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TU Delft

BASELINE STUDY ON CDW MANAGEMENT

Country: Mongolia

Project title: Improving resource-efficiency and cleaner production in the Mongolian construction sector through materials recovery

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I. INTRODUCTION TO THE SWITCH – ASIA II PROJECT

The booming construction industry in Mongolia has resulted in the production of massive amounts of Construction and Demolition waste (CDW). It is estimated that this waste accounts for 20-25% of all overall solid waste produced in Mongolia. CDW is thus one of the largest waste streams in Mongolia. In Ulaanbaatar (UB) and other cities in Mongolia, the construction waste is dumped illegally. A huge part of the construction and demolition work is done by small and medium-sized contractors and subcontractors. Thus, SMEs are producing most of the CDW, and their current unsustainable approaches have negative impacts on human health and the environment in Mongolia.

In Mongolia, CDW management represents a significant challenge because the performance of SMEs in construction and demolition debris management is still poor. There are difficulties which keep SMEs away from good CDW management practices. In addition, CDW Recycling SMEs in Mongolia face a lack of knowledge and the technical capability to deal with negative environmental impacts. Furthermore, there are no specific regulations or certifications for a proper demolition of an End-of-Life (EoL) building, recycling and reuse of CDW in Mongolia.

The European project SWITCH – Asia II "Improving resource-efficiency and cleaner production in the Mongolian construction sector through materials recovery" aims to promote sustainable production and consumption in the construction sector, through supporting SMEs to switch to more resource-efficient practices.

To achieve these objectives, different stakeholders have to be involved: SMEs in the construction industry; waste collectors; Mongolian state institutions and MUST.

TU Delft in cooperation with the Mongolian partners carried out a study of the current CDW situation in Mongolia. The objective of this "Baseline Study on CDW management" is to identify and document the current CDW management situation in Mongolia and prioritize technical and non-technical limitations in the CDW recycling and re-use also figuring out the commercial opportunities related to the CDW recycling and management.

Acronyms for involved organisations:

TUD	Delft University of Technology
CCR	Caritas Czech Republic
MUST	Mongolian University of Science and Technology
MNRA	Mongolian National Recycling Association
MBA	Mongolian Builders' Association

1.1 Baseline Study on CDW management

CDW is one of the main waste stream, generated during building construction, demolition activities, renovation of buildings, road jobs (Wu et al., 2014), building site clearing, and excavation (Shen et al., 2004). Despite the rapid growth of construction activity in Mongolia, CDW waste practices in Mongolia are not well understood. This baseline report primarily seeks to address this lack of knowledge.

CDW management is a common practice in Netherlands, Germany, Denmark and Belgium. CDW management and recycling is being developed in many countries such as Hong Kong (Tam et al., 2007), Malaysia (Hussin et al., 2013), Portugal (Coelho and de Brito, 2013), China (Hao et al., 2010), Australia and Japan (Tam, 2009), and Vietnam (S. Lockrey et al., 2016). Mongolia is a developing country witnessing an unprecedented construction boom, but with limited advances in CDW recycling and management. It is therefore important to understand the current practices of waste management, and in particular, CDW in Mongolia, to identify the main obstacles and opportunities for further improvements.

CDW management in Mongolia has several aspects to be taken into account. First of all, a clear understanding of the actors involved is needed. In addition, it is important to define the supply chain of construction materials and applied practices for demolition and separation of the valuable materials.

Field investigations during this study revealed the fact that the demolition of the buildings is performed in the traditional way with no separation of CDW. All produced CDW goes to landfills, both legally and illegally. It is important to notice that former studies have highlighted the presence of hazardous materials like asbestos[1]. However, it is not yet clear how hazardous materials are treated and if there is any safety procedure available in Mongolia to follow.

In order to publish an accurate baseline study several aspects must be considered, which are divided into three main groups:

1. Current waste management practices with a focus on CDW.
2. The supply chain of construction materials.
3. On-site practices, from construction to demolition.

Ch.1	**Methodology**
Ch. 2	**Current waste management practices with a focus on C&D waste**
Ch. 3	**Supply chain of construction materials**
Ch. 4	**On-site practices, from construction to demolition**
Ch. 5	**Conclusions**

[1] Report on the assessment of asbestos use in Mongolia. MOH, WHO, HSUM, 2010

2. METHODOLOGY

To obtain the information required for creating a comprehensive baseline study a systematic research methodology consists of the following steps is applied:

- **The literature review of previous studies about Solid Waste Management (SWM) and CDW in Mongolia.**
  Review of existing body of knowledge comprised of recent peer review journal articles about CDW management and reports regarding SWM in Mongolia.
  The study of journal articles helped to develop the surveys and to prepare the interviews with relevant stakeholders in CDW management.
  On the other hand, recent reports about SWM in Mongolia were used to understand the quantities of solid waste and CDW in UB and the current regulatory framework concerning SWM.
  In particular, JICA "Study on SWM plan of UB city in Mongolia" and ERM "Baseline Study Report" were the main sources of information for Mongolian situation.

- **Interviews with stakeholders in the construction and demolition sector and professors from MUST.**
  TU Delft researcher spent seven weeks in Mongolia to understand the sector by interviewing and meeting different stakeholders and obtaining documentation regarding CDW practices and legislation. All the meetings were organized by the CCR partner and its members provided the English translation of the collected documents during the field visit.
  Stakeholders consist of governmental departments, private large and medium scale construction groups, third-party representative groups such as Mongolian National Recycling Association (MNRA) and Mongolian Builders' Association (MBA), Government agencies as Inspection Agency and Construction Development Centre (CDC), and professors from Mongolian University of Science and Technology (MUST).
  The interviews were held during April and May 2016, conducted in Mongolian and simultaneously translated in English by an interpreter.
  Some key CDW sites suggested as important by stakeholders were visited by the research team to verify a particular point of interest for the research.

- **"Survey for Construction Company".**
  TU Delft developed the survey and the Term of References for Mongolian Builders' Association. The survey's results clarified the common practices among construction companies and their level of interaction with other stakeholders within the industry.
  The survey was based on similar questionnaires found in journal articles (Tam, 2008; P. Villoria Saez et al., 2013) but was tailored to the Mongolian needs emerged during the interviews with stakeholders in CDW sector.

- **Interview with engineers from selected construction companies.**
  After receiving the "Report on Assessment on Construction Companies", TU Delft prepared a series of questions for a structured interview with engineers from selected construction companies. The interview was intended for gathering further comments; elaboration and interpretation in the results obtained from the questionnaire.

- **"Mapping Construction Waste Management in Ulaanbaatar."**
  TU Delft provided the Term of References for "Mapping Construction Waste Management in Ulaanbaatar" useful to understand and map the C&D waste. The resulted report was written by Ger Mapping Community Center (GCMC), a not-for-profit and nongovernmental organization dedicated to community mapping to facilitate community engagement in decision-making towards sustainable urban development. GCMC mapped extensive data concerning construction waste management, researched construction waste handling at the site, and monitored construction waste flow.

- **"Study on the Construction Material".**
  TU Delft in collaboration with CCR defined the main construction materials needed to be studied and created the Term of References for the "Report on Construction Material".
  The aforementioned report provided useful information about the majority and most important materials used in the construction sector. The information collected clarified:
    - » The quantity of production for each of the selected construction material.
    - » Total demand and supply for construction material.
    - » Average prices.
    - » Practices of producers in Mongolia and Value Stream for their production.

All in all, Tools used for collecting the necessary information for "Baseline Study on CDW management" is presented in Figure 1.

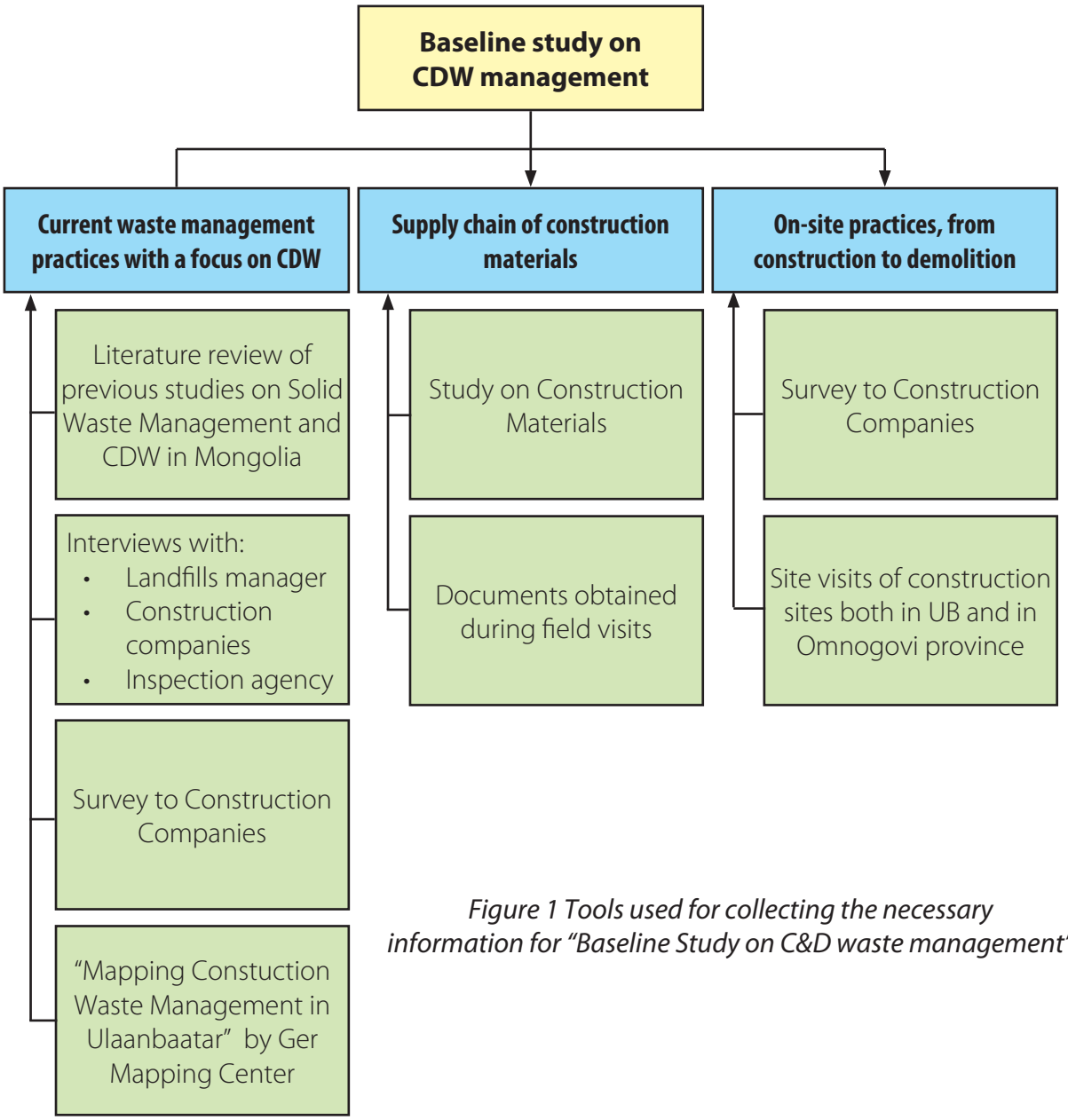


Figure 1 Tools used for collecting the necessary information for "Baseline Study on C&D waste management"

3. CURRENT WASTE MANAGEMENT PRACTICES WITH A FOCUS ON CDW

3.1 Introduction to solid waste management

CDW management encompasses the collection, transporting, storage, treatment, recovery and disposal of waste. It can be characterized as a comprehensive, integrated, and rational system approach towards the achievement and maintenance of acceptable environmental quality and support of sustainable development.

Waste management in the UB city is facilitated by the city municipality. Collection services are operated through a mixture of direct services and sub-contracts with service providers.

Solid Waste is normally disposed in one of the three landfill sites:

- Narangiin Enger (a sanitary landfill).
- Morin Davaa (with limited engineering or management).
- Tsagaan Davaa (with limited engineering or management).

Waste collection is provided at the district level by waste transportation organisations known as "TUK". TUK organisations provide collection services for both commercial and domestic premises. Construction waste is typically collected and disposed by construction companies or through direct contracting with waste collection companies or via private truck owners.

Recycling is mainly a back-end process with recyclables of economic value targeted by groups of waste pickers operating at the city's landfills/dump sites. There is limited source separation of recyclables from domestic or commercial sources.

The following chapter will analyse in details all the aspect related to CDW management to provide a comprehensive overview of the sector.

3.2	**Legal classification of CDW**
3.3	**Waste Quantities**
3.4	**CDW Disposal**
3.5	**CDW stakeholders' participation**
3.6	**Conclusions**

3.2 Legal classification

There is no proper solid waste management practice in Mongolia. The inadequate waste disposal system creates a lot of problems on the environmental and human health.

Current regulatory framework for solid waste management in UB is summarized below:

- **Environmental Protection Law of Mongolia (1995)**
  The purpose of this law is to regulate relations between the state, citizens, business entities and organisations in order to "guarantee the human right to live in a healthy and safe environment." Waste management is covered briefly within the Environmental Protection Law of Mongolia placing responsibilities on the various administrative divisions within Mongolia and also setting out rights of Mongolia's citizens with regards to access to waste management services.

- **Mongolian Law on Solid Waste Management (2012)**
  The purpose of the Mongolian Law on Solid Waste Management (2012) is to "regulate relations arising from the collection, transportation, storage and landfill of household and industrial waste as well as promoting the re-use of waste as an alternative to virgin materials."
  Moreover, the law aims to "prevent and eliminate hazardous impacts of waste on public health and the environment."
  The Mongolian Waste Law defines construction waste as any materials that are direct or indirect by-products of industrial and construction industry, and cannot be further reused.
  The existing management components of construction waste are largely conceptual and there is an absence of on-site enforcement and regulations to be followed.
  With regard to construction waste management, the State Central Administrative Body - Ministry of Construction and Urban Development. Matters is required to develop regulations relating to construction waste management.

