The Case Study of Life Cycle Perspective in Ready-mix Industry

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Abstract

ASEAN Economic Community (AEC) is a global commitment and has been started since December 2015. Globalization encourages countries to develop their own environment voices as environment has been also a global issue. Infrastructure is one of the key developments. Construction, which is an important part of infrastructure development depends heavily on the concrete industry. Ready-mix concrete is preferred material for construction because it has a good quality, ready to use, and cheaper. The thirty mega construction projects which have to be completed in 2019 will push ready-mix concrete industries to grow fast. This grow will undoubtedly have an impact on the environment.The purpose of this study is to observe the environmental impact of ready-mix concrete industry . This will cover an observation of life cycle perspective implementation, identification of the main potential environmental impacts and risks, identification of control and influence, and identification of the potential improvement opportunities. This study will hopefully contribute to the improvement of environmental awareness and stimulate more exhaustive research or study about environmental impact in Ready-mix concrete industry in the future. The method of this qualitative study is site observation and indirect investigation which included 15 plants at multiple locations. This study also addressed idea(s) around the understanding of life cycle perspective approach as described in the newest version of ISO 14001-2015 and ISO 14004-2016.

Keywords: *life cycle perspective, ready-mix industry*

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1. INTRODUCTION

ASEAN Economic Community (AEC) has been implemented since December 2015. Now, Indonesia is part of the global economic. Darmin said that infrastructure development is an option for competitiveness. Therefore, thirty mega projects have been defined for infrastructures such as toll road, train rail, Jakarta MRT, port ship, 35,000 MW power plants, inland water way, light rail transit, national capital integrated coastal development, Jakarta waste treatment system, Semarang drinking water supply, oil refinery, Palapa ring broadband[1]. Consequently, construction industry will also have high growth. The association of construction industries (Gapensi) estimates that construction sector will contribute about up to 16% in local gross revenues of 2016. Besides, construction industry will also be supported by property growth, which is estimated at 8 - 9 % in 2016[2].

Construction depends on concrete. Considering the growth of construction, property, and also the upcoming 30 government mega projects, ready-mixed concrete (RMC) will play significant roles and grow rapidly. RMC has an advantage of speed, big volume, customization, consistent quality, and cost reduction at the final result. Because of the nature of material, the manufacture of RMC is undertaken at plants close to the delivery site such as a city, real estate, and industrial estate.

Ready-mixed concrete is the concrete that is made at concrete batching plants and delivered to site in truck mixers. This concrete is ready to use at site without any treatment. The materials used in the manufacture of ready-mixed concrete are aggregates (coarse crushed rock or gravel aggregate and sand), cement including combinations of Portland cement and addition such as GGBS (from iron and steel manufacture) or fly ash from coal-fired power stations, water, chemicals admixtures such as water reducing, plasticizing, air entrainment agents and viscosity modifying productsô polymer or steel fibers to give specific properties [3]. Fly ash is also used as alternative material. Fly ash is a fine, glass-like powder recovered from gas created by coal-fired electric power generation. Fly ash increases concrete strength, improves sulfate resistance, decreases permeability, reduces the water ratio required, and improves the pump ability and workability of concrete [4]. Based on Indonesian regulation PPRI No. 101/2014, fly ash is categorized as hazardous waste. These shown that RMC has advantages as a basic material for construction and media to utilize fly ashð hazardous waste created from coal-fired power plant.

Beside those advantages, RMC has also environmental impacts. The most visible impact is dust. Dust is released from raw materials delivery, raw materials unloading and open dumping storage, raw material transport and weighing, returned concrete, and material or concrete spill. Lack of proper air quality management can be a source of community complaints and non-complaint at RMC plant sites. Particulate matter emissions to air, also known as dust emissions, are the major air quality concern at the ready mix plant site. The principal regulatory concern is the release of particulate matter (dust), particularly the size fraction known as ñparticulate matter less than 10 microns in diameterò which is called ñPM_{10}ò. These very small particles can pose a health and safety risk to persons who may breathe these particles [5]. Water usage is also the environmental issue, which comes from production, dust control, cleaning equipment and transport vehicles. Water usage has potential inefficiency and shortage resources. External water supply is enable to be procured but it will increase the carbon emission from delivery. Inefficient water usage has impact to wastewater which potentially a high pH runoff to waterways or land.

