## 1. Introduction

Construction is a large, multifaceted, and dynamic industry that accommodates processes for building new structures and engineering projects. Construction works also concern processes for renovation encompassing additions, alterations, or maintenance and repair of existing structures and engineering projects (Behm, 2008). Construction plays an important role for the growth of local and national economies(Chen, 1996; Lewis, 2004; Rameezdeen and Rameezdeen, 2006; Behm, 2008; Osei, 2013). The built environment which comprises all structures and living spaces constructed or modified by human beings offers social and welfare benefits (Ofori, 2004; Sarkis, Meade and Presley, 2009). For instance, housing accomplishes to meet the second necessity of mankind by offering shelter from the elements (George, 2002; Ijigah *et al.*, 2013). Concordantly, construction Industry underpins to foster a good quality of life as it creates the built environment and provides the tangible facilities and infrastructures in accordance with the needs, wants and values of the people (Bartuska, 2007; Myers, 2013; Osei, 2013). Therefore, happiness, life and need satisfactions of the society are interrelated with the quality of the built environment thus it is one of the standard indicators of the quality of life (Pearce, 2003; Mohit, 2013).

Despite the fact that completion of construction projects and their entry into service have a direct influence on people's wellbeing, development phases of construction projects generate countless unintentional adverse impacts on their surrounding environments (Butterworth, 2000; Gilchrist and Allouche, 2005; Centre for Good Governance, 2006; Sev, 2009; Zainul Abidin Nazirah, 2010; Balaban, 2012). Especially in urban areas, due to high density of population implementation of construction projects turn out to be the sources of serious nuisances to, including but not limited, adjacent residents and businesses (Pucker, Allouche and Sterling, 2006; Gangolells *et al.*, 2009; Ferguson, 2012). Apeldoorn (2008) put forward that level of construction causative nuisances incurred to the surrounding society is highly dependent on the location of a project. He performed several case studies and determined that in densely populated areas the negative effects of construction activities are greater compared to the areas with lower population.

Near or in every construction zone, no matter if the executed project accommodates processes for building new or renovating existing structures, contractors place signs which state “We apologise for the inconvenience we cause to environment”. Many researchers (Allouche, Ariaratnam and Abourizk, 2000; Gilchrist and Allouche, 2005; Najafi and Gokhale, 2005; Rahman, Vanier and Newton, 2005; Yu and Lo, 2005; Matthews, Allouche and Sterling, 2015), by referring the term “environment” as the society who surround the construction sites that are adversely impacted by the operation of these sites in terms of pollution, traffic problems, economic activities and damage to natural/built environment, embark to estimate the cost of contractors’ “apology” on behalf of the society (Apeldoorn, 2008; Xueqing *et al.*, 2008). These researchers have commonly entitled this attempt as the quantification of the construction causative “social costs”.

An overview on social costs in construction projects will be presented in this review. This study has intended to review previous studies about definition, identification, classification and quantification of social costs in construction industry. Finally, with regard to the social cost definitions in the previous researches, a comprehensive and exhaustive definition for social cost in construction industry is presented.

## 2. Social costs definition

Throughout the years, researchers proposed numerous definitions of the term “social cost”; however, consensus has yet to be formed. This indicates that there are matters of definition addressed in relation to this concept which are still to be resolved.

Ormsby (2009) emphasises that social costs which are new to civil engineering / construction management, are well studied subjects in economics with research dating back over a century and a half. On the other hand, Button (1993) states that the term social cost is originated by the economists for use in public policy analysis.

Economists generally have consensus to define the social costs as follows (Field, 1997; Baker *et al.*, 2013): "Social costs are the overall impact of an economic activity on the welfare of society. Social costs are the sum of private costs arising from the activity and any externalities".

It is implied in this definition that any cost associated with an activity are encompassed by the term social cost whether generated by the parties who are involved in the activity or incurred on the third parties. Additionally, this definition refers that social costs is equivalent to the total costs of a project and it has two cost constituents: private costs; which stand for the summation of abovementioned project direct and indirect costs and external costs; which represents the costs that are not considered by the parties involved in the project but are incurred on the third parties.

