

Impacts of Construction Activities on the Environment: The Case of Ghana

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Abstract
Construction activities impact on the environment throughout the life cycle of development. These impacts occur from initial work on-site through the construction period, operational period and to the final demolition when a building comes to an end of its life. Even though the construction period is comparatively shorter in relation to the other stages of a building's life, it has diverse significant impacts on the environment. This study investigates the major impacts of construction activities on the environment in Ghana. Thirty-three possible impacts of construction activities on the environment were identified from literature. These impacts were further categorized into nine major groups and were subjected to a cross-sectional survey. Questionnaire and interview were used to elicit the views of respondents. Questionnaires were distributed to 100 randomly selected construction practitioners made up of 58 architects, 37 quantity surveyors and 5 structural engineers registered with their professional bodies. Semi-structured interview was conducted amongst purposively selected contractors and consultants. The respondents were asked to identify the most important environmental impacts. The relative importance of the impacts identified were calculated and ranked by the relative importance index. According to the results of the study, the respondents agreed that resource consumption group impacts ranked highest among the major impacts of construction activities on the environment in Ghana. The resource consumption group impacts were raw materials consumption, electricity consumption, water consumption and fuel consumption. Biodiversity impact was second followed by local issues impacts. The paper recommends that stakeholders in the construction industry should come up with special legislations, codes or standards relating to sustainable construction practices specific to Ghana's construction environment and ensure proper and effective implementation.
Keywords: Construction Activities, Construction industry, Environment, Ghana, Impact

1.0 Introduction

Environmental deterioration has captured the world's attention and has been one of the most discussed subjects locally, nationally and globally (Bentivegna et al., 2002). Langston and Ding (2001) posited that the world is in crucial environmental catastrophe. The increase in population and the quest for development such as the built environment has resulted to ozone layer depletion, global warming, resource depletion and ecosystem destruction (ibid). This has put the built environment and the construction industry under the spotlight since its activities significantly impact on the environment.

Construction activities affect the environment throughout the life cycle of development. These impacts occur from initial work on-site through the construction period, operational period and to the final demolition when a building comes to an end of its life. Even though the construction period is comparatively shorter in relation to the other stages of a building's life, it has diverse significant effects on the environment. For that matter, there is progressively growing concern about the impact of construction activities on human and environmental health. Even though, construction project development potentially contributes to the economic and social development, and enhancing both the standard of living and the quality of life, it is also associated with deterioration of the environment (Azqueta, 1992).

The state of affairs of the construction industry in Ghana is not quite different from other developing countries. The focus of the Ghanaian construction industry is largely on economic growth and improving the quality of life of the people whilst environmental protection is utterly downgraded. The GDP released for the third quarter of 2012 by the Ghana Statistical Service, indicates that the construction industry contributed 19.2% to the economy. Accordingly, the construction industry was the second largest sector in the Ghanaian economy illustrating its contribution to the social and economic gains whilst its negative contribution to the environment is absolutely neglected. In spite of the social and economic gains, construction activities extend beyond the erection of houses, hospitals, schools, offices and factories to civil engineering works such as roads, bridges and communication infrastructure which support the economy. In meeting these demands, the Ghanaian construction industry exerts enormous pressures on global natural resources. The environmental significance of such pressures comes into play when some of these resources are depletable and non-renewable, bringing the construction industry in direct conflict with the physical environment. Moreover, in spite of the benefits of the construction industry, unsustainable design and construction processes as well as constant degradation of the environment for construction purposes exist in Ghana (Dadzie & Dzokoto, 2013). It is against this backdrop that investigating the major impacts of construction activities on the environment in Ghana and recommending measures to minimize the impacts assume great importance.

1.1 Objective of the Study

The main objective of this study is to identify the major impacts of construction activities on the environment in Ghana. The study sought to identify the perceptions of practitioners (architects, quantity surveyors and structural engineers), consultants and contractors regarding the impacts of construction activities on the environment in Ghana and to suggest possible ways of minimizing the impacts.

