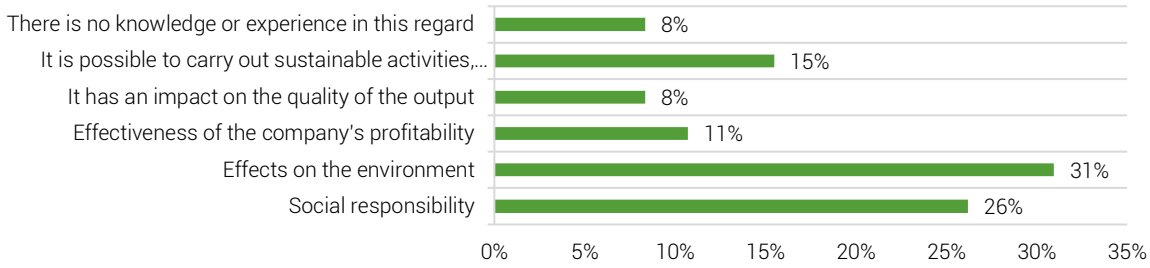
Figure 46. Readiness of CDW-based product (n=51)



Source: The survey results

If the CDW-based product is to be used, the most common reason (31%) is its effects on the environment. The next most preferred reason is social responsibility (26%). All other possible responses were selected, as well. There was only one company that gave another reason, and it is important to clarify that they believe consumers are not psychologically prepared to switch to the CDW-product.

Figure 47. Cause of the CDW-based product (n=84)



Source: The survey results

61% of companies said that the price of the CDW-based product would be lower than the current product. 31% said that the price will be the same, and 8% do not know. This is illustrated in Figure 50 by income classification of companies. 39 companies have provided their revenue information.

Figure 48. What should be the price of the CDW-based product (n=51)

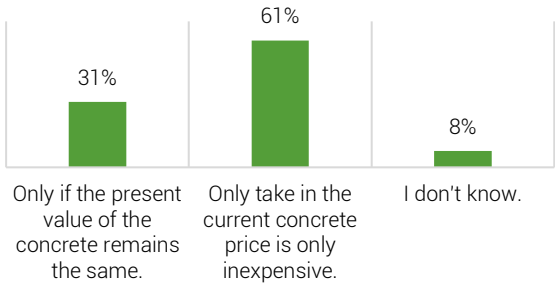
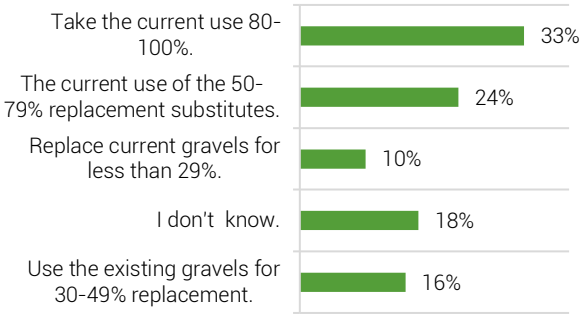


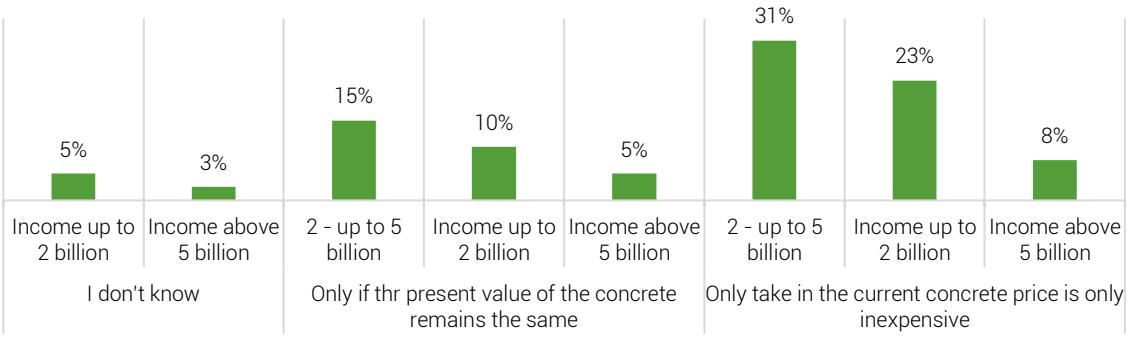
Figure 49. How much to substitute for the CDW-based product (n=51)



Source: Survey results

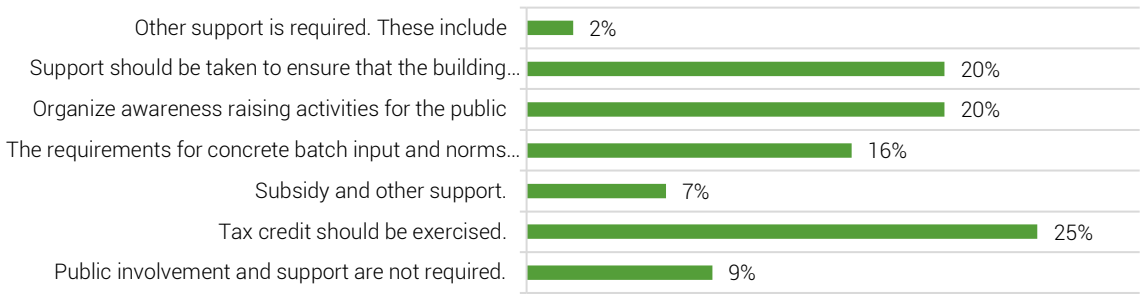
If the product is to be used, 33% said that the CDW-based product would substitute 80-100% of the current product. 24% of respondents are interested in replacing 50-79%. The remaining companies said that they would replace for a small amount and do not know.

Figure 50. The interest to purchase is the sales income classification (n=39)



Source: The survey results

Figure 51. What kind of policy (n=88)



Source: The survey results

We can see above how to support the government's use of the CDW-based product (Figure 51). From the graph, we can see that the most common responses are that a tax credit should be exercised (25%), support should be taken to ensure that the building collapse is appropriate and standardized (20%), and organize awareness raising activities for the public (20%). The remaining answers are that the requirements for concrete batch input and norms should be changed (16%), public involvement and support are not required (9%), subsidy and other support (7%) and other support is required (2%).

Most companies believe that the CDW-based product needs to be of good quality. In addition, the price, supply, and verification of the CDW-based product are most important.

3.2 Concrete batching plants

This section consider the awareness of concrete batch plant about CDW-based product. 52% agree that the use of CDW-based product is socially responsible. But 48% answered that they in some way agree.

48% of the total concrete batch plants said they are ready to use the product. About half of the respondents is currently in doubt (44%). If they choose to use the product, the reasons of social responsibility and effects on the environment will be most important. There are also some concrete batching plants who have suggested that the time has come for the CDW-based product to be introduced to the public and companies.