- **Regulation on Funding of Waste Management and Transportation Operations and Consolidation of Waste Management Service Fees (2015)**
  This regulation controls waste management activities connected to municipal solid waste emanating from domestic premises and commercial entities. It is not intended to apply to hazardous waste or wastes from the construction industry.

In Mongolia, the construction waste sector is loosely regulated and poorly monitored. In particular, there is no specific legal documentation for construction waste management. The Ministry of Environment and Tourism has in the past emphasized the issue of construction and demolition waste as the environmental hazard and the need for addressing as a priority. However, no activities have been followed so far.

Currently, the only legislation or regulation related to construction waste management in Mongolia is the Resolution No. 94 "Procedure for transporting

construction waste to landfill site" approved by the Presidium of the UB City Council in 2012.

Following are the available legal and standard documents related to waste:

- Law on Waste May 2017 which superseded the previous Law on Waste 2012 (4.6)

Standards:

- MNS 5606-1:2016 – Environmental protection. The emission limit for the crematoria operating on diesel fuel;
- MNS 6501:2015 – Classification and codes of wastes from leather and fur tanning;
- MNS 6487:2014 – Environment. General requirement and waste. Classification of mineral oil refineries;
- MNS 6342:2012 – The maximum permissible level of some air pollutants in fuel gas from hazardous waste incinerators;
- MNS 5344:2011 – General requirements for economical dust transportation;
- MNS 5975:2009 – Grease catcher equipment in wastewater. General requirements;
- MNS 5479:2005 – Protection against dangerous goods. The requirement on the method for disposal of waste from toxic chemicals;
- MNS ISO 11632:2005 – Determination of mass concentration of sulphur dioxide– ion chromatography method;
- MNS ISO 6853:2002 – Photography – Processing waste – Determination of ammonical nitrogen (micro diffusion method);
- MNS ISO 6851:2002 – Photography – Processing waste – Determination of total amino nitrogen (micro diffusion Kjeldahl method);
- MNS 3438:1983 – Auxiliary raw material waste of nonferrous technical requirement;
- MNS 3383:1982 – The Terms and Definitions of Pollutant Sources for Atmosphere;

3.3 Waste Quantities

The total amount of solid waste generated in UB in the period 2013 – 2015 has remained stable around 1 million tonnes per year. The exact quantities can be seen in Table 1 and it is important to notice that data of the year 2015 is limited to the duration of January to August.

Year	Total amount of Solid Waste in UB (tonnes)
2013	1,099,395
2014	1,091,478
2015*	722,682

**Data of year 2015 is limited to the duration of January to August*

Table 1 Total amount of Solid Waste in UB

As already mentioned, there is no proper solid waste management practice in Mongolia and this creates a lot of problems on the environment and human health.

Over 90% of waste quantities go to the aforementioned landfills, each servicing waste from the city's six central districts: Bayangol, Bayanzurkh, Songino-Khairkhan, Sukhbaatar, Chingeltei and Khan-Uul, including commercial, industrial and domestic wastes.

Narangiin Enger Waste Landfill Site is the biggest waste landfill site in UB, which is located in the northwest of UB. It was constructed with the cooperation of Japan and Korea in 2009. Heavy equipment (bulldozers, excavators, dump trucks and tire shovels) were also procured to operate the sanitary landfilling.

The landfill treats 1200 t waste per day. It was said that the capacity of this landfill is limited and will exceed its capacity in 2020. Design period of Narangiin Enger Disposal Site (NEDS) is 10 years which ends in 2020 but it might be shorter due to the increase of waste generation amount.

The types of waste are mainly paper, plastic and soil waste from domestic households. A workshop is located at the bottom of the landfill, which was constructed by Korea. They collect recyclable waste and classify this waste into glass, bottle, plastic and bone. After that, most of these are exported to China as resources to be used in industry.

The amount of solid waste in tonnes in each landfill site for the period 2013-2015 is presented in Table 2. Data for 2015 is limited to the first part of the year (January to August).

Landfill site	Solid waste generation in UB landfill sites (tonnes)		
	2013	2014	2015*
Narangiin Enger	**591,991**	**557,962**	**351,518**
Tsagaan Davaa	**401,796**	**380,596**	**258,491**
Moringiin Davaa	**105,608**	**152,920**	**112,673**
Total tonnes	**1,099,395**	**1,091,478**	**722,682**

Table 2 Figures related to the solid waste generation in UB landfill sites

The typical process on the landfill site is described below:

- A truck arrives and drives up onto the weight scale;
- The site employee inspects the content of the truck;
- The driver indicates the source District and Khoroo;
- The site employee records the weight, driver's name and plate number;
- The information is registered in the Waste Registration System;
- The receipt is given to the driver;

Tsagaan Davaa landfill located in Bayanzurkh district reported that on average they receive 400 trucks per day, and about 20% accounts to construction waste. This landfill is officially operational 24 hours over 7 days. However, due to lack of lighting in the area, trucks are not allowed to get into the landfill site (to prevent accidents). This is an important factor, leading to illegal disposal of waste, especially when construction waste is often hauled during night time.

It is reported that during 2006 to 2014, the amount of CDW has increased by a factor of six. According to the Ministry of Environment, on average, the CDW generated in UB is about 80 thousand tonnes per year. It should be noted that the estimation of the total amount of construction waste is highly problematic, and figures proposed by different authorities show a significant discrepancy. A joint baseline study conducted by the City Municipality together with the European Bank in 2015 estimates about 90 thousand tonnes per year.

The city municipality reports the percentage of CDW accounts to about 10-15% of all waste generated city-wide but another source estimates CDW to be 40% of all waste by mass. The amount of CDW varies from year to year, and the trend is on the increase.

Since a significant amount of CDW comes from demolition of the buildings, the total CDW amount can differ significantly among years based on the intensity of demolition activity.

Statistics show that the amount of CDW is booming every year in months March, September and October. Thus, it is obvious that the weather is a determinative factor in Mongolia to run the construction or demolition projects.

UB Municipality has recorded statistics on the amount of CDW entering into each of the three landfill sites via data obtained from its weighbridges. These statistics offer insight into the current patterns of waste generation from the construction industry.

The distribution of CDW between the three landfill/dumpsites in UB is shown in Figure 2. The majority of the generated CDW is dumped in Narangiin Enger and Morin Davaa sites while only a small amount is being disposed at Tsagaan Davaa site.

In the mentioned Figure the data for the year 2015 stands for the duration from January to August. Considering the fact that the majority of the construction and demolition activities are being done during the mentioned period, we considered

the data to be representative for the year 2015.

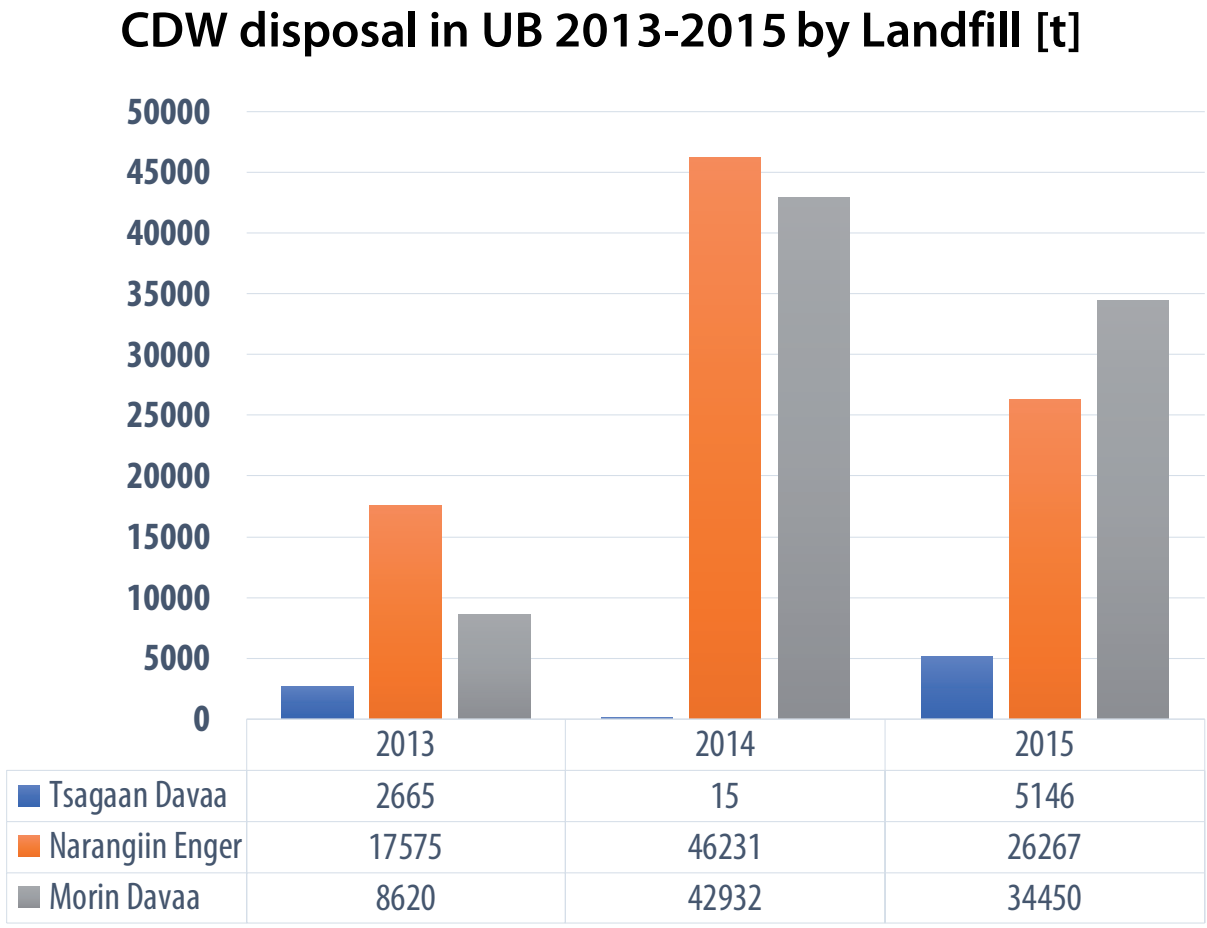


Figure 2 Construction Waste at Disposal Sites in tonnes.

Table 3 shows the detailed amounts in tonnes of CDW from each of the districts of UB.

District	2013	2014	2015
Baganuur total	4	36	19
Bayangol total	3,862	11,435	14,618
Bayanzurkh total	1,269	1,887	4,800
Sukhbaatar total	569	1,648	1,471
Songino-Khairkhan total	-	25,747	11,127
Khan-Uul total	10,189	47,549	33,300
Chingeltei total	370	874	529
TOTAL	**16,263**	**89,176**	**65,864**

Table 3 Tonnes of CDW amount from each district of UB

3.4 CDW Disposal

Based on discussions with the local construction industry, the waste management techniques for residual waste from construction activities is via one of the following four ways.

- **Disposal at the construction site**
  Construction waste may not leave the construction site. Typical disposal options include on-site burial of waste within the construction site.

- **Disposal at UBC landfills**
  There are records of approximately 90,000 tonnes of CDW entering the three UBC landfill sites. It is difficult to determine the proportion of the total CDW this represents in total due to the unofficial disposal practices occurring in the industry.

- **Private Collections**
  Based on the interviews taken during the field trip in UB, in some cases, construction waste is scavenged from larger construction projects and used by individuals in the construction of small dwellings in the Ger areas.

- **Illegal dumping**
  Backfilling off vehicles delivering materials to a site is a common approach to waste collection in the construction industry in UB. This approach utilises the empty vehicle whilst offering additional revenue for the driver. It is understood that much of this work is done on an informal "cash-in-hand" basis and may be executed without the knowledge of management from either party (e.g. construction company or transport company).

Illegal dumping represents a serious problem in UB, about 20% of all waste generated in the city is illegally disposed. The numbers from all three official landfills in 2015 report 65,859 tonnes of construction waste registered. It is reported that the city municipality spent 200 million Tugrugs to clean up illegal CDW in 2011.

The Ministry of Environment and Tourism reported on average 80,000 tonnes of CDW per year in UB. However, it is only an approximation and it is not clear if this figure is referring to the total amount of CDW or only that registered at landfills.

In any case, the uncertainty on the total amount of CDW reflects the difficulty of knowing how much CDW is being illegally disposed.

Illegal disposal of construction waste can occur at construction sites or anywhere else. A number of construction sites have reported that construction waste from the construction activity is buried under the site itself. Demolished building materials also are often disposed following the same mechanism. Otherwise illegally disposed construction waste ends in areas along the construction truck route. This route is often route between construction sites, and construction material producers,

including gravel quarries. Notable examples of illegal disposal of construction waste are shown in Figure 3.

Figure 3 Example of illegal disposal of construction waste in UB area

The main legal and illegal disposal sites in the UB area are presented in Figure 4 where it is possible to observe their localisation and districts division of UB.