2.0 Literature Review

The construction industry has a significant irreversible impact on the environment across a broad spectrum of its activities during the off-site, on site and operational activities, which alter ecological integrity (Uher, 1999). According to Levin (1997), buildings are very large contributors to environmental deterioration. It is clear that actions are needed to make the built environment and construction activities more sustainable (Hill & Bowen, 1997; Barret et al., 1999; Cole, 1999; Holmes & Hudson, 2000; Morel et al., 2001; Scheuer et al., 2003). Therefore the analysis of the impact of the construction activities on the environment may need to look at a “cradle to grave” view point (Ofori et al., 2000).

The construction industry is one of the largest exploiters of both renewable and non-renewable natural resources (Spence &Mulligan, 1995; Curwell & Cooper, 1998; Uher, 1999). It relies heavily on the natural environment for the supply of raw materials such as timber, sand and aggregates for the building process. According to World watch institute (2003), building construction consumes 40 percent of the world’s raw stones, gravel and sand and 25 percent of the virgin wood per year. It also consumes 40 percent of the energy and 16 percent of water annually. In Europe, the Austrian construction industry has about 50 percent of material turnover induced by the society as a whole per year (Rohracher, 2001) and 44 percent in Sweden (Sterner, 2002). The extraction of natural resources causes irreversible changes to the natural environment of the countryside and coastal areas, both from an ecological and a scenic point of view (Curwell & Cooper, 1998; Ofori & Chan, 1998; Langford et al., 1999). The subsequent transfer of these areas into geographically dispersed sites not only leads to further consumption of energy, but also increases the amount of particulate matter in the atmosphere.

Raw materials extraction and construction activities also contribute to the accumulation of pollutants in the atmosphere. According to Levin (1997), in the USA construction is responsible for 40 percent of atmospheric emissions, 20 percent of water effluents and 13 percent of other releases. Dust and other emission include some toxic substances such as nitrogen and sulphur oxides. They are released during the production and transportation of materials as well as from site activities and have caused serious threat to the natural environment (Spence & Mulligan, 1995; Ofori & Chan, 1998; Rohracher, 2001). Other harmful materials, such as chlorofluorocarbons (CFCs), are used in insulation, air conditioning, refrigeration plants and fire-fighting systems and have seriously depleted the ozone layer (Clough, 1994; Langford et al., 1999).

Pollutants have also been released into the biosphere causing serious land and water contamination, frequently due to on-site negligence resulting in toxic spillages which are then washed into underground aquatic systems and reservoirs (Kein et al., 1999). According to Langford et al (1999), about one third of the world’s land is being degraded and pollutants are depleting environmental quality, interfering with the environment’s capacity to provide a naturally balanced ecosystem.

A large volume of waste results from the production, transportation and use of materials (Ofori & Chan, 1998; Kein et al., 1999). It should be noted that construction activities contribute approximately 29 percent of waste in the USA, more than 50 percent in the UK and 20-30 percent in Australia (Teo & Loosemore, 2001). According to Levin (1997), in the USA construction contributes 25 percent of solid waste generation. In the European Union, the construction industry contributes about 40-50 percent of wastes on per year (Sjostrom & Bakens, 1999; Sterner, 2002). Most construction waste is unnecessary (Sterner, 2002). He added that many construction and demolition materials have a high potential for recycle and reuse. Nevertheless, screening, checking and handling construction waste for recycling are time consuming activities and the lack of environmental awareness amongst building professionals may create significant barriers to the usefulness of recycling (Langston & Ding, 1997). The depletion of natural resources by the building industry is a topic of serious discussion as most of the recyclable material from building sites ends up in landfill sites. Sterner (2002) stated that implementing a waste management plan during the planning and design stages can reduce waste on-site by 15 percent, and delivers cost savings of up to 50 percent on waste handling.