At the end of a comprehensive literature review, it is revealed that many definitions of the social costs particularly associated with civil engineering projects have been proposed over the last two decades (Boyce and Bried, 1998; McKim, 1998; Rahman, Vanier and Newton, 2005; Yu and Lo, 2005; Pucker, Allouche and Sterling, 2006; Matthews, Allouche and Sterling, 2015). For instance, Allouche, Ariaratnam, and Abourizk (2000) defines the social costs as costs generated due to execution of a construction project incurred by the parties involved in the contractual agreement. For measuring purposes, they encompassed social costs by the costs incurred on the third parties as a result of being exposed to air pollution, noise, vibration, disruption to traffic and increased level of traffic accidents. In their work, they identified costs subject to contract as direct, indirect, and social costs. Meanwhile, Tanwani (2011) offered the following definition: construction causative adverse impacts that neighbouring communities are inevitably being exposed to due to implementation of construction projects and for which in traditional practices parties involved in the project such as; owner, designer, contractor, and users are not held accountable is named as "social costs". Gilchrist and Allouche (2005) just as Allouche, Ariaratnam and Abourizk (2000) proposed that project contractual costs should be comprised of direct, indirect and social costs but for measuring purposes distinctively grouped the social costs based on the area of impact namely: traffic, pollution, economic activities, and ecological/social/health.

On the other hand, other researchers (McKim and Kathula, 1999; Rahman, Vanier and Newton, 2005) recognize the economic definition of Field (1997) and Baker *et al.* (2013) and appraise the entire project costs to be encompassed in the social costs and identified it as the overall impact of a construction activity on the welfare of society. They categorised the encompassing social costs as direct, indirect and intangible costs.

Apeldoorn (2008) offers the following definition: Implementation of construction projects generates disruptions to common life patterns of the society around the construction zones. Equivalent monetary values of these disruptions are called social costs. Contrary to previous researches, they offered two categories for costs associated with a construction project namely, costs incurred to the owner of the project: direct and indirect costs; and costs incurred to the society: quantifiable and non-quantifiable social costs.

It is clear enough that suggested definitions for the term “social cost” and suggested cost categories for consideration of these costs shows differences. One of the most common ways of eliminating differences in the use of a term is achieved by defining it in accordance with what is intended, or actually is, expressed or indicated by the meaning of the term to set out the essential attributes of the defined term. Essential attributes of an approach for a specific subject varies in accordance with the people’s point of view. As the people’s point of view for a specific subject cannot be standardised as so the social cost estimation methods.

## 3. Social costs consideration

Civil engineering projects’ development phases associated social costs while widely acknowledged, are predominantly not considered during estimation process of the project initial cost hence, they are rarely considered in the design, planning or bid evaluation phases of construction projects (Gilchrist and Allouche, 2005). In traditional bid estimation practices, bid price prepared by the contractors for the tendered project does not incorporate the social costs (Apeldoorn, 2008). According to Yu and Lo (2005), because the social costs are being undertaken by the public rather than the project participants, these costs are not included in the contractual bid value. Pucker, Allouche and Sterling (2006) explained why project participants do not take responsibility for considering the infrastructure related social costs as follows: "For the most part, social costs are not considered during a construction project's planning, design and bid evaluation stages because they cannot be calculated using standard estimating methods. In recent years, efforts have been made to introduce approaches for predicting social costs associated with utility construction projects. Nevertheless, unit cost data needed for the verification of such prediction methods is lacking."

In conventional practices parties involved in construction projects are not held accountable for the social costs as these costs are incurred to the public instead of parties involved in the project such as; owner, designer, contractor, and users (Kapp, 1970; Yu and Lo, 2005). This is why in practice the contractors' estimators did not involve in estimating the social costs for bidding purposes so far. Having not performing an effort to estimate the social cost does not mean that, the social costs are not existent. The study found that social costs can account for up to 400% of construction costs on certain projects (Rahman, Vanier and Newton, 2005).