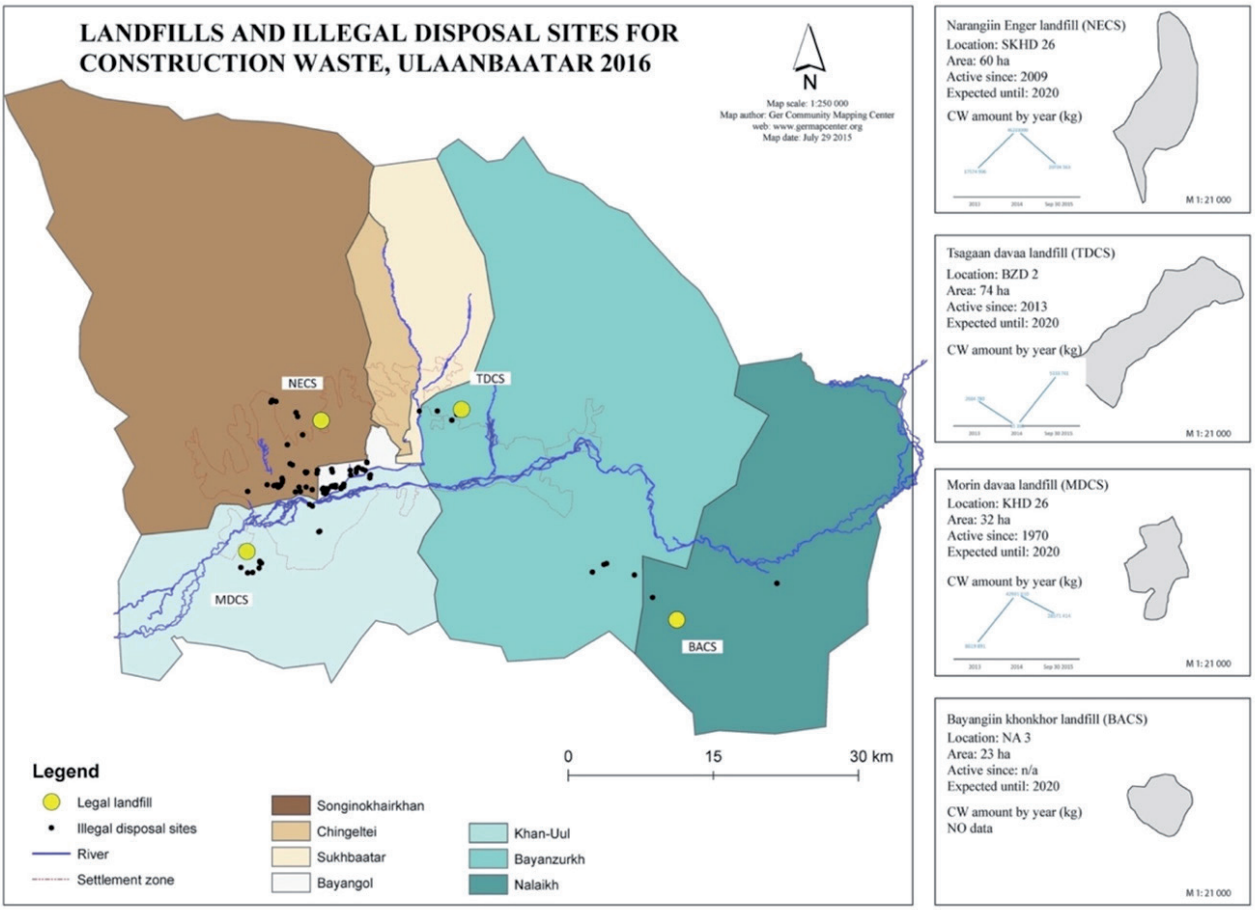


Figure 4 Legal and illegal disposal sites in the UB area

3.5 CDW stakeholders' participation

All actors in CDW practices are considered as stakeholders which can be divided into three categories: polluters, informal actors and monitoring bodies. Polluters and informal actors are purely involved in on-site activities. The monitoring body is involved in conceptual/policy activity, without on-site implementation.

The main stakeholders identified as CDW handlers, or potential polluters, are presented in below together with the respective area of responsibility.

CDW Polluter	Main responsibilities
Waste transporting trucks	• Load, transport and dispose CDW by approved route • Provide landfill receipt to contractor
Construction material producers	• Monitor and maintain his surrounding area
Construction sites	• Manage construction waste at site, contain it within site area • Contract transporter • Check landfill receipt to process payment
Gravel quarries	• Monitor and maintain surrounding area • Rehabilitate extraction site
Individuals	• Dispose of household CDW at nearest landfill

Table 4 CDW Stakeholders and their responsibilities

The main stakeholders identified as enforcement, accountability, and monitoring bodies and respective area of responsibility are presented in the following Table 5.

CDW Monitor	Main responsibilities
The State Inspection Agency and Ulaanbaatar City Mayor's Office	• Contract evaluation with transportation sevices • Monitoring of CDW transportation • Accountability in case of violation • On-ground surveillance for illegal disposal • Receive the reports on contract fulfilment and contract evaluation
Appointed monitoring committee	• Monitor disposal of CDW at legal landfills, by inspecting landfill receipts
District governor	• Contract waste transportation services; • Registers and monitors any construction activities in their own district area
Khoroo governor	• Monitor any construction activity in their own Khoroo area
Legal landfills	• Register, sort, recycle CDW

Table 5 Main stakeholders involved in monitoring activities and their responsibilities

Finally, the CDW management sector has important stakeholders, informal actors, who are not counted in the official system:

CDW Informal Participant	Main responsibilities
Hiring trucks companies	• Provide cheap, fast, on demand service to construction sites • Transporting CDW and construction material • No contract, no landfill receipt is required unless the company demands
CDW sorting, collection, sales individuals/companies	• Sorting at source /demolished buildings/ • Sorting and collection at illegal or legal disposal sites • Supply level collection for export/recycling • On-ground knowledge about CDW sites, materials, prices
City residents	• Largely uniformed about the issues of CDW • Has the power to demand stricter regulation and monitoring; • Has possibility to report any illegal disposal

Table 6 Informal Participant in the CDW Sector

It is important to highlight the poor monitoring and evaluation system in Mongolia. The processes described in official regulations and documents concerning handling, transporting, and disposal of CDW, respective roles and responsibilities are not reflected on the ground. Conceptually there are a number of entities assigned to monitor and evaluate the proper management of CDW, however, their absence is felt as illustrated by the presence of illegal disposal practice and sites.
The lack of attention to monitoring transportation and disposal of CDW is especially evident compared to other monitoring activities regarding the construction industry in general, such as land rights.

3.6 Conclusions

In Mongolia, like other developing countries, the major barriers in CDW management can be summarized in:

- Lack of awareness and culture regarding waste management by Government agencies.
- Lack of support and human resources from key stakeholders such as the Inspection Agency.
- Lack of incentives from construction regulatory authorities and low costs of sending materials to the landfill.
- Lack of community attention on CDW management.

However, one of the major factors to effectively handle waste in the construction industry is achieving the governmental support. Mongolian Government has to provide a uniform national approach to waste minimization and create regulations and building codes to mandate CDW management.

4. MATERIALS SUPPLY CHAIN

4.1 Introduction to materials supply chain

The construction industry has expanded rapidly in recent years in Mongolia and demand for all types of construction products (from concrete to metals) is expected to increase in the coming years.

Currently, more than 50% of building materials are imported. Therefore, imported products made from new raw materials are transported for long distances, resulting in high "carbon footprint" and significant contribution to climate change.
Although the government follows the policy of increasing the local production of building materials, it still faces problems. The main reason is that the local products are not able to compete with imported ones in terms of price and profitability.
Tables 7 presents the number of building materials which are locally produced or imported from other countries.

Materials	Percentage od locally produced	Percentage of imported
Concrete, reinforced concrete, civil engineering precast concrete mixture, chemical additives for concrete	100%	0%
Ceramic brick, block	100%	0%
Lightweight concrete, lightweight filter, ACC blocks	100%	0%
Concrete filter materials, construction sand, construction stone	100%	0%
All types of plastic windows, doors	100%	0%
Thermal insulation mineral wool board EPS, XPS, PUR type of polystyrene foam panels, composite structures magnesium and OSB panels, bars and sandwiches plate	75%	25%
PVC, HDPE, PPR PE types of plastic pipes underground montage hose, electrical wire threading pipes and wiring box	100%	70%
Cement, Lime, mineral powder	30%	70%
Casting, steel bars	30%	70%
Dry and wet mixtures for interior	30%	70%
Steel and cast iron pipe and its connection tools, heating, ventilation accessories	0%	100%
Ceramic finishing, plumbing, ceramic products, artificial stone	0%	100%
All types of glasses	0%	100%
Different types of floor and doors	25%	75%
Steel bars, steel hiring of nails and screws	70%	30%

Table 7 List of materials used in construction and percentage of the imported quantity

In Mongolia about 770 factories are active to produce building materials among which 571 factories are located in UB. This number corresponds with about 60% of

the producers in the whole country. Figure 5 shows the number of building material producers in UB distinctly.

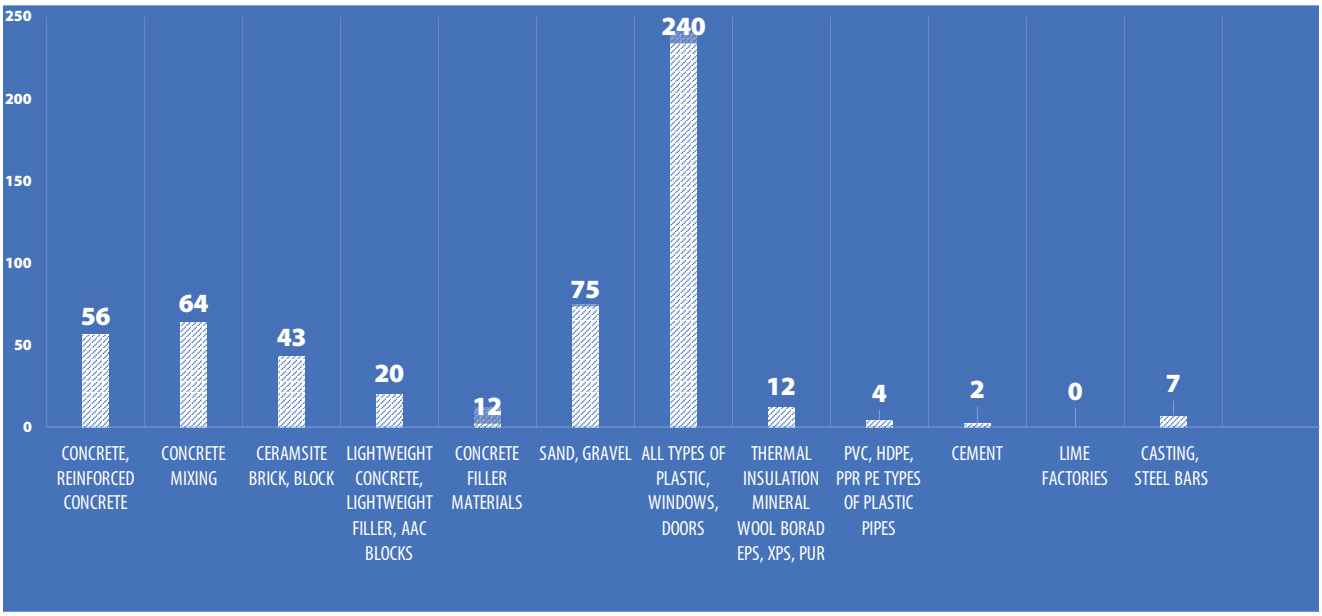


Figure 5 The number of construction material producers in UB distinctly.

The following chapter aims to present a comprehensive study of the construction materials industry and highlight the major barriers in order to adopt recycled materials as replacement of new ones.

4.2	**Methodology**
4.3	**Construction materials information**
4.4	**Conclusions and barriers**

4.2 Methodology

Obtaining information regarding the construction industry is a challenging activity in Mongolia, mostly because construction materials producers are often conservative to share data about their production. Among the producers, there is a general tendency to avoid sharing data to reduce the amount of paid taxes.
The following activities were performed to obtain a sufficient amount of data about the main materials used in the construction industry:

- **Literature review and interviews with construction materials producers**
  All the possible sources of information were translated and studied. These studies were obtained during interviews with third-party representative groups such as Building Material Manufacturer's Association of Mongolian and Barilga Corporation.

- **"Study on Construction Materials"**

TU Delft prepared the ToR for the study and defined with CCR which material required detailed information. In particular, a list of different construction materials was created and the needed information specified.
In the aforementioned document, to facilitate CCR in the research process, Table 8 was proposed to be filled out. Then, for each of the listed materials (Cement, PVC, Metal, Lime, Sand, Gravel, Ceramic Brick) the following points were asked:

- **Total demand for the product:** gives information over the general demand of that material during the year 2015 or the year before.
- **Area of action of the producer:** shows the "Aimag" and the location of its customers.
- **Location of the producer:** shows where the factory is located.
- **Technology used:** a small description of the process used and the number of people who work on the process.
- **Type of equipment:** explains which equipment is used, years of usage, country of origins for the machines.
- **Capacity:** the capacity of the producer in terms of [tonnes/unit of time].
- **Quantity produced over years:** actual production [tonnes/year] from 2000 – 2015.
- **Prices 2015**
- **Price change**
- **How they deal with waste:** what is the policy regarding waste produced during the production process.