Besides generating waste, building activities also irreversibly transforms arable lands into physical assets such as buildings, roads, dams or other civil engineering projects (Spence & Mulligan, 1995; Langford et al., 1999; Uher, 1999). According to Langford et al. (1999), about 7 percent of the world's cropland was lost between 1980 and 1990. Arable land is also lost through quarrying and mining the raw materials used in construction. Construction also contributes to the loss of forests through the timber used in building and in providing energy for manufacturing building materials. Both deforestation and the burning of fossil fuels contribute directly to global warming and air pollution. In addition, building industry considered to be a major consumer of energy and the use of finite fossil fuel resources for this purpose have contributed significantly to carbon dioxide emissions (Clough, 1994; Spence & Mulligan, 1995; Ofori & Chan, 1998; Langford et al., Uher, 1999). In Europe, construction activities have consumed about 40 percent of total energy production (Sjostrom & Bakens, 1999; Rohracher, 2001; Sterner, 2002).

2.1 Identification of Environmental Impacts of Construction Activities

According to Chen et al. (2000), sources of pollution and hazards from construction activities can be divided into seven major types: dust, harmful gases, noises, solid and liquid wastes, fallen objects, ground movements and others. Chen et al. (2005) considered construction impacts under eight categories: soil and ground contamination, underground water contamination, construction and demolition waste, noise and vibration, dust, hazardous emissions and odours, wildlife and natural features impacts and archaeology impacts. On the other hand, Cole (2000) stated that the environmental impacts of the construction process embrace resource uses, ecological loadings and human health issues. March (1992) observed the construction industry's environmental impacts under the categories of ecology, landscape, traffic, water, energy, timber consumption, noise, dust, sewage, and health and safety hazards. Shen and Tam (2002) classified construction environmental impacts as the extraction of environmental resources such as fossil fuels and minerals; extending consumption of generic resources namely: land, water, air, and energy; the production of waste that require the consumption of land for disposal; and pollution of the living environment with noise, odours, dust, vibrations, chemical and particulate emissions, and solid and sanitary waste. According to Cardoso (2005), typical negative impacts of the construction activities include waste production, mud, dust, soil and water contamination and damage to public drainage systems, destruction of plants, visual impact, noise, traffic increase and parking space shortage and damage to public space.

From the review above, it is apparent that there is no single approach regarding the environmental impacts associated with the construction process in the literature. Eco-Management and Audit Scheme (EMAS) regulation (Gangollels, n.d.) provides a standardized and comprehensive list of environmental aspects covering almost all the previous mentioned environmental aspects. So finally, guidance provided in EMAS regulation was used to initially identify generic environmental impacts: (1) emissions to air, (2) releases to water, (3) avoidance, recycling, reuse, transportation and disposal of solid and other wastes, particularly hazardous wastes, (4) use and contamination of land, (5) use of natural resources and raw materials (including energy), (6) local issues (noise, vibration, odour, dust, visual appearance, etc.), (7) transport issues, (8) risks of environmental accidents and impacts arising, or likely to arise, as consequences of incidents, accidents and potential emergency situations and (9) effects on biodiversity. However, environmental impacts coming from EMAS regulation had to be customized to the construction processes and for this reason an exhaustive preliminary analysis with a process-oriented approach (Zobel & Burman, 2004) was carried out. Environmental impacts provided in EMAS regulation were analysed for the entire construction process.

3.0 Research Approach

The study adopted the concurrent mixed study design (Quantitative and Qualitative). Quantitative research investigates facts and tries to establish relationships between these facts. While qualitative research is a subjective assessment of a situation or problem, and takes the form of an opinion, view, perception or attitude towards objects. A combination of quantitative and qualitative approach is advocated because it takes advantage of the strengths in the two approaches while limiting the weaknesses. Quantitative study of human phenomena can only give frequencies of occurrences of certain observable manifestations of the phenomena without explaining why they occur. Therefore it is important to also adopt a qualitative research paradigm to compensate for the limitations of using quantitative approach for a study.