Doing good environmental management, instead of improving environmental performances and compliance regulations, could prevent community complaints. Especially these days, regulations seem increasingly stringent. Related with construction, there are regulations about Green Building, e.g. Permenlh No. 8/2010, Pergub Prov DKI Jakarta No. 38/2012, and Permenpupr No. 02/PRT/M/2015. The global policy formulated in Sustainable Development Goals (SDGs) may drive to determine green procurement requiring eco-labeled products and service.

In Indonesia, lots of infrastructure and constructions projects have been started. Big business opportunities have opened up. On the other hand, environmental and sustainable development requirements have been increasingly stringent. Environment has become an international issue and appeared as one of Sustainable Developmentôs pillars. Many standards are established internationally. The most comprehensive and international recognized standard about environmental management is ISO 14001 Environmental Management System (EMS). Since firstly established in 1996, this standard has been revised twice. The latest one is ISO 14001:2015[6]. One of requirements is about life cycle perspective approach in evaluating environmental aspects and impacts and taking action to addressed associated risks and opportunities. These are conducted to achieve intended outcomes improving performance in environmental management. Since the customers of RMC industry will be the global community, the important issue is about how RMC industries implement life cycle perspective to have a sound environment policy.

Many countries have researched and developed guidelines about RMC industryôs environmental impacts. New Zealand has License Criteria for Ready Mixed Concrete that is established in 2010. British Ready-Mixed Concrete Association (BRMCA) makes a consensus on Ready-Mixed Concrete Resource Efficiency Action Plan in 2014. USA through National Ready-Mixed Concrete Association (NRMCA) determined Sustainable Concrete Plant Guidelines in 2011. From East Mediterranean country there is a research about Evaluation of Environmental Requirements for Sustainable Ready-Mixed Concrete Production in Abu Dhabi Emirate in 2010. Japan has research in 2005 about Advanced Concrete Recycling Technology and Its Application. In Indonesia, there is not yet any standard or research about environmental impacts in RMC industry. Hopefully this research can raise awareness and motivate future research about the environmental impacts of RMC industry.

This research is conducted at RMC industry with the following objectives.

a. To observe the implementation of life cycle perspective
b. To identify the main potential environmental impacts and risks
c. To identify the extent of control and influence
d. To identify the potential improvement opportunities.

2. METHODS

The method of this qualitative study is site observation and indirect investigation. The site observation was conducted at one ready-mix concrete plant nearby Jakarta. The indirect investigation drew experience and field notes from performance assessment visits at various ready-mix concrete plants. The researcher of this study happened to be an assessor for various company performances.

Site observation was conducted at one operating ready-mix concrete plant nearby Jakarta. The researcher talked to Technical Manager and interviewed HR & GA Manager and staff with questions around processes, raw materials, recycle, reuse, dust handling, wastewater handling, control and influence activities. In addition, the researcher explored the plant area to witness the operation of material management, process planning, ready-mix concrete processing, transportation and delivery, infrastructure, and site management.

Indirect investigation considered previous experiences and assessorôs field notes. The researcher had been assessing 14 companies during seven years. The field notes covered observation of overall performance, planning, problematic cases, anomalies, performance incident, conformity and nonconformity, control, and onsite activities.

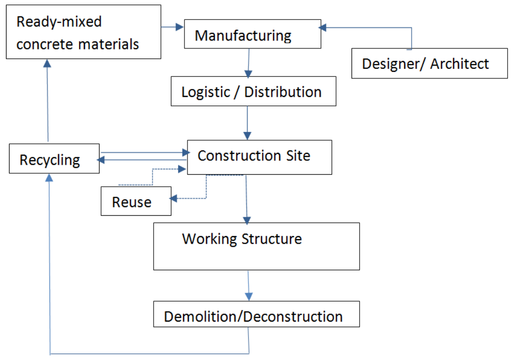

Fig. 1. A scheme of the supply chain for ready-mix concrete products [3]

Fig. 1 illustrates the main features of the supply chain for ready-mix concrete. This diagrams collectively outlines the primary routes to the market for ready-mix concrete and where some of the resource efficiency opportunities lie [3].