Materials	**Cement, PVC, Metal, Lime, Lightweight Block, Concrete Mix Sand, Gravel Ceramic, Brick, Concrete**		
Demand			
Producer	Small producer	Medium producer	Large producer
Area of action			
Location			
Tech. used			
Type of equipment			
Capacity			
Quantity produced over years	Quantity produced **2000** **2001** **2002** **2003**	**2004** **2005** **2006** **2007** **2008** **2009**	**2010** **2011** **2012** **2013** **2014** **2015**
Prices 2015			
Price change			
How they deal with waste			

Table 8 Information required for each of the selected construction material

4.3 Construction materials information

In the following sub-chapters, the information obtained for each of the material is presented:

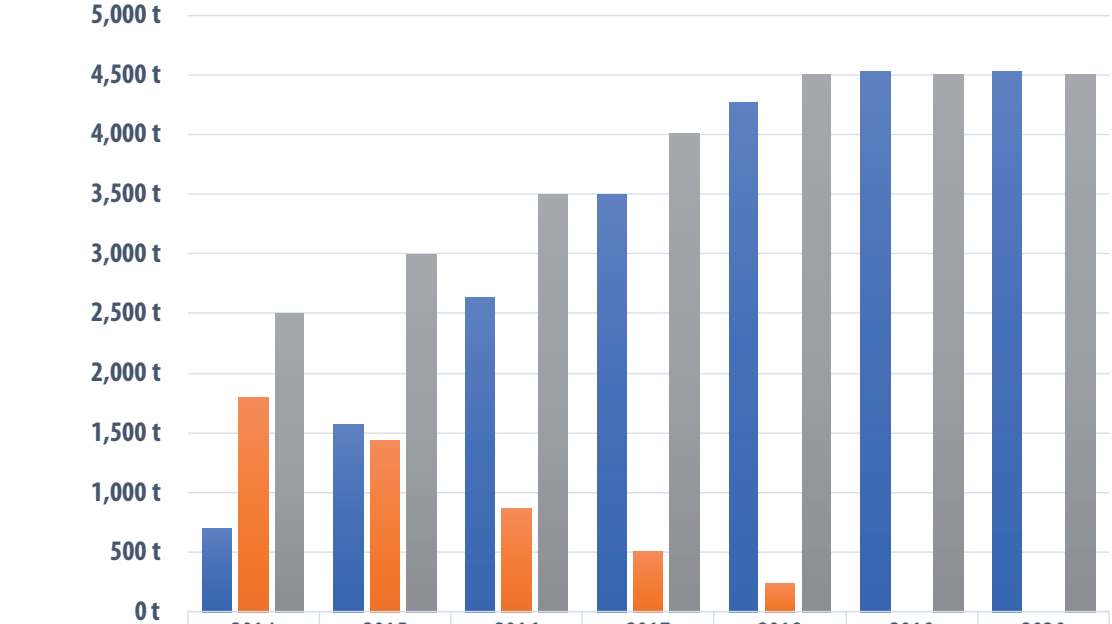
- Cement
- Concrete
- Sand, Gravel and Crushed stones
- Ceramic Brick
- Iron
- Plumbing plastic pipe, PVC and Window glass
- Asbestos

4.3.1 Cement

As already mentioned in Table 7, two factories satisfy 30% of the total demand for cement. Data collected shows that the amount of produced cement in 2014 was about 2,500,000 tonnes. Based on the available data and economic considerations local production is expected to increase while diminishing imported amount, as shown in Figure 9. This scenario is supported by the plan to build at least three new factories to produce cement.

Among all local producers, prices for one tonne of cement packaged are around 72 €/tonnes.[2]

The main raw material for cement production in Mongolia is limestone and supplements are often gypsums, ash from power plants, volcano slag, steel manufacturers slag.



	2014	2015	2016	2017	2018	2019	2020
Local production	700	1570	2630	3500	4265	4530	4530
Imported	1800	1430	870	500	235		
Total demand	2500	3000	3500	4000	4500	4500	4500

Figure 6 Total demand for cement, imported quantity and local production in millions of tonnes

4.3.2 Concrete

Concrete doesn't have a long history in Mongolia. Until the 1940s, lime was the primary binder utilized for masonry and plaster mortars. However, from the late 1940s, Portland cement began to be imported from the Soviet Union. The industrialization of Mongolia was between 1965 and 1970, and the first Portland cement factory was constructed in 1967 with the support of Czechoslovakia.

Later two more plants were built, in 1984 and 1999, using Russian technology.

From 1990, Mongolia undertook the market economy, with the privatization of many state factories and companies. During the mentioned decade, there was a sharp downfall in the construction sector, but the industry began to grow again since 2005.

Concrete mix contains raw materials such as sand, gravel and crushed stones.

Nowadays 40 Ready-made Concrete mix manufacturers are operating and producing ready-made concrete mix. Demand is fully satisfied, especially for UB, but of course, the trend is increasing.

The price for 1 m^3 is between a range of 64 – 98 € depending on the quality of the materials and the producer. Table 9 presents the concrete production in Mongolia and in UB from 2012 to 2015.

	2012	2013	2014	2015
Concrete consumption in Mongolia (m^3)	450,525	548,621	586,603	786,603
Concrete consumption in Ulaanbaatar (m^3)	387,894	488,466	489,952	639,952

Table 9 Concrete Consumption in Mongolia and UB

The study conducted for Reinforced Concrete type shows that 37 factories out of a total of 67 are actually active. They are divided between different areas of Mongolia

- 27 in UB Area
- 3 Central area
- 4 Khangai area
- 3 Western area

[2]1 € is equal to 2166 MNT currently. And the following prices are relative to October 2015

These local producers satisfy 100% of the market demand, exact amounts can be seen in Table 10.

Areas	Demand, thousand m^3/ year	Capacity, thousand m^3/ year
Western area	49.80	10.26
Khangai area	53.14	74.64
Central area	75.84	27.00
Eastern area	31.84	0.00
Ulaanbaatar	365.92	774.95

Table 10 Demand of Reinforced Concrete in thousand tonnes and Capacity

4.3.3 Sand, Gravel and crushed stones

There are around 60 quarries operating in Mongolia and they have the capacity to produce 1,200,000 m^3 concrete annually. The typical production process starts with full crushing and grading technology where mined mountain and river-basin sand and gravel mixture (raw gravel) pass through two crushing phases, through jaw-crusher and cone crusher with a belt conveyor connected to sieve with 3-4 circles. Then plant is equipped with a drum washer for sand washing.
Gravel quarries are a major player in construction waste flow, as the extent of their operations is spread around the city, more densely in the West-North area of the city. It was also observed that some gravel quarries allowed disposal of CDW nearby their extraction site for buyers.
In Figure 7 a map of quarries in the UB area is represented.

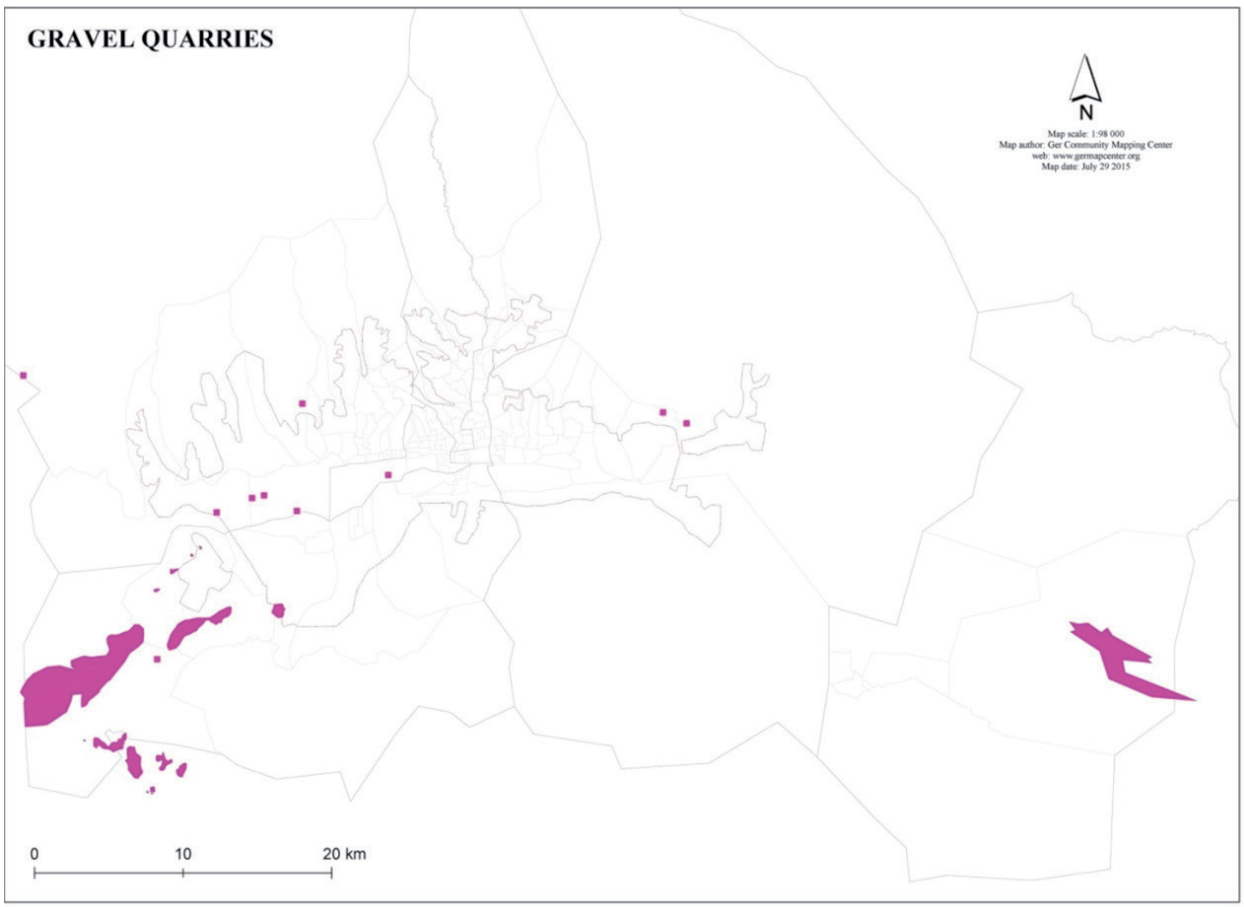


Figure 7 Gravel quarries location in the UB area

Table 11 is presented to show the total number of factories producing lime, sand and gravel and their production.

Product	Number of Factories	Production
Lime	14	90,000 tonnes
Sand	84 (all located in UB)	2.2 million m^3 per year
Gravel	69	2 million m^3 per year

Table 11 Number of factories and production for lime, sand and gravel

4.3.4 Ceramic Brick

The total number of bricks manufactures in Mongolia is 68 and 34 of them are located and serve UB. Other Mongolian manufactures are located:

- 17 in the Western area
- 10 in the Khangai area
- 4 in the Central area
- 3 in the Eastern area

In the capital, there is the capacity to manufacture 176 million units of bricks while the annual average consumption is around 300 million. Table 12 shows data relative to brick production in Mongolia.

	2012	2013	2014
Production (million pieces)	44.5	66.5	58.9
Importation (million pieces)	30	30.3	21.7
Importation (%)	40	31.3	27
Capacity (million pieces)	-	-	320

Table 12 Brick production and importation data from 2012 to 2014

The production process begins from crushed fallowed clay which is sized, then wet mixed in a double mixer, moulded in a vacuum press and cover dried in normal conditions and baked in a round kiln to manufacture regular or holed bricks.
It has to be noticed that statistical information relative to brick production is not accurate due to the following reasons:

- Insufficient registration of the factories.
- Insufficient information regarding construction materials procedures.
- Factories are not willing to provide reliable production reports.

4.3.5 Iron

Iron is mainly produced by one company which has a capacity of 79,000 tonnes of steel bar production and produced 74,400 tonnes in 2012. Some other smaller scale factories in Mongolia and China produce in total 39,100 tonnes of steel bar consumed inside of Mongolia.
Table 13 summaries the steel bar production from 2011 to 2014.

Steel bar	2011	2012	2013	2014
Produced (thousand tonnes)	71.1	86.5	65.1	71.5
Capacity (thousand tonnes)	160.8	180.7	246.0	313.1

Table 13 Steel bar total production

4.3.6 Plumbing plastic pipe, PVC-plastic and Window Glass

In the following Table data relative to plumbing plastic pipe, PVC-plastic used for windows and plastic doors and window glass are summarized.

	2008	2009	2010	2011	2012	2013	2014	2015
Production of Plastic pipe (million kg)	3.3	1.5	3.2	11.9	9.7	8.4	6.3	3.3
Importation of PVC-Window frames (m^3)	239.2	32.1	0.8	17.9	35.8	266.9	59	30
Importation of Window glass (million m^2)	1.44	0.96	0.92	0.82	1.85	2.73	2.65	1.92

Table 14 Production and Importation data for Plastic pipe, PVC frames and Glass

4.3.7 Asbestos in Mongolia

Mongolia has been using asbestos in thermal power plants, metal processing and construction industries as a component of thermal insulation and construction material since 1960.

Asbestos-containing products have been widely used as powder asbestos, handle asbestos (asbestos treads), asbestos sheets, asbestos gaskets, asbestos cotton and asbestos carton for PP's thermal insulation system, steam and turbine system patching and replacement, imitation brick cladding, profiled sheets for outer engineering insulation, insulation for water pipe system and window insulation.

Renovation and installation workers, heat sealer, storage workers, driver, service technicians, shop assistants, plumbers, maintenance workers, carpenters and transporters have been exposed by asbestos and impacted.

Since 1995, the Mongolian Customs Organization has started to get declaration and forms, quantity and total value (in monetary terms) of imported asbestos and asbestos-containing materials have been analysed, in the following Table can be seen the total amount of imported asbestos and asbestos-containing materials.