Figure 52. Social responsibility (n=25)

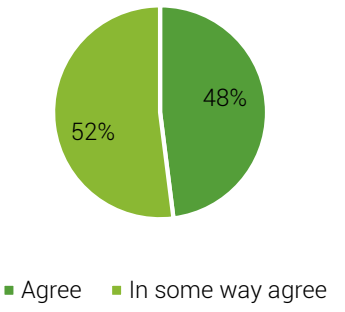


Figure 53. Possible to replace raw materials (n=25)

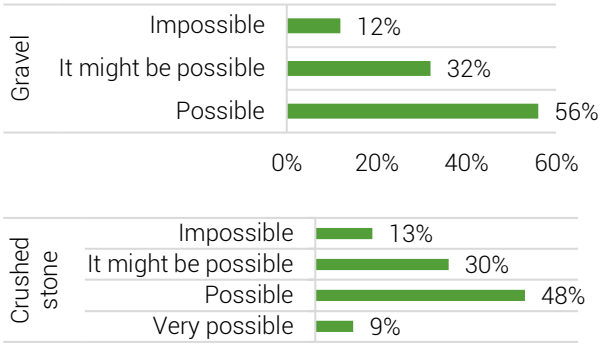


Figure 54. Readiness of the CDW-based product (n=25)

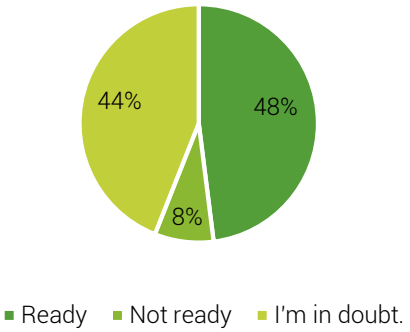
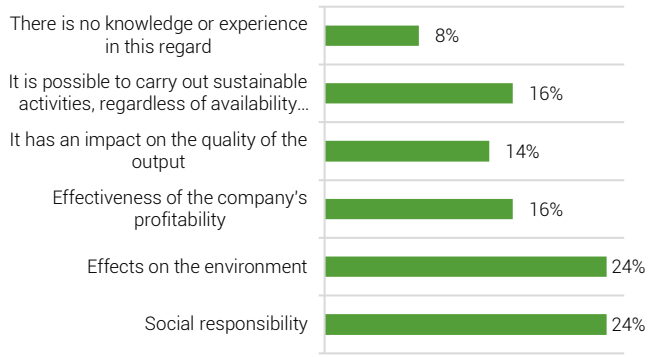


Figure 55. Cause of the CDW-based product (n=51)



Source: The survey results

Regarding the price, 52% responded said that they would be interested in purchasing the CDW-based product if the price was lower than the current product. The remaining respondents said the price was the same (28%) and others did not know (20%). When buying a product by interest rates, the industry can replace only 19% of the total production by 50-79%. The companies with the highest income responded that they usually do not know (19%). These companies are also interested in buying small replacement rate of 30-49%.

Figure 56. What is the price can be used for the CDW-based product (n=25)

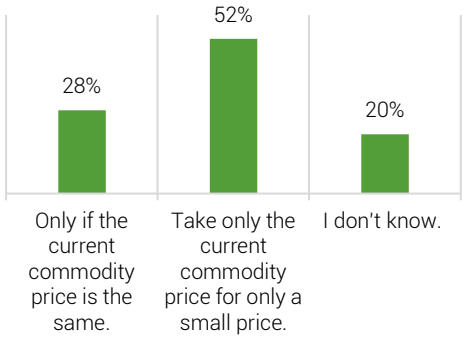
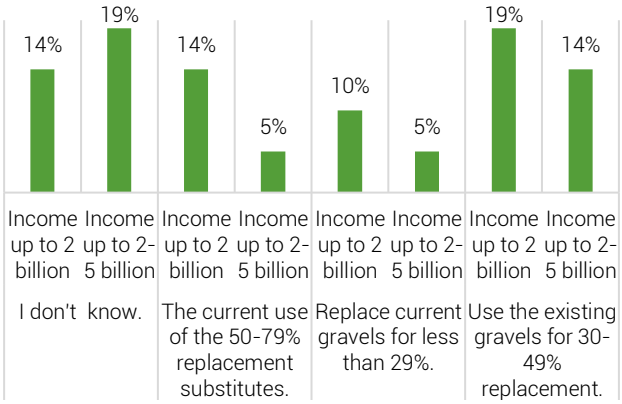


Figure 57. How much to substitute for the CDW-based product is income classification (n-=25)

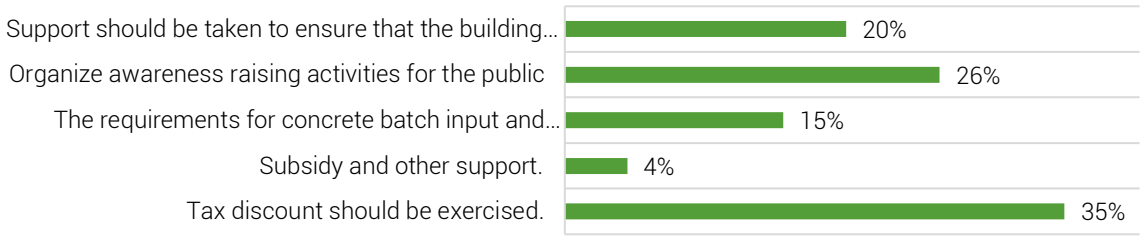


Source: The survey results

To increase the consumption of the CDW-based product, 35% of respondents stated that a state tax discount is needed. Organize awareness-raising activities for the public is 26%, the requirements for concrete batch input and norms should be changed is 15%, subsidy and other support is 4%, support should be taken to ensure that the building collapse is appropriate and standardized is 20%.

When asked about what requirements the CDW-based product producer can offer, the response was that they can offer a high standard of quality and low prices.

Figure 58. What kind of policy (n=46)



Source: The survey results

3.3. Quarries

Most quarries consider that the CDW-based product can be substituted for the current product. 50% of participants are interested in participating in the training on CDW-based products, 33% are not sure and 17% are not interested.

Figure 59. Do you agree that the CDW-based product can be replaced by gravel and crushed stone? (n=12)

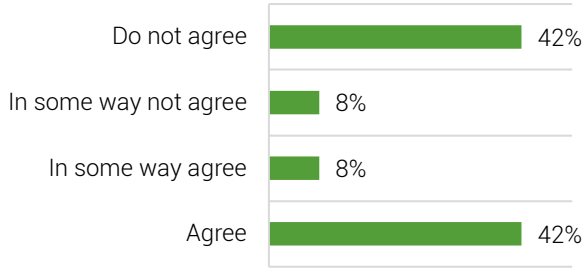
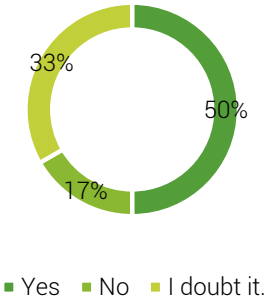


Figure 60. The interest in the training (n=12)



Source: The survey results

As for the reasons for attending the training, the two main ones are nature-oriented (29%) and social responsibility (29%). Effectiveness of the company's profitability, impact on the quality of the output and no knowledge or experience in this regard were other given reasons. About the state's support, 27% of respondents said that tax discount should be exercised, public involvement and support are not required are 23% and support should be taken to ensure that the building collapse is appropriate and standardized is 23%. Other reasons are very few. It should be noted that gravel and crushed stone quarries have agreed that the use of the CDW-based product is environmentally friendly.

Figure 61. Reason for training (n=12)

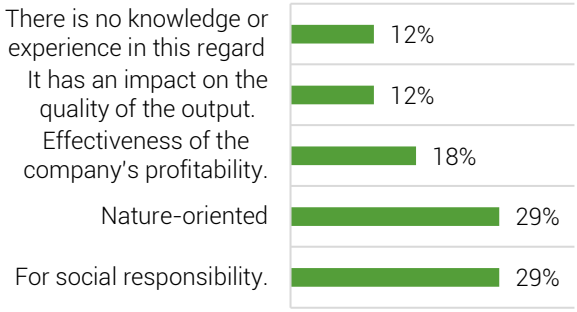
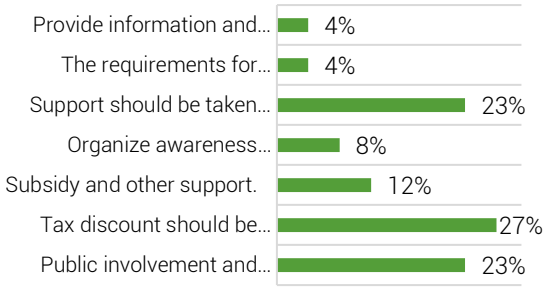


Figure 62. What kind of policy (n=26)



Source: The survey results

4. Cost effectiveness analysis

The cost effectiveness analysis for the CDW-based product was calculated based on the results of the research to test the CDW-based product, surveys, the market price information of the required equipment for the production, and the relevant provisions of existing legislation in Mongolia. The basic data used in the cost effective analysis are presented in the Appendix B.