3.1 Sample selection

Three categories of practitioners within the construction industry were chosen for the quantitative study which included architects, quantity surveyors and structural engineers. The study design led to a choice of only practitioners who are members of their various professional bodies thereby giving a research population of Architects, Quantity surveyors and Structural engineers who are members of their respective professional bodies i.e. Ghana institution of architects, Ghana institution of surveyors and Ghana institution of engineers. Stratified sampling procedure was applied to generate the sample for the study. Simple random sampling was further used to select practitioners from the various professional groups. A sample size of 100 practitioners from the total population of 413 practitioners registered with their professional bodies was determined for the questionnaire survey using the formula proposed by Yamane (1967) as follows: $n= N/1+N (e)^2$, Where N = the total population size; e = the standard error of sampling distribution assumed to be 0.013 and n is the sample size. Purposive sampling was used to select 18 contractors and 16 consultants for the qualitative study.

3.2 Data Collection

The data collection process involved two stages. The first stage consisted of literature search for information on the impacts of construction activities on the environment in other countries and interview of some experts involved in the implementation process. The purpose of interviewing the experts was essentially to validate a preliminary set of impacts of construction activities on the environment gleaned from the literature and to determine from their experience other impacts of construction activities on the environment in Ghana.

The first phase resulted in the identification of thirty-three (33) impacts of construction activities on the environment. The second stage involved the development of questionnaire incorporating the 33 impacts of construction activities on the environment identified in the literature reviewed. The questionnaire was organised in the form of an importance scale (i.e. 4 = 'highly important', 3 = 'very important', 2 = 'important', 1 = 'not important'). Respondents were then asked to indicate by ticking a column, the relative importance of each of the impacts of construction activities on the environment. A total of 100 questionnaires were personally distributed by the researchers to respondents in the Greater Accra Region of Ghana where the concentration of practitioners is highest. Fifty-eight (58) of the total questionnaires were dispensed to Architects, thirty-seven (37) to Quantity surveyors and five (5) to Structural engineers. In total, 83 questionnaires (83%) were retrieved from the respondents for analysis as presented in table 1.

In the same second stage, semi-structured interviews were also conducted amongst some contractors and consultants for the qualitative study. The interviews adopted an attitudinal approach which is used to subjectively evaluate the opinion of a person or a group of people towards a particular attribute, variable, factor or a question.

3.3 Data Analysis Technique

The quantitative data were analysed using the Statistical Package for Social Sciences (SPSS) and Microsoft excel software. Two forms of statistical analysis were undertaken: Descriptive statistics such as percentages were used to summarize information from respondents. Also inferential statistics such as relative importance index method (RII) was used herein to determine architects, quantity surveyors, and structural engineers' perceptions of the relative importance of the identified environmental impacts of construction activities. Kendall's coefficient of concordance was used to determine whether there is a significant degree of agreement among the 3 groups of respondents (Architects, Quantity Surveyors and Structural Engineers), Kendall's coefficient of concordance is used as a measure of agreement among raters. It indicates the degree of agreement on a zero to one scale. Kruskal-wallis test was also used to validate the results of Kendall's coefficient of concordance. The interview data was analysed using conceptual content analysis which takes into account the appearance of a concept or the numbers of times (frequency) a particular concept appears in a text. Bordens and Abbott (2008) note that content analysis is a useful technique to help in understanding behaviour adopting a purely descriptive approach.

4.0 Results

Out of 83 total respondents in the survey, 57.8% were architects, 36.2% of them were quantity surveyors while 6.0% of the respondents were Structural engineers. It was also found that 15.66% of the total respondents work with contractors, 48.19% work with consultants whilst 28.92% work with clients.

The survey data consisting of the 33 causes of environmental deterioration were analysed and grouped into nine major areas: Atmospheric emissions, water emissions, waste generation, soil alteration, resource consumption, local issues, and transport issues, effects on biodiversity, and accidents and incidents. The results of the study provide an indication of the relative importance index and rank of impacts of construction activities on the environment in Ghana as presented in table 2.