However, during design build and construction phases of a project, only considering needs, wants, and expectations of parties involved in the project and responding to these accordingly without being concerned about the expectations of other interest groups leads to lack of responsibility and improper management of the social costs which can in return result with public objection hence delay the completion date of the project (Yu and Lo, 2005). To clarify the interest groups of construction projects, Guoqing and Shaojun (2004) referred interest groups to those who have either direct or indirect relation with the development during the project preparation and construction period. In light of this information, it is deduced that society surrounding the construction sites should also be considered as project stakeholders and broader accountability should be taken by the parties involved in the project. This outcome is reinforced by the definition made by Ducoff (2013) about accountability. He has defined accountability as taking ownership for the behaviour of others as a result of implementing projects even if others are not directly involved because it occurred on your watch. In the past, many researchers have come to a consensus about the difficulty in predicting the social costs due to lack of a standard estimating method and in return they attempted to establish one (Boyce and Bried, 1998; McKim, 1998; Gilchrist and Allouche, 2005; Rahman, Vanier and Newton, 2005; Yu and Lo, 2005; Pucker, Allouche and Sterling, 2006; Matthews and Allouche, 2010). Additionally, each proposed method suggests a cost category for the consideration of the social costs but the way to compensate these costs for the society is yet to be determined. Xueqing *et al.* (2008) stated that in majority of the conducted researches the social costs incorporated into bid evaluation processes are predicted based on formerly collected data. In his research, he highlights the complexity in accurately predicting the future social costs during bidding period.

## 4. Social costs classification

Read and Vickridge (2004) showed an approach for quantification of social costs through considering public utility works hence, considering their research, types of social costs identified are only related to infrastructure works based on construction projects. They determined eleven social costs for public utility projects, namely traffic; diversion route effects, noise; over pumping; vibration; air pollution; dust, dirt and mess; visual intrusion; plant and materials; and safety.

Matthews, Allouche and Sterling (2015) assess the social cost impact on pipeline infrastructure projects. They categorized social cost in eight most important divisions for these types of projects which also can be considered for many utility construction projects, namely travel delay, vehicle operating costs, decreased road surface value, lost business revenue, loss of parking revenue, cost of dust control, noise pollution cost and safety.

Yuan, Cui and Jiang (2013) classified social costs in four main categories for residential building constructions, namely impact on the community, impact on the economy, impact on the environment and public property, and these categories consist of eleven social costs such as; the cost of damage on health; the cost of civil damage rights; effect on the transportation costs; decision-making errors costs; loss of income; loss of decreased productivity; loss of revenues; the cost of pollution; resource costs; property damage; and the destruction of the original building by any effect of the adjacent construction.

Wang (2011) analyses the urban underground expressway constructions based on social costs and determine specific social costs for these types of constructions. The social costs determined by Wang (2011) are pollution, traffic delays, access restrictions, other costs, safety and pavement damage.

Up until now in literature there have been many studies concerning various types of construction projects and incorporating the determination of social costs. Depending on the type of construction projects focused, construction activity related social cost types do not show immense variations, for instance, during both road construction and residential building construction in specific neighbourhood air pollution in terms of dust will occur.

For that reason, it can be said that social cost parameters more or less will be the same in any type of construction project, but the intenseness of it will vary. This is why some of the scholars classify social costs in general instead of focusing on specific project types. For instance, Yu and Lo (2005) mentioned that there are three types of social costs occurred in all construction projects, namely traffic impacts, environmental impacts, and business impacts. They consider traffic impacts as the vehicles and the road user costs emerged due to construction works. Environmental impacts are the daily environmental costs to the public due to the execution of construction works, such as daily noise pollution cost, daily air pollution cost. Business impacts are the daily loss of local business due to the construction operations, such as productivity loss and loss of income. Ferguson (2012) also classified the construction social costs in similar way.

In addition to these, Chung and Poon (1997) mentioned about loss of amenity and aesthetic values as construction social costs, however they determined that the social costs occurring due to these impacts are difficult to quantify.

Gilchrist and Allouche (2005) mentioned that there are four types of construction social costs, namely traffic, economic activities, pollution and ecological/social/health, and they elaborate this classification by inserting sub categories, namely adverse impact and social cost indicators. The proposed classification is shown in Figure 1. It depicts the breakdown structure of construction social costs. The construction social costs are classified under four categories: traffic, economic activities, pollution and ecological/social/health. These categories consist of sub-categories. These sub-categories are being considered under two main headings, namely adverse impacts and social cost indicators.

### 4.1. Traffic

The negative effects of construction projects on the traffic was stated widely in the literature (Jiang, 1999; Lee, Ibbs and Thomas, 2005). Especially, the highway renovation projects directly affect the traffic, and cause social costs to the road users due to the reduced speed, lane closures and alteration of traffic circulation patterns. However, the construction projects in urban areas can also affect the traffic; therefore, the construction social costs related to traffic should be considered not only in highway renovation projects but also in the construction projects in urban areas. Gilchrist and Allouche (2005) mentioned about three adverse impacts, namely prolonged closure of road space, detours and utility cut.