Year	China		Russia		Other countries	
	Quantity, kg	%	Quantity, kg	%	Quantity, kg	%
1995	-	0.00%	3,000	100.000%	-	0.000%
1996	-	0.00%	181,620	100.000%	-	0.000%
1997	-	0.00%	540,910	100.000%	-	0.000%
1998	15,200	4.04%	361,120	95.961%	-	0.000%
1999	25,200	37.00%	42,900	62.966%	-	0.000%
2000	175,300	31.75%	376,850	68.251%	-	0.000%
2001	15,830	3.11%	492,360	96.885%	-	0.000%
2002	47,010	10.27%	410,700	89.792%	-	0.000%
2003	311,636.24	55.52%	249,687.2	44.482%	1	0.000%
2004	311,636.24	55.52%	249,687.2	44.482%	1	0.000%
2005	1,610,640.5	78.15%	450,308.6	21.850%	-	0.000%
2006	3,315,939.2	88.41%	433,680.8	11.563%	1,000	0.027%
2007	4,968,425.5	97.64%	120,002.5	2.358%	25	0.000%
2008	7,726,147.2	98.40%	123,231.8	1.569%	2,500	0.032%
2009	7,554,744.2	99.84%	12,323	0.163%	-	0.000%
2010	5,099,852.49	96.95%	160,589.86	3.053%	37,4	0.001%
2011	38,009.99	38.78%	60,012	61.223%	-	0.000%
Total	**31,215,571.56**	87.96%	**4,268,982.96**	12.029%	**3,525**	0.010%

Table 15 Quantity and sources of imported asbestos and asbestos containing materials

During the period from 1995 to September 2011, according to the data of General Customs Authority, Mongolia has imported in total 35,484,554 kg asbestos and asbestos-containing materials from China and Russian Federation.

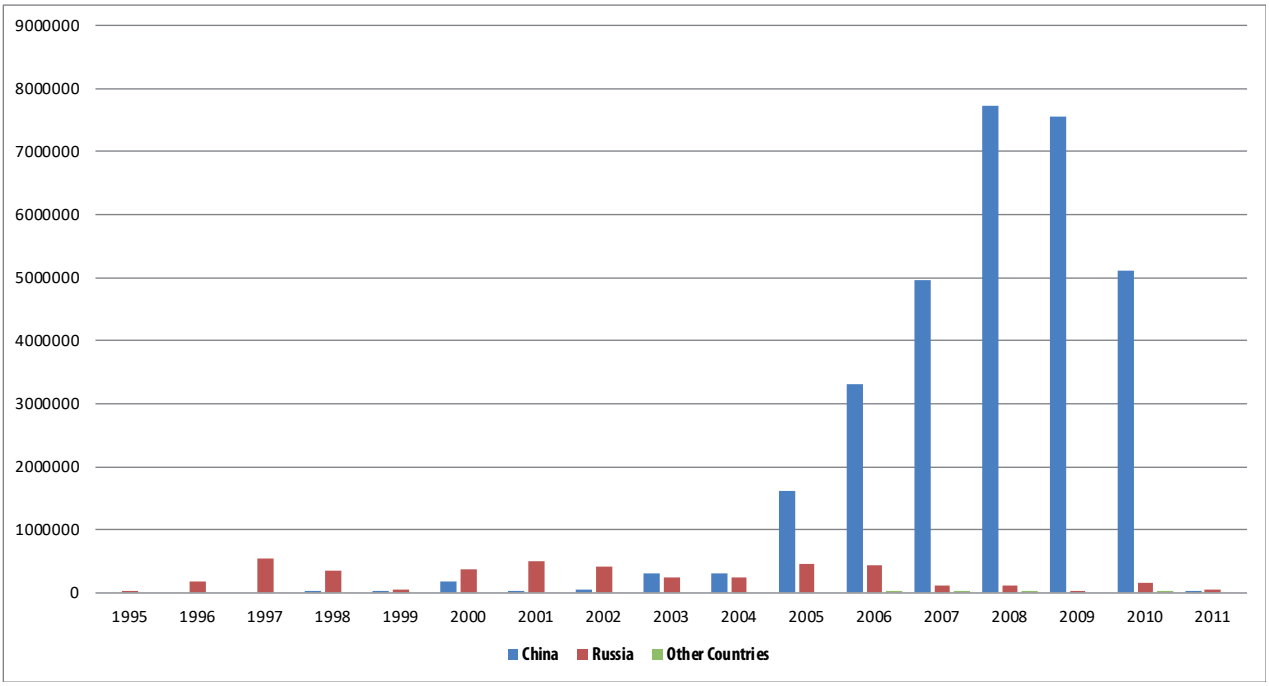


Figure 8 Importation of asbestos from major importers

Since the 1960s, roof slates by asbestos and various pipes made by asbestos have been imported from the Soviet Union and widely used in the construction sector. Asbestos was extensively used in ceiling, roof, wall, wall coating and insulation of heat pipes and it is most likely that all buildings built before 1974 have contained asbestos in some way.

Due to facts including the majority of building standards of the Soviet Union was used in Mongolia, many Russian experts worked in Mongolia and they made building architectures, it is very likely that asbestos-containing materials used in waste pipes, insulation of heat pipes and asbestos roof cyphers.

Figure 9 shows some examples of the application of asbestos in the construction.

At present, there is no formal manufacturer of asbestos and asbestos-containing materials in Mongolia and in the construction sector. Asbestos waste pipes are being replaced by plastic pipes. Insulation of heat pipes are being replaced by printed materials and roof cyphers are being replaced by various metal and asphalt containing materials due to the availability of different kinds of materials and market options. In addition, asbestos containing materials are not used in construction framing, replenishment, plastering and external and internal plumbing of drinking water.

Few entities that have licenses from Ministry of Environment and Tourism to import and use asbestos for the energy production sectors such as power plant stations.

A. Balcony of an apartment building was covered by asbestos panel

B. Storing old asbestos roof panels

C. Asbestos roof of an apartment building

D. Asbestos roof of an apartment building

Figure 9 Asbestos roof panels which are used in construction

4.4 Conclusions and barriers

The study of the building materials industry in Mongolia leads to the following conclusions:

- Processing technology and equipment are often obsolete.
- There is no knowledge of recycling process technologies.
- Construction materials producers are not aware of the environmental problems related to CDW.

The main obstacle to the adoption of recycled materials remains the cultural attitude toward waste and the consequent lack of connections among MUST, industries and Government agencies.

A scheme of the relations among different actors is proposed in Figure 9.

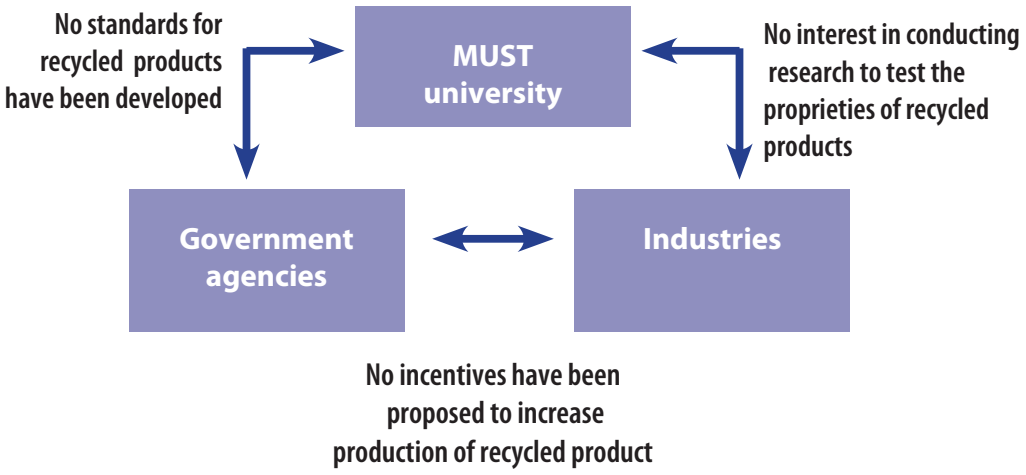


Figure 10 Relations among different actors in construction industry

5. ON-SITE PRACTICES, FROM CONSTRUCTION TO DEMOLITION

5.1 Introduction

With increasing urbanization and greater demand for housing and offices in the cities, as well as significant demolition of old buildings to make way for modern ones, there are currently many opportunities for construction and demolition companies in Mongolia.
A huge part of the construction and demolition work is done by small and medium-sized contractors and subcontractors. Thus, SMEs are producing much of the CDW. Their unsustainable approaches are having negative impacts on human health and the environment in Mongolia.
The problem is that the SMEs involved in construction and demolition have no knowledge or human resource capacity regarding how to manage waste according to the Reduce, Reuse, Recycle (3Rs) and life-cycle approaches. Also, there are no certified companies in Mongolia with experience in safe demolition processes that preserve usable materials at demolition sites.
The following chapter aims to investigate current practices among construction companies by presenting the results of the survey sent to construction companies in Mongolia.

5.2 Methodology

To examine current practices among Construction companies in Mongolia a questionnaire survey was conducted.
The questionnaire is divided into four sections as shown in Figure 11:

- General information
- Construction information
- Construction material procurement
- Demolition information

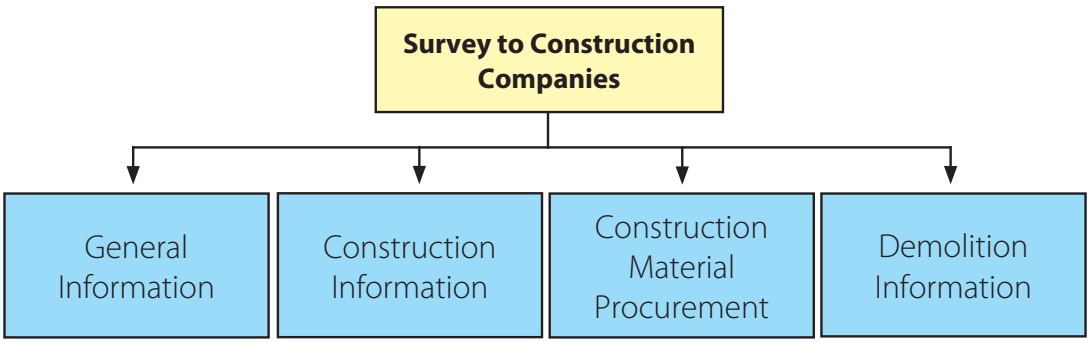


Figure 11 Sections of Survey to Construction Companies

- **In "General information"** section of the survey has to cover:
  - » The number of construction projects for each company.
  - » Location of different construction projects.
  - » Different types of constructions (Residential / Non - Residential).
  - » The number of employees for each company and years of experience in the construction sector.
  - » List of the information needed to be provided at the beginning of a construction project.
- **"Construction Information"** section is focused on Construction Practices and waste creation during the construction process.
  The results of this section will provide the following information:
  - » The relation between construction company and hired contractor.
  - » Regarding construction waste transportation: the responsibility of the waste produced on site.
  - » Material Wasted: average different materials quantities (Bricks, Concrete, Plastic, Glass, Wood) wasted in a construction project.
  - » Type of inspections received during a construction process.
  - » The exact sequence of operations for the construction process.
- The aim of **"Construction material procurement"** section is to assess the practices about Material Procurement and how it is handled during construction work. This section will prove answers to the following questions:
  - » The suppliers' information for each material.
  - » Average prices for construction materials.
- **"Demolition Information"** section will provide information about demolition practices. It has been found that most of the construction companies also operate as demolished, so it is important to clarify the dynamics about:
  - » Collaboration with contractors.
  - » Type of permit needed to perform the demolition.
  - » An average number of workers necessary to perform demolition and the average number of days to complete it.
  - » CDW produced during a demolition.

» Level of knowledge of asbestos risks and procedures followed to treat hazardous waste.
» Equipment used for demolition.

To obtain a representative sample of the companies, MBA selected 70 active construction companies which are divided in:

- 45 active construction companies in the UB area.
- 35 active construction companies outside UB. The 35 construction companies covered almost every Aimag (province) in Mongolia, included the Omnogovi province.

The number of construction companies constitutes the 10% of the total members of Mongolian Builders' Association. In total, 700 construction companies are active in Mongolia from which 450 companies are active inside and 350 companies operate outside of UB.

Figure 12 presents different phases for obtaining the information via survey. An explanation of each phase is given below:

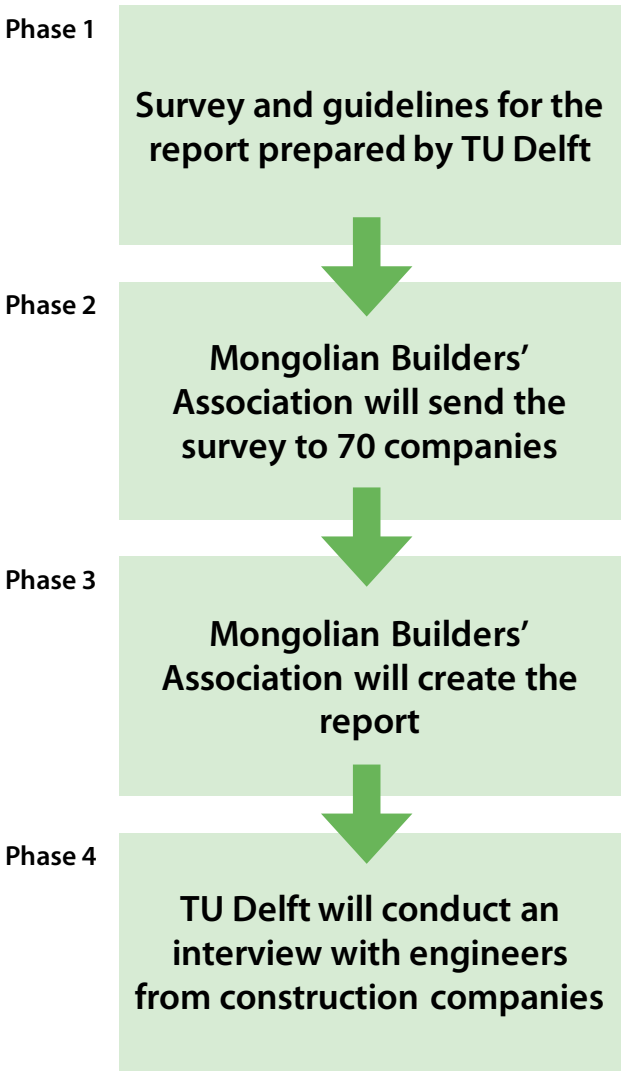


Figure 12 Steps to finalize the Report on Construction Companies

Phase 1

TU Delft has prepared the survey and the Term of Reference to be received by MBA. ToR presents the method for conducting the survey and the table of content for the "Report on Assessment on Construction Companies Practices" to be written by MNRA.