5.0 Discussion

The relative importance index and ranks of environmental impacts by all the respondents are presented in Table 2. Table 2 also illustrates the average relative importance index and ranks of environmental impacts by all respondents.

Generally, all major stakeholders agreed that the top ten most important environmental impacts of construction activities in Ghana are:

- raw materials consumption

- noise and vibration generation
- vegetation removal
- interference with the ecosystem
- water consumption
- electricity consumption
- loss of edaphic soil
- dust generation from machinery
- ordinary waste
- fuel consumption

Based on the different groups of environmental impacts, the respondents generally agreed that the top three groups of impacts are:

- resource consumption
- effects on biodiversity
- local issues

The following discussion is focused on the nine groups of environmental impacts in descending order of their ranking.

5.1 Resource consumption

The resource consumption group of environmental impacts was ranked highest by all the respondents put together. Raw materials consumption was determined by all respondents under the resource consumption group of environmental impacts as the first major environmental impact of construction activities in Ghana. It is encouraging to note that contractors and consultants interviewed also admitted that raw materials consumption is the most important environmental impact. The world watch institute (2003) opined that building construction consumes 40 percent of the world's raw stones, gravel and sand and 25 percent of the virgin wood per year. It also consumes 40 percent of the energy and 16 percent of water annually. Water, electricity and fuel consumption which are all under the resource consumption group of environmental impacts were ranked within the top ten most important environmental impacts of construction activities in Ghana.

5.2 Effects on biodiversity

The effects on biodiversity group were ranked the second most important environmental impact of construction activities by the three groups of respondents. Vegetation removal, interference with the ecosystem and loss of edaphic soil which are all under the effects on biodiversity group of environmental impacts were also ranked within the top ten most important environmental impacts of construction activities in Ghana. This was also corroborated by the contractors and consultants interviewed.

5.3 Local issues

Architects, Quantity surveyors, and Structural engineers together ranked local issues group as the third most crucial environmental impact of construction activities with the relative importance index of 0.932, 0.933, and 0.800 respectively. Within this group, Architects ranked noise and vibration generation as the most important environmental impact of construction activities. Quantity surveyors as well as Structural engineers also ranked noise and vibration generation as the most important. This result may be due to the personal experience of the respondents in their day to day activities. There is also abundant evidence to support the assertion that construction activities generate dust, noise and vibration.

5.4 Transport issues

Transport issues as an environmental impact group was ranked the fourth most important environmental impact of construction activities by the three groups of respondents. Within this group, architects and quantity surveyors agreed that interference in road traffic was the most important environmental impact of construction activities. On the other hand, Structural engineers ranked road traffic the most important factor. It is imperative to also note that contractors and consultants interviewed raised the issue of road traffic but attributed it by and large to road construction.

5.5 Waste generation

Architects, quantity surveyors, and structural engineers together ranked waste generation as the fifth most essential environmental impact of construction activities with relative importance index of 0.896, 0.883, and 0.850 respectively. Within this group, architects and Structural engineers ranked ordinary waste as the most important environmental impact of construction activities. Quantity surveyors on the other hand ranked inert waste as the most important. According to Ofori and Chan (1998) majority of the wastes generated from construction activities resulted from the production, transportation and the use of materials. A study conducted by Teo and Loosemore (2001) also posited that construction activities contributes approximately 29 percent of waste in the USA, more than 50 percent in the UK and 20-30 percent in Australia to the overall landfill volume. However, Sterner (2002) stated that implementing a waste management plan during the planning and design stages can reduce waste on-site by 15 percent, with 43 percent less waste going to the landfill through recycling, and it delivers cost savings of up to 50 percent on waste handling.