This study addressed idea(s) around the understanding of life cycle perspective approach as described in the newest version of ISO 14001-2015. ñWhen determining environmental aspects, the organization considers a life cycle perspective. This does not require a detailed life cycle assessment; thinking carefully about the life cycle stages that can be controlled or influenced by the organization is sufficient. Typical stages of a product (or service) life cycle include raw material acquisition, design, production, transportation/delivery, use, end-of-life treatment and final disposal. The life cycle stages that are applicable will vary depending on the activity, product or service.ò

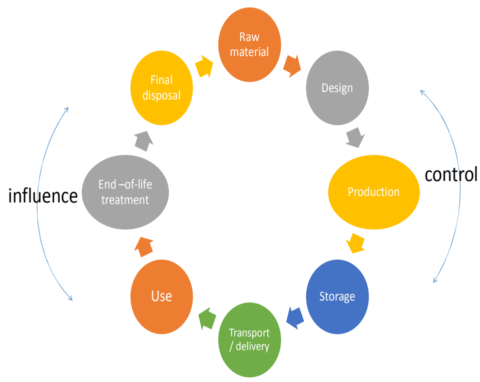

Fig. 2. Schematic of the life cycle perspective in ISO 14001:2015

Fig. 2 draws life cycle perspective understanding as described in ISO 14001-2015. To understanding about control and influence, ISO 14004-2016 provide guideline in detail. "The degree of control it has over the life cycle stages, e.g. a product designer may be responsible for raw material selection, whereas a manufacturer may only be responsible for reducing raw material use and minimizing process waste and the user may only be responsible for use and disposal of the product. The degree of influence it has over the life cycle, e.g. the designer may only influence the manufacturer production methods, whereas the manufacturer may also influence the design and the way the product is used or its method of disposal. The organization can consider those stages in the life cycle over which it has the greatest control or influence, as these may offer the greatest opportunity to reduce resource use and minimize pollution or waste" [7].

Mainstream qualitative methodologists, by contrast, fit more comfortably into a cause-of-effects template, in particular, explaining the outcome of a particular case or a few cases. They do not look for net effect of a cause cover a large number of cases, but rather how causes interact in the context of a particular context of a few cases to produce an outcome. The causes-of-effects approach a second-best strategy to be followed when circumstances do not allow the use of quantitative methods [8].

3. RESULTS AND DISCUSSION

This qualitative study presented and discussed data as two cases. Case A described the results from site observation at Company XY located nearby Jakarta. This company now is the third year of operation. As the manager explained, this company was established by following the best practice ways in ready-mix concrete industry. Case B presented the researcher's perspective of previously assessed 14 ready-mix concrete plants in multiple locations. These ready-mix plants had various time establishment; one plant with newest lay out and building design was established in 2009.

In this section, first, this qualitative study described the typical life cycle stages of ready-mix concrete plant which was observed in Case A and Case B. Second, data included cases associated with dust, water, wastewater, and solid wastes were presented and discussed. Discussion covered analysis of possible causes, control, influence, risks, and opportunities for improvements.

3.1. Life Cycle Stages of Ready-mix Plant

Life cycle stages of ready-mix plant were observed from Case A and Case B. The materials used in the manufacture of ready-mixed concrete were aggregates (coarse crushed rock or gravel aggregate and sand), cement, fly ash from coal-fired power stations, water, and chemicals admixtures or additives. Aggregate was piles out door. Cement and fly ash were stored in silos. Chemical additives and water were stored in tanks. During operation, aggregate was transported by conveyor to weighing and batching. Cement, fly ash, chemical additives and water were piping. In wet process, batching and mixing in one process then concrete was filled into trucks. In dry process, all materials were batching and mixing in truck mix. Either wet or dry process, their process was completed with dust release control. After QC pass, concrete was delivered to project sites. When return from the project sites, truck mix sometimes brought returned concrete. Before washed by using recycled water, truck mix was cleaned up from returned concrete.