4.1. Investment Plan

Based on the market readiness survey, pricing survey of facilities and equipment, and the findings of the research to test the CDW-based product, the production process and required equipment needs are defined. The investment plan is made for setting up the plant of the CDW-based product. Based on the preliminary technological and equipment survey, investment is planned for the following:

- Purchase land in the industrial zone
- Construct the factory and office buildings
- Construct infrastructure
- Purchase of equipment and devices
- Cost of handling and installment of equipment
- Purchase vehicles for operation
- Purchasing software

Table 10. Consolidation of investment plans, MNT

#	Investment Item	Unit of Measure	Unit	The amount of investment (MNT)
Building and Land				
1	Land Purchase	ha	0	-
2	Factory and office buildings' blueprint design	m^2	170	3,400,000
3	Factory and other building	m^2	170	51,000,000
4	Electricity coverage equipment and substations	package	1	124,500,000
5	Other infrastructure facilities	package	1	315,000,000
6	Factory fence and land	package	1	366,000,000
	Sub-total			859,900,000
Production equipment				
7	Production equipment	package	1	359,100,000
	Sub-total			359,100,000
Automobile and equipment				
8	Office equipment	package	1	37,660,000
9	Automobile	package	1	245,000,000
	Sub-total			282,660,000
Software				
	Software, website	package	1	50,000,000
	Sub-total			50,000,000
	Total amount of investment	**MNT**		**1,551,660,000**

The details of investment spending are provided in the Appendix C.

4.2. Project efficiency estimation

4.2.1. Production process

The production process of the CDW-based product runs with the procedure as shown in following picture (Figure 63). Generally, the CDW-based product is sorted after the main production lines with equipment including the feed-pump, crusher, and screen. The final CDW-based product will be sorted into three different types via its size by strainer. The sorted CDW-based product is supplied to the customers including the concrete batch plant and citizens.

The production process of the CDW based product is described more in detail as following:

Step 1. Transport and carried in the debris from demolished buildings to the plant

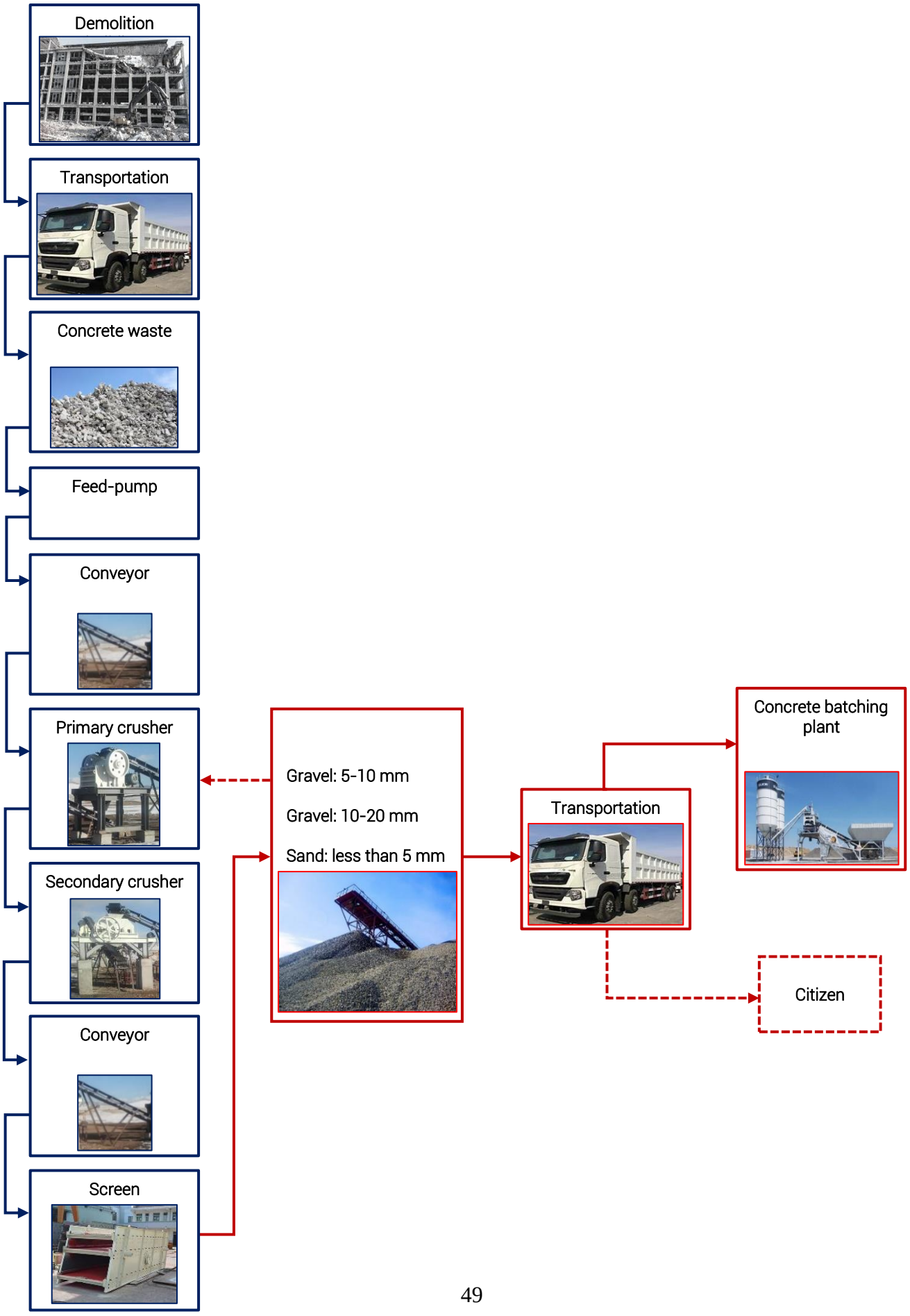
Step 2. Pass through main equipment:

1. Feed-pump
2. Conveyor
3. Primary crusher
4. Secondary crusher
5. Conveyor
6. Screen

Step 3. The CDW based product is sorted into 3 types via its size by screen or filter.

Step 4. Sales and supply to the customers including concrete batch plants and citizens.

Figure 63. Processing image



4.2.2 Production Plan

The production plan is developed based on information of the research to test the CDW-based product. Assumptions used in the production plan:

- 85% of debris from demolished buildings is concrete waste, which is the finding of the survey conducted among demolition companies.
- Construction work is projected to be operational in between April to October, as the construction industry is seasonal.
- Debris from demolished buildings will be transported from the site by three trucks with a capacity of 25 tons each. It is planned that these trucks will make 4-5 round trips a day in order to prepare raw materials for production.

With this basic assumption, the production plan is calculated as follows (Table 11).

Table 11. Production Plan in 2020

#	Specification	Unit of measure	January – December, 2020												Annual amount
			1	2	3	4	5	6	7	8	9	10	11	12	
1	Work day	day	0	0	0	15	22	30	25	31	31	15	0	0	169
2	Factory hours	Hour				8	8	8	8	8	8	8			56
3	Number of trucks to transport raw materials	Quantity				3	3	3	3	3	3	3			21
4	Truck capacity	tons				25	25	25	25	25	25	25			175
5	Truck number of round trips	Quantity				4	5	5	5	5	5	5			34
6	The amount of raw material to transport	tons				4500	8250	11250	9375	11625	11625	5625			62,250
7	Debris from demolished buildings	m^3				3,000	5,500	7,500	6,250	7,750	7,750	3,750			41,500
8	Concrete mixture waste	m^3				2,550	4,675	6,375	5,312.5	6,587.5	6,587.5	3,187.5	-	-	35,275
9	Feed-pump capacity / hour	m^3				30	30	30	30	30	30	30			210
10	Capacity to crush daily	m^3				3,600	5,280	7,200	6,000	7,440	7,440	3,600	-	-	40,560
Final product output															
11	0-5	35%				897.6	1,645.6	2,244	1,870	2,318.8	2,318.8	1,122	-	-	12,416.8
12	5-10	28%				715.5	1,311.7	1,788.7	1,490.6	1,848.3	1,848.3	894.4	-		9,897.6
13	10-20	37%				936.9	1,717.7	2,342.3	1,951.9	2,420.4	2,420.4	1,171.1	-		12,960.6
14	Percentage of use of factory capacity	tons				71%	89%	89%	89%	89%	89%	89%			87%

According to product preliminary testing results, 35% of crusher output is 0-5 mm, 28% is 5-10 mm, and 37% is 10-20 mm sand and gravel replacement products. This result is used for the production plan. In the year 2020, the crushing machine is estimated to use 87% of its full capacity.