5.6 Atmospheric emissions

The atmospheric emissions group of environmental impacts was ranked sixth by all the respondents. Architects, Quantity Surveyors and Structural Engineers all agreed that within the atmospheric emissions group of environmental impact of construction activities, emissions of volatile organic compounds (VOCs) and chlorofluorocarbons (CFCs) was a major environmental impact. According to Levin (1997), in the USA construction is responsible for 40 percent of atmospheric emissions. The emissions include some toxic substances such as nitrogen and sulphur oxides. They are released during the production and transportation of materials as well as from site activities and have caused serious threat to the natural environment (Spence & Mulligan, 1995; Ofori & Chan, 1998; Rohracher, 2001). Other harmful materials, such as chlorofluorocarbons (CFCs), are used in insulation, air conditioning, refrigeration plants and fire-fighting systems and have seriously depleted the ozone layer (Clough, 1994; Langford et al., 1999).

5.7 Accidents and incidents

Accidents and incidents as an environmental impact group was ranked the seventh most important environmental impact of construction activities by the three parties put together. Within this group, architects and quantity surveyors agreed that fire outbreak was the most important environmental impact of construction activities. On the other hand, Structural engineers' ranked breakage of service pipes as the most important factor. Some contractors and consultants interviewed also raised the issue of building collapse in the course of construction as part of accidents and incidents.

5.8 Soil alteration

The three groups of respondents together ranked soil alteration as the eighth most essential environmental impact of construction activities. Soil alteration as an environmental impact group was ranked relatively low. All parties agreed that land occupancy was the most important factor in this category.

5.9 Water emissions

The water emissions group was ranked the lowest by the three groups of respondents. Regarding all the factors in the group, all three parties ranked water from excavation high. As indicated by the respondents, water emissions from construction activities do not impact the environment so much in Ghana.

5.10 Degree of agreement

To determine whether there is a significant degree of agreement among the 3 groups (architects, quantity surveyors, and structural engineers) Kendall's coefficient of concordance is used as a measure of agreement among raters.

H0: There is no significant degree of agreement among Architects, Quantity surveyors and Structural engineers.

H1: There is a significant degree of agreement among Architects, Quantity surveyors and Structural engineers.

For all the environmental impact groups, the p-values (Sig.) are greater than ά = 0.05 (ά is the level of significance), the null hypothesis, H0, is rejected. Thus, it can be said that there is a sufficient evidence to support the alternative hypothesis, H1. Therefore, there is a significant degree of agreement among the Architects, Quantity Surveyors and Structural Engineers regarding the environmental impacts of construction activities in Ghana.

The Kruskal-Wallis (KW) test was used to validate the result of the Kendall's coefficient of concordance test. KW test is a statistical test that is used to compare the ranks means between two or more samples. This test is used in order to check out if there are any significant differences in the point of view of the respondents (Architects, Quantity Surveyors and Structural Engineers) regarding the levels of each of the environmental impacts of construction activities.

H0: There is no significant difference between the responses of the Architects, Quantity surveyors and Structural engineers.

H1: There is a significant difference between the responses of the Architects, Quantity surveyors and Structural engineers.

For all the environmental impact groups, the p-value (sig.) for each group is greater than ά = 0.05 (ά is the level of significance), hence it can be concluded that there is no significant difference between the three group of practitioners' responses regarding the environmental impacts of construction activities. This result validates the previous result. Therefore, it can be reliably stated that the three groups of respondents' agree with each other in terms of environmental impacts of construction activities.

6.0 Conclusion

This study focused on impacts of construction activities on the environment in Ghana. The study sought the views of architects, quantity surveyors and structural engineers on the relative importance of the environmental impacts of construction activities in Ghana. The study showed that, out of a total of 33 environmental impacts identified, the top ten most important environmental impacts factors agreed by all the respondents are as follows: raw materials consumption, noise and vibration generation, vegetation removal, interference with the ecosystems, water consumption, electricity consumption, loss of edaphic soil, dust generation from machinery, ordinary waste and fuel consumption. The 33 environmental impacts identified in the study were grouped into nine categories and ranked accordingly. The results also indicated that, all the respondents agreed that the resource consumption group of environmental impacts was the most influential impact. Effects on biodiversity impacts were considered the second most important causing environmental deterioration followed by local issues impacts.