Table 1. Data from Two Separated Case A and Case B

No.	Study's object	Case A	Case B
1	Plant's number	One (1)	Fourteen (14)
2	Location	Nearby Jakarta	Jakarta and other city
3	Operation year	Third year	More than third year, one (1) plant was a new design in 2009
4	Dust release sources and dust control equipment	From batching/mixing, driveways, material piles, control by using water spray. Dust was released during its batching/mixing operation. Water sprinkle was not installed at material piles.	From batching/mixing, driveways, material piles, control by using dust collector, bag filter, water sprinkle, fixed verticl holed pipe. More than three (3) plants had dust release during their batching/mixing operation.
5	Water sources	Ground water, external water provider, recycled water which was traeted mix with rain water	Ground water, external water provider, recycled water which was treated with rain water, one (1) plant directly collected rain water from the roof
6	Water usage	Ground water mixed external water provided for process and truck mix washing, recycled water mixed with rain water for watering driveways and living plants	Ground water or external water provided for process, recycled water (mixed with rain water) for washing truck mix, watering driveways and living plants, recycled water was used for process in certain portion. One (1) plant could reduce ground water usage from 450 liter/m^3 of concrete to 260 liter/m^3 concrete.

Table 1. Data from Two Separated Case A and Case B (Contôd)

	Wastewater	Separated with solid waste to be recycled water	Separated with solid waste to be recycled water, two (2) plantôs wastewater was over limit pH, one (1) plant made by pass drained, more than three (3) plants had over flow/insufficient setting pond capacity and released wastewater to public ditch
7	Solid waste	Sediment waste from settling pond, material spill returned concrete	Sediment waste from settling pond, material spill, returned concrete
8	Space management	It had been re-lay out during visit. Parking areas were not clearly designated and transporter trucks were parked at several places such as nearby the waste water settling pond.	Several plants had no clear parking areas, pedestrian route, insufficient settling pond capacity
9	Control	All production stages and transportation	All production stages and transportation
10	Influence	Users project sites and reuse of returned concrete and sediment waste	Users project sites and reuse of returned concrete and sediment waste. Consultant for developing UKL/UPL Report

Fig. 3 presented typical life cycle stages of Ready-mix plants, which was observed from this qualitative study. It shows four main environmental impacts, namely dust released, water usage, wastewater, and solid wastes. Recycling was conducted for wastewater. Dust released from material piles (e.g. sand, split, aggregate) was mostly controlled by operating water sprinkle. Dust released from batching/mixing had been controlled by dust collector, bag filter, or water spray. Collected dust was piled together with sediment deposit. Sediment waste and concrete waste or returned concrete were reused by plant itself or community. In Case A, plant had concrete recycling machine but it was not feasible to be operated. Water sources were groundwater, external provided water, recycled water, and rain water. Recycled water was the result of waste water treatment at settling pond. Wastewater mostly came from transportation vehicleôs washing. Rainwater also flew to the settling pond through driveways and drainage. It was treated together with wastewater become recycled water. There was one plant of Case B, which already collected rain water from the roof to rainwater reservoir.

3.2. Dust

All plants that were observed in this study had been aware about dust as the most environmental issue and they already installed dust control equipment. In Case A, water spray was operated to control dust but dust was still released during batching/mixing process in loading dock. In Case B, one plant operated dust collector during batching/mixing process but dust was still released while one other plant did not operated dust collector because of under repair.