4.2.3 Cost budget

Based on the information of the research to test the CDW-based product and market readiness survey, the cost budget has been developed. Classifications of costs were based on the principle of the classification of similar types of plant costs.

Table 12. Cost categories and related costs

#	Cost dimensions	Sub-classification of costs	Cost Item
1	Product Cost	Direct costs	• Direct labor costs • Electricity cost of production • Transportation cost of debris from demolished buildings • Labor costs and safety costs for production staff
2	Operation Cost	• Administrative costs • Cost of sales	• Salary of administration team • Office operating costs • Transport of administration team • Depreciation cost • Other fixed costs
3	Other Expenditures	• Cost of financing	• Interest expense

Estimated cost for each item were calculated according to the above classification.

A. Production cost estimation

Direct labor costs

The direct labor cost is calculated based on the number of employees in accordance with the technological procedures and all employees who will work on every stage of production. The factory workers will be paid on monthly basis not on productivity based.

Average salary of factory workers is calculated based on the average salary of processing workers informed by the NSO[20] and the average salary of similar employees involved in the survey (Table 9).

[20] www.1212.mn

Table 13. Direct labor costs

#	Position	Number of required human resources	Average monthly salary (MNT)	Pay costs (MNT)
1	Operator	3	1,000,000	3,000,000
2	Mechanist	1	1,200,000	1,200,000
3	Driver	3	1,200,000	3,600,000
	Total			**7,800,000**

Employee's food and transportation costs are included in product direct cost budget.

Table 14. Employee Food and transportation costs

#	Workers	Employee quantity	Employee cost per person	Total monthly expenses (MNT)
1	Workers	7	8,000	1,232,000
	Total			**1,232,000**

Labor safety expense

In calculating the labor safety cost, the reference industry standards were used and the type and average spending on clothes and protective equipment provided to the refinery factory were a benchmark. Based on the average market price of the labor safety instrument, annual and monthly safety cost is calculated as follows.

Table 15. Labor safety costs

#	Labor safety material	Unit of measurement	No. factory workers	Worker's norm for one year	Unit price (MNT)	Annual cost (MNT)	Cost per month (MNT)
1	Work clothes /pants, sweater/	piece	7	2	65,000	910,000	75,833
2	Work shoes, (summer)	piece	7	1	80,000	560,000	46,666
3	Work shoes (winter)	piece	7	1	100,000	700,000	58,333
4	Work gloves	piece	7	24	300	50,400	4,200
7	Mask	piece	7	48	200	67,200	5,600
8	Soap	piece	7	12	550	46,200	3,850
9	Towel	piece	7	48	1,500	504,000	42,000
	Total					**2,837,800**	**236,483**

Direct technologicily costs

Based on the information on the power consumption data of the equipment, the electricity costs were calculated and the electricity price was calculated according to the electricity tariff for the Central Electricity Sales Zone, which is regulated by the Energy Regulatory Commission.

Table 16. Factory electricity expense

#	Equipment	Unit of measure	Quantity	Electricity use per hour	Electricity price	Electricity expense per hour (MNT)
1	Feed-pump	kW	1	7.5	156	1,170
2	Jaw crusher	kW	1	35	156	5,460
3	Horizontal rotary crusher	kW	1	50	156	7,800
4	Screen	kW	1	50	156	7,800
5	Conveyor	kW	5	12	156	1,872
	Total			154.5		24,102

The cost of fuel for transporting raw materials or debris from demolished buildings is included within the direct cost of the product. It is calculated based on the fuel price and the fuel consumption of the vehicle.

Table 17. Fuel use estimation

#	Specification	Unit of measure	April – October, 2020							Annual amount
			4	5	6	7	8	9	10	
1	Work Days	day	15	22	30	25	31	31	15	169
2	Factory Hours	hours	8	8	8	8	8	8	8	56
3	No. trucks to transport raw materials	piece	3	3	3	3	3	3	3	21
4	Capacity per truck	tons	25	25	25	25	25	25	25	175
5	Truck number of round trips	times	4	5	5	5	5	5	5	34
6	Length of one round trip	km	15	15	15	15	15	15	15	105
7	Total distance	km	2700	4950	6750	5625	6975	6975	3375	37,350
8	Total cost of fuel	thous. MNT	2,997	5,494.5	7,492.5	6,243.7	7,742	7,742	3,746	41,458

Cost estimation of the product

Direct cost of the product is calculated based on direct production and above-mentioned direct costs calculation. The direct cost estimation is shown in following table.

Table 18. Estimates of production cost

#	Specifications	Unit of measure	January – December, 2020												Annual amount
			1	2	3	4	5	6	7	8	9	10	11	12	
1	Debris from demolished buildings	tons	-	-	-	3,000	5,500	7,500	6,250	7,750	7,750	3,750	-	-	41,500
2	Cost of unloading waste	MNT	-	-	-	-	-	-	-	-	-	-	-	-	
3	Direct labor costs	MNT, thous.				7,800	7,800	7,800	7,800	7,800	7,800	7,800			54.6
4	Employee food and transportation cost	MNT, thous.				1,232	1,232	1,232	1,232	1,232	1,232	1,232			8,624
5	Social insurance cost	MNT, thous.				1,083.8	1,083.8	1,083.8	1,083.8	1,083.8	1,083.8	1,083.8			7,586.8
6	Fuel cost	MNT, thous.	-	-	-	2,997	5,494.5	7,492.5	6,243.7	7,742.2	7,742.2	3,746.2	-	-	41,458.5
7	Electricity production costs	MNT, thous.				2,892.2	4,241.9	5,784.5	4,820.4	5,977.3	5,977.3	2,892.2			32,585.9
8	Labor safety cost	MNT				236,483	236,483	236,483	236,483	236,483	236,483	236,483			1,655,383
9	Total production cost	MNT, thous	-	-	-	16,241.5	20,088.7	23,629.3	21,416.4	24,071.8	24,071.8	16,990.8	-	-	146,510.6
Final product output															
1	0-5 mm	35%	-	-	-	897.6	1,645.6	2,244	1,870	2,318.8	2,318.8	1,122	-	-	12,416.8
2	5-10 mm	28%	-	-	-	715.5	1,311.7	1,788.7	1,490.6	1,848.3	1,848.3	894.3	-	-	9,897.6
3	10-20 mm	37%	-	-	-	936.9	1,717.6	2,342.3	1,951.9	2,420.3	2,420.3	1,171.1	-	-	12,960.6
4	Cost per unit		-	-	-	6,369.2	4,297	3,706.5	4,031.3	3,654.2	3,654.2	5,330.4	-	-	**2,586.9**

B. Operation cost

Production management, product sales, and marketing activities costs are all included in the operation cost as shown in cost classification table.

Management, sales service salaries, cost of supply

As a small business, it is planned to work with five core employees in management, sales service, and general service department. Average salary is planned based on salary statistical information of similar entities.

Table 19. Salaries of staff in positions of management, sales, and services.

#	Position	Quantity	Average salary (MNT)	Total salary (MNT)
1	Head of factory and manager	1	1,500,000	1,500,000
2	Financial officer	1	1,000,000	1,000,000
3	Security guard	3	650,000	1,950,000
	Total	**5**		**4,450,000**

The social issue of employees such as food and transportation cost are estimated based on the average cost of transporting and meals compensation to employees in similar fields of work. The plan is to provide 8,000 MNT to administration and sales staff for the cost of both transportation and food.