Finally, there is a pressing need for government to intervene in order that the use of sustainable construction designs and construction strategies that is environmentally friendly becomes the custom in Ghana. The paper therefore recommends that government with the support of stakeholders in the construction industry should come up with special legislations, codes or standards relating to sustainable construction practices specific to Ghana's construction environment to ensure its proper and effective implementation. Specifically, the national building regulations should be reviewed to take account of environmental regulations. Besides, all forms of construction activities should be subjected to an environmental impact assessment to determine the potential impacts and also come up with some mitigation measures before they are executed.

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Table 1: Field Data (Percentage of questionnaires distributed and responses received)

Respondents	**Questionnaires Distributed**	**Questionnaires Returned**	**Percentage of Responses**
Architects	58	48	83%
Quantity Surveyors	37	30	81%
Structural Engineers	5	5	100%
Total	100	83	83%

Table 2: The relative importance index (RII) and rank of impacts of construction activities on the environment in Ghana according to the three groups

Environmental Impacts	Architects		Quantity Surveyors		Structural Engineers		Overall	
	RII	Rank	RII	Rank	RII	Rank	RII	Rank
1. atmospheric emissions								
green house gas emissions	0.766	27	0.825	25	0.850	12	0.814	24
emission of vocs and cfcs	0.776	26	0.833	24	0.900	5	0.836	22
2. water emissions								
water from excavation	0.750	28	0.758	32	0.750	23	0.753	28
water from cleaning tools	0.677	30	0.767	31	0.700	26	0.715	29
sanitary water	0.693	29	0.750	33	0.650	28	0.698	30
3. waste generation								
excavated waste material	0.891	16	0.892	17	0.850	12	0.877	17
municipal waste	0.880	21	0.875	20	0.850	12	0.868	18
inert waste	0.885	19	0.908	10	0.850	12	0.881	16
ordinary waste	0.901	15	0.900	15	0.900	5	0.900	9
toxic waste	0.880	21	0.875	20	0.800	20	0.852	21
4. soil alteration								
land occupancy	0.849	25	0.867	22	0.750	23	0.822	23
concrete relase agent	0.656	32	0.792	29	0.500	32	0.649	32
cleaning agents	0.651	33	0.817	28	0.450	33	0.639	33
construction machinery waste	0.677	30	0.783	30	0.550	31	0.670	31
5. resource consumption								
water consumption	0.948	5	0.942	3	0.900	5	0.930	5
electricity consumption	0.932	7	0.933	6	0.900	5	0.922	6
fuel consumption	0.953	2	0.942	3	0.800	20	0.898	10
raw materials consumption	0.979	1	0.967	1	1.000	1	0.982	1
6. local issues								
dust generation from machinery	0.917	13	0.908	10	0.900	5	0.908	8
dust generation in earthworks	0.906	14	0.892	17	0.800	20	0.866	19
dust generation in cutting operations	0.891	16	0.925	7	0.850	12	0.889	15
noise and vibration generation	0.948	5	0.950	2	0.950	2	0.949	2
landscape alteration	0.922	9	0.900	15	0.850	12	0.891	14
7. transport issues								
road traffic	0.922	9	0.908	10	0.850	12	0.893	13
interference in road traffic	0.922	9	0.908	10	0.750	23	0.860	20
8. effects on biodiversity								
vegetation removal	0.953	2	0.942	3	0.950	2	0.948	3
loss of edaphic soil	0.922	9	0.917	9	0.900	5	0.913	7
potential soil erosion	0.932	7	0.908	10	0.850	12	0.897	11
interception of water bodies	0.891	16	0.892	17	0.900	5	0.894	12
interference with the ecosystems	0.953	2	0.925	7	0.950	2	0.943	4
9. accidents and incidents								
fire outbreaks	0.885	19	0.850	23	0.650	28	0.795	26
breakage of service pipes	0.865	23	0.825	25	0.700	26	0.797	25
breakage of receptacles	0.865	23	0.825	25	0.600	30	0.763	27