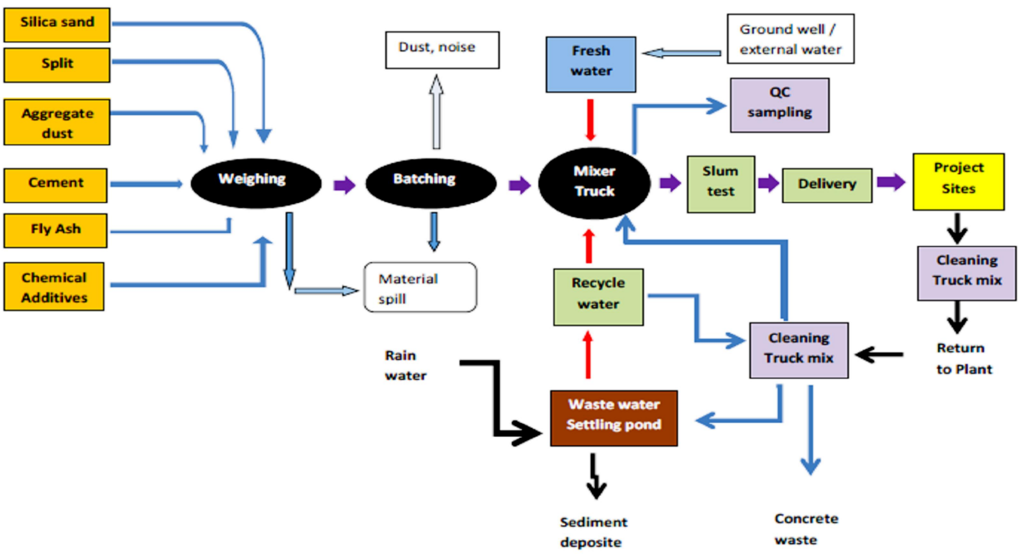

Fig. 3. General life cycle stages of Ready-mix plant

The operated water spray and dust collector could not absorbed and exhausted dust may because of their specification, installation, and or maintenance. Specification related with proper capacity to absorb or exhausted dust. If the capacity was under requirement then the excess dust was released. In Case B, one plant used fixed vertical holed pipe to water dust from coarse aggregate piles. This was an example about dust control capacity limitation that is unable to water all dust release because the fixed vertical holed pipe could not swing around. Installation was about precision position to optimally absorb or exhaust dust. A small opening may cause dust release in small amount at the beginning but then because of the dust pressure, the opening became bigger and bigger. Maintenance program consist of cleaning, resetting, and repairing. Incomplete and incomprehensive maintenance program may cause equipment problem. Sometime, maintenance program had to be rescheduled because of production activity. Delaying even skipping maintenance program caused problems to those dust control equipment such as broken down. When dust collector under repaired there should be a backup unit. It was not allowed to conduct batching/mixing process without adjust controller. The other factor that cause dust control problems was human or people factor. People were important as they were subjects to select, decide, operate, maintain and evaluate the dust control equipment. Bad equipment condition may cause bad maintenance and this may relate with bad peopleȇs competence. People may gain awareness from training, experience, and education. Sometime people were competent but they may not care. In Case A, people did not install water sprinkle to control dust from the materials piles during relay out. In Case A, people were experienced in implementing ISO 14001 therefore they were competent enough. Frequently now, people talk about human behavior. As expected behavior could not stand by themselves, system, infrastructure and supervision should complement and caring people.

Environmental impact of dust release was air pollution. Polluted air covered the plant site and surrounding outside the plant. Visible dust release may happen in shortly and then diluted by air and blown by the wind to far away places. Dust was also recognized to cause human respiratory disease. When impact was direct to human, it may risk gaining community or peopleȇs complaint. Compliance to obligation and company reputation are also at risk. At some places, the risk also brought consequence to finance, for example the cost of research, and hospitalization.

For the sustainable business, the environmental impacts and the risks had to be addressed. Opportunities of improvement had to be made, for example: providing proper dust controlȇs capacity, proper installation, comprehensive maintenance program, back up dust control, and suitable trainings. In this way, RMC plant could control operation to minimize environmental impacts because of dust release.

3.3. Water

Water was only around 18% in the proportion of ready-mix concrete formula. Even though this is a small amount, water was critical to manufacture concrete. Most ready-mix plants used groundwater for production. In Case B, one plant was fully supplied by external water provider. In addition, water was also used for dust control, transport vehicle washing, and plant cleaning. In Case A, groundwater was used for truck wash. In Case B, one plant consumed ground water as much as five times the allowed limit. Another plant could reduce water consumption from 450 liter/m^3 of concrete to 260 liter/m^3 concrete. In ready-mix industry, water ratio average was around 200 liter/m^3 concrete. Since there is limitation for taking groundwater and there is an increased awareness about environment, plants had also used recycled water and even rainwater for production, dust control, washing transport vehicles, plant cleaning, and watering living plants. In Case A, rainwater was collected by using wastewater drainage system. The mixture of rainwater and wastewater was flown to settling pond to separate as recycled water from the sediment waste. This case also happened in more than two plants in Case B. In Case B, one new relocated plant collected rainwater from the roof and redirected it to the rainwater reservoir.