Although most of the construction activities are performed within the border of the construction site, some of the activities can require space outside the construction site, such as movement of machineries while performing the construction activities and entry/exit corridors. Especially, in urban areas, the entry/exist corridors can affect the traffic flow intensely, since the manoeuvre capacity of the construction vehicles are so limited when compared with the vehicles used in daily life. Therefore, traffic congestion, loss of parking spaces and changes in traffic patterns can be observed in the roads close to the construction sites. These could lead to time delay costs, extra oil combustion, increase in number of traffic accidents, vehicle loss cost and environmental pollutions (Mao, Zhu and Duan, 2012).

As mentioned before, due to the construction activities, the roads can be closed for a while, therefore the vehicles can be diverted to the secondary roads designed for light traffic loads in order to avoid excessive delays. This can create problems related to deterioration of road pavement due to overloading which decrease the economic life of the pavement structure, therefore the pavements should be resurfaced and repaved earlier than planning period. In addition, the detours can cause a greater cost to the drivers in terms of increased mileage, time, and fuel consumption.

### 4.2. Economic activities

Throughout a project, the businesses placed in the neighbourhood of the construction sites can be affected negatively, since, the customers can be confronted with difficulties to reach these businesses due the closure of the roads and detours. In addition, the customers do not prefer spending their spare time in an environment where dust and noise exist, in other words they will prefer other markets to shop. Consequently, these companies can lose their income. In addition, the householders close to the construction site can lose their income. Firstly, the value of their properties decreases significantly due to high noise and dust levels, and lack of aesthetics. Secondly, the householders can lose the rent revenue. Even, in some situations, the governments have to mitigate the loss of the householders, for instance, Manchester airport provides financial assistance to the householders for installation of sound proof glazing and home relocation (Manchester Airport, 2013). Finally, the properties adjacent to construction projects can be damaged hence, additional necessity in terms of cost occurs, in order to repair and maintain the damaged properties.

The construction can also affect the employees' productivity rate adversely due to dust and noise, and construction related nuisances. In addition, the efficiency level of the equipment that are sensitive to the high level of noise and vibration can be reduced which can cause fatal consequences. Finally, traffic congestion can affect the mood of the employees which affect their productivity indirectly. The loss of income of businesses is also likely to affect the economy of governments indirectly due to the reduction in tax revenue. Consequently, the impact of the construction on business and public agencies should be considered as one of the construction social costs.

## 4.3. Pollution

The negative impact of construction projects on the environment has been addressed in the literature (Teo and Loosemore, 2001; Wong and Yip, 2004). In addition, it is discussed that the environmental impacts of construction activities have become an important concern of governments and public agencies. Consequently, Gilchrist and Allouche (2005) considered pollution as a construction social cost. They considered four leading pollution sources due to construction activities, namely noise, dust, vibration, air/water pollution.

### *4.3.1. Noise*

Noise is defined as any sound that has potential to cause psychological or physiological symptoms such as high blood pressure, cardiovascular disease, anxiety, restlessness, irritability, sleep disturbances and difficulty in concentrating (Gilchrist and Allouche, 2005; Akan *et al.*, 2012). Bein (1997) stated that noise can affect social behavioural, mental and physical health of people. In other words, high decibel noises should be considered seriously by the government, especially in urban environment.

Unfortunately, construction is one of the main sources of noise. Noise will be generated by site operations including heavy earth moving and paving equipment, operator pumps, generators, and demolition activities. The effects of noise are not limited only with psychological and physiological symptoms, but also the economic effects of noise are also observed

*4.3.2. Dust*

The other adverse effect of construction on the environment is dust. Throughout the construction activities, the high amount of dust can be observed on the construction site. The dust can cause damage to the electronic and mechanical equipment. In addition, the governments should spare funding for cleaning and maintenance.

The dust reduces the fertility of the agriculture and lowers the aesthetic quality of the environment. Finally, high concentration of dust in the air can lead to declination in lung function, increase in respiratory hospitalization and increase in mortality from respiratory and cardiovascular causes (Woskie *et al.*, 2002).

*4.3.3. Vibration*

Around the construction site, a damaging vibration can always be felt throughout digging, pile driving, compacting, blasting and operation of heavy construction equipment. The vibration can create social costs, since these vibrations can damage structures adjacent to the construction site. In addition, it can affect the sensitive equipment that is used in the businesses and hospitals. This situation can lead to fatal and unexpected results. Finally, high frequency vibration can create psychological trauma due to lack of safety psychology, even low frequency vibration can have a psychological impact on people (Read and Vickridge, 2004).