Phase 2

MBA sent the survey to 70 construction companies following the methodology proposed by TU Delft.

Phase 3

Once all the surveys were collected, MBA created a Report following the proposed table of content in phase one.

Phase 4

After receiving the report written by MBA and analysing the data, TU Delft prepared a structured interview with engineers from selected construction companies. The interview was organized and conducted by CCR together with the help of MBA.

5.3 Survey results

5.3.1 General information regarding construction companies in Mongolia

In 2014, there were more than 700 companies with permission for construction and structural engineering activities. The activities under the permission allow:

- All types of groundwork
- Building, repairing, demolishing construction or engineering structures
- Construction and repair of pedestrian, public space, and paved roads
- Creating green space
- Construction and repair of flood protection dam
- Construction materials sales and services
- All types of production of construction materials

The companies may operate under the signed contract with the respective district governor. From the survey results, it has emerged that not all the companies are active and surprisingly the same ratio has been found for each of the two groups. Table 16 represents the actual status of the different companies for both the UB area and provincial area.

Companies status	UB area	Provincial area
Active	20	10
Temporarily inactive	25	15

Table 16 The number of active and inactive companies in UB area and Provincial area

The majority of the companies in each the two areas are involved mainly in non-residential projects as is presented in Figure 13.

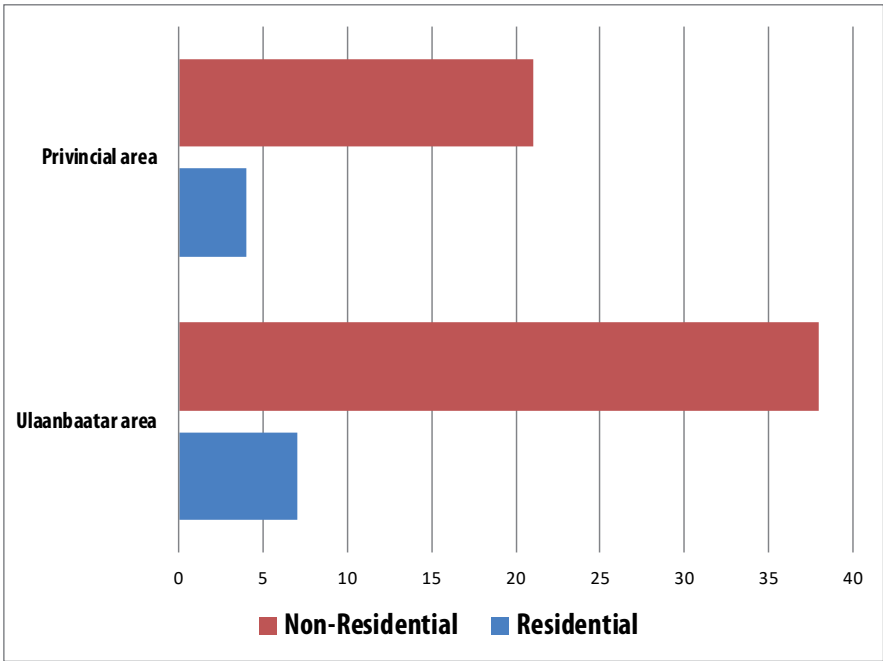


Figure 13 Type of Construction projects done by the surveyed companies

An interesting data comes from the years of activity of the analysed companies showed in Table 17. It is important to notice that construction companies in UB are more mature than companies in the Provincial area. Furthermore, data in Table 18 show a positive correlation between years of activity and the average number of employees.

Number of years of activity	Less than 5	Between 5 and 10	Over 10
Ulaanbaatar area	11	20	14
Provincial area	1	9	8

Table 17 The number of years of activity for Construction company

Average number of employees	Less than 5 years of activity	Between 5 and 10	Over 10
Ulaanbaatar area	28	57	75
Provincial area	14	22	26

Table 18 The average number of employees in a company with different years of activity

5.3.2 Construction practices

Based on the survey results 64% of the surveyed companies decide to hire a contractor to perform the construction work on-site.
Therefore, in the construction process usually three different actors can participate:

- Investor of the construction project
- General contractor selected by the Investor with a tender
- Construction sub-contractor companies

Construction sub-contractors are in charge of the following activities:

- Electrical systems installation
- Plumbing systems installation
- External engineering networks installation

Generally, the process is divided into different phases as described below in Figure 14:

Figure 14 Participation of the different actors in the Construction process

The Sub-Contractor selection does not happen within an official tender, below the different indicators involved in the sub-contractor selection are presented based on their importance:

1. Work experience
2. Previous cooperation
3. Financial resource
4. The number of professional staff
5. The capacity of engineering and technical staff

Before a construction project can start it is necessary to obtain the following required information:

1. Official letter and permission requested.
2. Copies of construction contract made by a general contractor, construction official license (compatible with assigned construction work), diploma, professional ID, training certificates of a general engineer.
3. Copyright of the inspection contract with technical drawings.
4. Copies of the order and diploma of technical inspection engineer appointed by the Investor.
5. A copy of a notarized land allocation decision, use and ownership agreement and certificate.
6. Approved blueprint and architectural planning reference
7. Technical conditions (thermal, power, clean water and sewage).
8. The general conclusion of feasibility on technical drawings.
9. Complete technical drawings of the construction approved by the feasibility study and the consent of Fire department.
10. Approved technical drawings of construction site arrangement including the specific area for vehicle tire cleaning at the adjoining section construction

site and road, authorization of lift trucks at the site, officials in charge of labour and crane safety during loading.

Once all the required documents are collected the construction work can start. To show the most important activities and the actors involved along the construction work a Gantt diagram in Figure 15 is presented as an example.

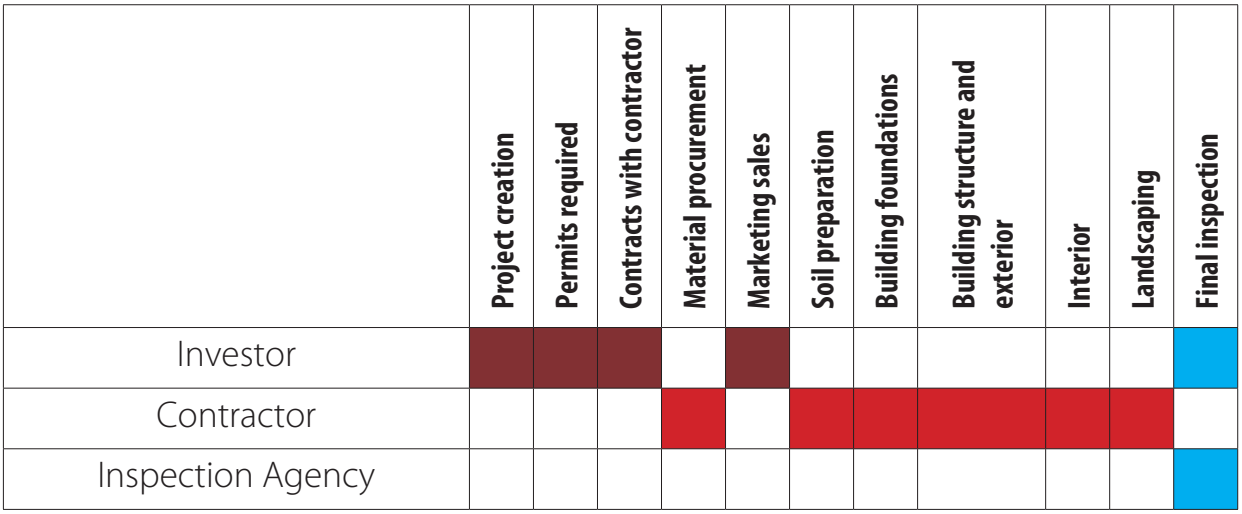


Figure 15 Gantt diagram of the main activities under a construction project

By observing the Gantt diagram it is clear that the construction waste is generated mostly during "Soil Preparation" and "Landscaping" activities.

To ensure the quality of the construction work and the respect of the regulations, different inspections are conducted during the whole process. They are conducted by different actors and aim to check different aspects of a construction, the main inspections are:

- *Owner/Company's inspections*
  - » Inspection of the Technical drawings developer
  - » Inspection of Contracted consulting company
- *Developer's inspection*
  - » The drawings developer company signs a contract with the owner/company and inspects through whole construction processes.
- *Specialized inspection*
  - » Inspectors from General Inspection Agency have to conduct an inspection during the construction and the end of it

Construction field engineer is responsible for keeping track of works completed during the construction work in **"Construction journal"** which is the key document to obtain approval of the building by State Commission.

5.3.3 Construction waste production

The CDW loads are transported to the disposal sites by hired trucks but, as already mentioned, the waste is dumped into the nearest valley around official disposal sites. The number of trucks filled with CDW is highly variable and it depends on the type of structure. As an example, during the construction work of a 9 to 12 storey building the following activities can generate waste:

- Digging the land: 3 – 4 trucks of construction waste produced in a week
- Caracas/steel frame installation: 2-3 trucks of waste per 1-2 months
- Construction process: 1-2 trucks of waste in a week

Regarding the construction waste, Ger Community Mapping Center reports the following observations after several site visits:

- No construction waste handling plan was present in any of the sites visited.
- Construction waste amount depends on how technologically efficient the materials are being used.
- Construction waste is piled in the site area where it is likely to cause the least interference to other activities and easily accessible by trucks for hauling.
- For companies working on large-scale construction, the construction waste transporter was required to submit landfill receipt to complete the hauling service payment.
- Construction waste from individual activity tended to be disposed of infor mally.

All the waste ends into the legal or illegal disposal sited because during these days in UB there are not any recycling industries specialized in CDW.

5.3.4 Demolition practice

In Mongolia, there are no certified companies with experience in safe demolition processes that preserve usable materials at demolition sites. All the demolition work is performed following the traditional methods by contractor and sub-contractor with experience only in construction activities.

There are regulations and codes which determine if it is necessary to demolish a building. Demolition can happen when:

- The condition of the building has become out of use as a result of natural phenomena and other factors.
- The building is found as impractical and dangerous by the professional organization.
- The structure is defined as economically inefficient by technical assessments.
- The owner decides to demolish it.

The relevant authority issues building demolition technical assessments based on the following related legal documents, codes and regulations:

- "Construction codes on construction planning at seismic zones of Mongolia" CCN 22.01.01*/2006.
- "Instruction for assessing earthquake resistance rate of existing building" CR 31-102-00.
- "Methodological instructions on certification to existing building in seismic zones" CR 31-103-00.
- "Estimation manual of residential buildings physical deterioration" CR 31-104-01.
- According to 25.2.1, 25.2.2, 25.2.3, 25.2.4, 25.2.5, 25.2.6, 25.2.7, 25.2.8, 25.2.9, 25.2.10 of the Article 25 of Mongolian Law on Construction, condemned as required to demolish by Specialized Inspection Agency.
- According to 26.1.1 of Article 26 of Mongolian Law on Construction, official statement of demolition is issued.
- "Methodological instructions for assessing requirements for residential buildings approved by" Decree No.322 by the Minister of Road, Transportation, construction and Urban development, 2011.

For demolition usually the buildings in Mongolia fall in one of the following categories which could affect the number of required workers, equipment and etc.:

- Very hard
- Medium
- Not very hard

A very hard condition is found when:

- The building is included in a high class or consists of multiple buildings
- Built with complex technological and space/volume planning
- Located in high-density, small area
- There is the presence of complicated structures and bases
- Requires different construction companies in the process of demolition work

The client and the contractor shall choose the suitable methods of demolition after taking construction architectural planning, structure base and the technological capacity into consideration.

The duration of the demolition work, professions and the number of staffs shall be decided by the Contractor after choosing the best method.

As an example, it is presented a demolition done in UB by "MGLTECH" LLC. The demolition was of a 10-storey office building of "Trade and Development Bank of Mongolia" from March to June of 2016.

Figure 16 Demolition of the 10-storey building in UB

In the construction case shown in Figure 16, the demolition was performed in an optimal way and all the required procedures were followed. It has to be noticed that for Mongolian companies a building of that kind represents a challenge in terms of equipment and knowledge of the workers.

The following photos were taken during the demolition process. Different stages of the demolition process of the aforementioned structure can be seen in Figure 17.

Figure 17 Different stages of the demolition process

At the end of the demolition process, the following CDW quantities were estimated.

№	Types of waste	Unit	Quantity	Average number of loaders
1	Brick	tonnes	10,000	100
2	Concrete	tonnes	7,000	50
3	Plastic	tonnes	3	1
4	Glass	tonnes	5	2
5	Wood	tonnes	40	15

Table 19 Waste materials coming from the demolition of the 10-storey building

5.4 BUILDING CATALOGUE

Collecting information about the exact number of the buildings and its characteristics is one of the biggest challenges in Mongolia. This is mainly due to the lack of a digital database and the difficulty to obtain information from some Governmental Agencies.
By the extend of this baseline study, it is sufficient to present information about the number of buildings for each districts by year built in Table 20.