Table 20. Budget for staff meals and transport costs

#	Item	Staff quantity	Cost of food (MNT)	Cost of transportation (MNT)	One employee's cost (MNT)	Total monthly expense (MNT)
1	Management and sales staff	5	6,000	2,000	8,000	880,000
	Total					**880,000**

Fuel expenses budget

Fuel expense was determined by per employee per working day. Due to the scope of operation and location of the plant, fuel costs can be identified and budgeted. Based on the fuel limits and standards used in industrial plants, the fuel limits are set according to their level of standard. Depending on the fuel consumption and fluctuations of fuel, the cost of planning can be adjusted further.

Table 21. The fuel cost of the Management Team

#	Position	Quantity	Daily fuel limit	Average working days per month	Fuel cost per month (MNT)
1	Head of factory and manager	1	30,000	22.00	660,000
2	Financial officer	1	25,000	22.00	550,000
	Total	**2**			**1,210,000**

Depreciation cost

Estimation of depreciation expense is calculated using the straight-line depreciation method, taking into account depreciation of the assets specified in the Corporate Income Tax Law of Mongolia. In calculating the plant equipment depreciation, the costs were calculated for a 15-year useful life based on information provided by the manufacturer. In this case, the depreciation policy for tax purposes and financial purposes should be included in the accounting policy documentation.

Table 22. Depreciation cost

#	Property item	Original cost (MNT)	Estimated useful life	Annual depreciation (MNT)	Monthly depreciation (MNT)
1	Building depreciation	859,900,000	40	21,497,500	1,791,458.3
2	Equipment depreciation	359,100,000	15	23,940,000	1,995,000
3	Depreciation of motor vehicles and other assets	282,660,000	10	28,266,000	2,355,500
4	Software depreciation	50,000,000	3	16,666,666.6	1,388,888.8
	Total	**1,551,660,000**	**68**	**90,370,166.6**	**7,530,847.2**

Other expenditure budget

The category named "other" includes the cost of office use and other expenses. Costs were calculated based on the baseline of consumption per-office. Costs are calculated based on the cost of the central heating and thermal connection.

Table 23. Office operating expenses

#	Cost item	Square size, m^2	Cost per unit area (MNT)	Monthly cost (MNT)	Annual cost (MNT)
1	Electricity cost of workplace	120	2,200	264,000	3,168,000
2	Heating cost	120	5,414	649,680	7,796,160
3	Cleaning and service costs	120	3,000	360,000	4,320,000
4	Water / waste water costs	120	600	72,000	864,000
	Total			**1,345,680**	**16,148,160**

Other expenditures for office use include stationary items, communication bills, foreign travel expenses and tax bills. In calculating maintenance costs, it was calculated as 0.2% of total depreciation expense for total assets.

Table 24. Other fixed costs

#	Cost item	Monthly cost (MNT)
1	Maintenance costs	258,610
2	Stationery costs	125,000
3	Communication costs	250,000
4	Taxes and fees	500,000
5	Social costs	600,000
6	Foreign business trip costs	1,500,000
7	Contingency	1,000,000
	Total	**4,233,610**

Depending on the seasonal activities, it is assumed that the expenses of the management team will only be incurred during the months in which production is not available.

4.2.4 Sales revenue plan

Sales revenue plan is calculated based on the production plan and market price survey of conventional products such as gravel and crushed stone. Sales revenue is calculated as shown in table (Table 25).

4.2.5 Profit Forecasting

Based on the sales revenue plan and cost budget, the profit forecasting is made on a monthly basis in 2020 and in 2021-2024 on a yearly basis. In making the profit forecast for 2021-2024, it is estimated that production capacity is projected to increase by 5-10% annually by utilizing the 5% increase in the sales price. The cost of the product will be increased 5 percent every year, the salary increase would be 10 percents and the other costs are projected to be increased by 5 percent every year compared with previous. Expenditure growth is forecasted while taking into account the inflation rate and the rise in commodity prices. The profit projection is shown in the Table 26.

In the profit projection, financing expenses are also included besides the direct production cost and operation cost. We estimated that 40 percent of the total initial investment would be financed by a loan. However, the loan should be special conditional loan for small business. In the calculation, it is estimated that the loan repayment condition is set at 5 percent interest per annum and the business is exempted from loan payment in the first two years (Table 26).

Table 25. Sales plans

#	Specification	Unit of measure	January – December, 2020												Annual amount
			1	2	3	4	5	6	7	8	9	10	11	12	
1	Final product output														
1.1	0-5 mm	m^3	-	-	-	897.6	1,645.6	2,244.	1,870.	2,318.8	2,318.8	1,122.	-	-	12,416.8
1.2	5-10 mm	m^3	-	-	-	715.4	1,311.7	1,788.7	1,490.6	1,848.3	1,848.3	894.3	-	-	9,897.6
1.3	10-20 mm	m^3	-	-	-	936.9	1,717.6	2,342.3	1,951.9	2,420.3	2,420.3	1,171.1	-	-	12,960.6
2	Sales revenue														
2.1	0-5 mm	13,200	-	-	-	11,848,320	21,721,920	29,620,800	24,684,000	30,608,160	30,608,160	14,810,400	-	-	163,901,760
2.2	5-10 mm	11,000	-	-	-	7,870,381.2	14,429,032	19,675,953.	16,396,627	20,331,818	20,331,818	9,837,976.5	-	-	108,873,606
2.3	10-20 mm	12,000	-	-	-	11,242,929	20,612,037	28,107,324	23,422,770	29,044,234	29,044,234	14,053,662	-	-	155,527,192
	Total income		-	-	-	30,961,630	56,762,989	77,404,077	64,503,397	79,984,212	79,984,212	38,702,038	-	-	428,302,559

Table 26. Profit forecasting

Indicators	Type	Unit	2020	2021	2022	2023	2024	2025
Production	0-5 mm	m^3	12,416.80	13,658.48	15,024.33	15,024.33	15,024.33	15,024.33
	5-10 mm	m^3	9,897.60	10,887.36	11,976.10	13,173.71	14,491.08	15,940.18
	10-20 mm	m^3	12,960.60	14,256.66	15,682.33	17,250.56	18,975.61	20,873.17
Product unit price	0-5 mm	MNT	13,200.00	13,860.00	14,553.00	15,280.65	16,044.68	16,846.92
	5-10 mm	MNT	11,000.00	11,550.00	12,127.50	12,733.88	13,370.57	14,039.10
	10-20 mm	MNT	12,000.00	12,600.00	13,230.00	13,891.50	14,586.08	15,315.38
Product Income	0-5 mm	MNT	163,901,760.00	189,306,532.80	218,649,045.3	229,581,497.6	241,060,572.5	253,113,601.16
	5-10 mm	MNT	108,873,606.60	125,749,015.62	145,240,113	167,752,330.5	193,753,941.8	223,785,802.78
	10-20 mm	MNT	155,527,192.80	179,633,907.68	207,477,163.3	239,636,123.7	276,779,722.8	319,680,579.92
REVENUE RESULTS			**2020**	**2021**	**2022**	**2023**	**2024**	**2025**
Sales								
Sales revenue		MNT	428,302,559	494,689,456	571,366,322	636,969,952	711,594,237	796,579,984