*4.3.4. Air pollution*

The machines used in the construction have high power engines which produce harmful air emissions causing serious damages to human beings and other living organizations. These harmful emissions not only affect the lower layer of atmosphere, but also affect ozone layer which absorbs the sun's harmful ultraviolet radiation.

### 4.4. Ecological / Social / Health

The construction projects can affect the ecological systems, especially the groundwater table, surface water areas and the recreational areas are vulnerable against the construction activities. In addition, the quality of life of the residents close to the construction site is significantly decreased due to the environmental pollution and traffic. The environmental pollution can lead to fatal diseases, such as respiratory illness, cardiovascular diseases, allergies, anxiety and annoyance. (Gilchrist and Allouche, 2005) mentioned two adverse impacts associated with damage to ecological systems, namely; surface/subsurface disruption and damage to recreational areas.

The negative impact of construction on the ground is obvious, however the construction does not only damage the ground but also it affects the natural water that exist around the construction site and groundwater. The construction activities can affect the natural structure of the water which lead to bank erosion, flooding, alterations of the normal course of rivers and streams and damage to the aquaculture (Gilchrist and Allouche, 2005). In addition, in order to facilitate construction, the ground water level placed under the construction area is lowered by using different methods, such as deep wells, well-points and horizontal drainage. However, this operation can lead to serious consequences, such as deterioration of green life, and reduction of water required for agriculture

## 5. Social costs quantification

The quantification of social costs is set of procedures followed to evaluate the cost of construction originated adverse impacts. Various scholars have proposed numerous approaches where each approach accommodates similar procedures to evaluate the social costs. It is construed that majority of the performed studies focused on evaluation of the infrastructure projects related adverse impacts. Most of the studies for quantifying the social cost are conducted in highway construction projects.

For instance, Jiang (1999) developed a model for estimating excess user costs at highway work zones. He determined that the highway work zones can cause additional travel time, consumption of extra fuel and oil, and wear and tear of vehicle parts due to the traffic bottlenecks where accumulation of these lead to traffic delays and congestions.

Matthews, Allouche and Sterling (2015) propose a mathematical method to quantify eight different types of social costs relating to water infrastructure construction projects. They analyse two pipeline infrastructure projects, each presenting an open-cut and trenchless scenario to determine trends for the different social cost divisions. The analysis of these two projects reveal that the inclusion of social cost on the project cost estimation could make open-cut method less advantageous in comparison to trenchless technology, especially in high density urban areas. Moreover, it is stated that the relative percentage of social costs is greater for the projects with low direct costs due to the limited impact of project technical complexity on its social costs.

the social costs are mostly independent of many of technical parameters which affecting direct costs such as groundwater elevation, pipe diameter and soil conditions.

Lee, Ibbs and Thomas (2005) developed an innovative approach to development of construction and traffic management plans for I-15 Devore project constructed in Southern California. They used CA4PRS (Construction Analysis for Pavement Rehabilitation Strategies) software for scheduling analysis. They mentioned about the negative effects of construction activities on the traffic flow of the roadways above or near flow capacity. They compared the different scenarios in determination of optimum solution for this project and obtained an optimum solution by considering construction cost, road user cost, and agency cost. In addition to these, there are studies that have developed innovative contracting methods which consider social costs in the literature.

Herbsman (1995) evaluated A+B bidding method which consists of two parts. First part, namely A, is the construction costs which can be considered as the traditional bidding method. The second part composes of project duration time and this part was calculated by considering the road user cost which is basically social cost.

Herbsman and Glagola (1998) mentioned about lane rental method which used in United Kingdom. In the lane rental method, the contractors have to pay the cost of the delays for peak and off-peak periods for those periods of time when traffic is obstructed through lane or shoulder closures and other damages to the public.

Çelik (2014) describes the social costs of a building construction site in the residential areas and develop a generic social cost estimation system to monetize it. Moreover, a social cost compensation method is also presented that consists of a cost category for the social costs and a compensation method for the affected residents in the vicinity of construction sites. It is found that execute of building construction projects in residential areas incur £6.25 per day per house located within 150m distance of a construction site.