Over usage of water consumption beyond the limit was not a law compliance practice. Usually, it was because people did not know about the law. In some situation, people understood the law but groundwater was preferred because of its cheaper price. This would reflect people's awareness about environment. Low environment awareness may also cause people to use groundwater for washing concrete trucks. As mentioned above, peopleȇs behavior was influenced by improper infrastructure, operating system, and supervision. In Case A, people used groundwater to wash truck mix. This may because there was no recycled water piping in the working area. Also, available recycled water piping was not used because there was neither direction nor supervision. Mostly, signs of clear procedure could be effective to direct people for maintaining or improving performance. In Case B, people could save water from 450 liter/m^3 to 260 liter/m^3 of concrete and then to 230 liter/m^3 because it was required by determined performance objective. When objectives were set, people looked for innovation to achieve objectives. In Case B, one plant collected rainwater from the roof to rainwater reservoir. This was not much yet implemented in industries commercial buildings, and parks maintenance.

Consuming groundwater leads to natural resource depletion. Groundwater is crucial to maintain the land surface. When groundwater was reduced significantly to leave vacuum space in the ground, then, the land surface would be lower and lower. These surface changes may affect buildings, e.g. wall crack and, inward collapses. Over extraction of groundwater in one place may cause dried groundwater at surrounding wells. Water scarcity is the risk from ready-mix plant operation.

The opportunities for improvement may require understanding related laws, environmental awareness, identified infrastructure, and standard operating system. Determining performance objectives, monitoring, reviews and evaluations were parts of operating system and control. Providing field signage was a common practice. For new, planned or modified activities, products and services should also consider environmental impacts in addition to technical and business considerations.

3.4. Wastewater

For transportation vehicles washing, plant cleaning, driveways watering, water was consumed and wastewater was released. Wastewater flew to settling pond through drainage. The treatment separated water from solid waste. Treated water was called recycled water. Recycled water was used to manufacture concrete in certain portion. The rest recycled water was used to wash transportation vehicles and plant, and watering raw material piles, driveways and living plants. In Case A, truck mix was washed by using groundwater at test slump area during testing and the wastewater flew to settling pond through nearby drainage. The other transportation vehicle washing area (e.g. raw material and solid waste transportation) was not defined. In Case B, more than five plants washed transportation vehicles by using recycled water in settling pond area. The floor of settling pond area was concrete and surface elevation was made properly enough for wastewater flowing to settling pond. In Case A, plant had no sufficient drainage and elevation system to effectively collect wastewater. As a result, there were puddles of water here and there. In Case B, more than three plants had no sufficient settling pond capacity to contain excessive wastewater and rainwater as result wastewater flow to the public ditch. Internally, the excessive wastewater formed puddles at many spots and cause damage to roads/land surface. One plant made by pass drainage to release wastewater to public ditch. Two plants had wastewater quality with over limit pH value. Regulation required pH level of 6 ï 9.

It was obvious insufficient control if there was no defined transportation vehicle washing facility in the plant. This may be caused by poor awareness and commitment, business growth without growth of land space, or space obstacle from the beginning. Space obstacle was not likely because environmental permit require adequate lay out and environmental impact management and monitoring. From my notes on environmental monitoring reports called UKL/UPL Report, there were many reports without updated data of business growth and lay out. It was likely that business growth might result in land space obstacle. In Case A, the land space obstacle did not allow defined transportation vehicle washing facility, and sufficient drainage and elevation system; it caused puddles of water at many places. In Case B, land obstacle caused the public ditch water pollution, no sufficient settling pond capacity to contain excessive wastewater and rainwater, puddles at many spots and damage roads/land surface. In Case B, insufficient control by supervision and monitoring allowed by-pass drainage to release wastewater to public ditches, and wastewater quality with over limit pH value. Most UKL/UPL Reports were prepared by external provider (i.e. Consultant). Reports presented laboratory analysis results and simple description about conformity and nonconformity laboratory results against the threshold values. Mostly there was no recommendation to take action when the nonconformity was identified, for example in case of over limit wastewater pH value. The consultant might not help to justify the proper UKL/UPL and actions. Lack awareness and supervision may also cause improper reports and actions.

The environmental impact of wastewater release was water pollution because of pH, turbidity, etc. The risks might be compliance obligation, community complaint, cost for cleaning up pollution, and plant reputation. Opportunity to improve control may about commitment, awareness, competence, supervision and monitoring. RMC plants could have more control over internal operation and external provider (i.e. Consultant).