Total Revenue	MNT	428,302,559	494,689,456	571,366,322	636,969,952	711,594,237	796,579,984
Total production cost	MNT	146,510,667	153,836,201	161,528,011	169,604,411	178,084,632	186,988,863
Operation cost							
Salary Cost (year)	MNT	59,560,000	59,560,000	65,516,000	72,067,600	79,274,360	87,201,796
Income tax (year)	MNT	7,147,200	7,147,200	7,861,920	8,648,112	9,512,923	10,464,216
Vehicle / fuel cost (year)	MNT	69,916,000	69,916,000	73,411,800	77,082,390	80,936,509.5	84,983,334.98
Other fixed cost (year)	MNT	29,635,270	29,635,270	29,635,270	29,635,270	29,635,270	29,635,270
Total operating costs (year)	**MNT**	**166,258,470**	**166,258,470**	**176,424,990**	**187,433,372**	**199,359,063**	**212,284,616**
Profit before interest, tax and gains (year)	MNT	115,533,422	174,594,785	233,413,321	279,932,169	334,150,543	397,306,504
The rate of interest before tax, gains and depreciation		27%	35%	41%	44%	47%	50%
Depreciation (year)	MNT	52,715,931	52,715,931	52,715,931	52,715,931	52,715,931	52,715,931
Interest and pre-tax profit (year)	MNT	62,817,492	121,878,855	180,697,391	227,216,238	281,434,612	344,590,573
Interest rate and pre-tax profit levels	-	15%	25%	32%	36%	40%	43%
Expenditures (year)	MNT	-	31,033,200	31,033,200	31,033,200	31,006,782	30,986,782
Profit before tax (year)	MNT	62,817,492	90,845,655	149,664,191	196,183,038	250,427,830	313,603,792
The pre-tax profit level (year)	-	15%	18%	26%	31%	35%	39%
Tax expense (year)	MNT	6,281,749	9,084,565	14,966,419	19,618,304	25,042,783	31,360,379
Net profit (year)	MNT	56,535,742	81,761,089	134,697,771	176,564,734	225,385,047	282,243,413
Net profit level	-	13%	17%	24%	28%	32%	35%

4.3. Analysis of economic efficiency

Social benefits of the project

The following social benefits will be provided through re-processing and producing products that replace non-renewable resources and supply them to the building materials market.

- It will contribute substantially to reducing waste, ensuring ecological balance and reducing soil pollution. The introduction of waste management will help to encourage business entities and individuals to learn to live a healthy life and create positive social impacts.
- Particular contribution to creating state and local budgets by establishing a permanent establishment and workplaces for people, allowing more taxpaying workers, which would both increase the individual income tax and corporate income tax. Also, the budget will include a movable property tax, and taxes such as water and waste taxes.
- Contribute to the achievement of a program aimed at promoting small to medium enterprise implementation by the Government of Mongolia, with advanced technology and supporting a green economy.

Analysis of economic efficiency

The CDW-based product is cheaper than conventional products for direct costs, and its indirect efficiency is high because of being environmentally friendly and promoting a green economy.

Table 27. Unit of output cost and Break-even point analysis

Items	Unit of measure	Values
Yearly average production	m^3	35,275
Product unit price	m^3/MNT	11,000
Average direct cost	m^3/MNT	2,586
Yearly fixed cost	MNT	218,974,400
BEP	m^3	26,028
Average fixed cost	m^3/MNT	6,207
Average total cost	m^3/MNT	8,794

The CDW-based product is economically competitive since its average cost is MNT 8700, which is slightly lower than the average costs of gravel and crushed stone. However, the period of initial investment for a small factory can be long due to seasonal production. It can be shortened in case the business receives a discount for its investment in connection with the social benefits of the project.

5. Conclusions

Market readiness of the CDW-based product

The market environment

The Mongolian construction sector has grown rapidly over the past decade. The need for demolishing and reconstructing the buildings constructed during the 1960s and 1970s has been increasing. By 2018, the State Specialized Inspection Agency has evaluated that 143 buildings need to be demolished in the capital city, 74 of which were demolished and re-constructed.

As urbanization and industrialization have been increasing, construction companies are still doing environmentally harmful activities by using river and mountain gravel and crushed stone as the main material for concrete. Even though there are policy documents on waste management, such as on the recycling of waste from buildings and separating garbage, few of these are implemented in practice.

In such circumstances, recycling of waste and use of the CDW-based products will be most important and beneficial for the environment and also for entrepreneurs and citizens.

The raw material suppliers of the CDW-based product will be construction and demolition companies/SMEs and major customers can be concrete batching plants, and SMEs that produce a mix themselves in constructing new buildings, and construction companies/SMEs. Even so, competitors and potential producers can be quarries extracting gravel and crushed stone. Exploration and mining licenses are required to quarry extracting gravel and crushed stone.

The surveyed quarries companies judged that this permission was more difficult to get which could be a barrier for a new company to enter the market. The next key barrier is the requirement of heavy technology, more skilled labor, and more investment to operate in the market, as well as, the chief difficulties in the reality are the barter exchange because of the shortage of cash in the market and the higher marketing costs to compete with many companies.

The market demand of the CDW-based product

Concrete batching plants, SMEs that produce a mix themselves in constructing new buildings, construction companies/SMEs interested in purchasing the CDW-based concrete for constructing the new buildings are the potential consumers of the CDW-based product. A total of 54 concrete batching plants and 87 construction companies/SMEs are actively working in Ulaanbaatar city. It means that approximately 141 companies can be the potential consumers of the CDW-based product.

Based on the survey data, the Cobb-Douglas production function, the empirical rule, and the norm of ingredients of 1 m^3 concrete, we calculated that the total market demand for concrete batches equals approximately 2.17 million m^3 and the total demand for gravel and crushed stone for construction equals 799 thousand m^3 in a year. Therefore, the potential quantity of total market demand for the CDW-based product is 799 thousand m^3 in a year because the CDW-based product can substitute the gravel and crushed stone.

The concrete batching and construction companies have been working on this subject for an average of 10 years. The concrete batching plants have around 32 workers and earn MNT 1,775 million on average, and MNT 4 billion at maximum in a year. We have segmented the concrete batching companies based on the number of employees, and 36%, 28%, 36% of them are small, medium, large enterprises, respectively.

20% of concrete batching plants own the quarries where they extract gravel and crushed stone, the remaining 80% buy gravel and crushed stone from other companies. 32% of the companies surveyed use conventional and common technology, with the other 68% using modern and new technology. 65% of the companies with modern & new technology were originally from China, the remaining were from South Korea.

About 60% of companies surveyed usually buy their raw materials in terms of bulk purchase, while 16% buy using retailing. Also, 88% of the respondents purchase their raw materials under contracting with suppliers of gravel and crushed stone. The most important requirement for the quality of gravel and crushed stone is its relative humidity and durability.

On average, the surveyed concrete batching plants revenue MNT 1,775 million in 2018. The average price of 1m^3 concrete is MNT 115,000 and on average 16% of the unit price includes the cost for the gravel and crushed stone. Respondents described the most significant factors that affect change in the price of raw materials as the self-cost of raw materials (40%) and transportation cost (40%).

Raw material's supply of the CDW-based product

Construction companies demolishing old buildings, SMEs that are contracted with construction companies to demolish an old building, and construction companies constructing new buildings[21] are the potential raw material suppliers of the CDW-based product. A total of 87 construction companies and 10 demolition companies are actively working in Ulaanbaatar city. Therefore, 97 companies can be the potential raw material suppliers of the CDW-based product.

On average, the construction and demolition companies have a sectoral experience of 9-11 years. The construction companies have around 80 workers and earn MNT 3.1 billion in a year on average, while the demolition companies have around 10 workers and earn MNT 1.2 billion in a year on average. Based on the sales income information, the construction companies are classified as 2%-micro-enterprise, 24%-small enterprises, 41%-in medium companies, and 32%-large companies. The most demolition companies are small enterprises.

According to the Urban Development and Planning Agency, a total of 238 residential buildings had been prohibited for use in recent years as they do not meet the requirements of usage and are not able to tolerate earthquakes. The decisions were made to demolish and re-plan to construct for 143 residential buildings. As of 2018, 74 residential buildings were demolished and 62 residential buildings in 12.6 ha were planned to be demolished in 2019. Moreover, 80,000-90,000 tons of debris are wasted in a year (Caritas Czech Republic, 2017).