Yu and Lo (2005) develop a time-dependent construction social costs (COSCO) model to quantify the comprehensive construction social cost. In their model, they tried to integrate three social costs. Gilchrist and Allouche (2005) proposed a model based on abovementioned four types of social costs they categorized with the intention of quantifying the social costs associated with the construction projects. They considered seven methods for valuation of social costs, namely; loss of productivity, human capital, replacement cost, lane closure cost, hedonic pricing, user delay costs, and contingent valuation technique. They identified that different methods are suitable for valuation of different social costs. For instance, they concluded that the loss of productivity method should be used for valuation of loss of income, productivity reduction, reduction in taxes revenues and health costs. In addition, different methods can be used for valuation of one social cost. For instance, travel time social cost can be quantified by using lane closure cost and user delay costs valuation techniques.

## Conclusion

It can be concluded that, in the literature the majority of the attempts to define and quantify the social costs, have been focused on the construction projects incorporating infrastructure works. It is obvious that, the majority of the infrastructure projects, such as highways, railways, airports, etc. are being accomplished mostly out of the congested residential areas. Therefore, inherently the social costs of those projects are less involved with the residents. However, attempts to investigate the social costs of building constructions in urban residential areas are still insufficient due to probable difficulties and complexities of including the third parties.

With regard to the previous social costs definition, the following statement can be considered as an appropriate definition for construction social costs. "The people themselves and the environment they live in; their homes and neighbourhoods if located around the building construction zones are exposed to adverse impacts of the construction activities. In return, people react via altering their daily routine to resolve or alleviate the exposed disruptions to their common life patterns. Cost of this reaction is defined as the social costs associated with building construction projects".

In line with the abovementioned definition of the social costs, it can be said that consequences of executing the construction activities in residential areas are also important to be investigated due to higher population of third parties.

As the definition of social cost implies, there are costs caused by constructions that are to be paid by the third parties. Therefore, the estimation of construction based social cost still needs to be investigated further. Additionally, it is not true to presume that the amount of social cost will be the same in all parts of the world. The reason behind this is the fact that people's perception about the nuisance varies according to their culture and manners of the society hence, the proposed social cost quantification methods cannot be generalised or global. Even though it is not possible to include all members of the society into social cost calculations, some researches that are conducted in this manner can be used as a road map during further investigations.

Additionally, the social cost quantification techniques suggested by researchers are superficial and need to be elaborated more. The methods and techniques developed so far have not managed to go beyond a conjecture. Still more investigations and researches are required to corroborate the effects of social costs especially building construction social costs in the residential areas. Up until now, the developed formulas and models for social cost calculation are scholarly hypothesis based on their investigations.

As aforementioned, up until recently different methods are suggested by scholars concerning the quantification methods of the social costs and many scholars have discussed the difficulties/complexities in doing it. In majority of these studies, there are attempts with the intention of expressing the social costs in terms of monetary units. The only common part among the numerous methods suggested by scholars for quantifying the social costs is the aspect that drivers of these costs are evaluated on daily basis for the duration of the construction project. This indicates that even though elements of the social costs may act upon the third parties at different intensity level on each day, an average daily cost of the nuisances occurring due to existence of construction site in the neighbourhood can be taken into consideration during quantification of the social costs.

Finally, it is acknowledged that quantifying the social costs on construction activity basis is not practicable. For instance, the third parties who are being exposed to nuisance are normally not aware of which specific construction activity is the driver for the exposed nuisance. This is the reason why the social costs have been preferred to be quantified on daily basis by scholars as well.

## References

Akan, Z., Yilmaz, A., Özdemir, O., Selvi, Y. and Korpinar, M. A. (2012) 'P-436 - Noise pollution, psychiatric symptoms and quality of life: noise problem in the east region of Turkey', *European*

*Psychiatry*. Elsevier Masson, 27, p. 1. doi: 10.1016/S0924-9338(12)74603-5.

Allouche, E. N., Ariaratnam, S. T. and Abourizk, S. M. (2000) 'Multi-dimensional utility model for selection of a trenchless construction method', in *Construction Congress VI: Building Together for a Better Tomorrow in an Increasingly Complex World*. Reston, VA: American Society of Civil Engineers, pp. 543–553. doi: 10.1061/40475(278)59.

Apeldoorn, S. (2008) 'Comparing the Costs – Trenchless Versus Traditional Methods', *MIESA*, 38(4), pp. 55–57.