3.5. Solid waste

Solid wastes were sediment waste and returned concrete. Sediment waste was periodically collected from the settling pond. The sediment waste may contain material spill and mud, which contaminated water for washing plant and watering driveways. The sediment was transported to waste piles. In one plant in Case A and some plants in Case B, the piles were made available for the public to collect for various usage such as landfill, sand mix, and mason mix. Returned concrete was unconsumed concrete that was carried back to ready-mix concrete facility from project sites. The returned concrete may have hardened by the time the truck arrived at the ready-mix concrete plant. Technically, this hardened concrete mix can be reprocessed by recycling engine to be reserved to raw materials. In Case A, plant had a recycling machine. However, the recycling machine operation was not feasible when there was not enough returned concrete to reverse. In Case B, more than two plants transformed returned concrete into concrete block for various purposes such as parking stopper, divider wall, and bund wall. These concrete blocks were made available to community.

Sediment waste resulted from material spill may result from improper setting or leakage of process equipment, example: conveyor rubber, weighing bucket. In Case B, more than two plants had material spill at the area of raw material convey and batching/mixing. Mud was picked by trucks and fell down to the driveways. These trucks may come from outside (e.g. raw material trucks) or move around inside. When the internal areas had many paddles and mud, the mud would be picked up by tires of trucks and fell down to contaminate water that sprayed driveways. This sediment resulted from improper infrastructure such as space management. Sediment waste may also come from external trucks. When transporting raw material from mining or manufacturing sites (e.g. aggregate, cement), external trucks may have no washing or cleaning procedure prior to delivery.

Returned concrete happened when the project had over order or the batching capacity was bigger than the quantity order. When the project had miscalculation then excessive concrete could not be applied on site, the returned concrete may be brought back to the plant as part of customer service. Another cause was possibly plant capability; returned concrete was a consequence. Returned concrete needed to be recycled as raw material; otherwise sediment waste increased. In Case A, the recycling machine was not feasible to be operated because of inadequate amount of returned concrete to reverse. Some amount of returned concrete may be used for landfill, concrete block.

Natural resource depletion was possible the environmental impact of solid waste. When raw material usage was efficient, solid waste could be reduced even eliminated. The risks related to solid waste result in increasing cost on tipping fees, and landfill bans. The opportunities of improvement could be strengthening internal control (e.g. proper setting and maintenance plant equipment, proper space management), to influence external raw material suppliers and project sites to make joint operation to recycle returned concrete or to hire a third party.

4. CONCLUSIONS

The implementation of life cycle perspective assisted ready-mix plants in determining potential main environmental impacts and risks. The main potential environmental impacts were air pollution and human respiratory disease associated with dust released, natural resource depletion associated with water and raw material consumption, water pollution associated with wastewater released. The potential risks were community or people complaint, incompliance to law, company reputation, consequence to financial investigation, hospital, and cleaning up pollution, and water scarcity.

The implementation of life cycle perspective assisted ready-mix plants in determining opportunities to improve control. They may be determined in four hierarchies such as elimination, substitution, engineering control and administrative control. Elimination control may be conducted by reducing groundwater usage to reduce wastewater and potential incompliance to law. Substitution control may cover using rainwater and recycled water. Engineering control can install dust control equipment, dust control back up, proper piping lines of recycled water and rainwater, truck washing facility, and proper capacity of wastewater settling pond. Administrative control may be implemented by providing people competent in and aware of environment and law, comprehensive maintenance program for equipment or infrastructure, field signage, procedure or standard operating system, and defined performance objectives. Administrative control may be implemented through contract agreement with Consultant in developing UKL/UPL Reports.

The implementation of life cycle perspective assisted ready-mix plants in determining opportunities to improve influence. It may be conducted at project site by eliminating returned concrete, to other plants by making joint operation, for example, to meet required production capacity and to operate joint recycling machines, and to raw material suppliers in cleaning vehicles. which is possible to meet required production capacity, to other plants or relevant parties in operating recycling machine, and to raw material suppliers in making clean vehicles.

For new, planned or modified activities, products and services, environmental impacts should be considered as early as possible by using life cycle perspective as an addition to technical and business consideration. This may include business growth. In general, a guidelines for good ready-mix concrete manufacturing or standard may be developed by Government Agency or Association to minimize and to manage environmental impacts.

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