Districts	Built before 1961	Built during 1961-1974	Built during 1973-1987	Built during 1987-2000
Bayangol	20	3	130	108
Bayanzurkh	22	41	33	51
Sukhbaatar	23	6	56	40
Songinokhairkhan	5	19	41	40
Chingeltei	72	37	85	35
Khan-Uul	22	67	15	36
Nalaikh	30	10	18	11
Total	**194**	**183**	**378**	**321**

Table 20 Number of buildings for each district by year built

UB is a relatively young Capital with about 100 years of urbanisation, therefore each predominant construction style corresponds to a period in its history. An important classification is provided in Figure 18 where different buildings are divided by the year of construction.

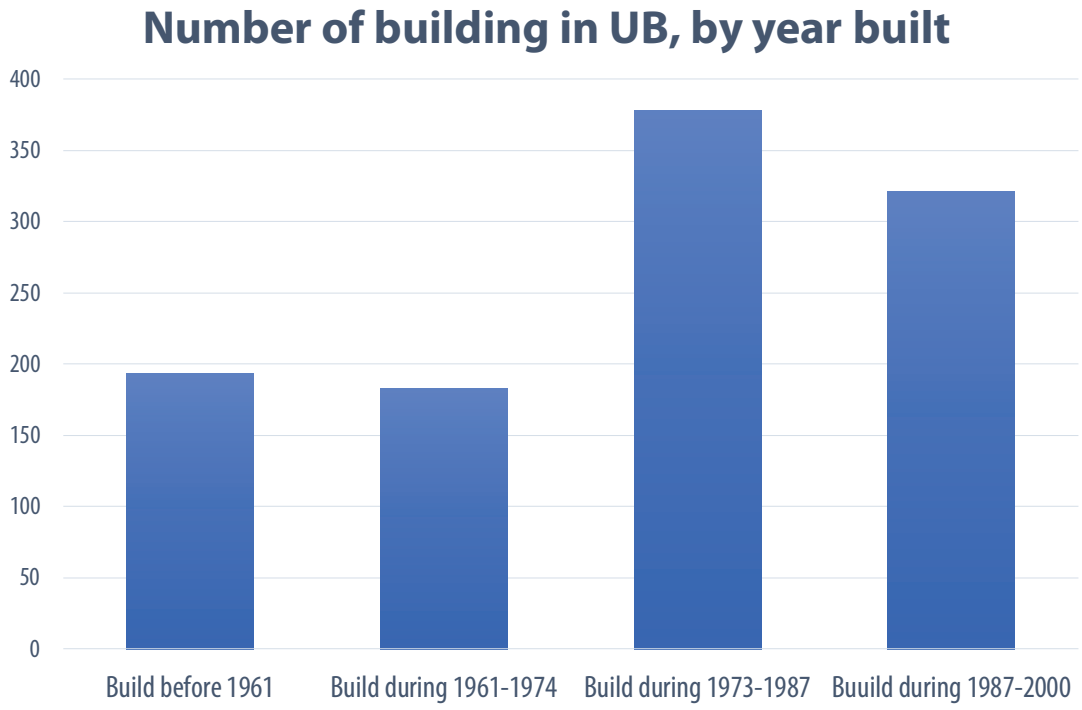


Figure 18 Number of buildings by year built

5.4.1 Construction and Demolition sites

UB is facing an important transformation in the last years and the number of construction sites has started to increase again after a small interruption during 2013-2015. The following Figure shows the number of construction sites for each district.

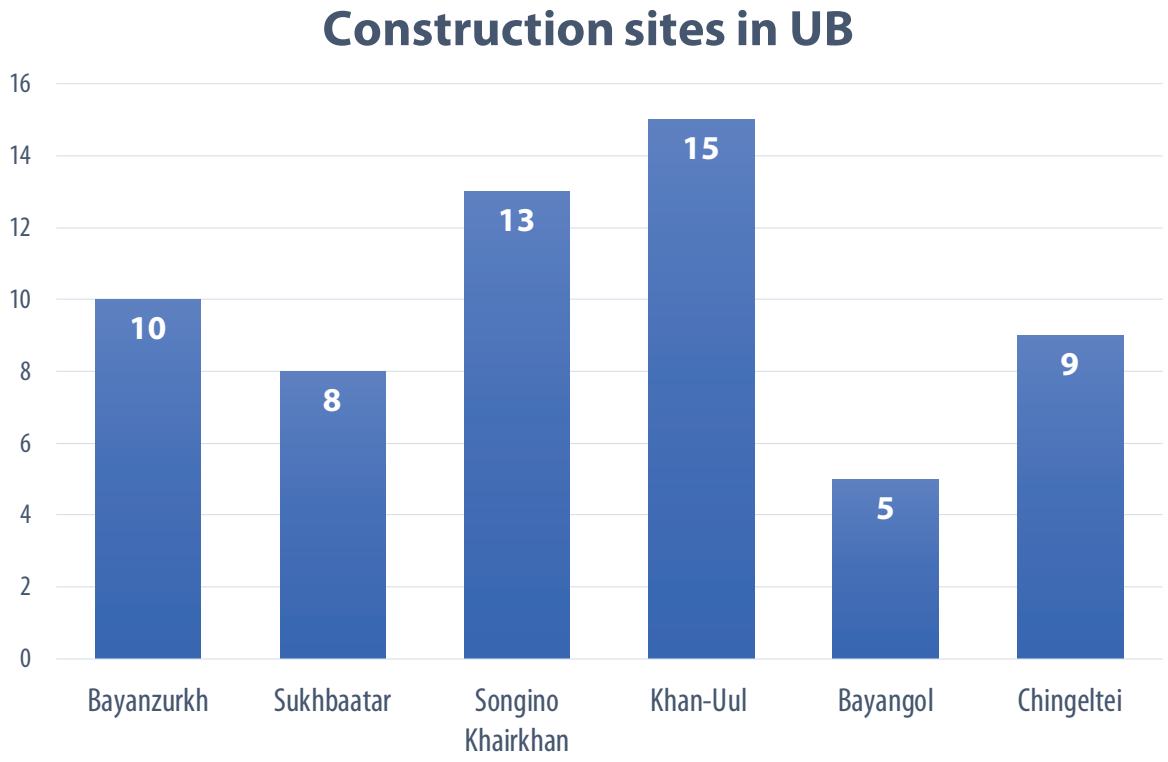


Figure 19 Number of construction sites in each district

With regards to the future demolition project, in 2014, the City Municipality published a list of 324 buildings to be demolished and in 2016, the State Inspection Agency published a list of unapproved 97 buildings.

The density location of the buildings planned for demolition is an important base information to plan construction waste management when the demolition activities start. Based on the density of the buildings and their location, it is possible to predict the amount of waste to be expected at the nearest landfills and the possibility of illegal disposal.

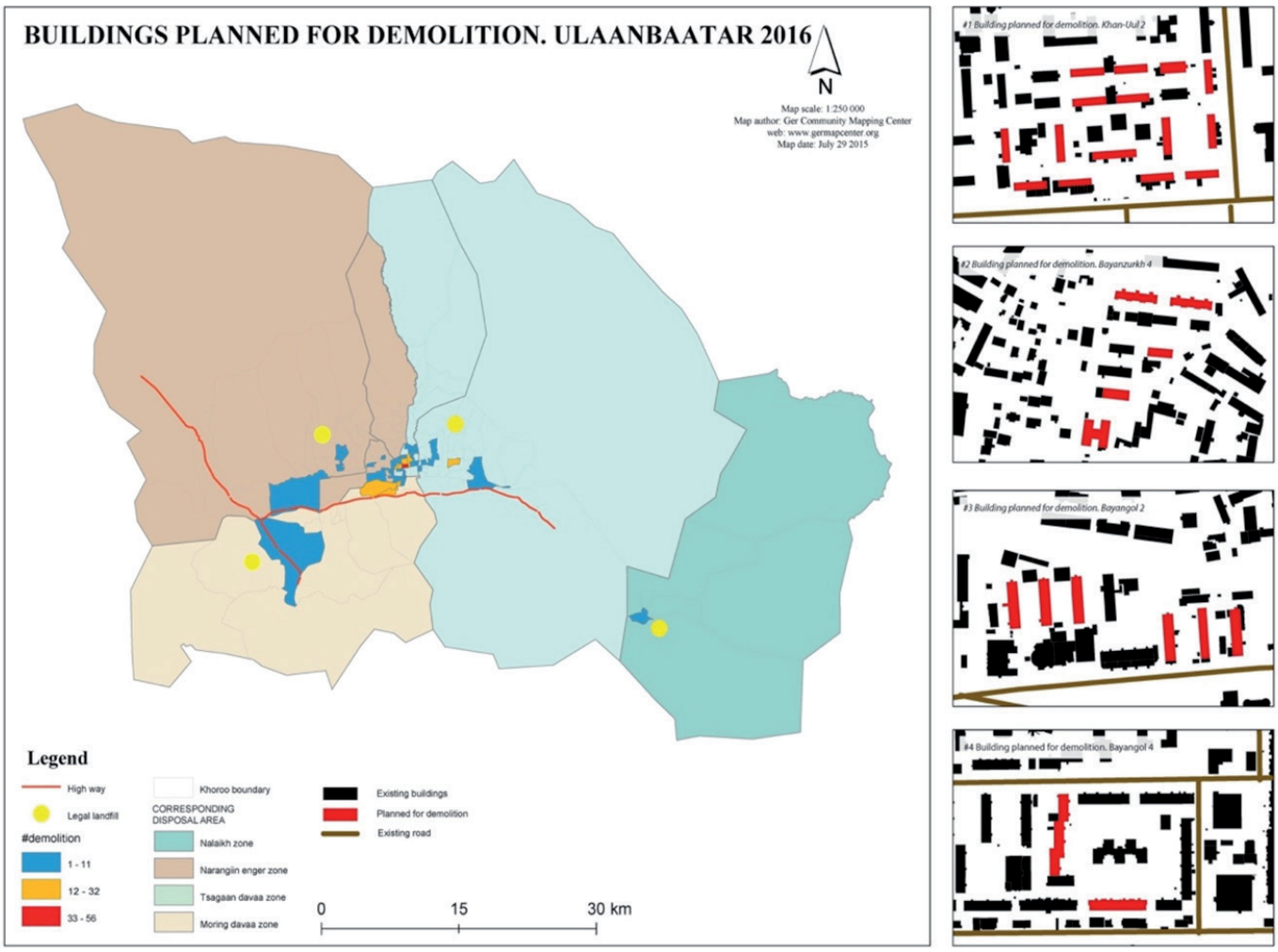


Figure 20 Buildings planned to be demolished

5.5 Conclusions

After presenting information from the questionnaire survey about practices adopted by construction companies in Mongolia, the following conclusions can be drawn:

- Demolition activity is not followed by the separation of CDW because companies have no incentives to perform this task.
- Construction companies do not collaborate with recycling companies, most of the time they are not aware of the existence of the recycling sector in Mongolia.
- No certified company exists to perform a safe demolition and there is no specific regulation which addresses this problem.
- No policy is required for designers/contractors to use a suitable portion of recycled aggregates in the construction project.
- Lack of a database for the buildings of UB create a big obstacle to a clear understanding of the quantities of CDW produced after a demolition.

6. CONCLUSIONS

In Mongolia, during 2006 to 2014 the amount of CDW has increased by a factor of six but estimating the exact quantities remains highly challenging. Therefore, CDW is a critical concern and requires better management. In this report it is estimated that CDW represents about 10-15% of the total waste generated in UB.

In Mongolia, CDW management represents a significant challenge because the performance of SMEs in this field is still poor. There are difficulties which keep SMEs away from proper CDW management practices. In addition, CDW Recycling SMEs in Mongolia face a lack of knowledge and the technical capability to deal with negative environmental impacts.

The European project SWITCH – Asia II "Improving resource efficiency and cleaner production in the Mongolian construction sector through materials recovery" aims to promote sustainable production and consumption in the construction sector, through supporting SMEs to switch to more resource-efficient practices.

TU Delft in cooperation with the Mongolian partners carried out a study on the current CDW situation in Mongolia. The objective of this "Baseline Study on CDW management" is to identify and document the current CDW management situation in Mongolia and prioritize technical and non-technical limitations in the CDW recycling and re-use also figuring out the commercial opportunities related to the CDW recycling and management.

Based on the results of the baseline study, it is concluded that the technical and non-technical limitations in the existing CDW management system include mainly:

- Lack of awareness and culture regarding waste management by Governmentagencies.
- Lack of support and human resources from key stakeholders such as Inspection Agency.
- Lack of incentives from construction regulatory authorities and low costs of sending materials to landfill.
- Lack of community attention on CDW management.
- In the building materials industry in Mongolia processing technology and equipment are often obsolete.
- Demolition activity is not followed by the separation of CDW because companies have no incentives to perform this task.
- Construction companies do not collaborate with recycling companies, most of the time they are not aware of the existence of recycling sector in Mongolia.
- Lack of a database for the buildings of UB create a big obstacle to a clear understanding of the quantities of CDW produced after a demolition.

Improvements in CDW management can improve the city in various ways including reuse and recycling of CDW and sustainable construction materials and on the other hands decreasing the rate of landfilling. There are now, more than ever, clear opportunities for business and industry to invest in activities that will create profit and improve environmental outcomes by extracting valuable resources from the CDW. Legislations must be defined and a scheme of incentives and fees for construction companies has to be designed and enforced.

In Europe, Japan and other developed countries, recycling of building materials started from the end of World War II when bricks and other materials, were recovered from the ruins of war and utilized for reconstruction.

Based on the current EU practices, the following recommendations should be considered to reduce the CDW generation:

- **Landfill Regulations**

A stricter control of landfilling for CDW is needed. Setting proper landfilling regulations will be a major driver towards better CDW management. For example, in Denmark, Netherlands and Germany it is forbidden to landfill waste materials which can be recycled or incinerated. In addition, the landfill disposal fees and taxes, governmental encouragement for environmentally friendly practices and granting the related activities and management of demolition waste are key factors.