Baker, E., Fowlie, M., Lemoine, D. and Reynolds, S. S. (2013) 'The Economics of Solar Electricity', *Annual Review of Resource Economics*. Annual Reviews, 5(1), pp. 387–426. doi: 10.1146/annurev-resource-091912-151843.

Balaban, O. (2012) 'The negative effects of construction boom on urban planning and environment in Turkey: Unraveling the role of the public sector', *Habitat International*, 36(1), pp. 26–35. doi: 10.1016/j.habitatint.2011.05.003.

Bartuska, T. (2007) 'The Built Environment: Definition and Scope', in Bartuska, T. and Young, G. (eds) *The Built Environment: A Creative Inquiry into Design and Planning*. Crisp Publications.

Behm, M. (2008) 'Construction Sector', *Journal of Safety Research*, 39(2), pp. 175–178. doi: 10.1016/j.jsr.2008.02.007.

Bein, P. (1997) *Monetization of Environmental Impacts of Roads*. Victoria: HighwMinistry of Transportation and Highways.

Boyce, G. and Bried, E. (1998) 'Social Cost Accounting for Trenchless Projects', in *NORTH AMERICAN NO DIG*. Albuquerque, pp. 2–12. Available at: https://www.tib.eu/en/search/id/BLCP%3ACN029319728/Social-Cost-Accounting-for-Trenchless-Projects/.

Butterworth, I. (2000) ‘The Relationship Between the Built Environment and Wellbeing : a Literature Review’, *Prepared for the Victorian Health Promotion Foundation*, (February).

Button, K. (1993) *Transport, the environment, and economic policy*. Aldershot: Edward Elgar.

Çeli☒k,T. (2014) *Developing a Building Construction Associated Social Cost Estimation System for Turkish Construction Industry*. University of Salford.

Centre for Good Governance (2006) *A Comprehensive Guide for Social Impact Assessment*.

Chen, J. J. (1996) ‘The impact of public construction investment upon special economic zones - The Chinese experience’, *Construction Management and Economics*. Taylor & Francis Group, 14(2), pp. 175–182. doi: 10.1080/014461996373610.

Chung, S.-S. and Poon, C.-S. (1997) ‘Quantifying externalities in solid waste management in Hong Kong’, *Journal of Environmental Engineering*. American Society of Civil Engineers, 123(3), p. 282. doi: 10.1061/(ASCE)0733-9372(1997)123:3(282).

Ducoff, N. (2013) *Six strategies to create a culture of accountability - Strategies*. Available at: http://www.strategies.com/blog/six-strategies-to-create-a-culture-of-accountability/ (Accessed: 4 April 2014).

Ferguson, A. (2012) *Qualitative Evaluation Of Transportation Construction Related Social Costs And Their Impacts On The Local Community*. The University of Texas at Arlington. Available at: http://hdl.handle.net/10106/11165.

Field, B. C. (1997) *Environmental Economics: An Introduction*. 2nd edn. Irwin/McGraw-Hill.

Gangolells, M., Casals, M., Gassó, S., Forcada, N., Roca, X. and Fuertes, A. (2009) ‘A methodology for predicting the severity of environmental impacts related to the construction process of residential buildings’, *Building and Environment*, 44(3), pp. 558–571. doi: 10.1016/j.buildenv.2008.05.001.

George, C. K. (Catherine K. (2002) *Basic principles and methods of urban and regional planning*. 2. Aufl. Lagos: Libro-Gem Books.

Gilchrist, A. and Allouche, E. N. (2005) ‘Quantification of social costs associated with construction projects: State-of-the-art review’, *Tunnelling and Underground Space Technology*, 20(1), pp. 89–104. doi: 10.1016/j.tust.2004.04.003.

Guoqing, S. and Shaojun, C. (2004) ‘ANALYSIS ON SOCIAL IMPACT IN WATER CONSERVANCY AND HYDROPOWER DEVELOPMENT’, in *UNHYDRO*. Beijing, pp. 1–8.

Herbsman, Z. J. (1995) ‘A+B Bidding Method—Hidden Success Story for Highway Construction’, *Journal of Construction Engineering and Management*. American Society of Civil Engineers, 121(4), pp. 430–437. doi: 10.1061/(ASCE)0733-9364(1995)121:4(430).