On average, the demolition companies demolish 4-5 residential and non-residential buildings in a year, and this number has been increasing in connection with the construction sector

[21] Since they generate concrete waste in constructing new buildings.

growth. 37% of the construction companies constructed their buildings on land where old buildings were before, and this type of demand for the demolition of old buildings tends to be increase in the future in Ulaanbaatar. On the other hand, 68% of the construction companies generate concrete waste when constructing a new building, and 5% per ton of concrete is wasted on average. If we assume the production of concrete batching is around 639,952m^3 (or 1,540,000 tons)[22] in Ulaanbaatar, it is estimated that 32,000m^3 of concrete[23] may be wasted in construction of new buildings.

All demolition companies use non-explosive demolition methods, and they all perform top-down demolitions. The majority of demolition companies sort demolished building debris by wood, concrete, reinforcing, and roof material. After sorting, they transfer the remaining debris to the landfill.

All demolition companies involved in the survey have the interest to supply demolished building debris for recycling. The majority of construction companies generating concrete waste are interested in supplying their concrete waste from construction to new buildings for recycling.

Competitors of the CDW-based product

The competitive products or substitutes of the CDW-based product are gravel and crushed stone, and potential competitors are the quarries extracting gravel and crushed stone. A total of 26 quarries extracting gravel and crushed stone are actively working in Ulaanbaatar. Although the number of quarries has grown rapidly in the last few years, a number of quarries have been closed due to illegal operations.

The majority of the quarries were established within the last 10 years, and the average number of total workers in the quarries is 24 employees, with 9 employees working in mining activities on average. Micro and small enterprises tend to be the majority among the quarries. The average capacity of the quarries is 77m^3 per hour, and all quarries have their factory building, production area, and storage area.

The annual average production of the quarries increased 2.7 times from 2017 to 2018 due to the increase in demand as well as decrease in the number of quarries. The average monthly sales are 7200m^3 for gravel and 15,700m^3 for crushed stone in warm seasons. The demand for crushed stone is 2.1 times higher than gravel.

In 2019, the quarries have MNT 11,730/m^3 of gravel on average, and the price of gravel this year fell by 9 percent or MNT 1,625 from the same period of last year. Crushed stone is sold for MNT 13,640/m^3 on average at the site. There is almost no change in the price of crushed stone from previous year.

The half quarries expressed their interest to produce the CDW-based product under social responsibility.

Awareness of the CDW-based product

A total of 92 companies involved in the survey, 60% of them were the construction and demolition companies/SMEs, and 27% were the concrete batching plants, the remaining was the quarries extracting gravel and crushed stone. The absolute majority of them agree that

[22] (Caritas Czech Republic, 2017)
[23] 1,540,000 tons*0.05=77,000tons or 32,000m^3 (1ton=0.42m^3)

debris from demolished buildings is a big source of environmental pollution and 99% of all companies involved in the survey said the CDW-based product can be nature-oriented. They answered that if the CDW-based product will be produced, (i) citizens and residents, (ii) construction companies (iii) concrete batch plants (iv) project implementers will benefit more than others.

59% of the respondents expressed that they are ready to use the CDW-based product and the rest were not ready or in doubt. But, 91% of them expressed their readiness to use the CDW-based product for as a part of their their social responsibility.

92% of surveyed companies expressed that if the price of the CDW-based product was cheaper than the current price of the same type of construction material, they will buy the CDW-based product. If companies will use the CDW-based product, they will require high quality, lower price, and stable supply.

In order to increase CDW-based product consumption, the government needs to support tax credit, organize awareness-raising activities for the public and ensure that the building demolition is appropriate and standardized.

Cost effectiveness analysis

It is of great advantage and benefits for both society and the green economy to implement the project to produce the CDW-based product. Therefore, the government or other investors would concentrate on the socio-economic benefits rather than the direct economic efficiency of this project.

Based on the direct cost calculation of the CDW-based product, the product is well able to compete with existing conventional products in the market. Specifically, the average variable cost is 3700-6400 MNT/m^3 depending on the utilization capacity of the production, or an average of 2600 MNT. The average variable cost of the conventional product or gravel is estimated to be 6000-9000 MNT/ m^3 depending on the volatility of the cost of extraction.

In the case of the initial investment in equipment, machines, factory building, and the land are high for a small factory to produce the CDW-based product, the payback period of the investment will be long, which will reduce the competitiveness of the CDW-based product in the market. For instance, when the annual production size is 35,725m^3 and the fixed cost is about MNT 218.9 million per year, then the average fixed cost is MNT 6207/m^3 for the CDW-based product. This shows that the initial capital investment and the fixed cost of production are strongly relevant for effective production for the CDW-based product to be competitive on the market.

The cost effectiveness analysis result is shown in following table.

Yearly average production	m^3	35,275
Product unit price	m^3/MNT	11,000
Average direct cost	m^3/ MNT	2,586
Yearly fixed cost	MNT	218,974,400
BEP	m^3	26,028
Average fixed cost	m^3/MNT	6,207
Average total cost	m^3/MNT	8,794

Based on cost analysis, the CDW-based product can be economically viable and competitive if the production line of the product is introduced in the existing quarries extracting gravel and crushed stone or the initial required investment is low.

Appendix-A: Calculation of demand for the CDW-based product

Calculation of direct demand for the CDW-based product. Concrete is a mixture of sand, gravel, crushed rock and/or other aggregates that are held together by a hardened paste of cement and water. The properties of concrete vary depending on the ingredients used and their proportions in the mix.

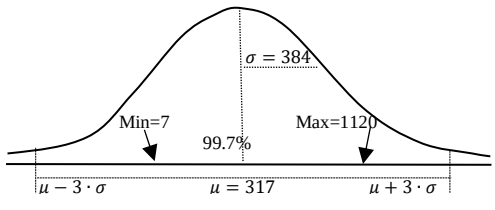
Table 28. The ingredients of 1m^3 concrete

Types of concrete	Mark of concrete	Gravel and crushed stone (m^3)	Sand (m^3)	Cement (kg)	Water (liter)
B7.5	M100	0.354	0.351	234	220
B10	M150	0.349	0.346	267	219
B15	M200	0.353	0.347	299	204
B20	M250	0.373	0.336	327	183
B25	M300	0.369	0.334	348	184
Source: barilgachin.mn[24]					

According to the empirical rule, approximately 99.7% of the data falls within three standard deviations of the mean (or between the mean – three times the standard deviation and the mean + three times the standard deviation). The following notation is used to represent this fact: $\mu \pm 3\sigma$. If data from a survey is outside the interval, the observation should be an outlier. So, we detected the outliers from our survey data based on the empirical rule, then calculated the descriptive statistics of the observations. The results of the calculation using the per capita form of the Cobb-Douglas function are shown in the following table.

Table 29. Descriptive statistics of the quantity of gravel and crushed stone per unit of employees

Average	317
Maximum	1120
Minimum	7
Standard deviation	384



Based on the statistics in the above table, we calculated the demanded quantity of gravel and crushed stone for a company that employs 32 workers.

$$K_{gravel}^{per\ company} = L \cdot k = 32 \cdot 317 = 10{,}132\ m^3$$

The total market demand for gravel and crushed stone was calculated by multiplying the demanded quantity per company by the number of 54 active companies in Ulaanbaatar.

$$K_{gravel}^{demand} = n \cdot K = 54 \cdot 10132 = 547{,}128\ m^3$$

[24] http://barilgachin.mn/index.php/news/show/182?fbclid=IwAR1rPxyoHXfStzwmwJuI6TjlFxVBRrZcLKupDX5zPTLNw6nB1pd1L7QdfwE

Where $\mathrm{K}_{\mathrm{gravel}}^{\mathrm{demand}}$ denotes the quantity of market demand for gravel & crushed stone, n denotes the number of actively operating companies.