- **Waste Management Policy**

CDW policy should be based on: the precautionary principle, the producer of CDW pays principle and the principle of co-operation. He is required to consider the environmental impacts and possible risks occurred during his activity, in collaboration with the other parties involved (producers, distributors and consumers of building materials, disposal and recycling companies, as well as government offices).

The CDW producer should develop a system which minimizes the adverse environmental impacts and maximizes the recovery of resources (recycling, reuse).

For that reason, the implementation of a waste management policy with not only economic instruments (taxes on landfill), but legal measures such as: demolishing selectively obligation, voluntary agreements and responsibilities is needed. In this way, even during the production phase, the foundations are laid for the effective and environmentally compatible avoidance and recovery of waste. Manufacturers and distributors must design their products in such a way as to minimize the amount of waste produced during manufacturing and, finally, to facilitate an ecological removal of those components of the waste which can no longer be reused. This measure is widely used in the United Kingdom, Austria or Germany.

- **Quality Standards**

The implementation of secondary raw material regulation and standards is needed. For example, setting standards on the quality of secondary materials from CDW. This is another important key factor; For example, Belgium's waste framework policy specifies the nature of the waste which can be used as a secondary raw material in construction.

- **Selective demolition**

One of the main objectives of the CDW project in Mongolia is to transfer the knowledge of an optimum demolition strategy (for example process, costs, logistics, procedures, timing) and select the best tools for dismantling and demolition that will maximize the high-quality reuse of valuable components and materials, minimize contamination mixed with recycled products, and minimizing time, the safety risk and the impact of the demolition process on the environment. An End-of-life (EoL) building may be conventionally or selectively demolished. In the Netherlands, selective dismantling and demolition of EoL buildings are one of the common practices in CDW management projects.

The difference between conventional and complete selective demolition is that in selective demolition the workers use light mechanical tools in order to recover the highest percentage of materials that can be reused, whereas in conventional demolition the workers use heavy equipment (explosives, wrecking balls, bulldozers) and, as a result, the generated waste is mixed and the recovery of materials is difficult.

This technique requires more working hours and a longer time period, as the removal of various materials is carried out manually. However, the generated waste is clean from dangerous contaminants and materials that cannot be recycled, thus, in the end, the process is economically beneficial as well. The complete selective demolition is separated into various phases, so in each phase, a different material is removed and collected (Nakajima 2000). Consequently, the recovery and recycling rates of materials are increased substantially.

Based on the information gathered under the baseline study, the project partners will conduct a study to identify the most relevant local CDW materials for successful recycling and re-use. This will involve conducting a Material Flow Analysis (MFA) of CDW in Mongolia. In cooperation with MUST and MNRA, TU Delft will prepare the MFA and investigate the possibilities for using recovered CDW, in accordance with European applications and standards.

The study will focus on five types of CDW. The study will also compile information on the recycling sector (technologies, equipment, waste processing techniques). In addition, the study will compare the European and Mongolian standards and codes relevant to CDW recycling and re-use in order to identify gaps in Mongolian standards that should be addressed.

References:

- Ger Community Mapping Center, "Mapping Construction Waste Management in Ulaanbaatar", 2016.
- ERM, "Baseline survey on solid waste management", 2015
- Dashnyam Altantuya, Zhongrui Zhang, Haomiao Li, "Municipal solid waste management of Mongolia: Analysis on the solid waste treatment of Ulaanbaatar city", AASS, Vol. 3, No. 3, pp. 695-697, 2012
- "Rapid Sector Assessment, Operations Evaluation Department "Mongolia: Urban Development Sector", October 2008
- Lkhagvadorj O., Och N., Ulaankhuukhen M., "Supply of raw materials in Mongolia", Caritas Czech Republic, 2012
- JAPAN INTERNATIONAL COOPERATION AGENCY (JICA) Project Team for SWM in Ulaanbaatar City, "Strengthening the Capacity for Solid Waste Management in Ulaanbaatar City", Final Report, 2012
- JAPAN INTERNATIONAL COOPERATION AGENCY (JICA). Ulaanbaatar city, Mongolia, "Guidelines on how to conduct proper landfill operations at NEDS", 2010
- Report on the assessment of asbestos use in Mongolia. MOH, WHO, HSUM, 2010
- Wu, Z., Ann, T.W., Yu, L.S., Liu, G., 2014. Quantifying construction and demolition waste: an analytical review. Waste Manag. 34 (9), 1683e1692.
- Shen, L.Y., Tam, W.Y.V., 2002. Implementing of environmental management in the Hong Kong construction industry. International Journal of Project Management 20 (7), 535–543.
- Hussin, J., Abdul Rahman, I., Hameed Memon, A., 2013. The way forward in sustainable construction: issues and challenges. Int. J. Adv. Appl. Sci. 2 (1), 15e24.
- Coelho, A., de Brito, J., 2013. Environmental analysis of a construction and demolition waste recycling plant in Portugal - Part II: environmental sensitivity analysis. Waste Manag. 33, 147e161.
- Hao, J., Hills, M., Tam, W., 2010. Dynamic modelling of construction and demolition waste management processes an empirical study in Shenzhen China. Eng. Constr. Archit. Manag. 17 (5), 476e492.
- Tam, V., 2009. Comparing the implementation of concrete recycling in the Australian and Japanese construction industries. J. Clean. Prod. 17 (7), 688e702.
- Kourmpanis B. et al.,2008. Preliminary study for the management of construction and demolition waste. Waste Management & Research 26, 267e275.

ANNEX: FIELD VISIT

TU DELFT-RESEARCHER VISIT (FIELD VISIT FOR THE BASELINE STUDY)

Project: "Improving the resource-efficiency and cleaner production in the Mongolian construction sector through materials recovery" project

Date: 18th April – 3rd June 2016

Prepared by: Tommaso Troiani

Description: 7 weeks of field trip was planned for Tommaso Troiani - Researcher from the TU Delft in Mongolia.

Week 1	Activity	Purpose	Main findings
18/April	Individual meetings with 16 professors of different departments of School of Civil Engineering and Architecture (SCEA), MUST	To study and gain an understanding of the academic situations of construction waste management and recycling	• Understanding of the academic situation • Waste studies in MUST • Level of integration with industries • General overview of C&D waste • Main standards used in construction • Common practices with dealing with C&D waste • Main problems related to C&D waste recycling
19/April			
20/April	Round Table Discussion has been conducted with these professors to summarize the individual meetings	To present the main findings of the interviews and create a common perspective regarding C&D problem and role of the MUST university	• Waste management in Mongolia and in the Netherlands • Legal framework in Mongolia for C&D waste • Role of MUST in creating a new curriculum of C&D waste
21/April	Meeting in MNRA headquarters and meeting with MNRA staff and 4 industrial members of MNRA	Knowing the Recycling sector in Mongolia and assessing the problems of recycling companies	• Information regarding MNRA members and organization • Problems regarding recycling sector • Production and process of several recycling products (plastic, glass)
21/April	Meeting with MDA	Understanding demolition process and main gaps in legislation	• Demolition process used in Mongolia • Lack of norms regarding safe demolition • Role of MDA in creating new standards and certificate for demolition
22/April	New meeting with MDA members	New information about the demolition process and meeting with new members	• No sorting of C&D waste • Situation regarding hazardous waste • Situation regarding illegal and legal landfills
22/April	Site visit of Tsagaan davaa landfill together with MNRA members	Understand the real situation regarding landfill and interview manager of the landfill site	• Situation regarding waste delivery • Situation of waste scavengers • Getting data of waste delivered during last years

Week 2	Activity	Purpose	Main findings
25/April	Meeting with Ministry of Environment and Tourism (Officer Tulga)	To study the legal environment of the construction sector and its waste management situation	• Regulations about C&D waste • Sanctions for illegal waste • Inspection agencies in Mongolia • Incentives for recycling industries and their problem to access funding • Future strategy for C&D waste regulations
25/April	Ministry of Construction and Urban development (Senior officer Enkhtuya)		• Database for construction activities and problems to find exact data • Number of new constructions approved by the government • Regulations about demolition and hazardous materials • Level of coordination among different stakeholders (industries, universities and government)
25/April	Meeting with Inspection agency officer		• Number of inspections • Type of inspections in Construction sites and sanctions • Number of workers performing inspections
26/April	Meeting Municipality (Planning and research department officer - Dalanjargal)		• No collaboration because an official statement was missing
26/April	Meeting with Construction development center (Vice director Gantulga)		• Main standards followed in construction • Documents necessary to have permission to built • Main categorization of buildings type
27/April	Meeting with MNRA – Byambasaikhan (Project partner)		• Ekopark project in Ulaanbaatar • History of the recycling industry in Mongolia • Actual situation in Mongolia regarding C&D waste • Demolition practices • Ger districts renovation
27/April	Meeting with Tuul river basin's authority (Head of Water management and planning department-Myagmar)		• Main areas of illegal waste • Photos of the illegal landfill sites
28/April	Meeting with Songinokhairkhan district (environment inspector) Khan-uul district (environment inspector)		• Introduction to districts and waste situation • Cost scheme for companies for waste transportation • Number and information regarding collection points • Data regarding an on-going construction project
29/April	Conference at MUST regarding Concrete production	Attending conference at MUST university	• Presentation from UN, Municipality of Mongolia
29/April	Round table with public sector representatives		• Introduction of partners • Representatives have exchanged opinions and expressed support to the project.

Week 3	Activity	Purpose	Main findings
02/May	Meeting with Ger Mapping Center	Arrange the study for illegal landfill in Mongolia	• A study about Illegal landfills started • A report was decided
03/May	Meeting at the Institute of Engineering and Technology (Director – Sergelen and other MDA members)	Visit the school and its laboratories	• Curriculum of students regarding demolition • School information and its link with MUST • Visits of laboratory
03/May	Visit of "Talst" LLC block factory (small recycling activity in the factory and site visit - Director Bold)	Understand the recycling process of Block Factory	• Process of recycling • Quantities produced every year • Technologies used in the production
03/May	Meeting with Building material manufacturer's association (Executive director-Lkhagvadorj)	Understanding of construction materials market	• Construction industry main information • Information about Concrete and Brick material • Permit to produce
03/May	Meeting with Barilga.mn	Discussing the retail market	• Information about the construction sector • Number of companies operating in construction sector • Opportunities for recycling sector and main obstacles
04/May	Meeting with "Khungun beton" LLC (Manager Batchimeg)	Obtaining information about construction activities and practices on site	• Gantt diagram of main activities at a construction site • Data about concrete production • Further development of Ger Area
04/May	Meeting with Health and social policy institute (Director Nyamdorj)	Discussing the activity of the institute and present the Project	• Illegal waste information • Social media characteristics for public awareness
06/May	Round table with the private sector and Professional associations' representatives	Sharing information and increase the private sector's willingness to collaborate in project	• Knowledge sharing • Enforce relations with the private sector
06/May	Second meeting with Ministry of Construction and Urban development (Senior officer Enkhtuya)	Developing data tables for buildings information and creating a collaboration for data gathering	• More information about buildings types • Strategy for data gathering of building information useful to calculate MFA

Week 4	Activity	Purpose	Main findings
09/May-13/May	Several important events were organized: • Steering committee meeting with the main partners of the project • Workshop with MUST-SCEA professors and TU Delft (To introduce MOOC, exchange information and discuss future cooperation) • Workshop with MDA (To introduce MOOC, exchange information and discuss future cooperation) • Official Opening Ceremony of the project (key stakeholders and main partners participated) • Site visit to the construction site and waste landfill		• To organize all project partners first official meeting to discuss the activity plan • To introduce the project outcomes for MUST and exchange opinions on the future cooperation with MUST and TUD • To introduce the project outcomes for MDA and exchange opinions on the future cooperation with MDA and TUD • An official launch of the project and introduce to the key stakeholders of the project

Week 5	Activity	Purpose	Main findings
17/May	Meeting with MNRA team member	Defining the survey to Recycling companies and the outline of the report	• Survey to Recycling companies • Survey to Collection points • Deadlines were fixed
18/May	Third meeting with Ministry of Construction and Urban development (Senior officer Enkhtuya)	Discuss the cooperation with the project	• From CCR prepared the draft MoU and waiting for feedback from the Ministry (waiting due to the government changes)
18/May	Meeting with a Demolition Company	Understand the practices in a demolition site	• Process to win a tender • Number of people usually working on site • Type of equipment used for demolition • Level of expertise required by the company
20/May	Meeting with Builder's Association (President-Batbaatar)	Presenting the Project and asking for collaboration regarding Survey on construction companies	• The survey on construction companies • Information about Mongolian Builders' Association active members • Planning on the survey process

Week 6	Activity	Purpose	Main findings
23/May - 27/May	Field trip to Umnu-Gobi aimag • Khanbodg soum (meetings with Officer Erkhembayar of Urban Development Department and Nekhiit-Head of citizen's representatives' khural) • Tsogtstsetsii soum (Orgilmaa-Head of environment and tourism) • Urban development department of Dalanzadgad • Builders association of Dalanzadgad • Site visit to Dalanzadgad landfill, brick factory and several construction sites	As one of the target area of the project, Umnugobi aimag situation had to be studied and so organized field trip.	Gained more detailed information on the situation in Umnugobi aimag. The representatives of the public and private sector was pleased to cooperate with the project and understands the need. Provided the information of the construction companies and material producers.

Week 7	Activity	Purpose	Main findings
30/May-31/May	Internal meeting with CCR	Defining all activities to be conducted	
02/June	Second meeting with Construction Development Centre	Obtaining more information about Buildings type and researches already done by CDC	• List of buildings to be demolished • Standards for demolition • Information about construction techniques
03/June	Conference at MUST	Sharing information about the project and increase awareness	

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