We used the Cobb-Douglas production function to calculate a direct demand for gravel and crushed stone.

$$Y = K^{\alpha} \cdot L^{1-\alpha}$$

Where,

Y – denotes total concrete measured by cubic meter
K – denotes the quantity of gravel or crushed stone measured by cubic meter
L – denotes the number of employees
$\alpha;\ (1-\alpha)$ – output elasticities of gravel and crushed stone and number of employees, respectively

To concentrate attention on what happens to $\frac{Y}{L}$ or output per employees, we rewrote the Cobb-Douglas production function in what we shall refer to as per capita form:

$$y = \frac{Y}{L} = \left(\frac{K}{L}\right)^{\alpha} = (k)^{\alpha}$$

Where, y – the quantity of output per unit of employees, k – denotes the quantity of gravel or crushed stone per unit of employees

As shown in Table 28, the $1m^3$ concrete batch includes approximately $0.369m^3$ gravel / crushed stone. We can forecast the supplied quantity of concrete in the total market based on $K_{gravel}^{d} = 547{,}128\ m^3$ and the ingredients of 1m^3 concrete batch.

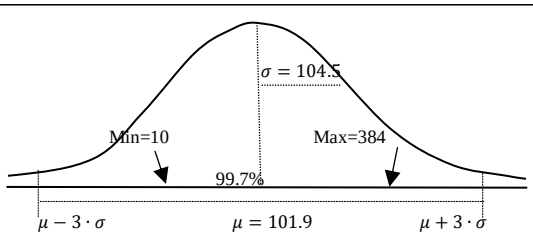
$$Y = K_{gravity}^{d}/0.369 = 547{,}128\ m^3/0.369 = 1{,}482{,}731m^3 \approx 1.48\ million\ m^3$$

Calculation of indirect demand for the CDW-based product. The demand for concrete batch created by construction companies will generate indirect demand on gravel and crushed stone, which can substitute CDW-based products. Construction companies/SMEs will generate demand in the market indirectly. We forecast the indirect demand on gravel and crushed stone by the inverse step of the method for the direct demand.

87 construction companies in Ulaanbaatar are actively operating in Ulaanbaatar and 51 of them were surveyed. The surveyed companies have on average 77 employees. We can calculate the indirect demand of raw materials based on the number of employees because the main indicator of production capacity was the number of employees.

Table 30. Descriptive statistics of the demanded quantity of concrete batch per employee

Average	101.9
Maximum	384
Minimum	10
Standard deviation	104.5



The demand for concrete batch generated by a construction company is calculated as follows:

$$d_{concrete}^{indirect} = L \cdot d_{concrete}^{per\ employee} = 77 \cdot 101.9 = 7848m^3$$

Where, $d_{concrete}^{indirect}$ – demand for concrete batch and/or indirect demand on gravel and crushed stone per company, L – number of employees, $d_{concrete}^{per\ employee}$ – average demanded quantity of concrete batch per employee.

The total indirect demand of gravel and crushed stone (and/or demand for concrete) is determined by multiplying the quantity of concrete batches per company by the number of companies.

$$D_{concrete}^{indirect} = n \cdot d_{concrete}^{indirect} = 87 \cdot 7848 = 682{,}776m^3$$

It means that the construction companies generate 682,776m^3 of concrete batching demand indirectly. Now, we can calculate the indirect total demand for gravel and crushed stone based on the norm that 1m^3 of concrete includes 0.369m^3 of gravel and crushed stone.

$$K_{gravel}^{indirect\ demand} = 682{,}776 \cdot 0.369 = 251{,}944m^3$$

According to these calculations, we summarized that the total market demand for concrete batches equals approximately 2.17 million cubic meters (1,482,731 m^3+ 682,776 m^3= 2,165,507 m^3) and the total demand for gravel and crushed stone for construction equals 799 thousand cubic meters (547,128 m^3+ 251,944 m^3 = 799,072 m^3).

Appendix-B: Basic data used in the projection

Name of indicators	Data used	Unit of measure
Social insurance rate	12%	percentage
Maintenance cost	0.2%	percentage
Contingency cost	0.5%	percentage
Year of Investment	2020	year
Year of project completion	2027	year
Average working days per year	260	day
Working hours per day	8	Hour/day
Production capacity	-	-
Ton to m^3 converting ratio	1.5	-
Percentage of concrete wastes in debris from demolished buildings	85%	-
Demolition cost, m^3	-	-
The initial investment cost of project	-	-
Equipment	359,100,000	MNT
Land	-	MNT
Buildings, facilities	859,900,000	MNT
Trucks and furniture	282,660,000	MNT
Software	50,000,000	MNT
Working capital	-	MNT
Total initial investment	1,551,660,000	MNT
Percentage of owner's investment	60%	percentage
Percentage of loan investment	40%	percentage
Total loan size	620,664,000	MNT
Loan term	10	years
Loan interest	5%	percentage
Income tax, percentage	10%	percentage
Social insurance rate, industry	12%	percentage
VAT rate	10%	percentage
Buildings	40	years
Equipments	15	years
Other assets	10	years
Software	3	years

Appendix-C: Cost breakdown

Equipment is used in the production

#	Equipment	Quantity	Unit price /MNT/	Total unit price
1	Jaw Crusher	1	56,700,000	56,700,000
2	Horizontal rotary crusher	1	64,260,000	64,260,000
3	Screen	1	56,700,000	56,700,000
4	Feed-pump	1	30,240,000	30,240,000
5	Conveyor	5	26,460,000	132,300,000
6	Cost of equipment assembly	1	18,900,000	18,900,000
	Total			**359,100,000**

Building

#	Investment item	Unit of measure	Size of land	Unit price /MNT/	Total unit price
1	Purchase of factory	ha	0	100,000,000	-
	Property item	Unit of measure	Quantity /ton/	Unit price (m^2)	Total price
1	Office, warehouse, worker's resting place	m^2	120	300,000	36,000,000
2	Guardhouse	m^2	50	300,000	15,000,000
	Total		**170**		**51,000,000**
	Property item	Unit of measure	Quantity /Tn/	Unit price (m^2)	Total price
1	Construction blueprint, budget	m^2	170	20,000	3,400,000
	Total				**3,400,000**
	Property item	Unit of measure	Size	Unit price (m^2)	Total price
1	Cementing factory area	m^2	25000	12,000	300,000,000
2	Factory fence	m	1100	60,000	66,000,000
	Total				**366,000,000**

Electrical facilities and connections

#	Property item	Explanation	Unit of measure	Unit	Unit price /MNT/	Total unit price
1	Electrical power station and assembly	35/0.4 SA/630	package	1	75,000,000	75,000,000
2	Pull lines	10Kw, AC cable	m	500	99,000	49,500,000
	Total expense					**124,500,000**
Water and heating facilities						
	Property item	Explanation	Unit of measure	unit	Unit price /MNT/	Total unit price
1	Deep wells	100 meter deep	package	1	30,000,000	30,000,000
2	Cleaning station and connection	Clean and reuse water	package	1	190,000,000	190,000,000
3	Install and connect heating system	Mixed solution	Package	1	95,000,000	95,000,000
	Total cost					**315,000,000**

Office equipment

#	Investment item	Unit of measure	Quantities	Unit price /MNT/	Total unit price
1	Office desk / A version	piece	2	1,100,000	2,200,000
2	Office desk / B version	piece	2	550,000	1,100,000
3	Computer	piece	2	1,199,000	2,398,000
4	Printer	piece	1	950,000	950,000
5	Chair	piece	10	300,000	3,000,000
6	Locker	piece	4	295,500	1,182,000
7	Safe	piece	1	830,000	830,000
8	Closet	piece	10	850,000	8,500,000
9	Worker wardrobe	piece	10	750,000	7,500,000

10	Kitchen Appliances	package	1	5,000,000	5,000,000
11	Workers' dressing room	Male/Female	1	5,000,000	5,000,000
	Total				**37,660,000**

Cars and technology tracks

#	Investment item	Unit of measure	Quantities	Unit price /MNT/	Total unit price
Technological machine					
1	Truck	piece	3	75,000,000	225,000,000
Automobile for office use					
2	Work car for official use	piece	1	20,000,000	20,000,000
	Total		**4**		**245,000,000**

IT and Software

#	Investment item	Unit of measure	Quantities	Unit price /MNT/	Total unit price
1	Financial management	Package	1	50,000,000	50,000,000
	Total				**50,000,000**

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