Herbsman, Z. J. and Glagola, C. R. (1998) ‘Lane Rental - Innovative way to reduce road construction time’, *Journal of Construction Engineering and Management*. American Society of Civil Engineers, 124(5r), pp. 411–417. doi: 10.1061/(ASCE)0733-9364(1998)124:5(411).

Ijigah, E. A., Jimoh, R. A., Aruleba, B. O. and Ade, A. B. (2013) ‘An Assessment of Environmental Impacts of Building Construction Projects’, *Civil and Environmental Research*, 3(1), pp. 93–105.

Jiang, Y. (1999) ‘A Model for Estimating Excess User Costs at Highway Work Zones’, *Transportation Research Record*. Transportation Research Board of the National Academies, 1657(1), pp. 31–41. doi: 10.3141/1657-05.

Kapp, K. W. (1970) ‘ENVIRONMENTAL DISRUPTION AND SOCIAL COSTS: A CHALLENGE TO ECONOMICS’, *Kyklos*. Blackwell Publishing Ltd, 23(4), pp. 833–848. doi: 10.1111/j.1467-6435.1970.tb01047.x.

Lee, E.-B., Ibbs, C. W. and Thomas, D. (2005) ‘Minimizing Total Cost for Urban Freeway Reconstruction with Integrated Construction/Traffic Analysis’, *Journal of Infrastructure Systems*.

American Society of Civil Engineers, 11(4), pp. 250–257. doi: 10.1061/(ASCE)1076-0342(2005)11:4(250).

Lewis, T. M. (2004) ‘The construction industry in the economy of Trinidad & Tobago’, *Construction Management and Economics*. Taylor & Francis Group, 22(5), pp. 541–549. doi: 10.1080/0144619042000190234.

Manchester Airport (2013) *Mitigation Schemes*. Available at: http://www.manchesterairport.co.uk/community/living-near-the-airport/mitigation-schemes/ (Accessed: 21 May 2013).

Mao, L.-Z., Zhu, H.-G. and Duan, L.-R. (2012) ‘The Social Cost of Traffic Congestion and Countermeasures in Beijing’, in *Sustainable Transportation Systems*. Reston, VA: American Society of Civil Engineers, pp. 68–76. doi: 10.1061/9780784412299.0010.

Matthews, J. C. and Allouche, E. N. (2010) ‘A social cost calculator for utility construction projects’, in *North American Society for Trenchless Technology No-Dig Show 2010*.

Matthews, J. C., Allouche, E. N. and Sterling, R. L. (2015) ‘Social cost impact assessment of pipeline infrastructure projects’, *Environmental Impact Assessment Review*, 50, pp. 196–202. doi: 10.1016/j.eiar.2014.10.001.

McKim, R. A. (1998) ‘Bidding Strategies for Conventional and Trenchless Technologies Considering Social Costs’, *Canadian Journal of Civil Engineering*, 24(40), pp. 819–827. doi: 10.1139/l97-036.

McKim, R. A. and Kathula, V. S. (1999) ‘Social Costs and Infrastructure Management’, in *INFRA 99 International*. Montreal: CERIU, p. 10.

Mohit, M. A. (2013) ‘Quality of Life in Natural and Built Environment – An Introductory Analysis’, *Procedia -Social and Behavioral Sciences*. Elsevier, 101, pp. 33–43. doi: 10.1016/j.sbspro.2013.07.176.

Myers, D. (2013) *Construction Economics: A New Approach*. 3rd edn. Routledge.

Najafi, M. and Gokhale, S. (2005) 'SOCIAL COSTS OF UTILITY CONSTRUCTION: A LIFE CYCLE COST APPROACH - Access Engineering from McGraw-Hill', in Najafi, M. (ed.) *Trenchless Technology: Pipeline and Utility Design, Construction, and Renewal*. McGraw-Hill Education. Available at: https://accessengineeringlibrary.com/browse/trenchless-technology-pipeline-and-utility-design-construction-and-renewal/c9780071422666ch02.

Ofori, G. (2004) 'Construction Industry Development for disaster prevention and response', *2nd International Conference on Post-Disaster Reconstruction: Planning for Reconstruction*, (65), pp. 1–21.

Ormsby, C. (2009) *A framework for estimating the total cost of buried municipal infrastructure renewal projects: A Case Study in Montreal*, *[Master's Thesis]*. McGill University. Available at: digitool.library.mcgill.ca/thesisfile66768.pdf.

Osei, V. (2013) 'the Construction Industry and Its Linkages To the Ghanaian Economy-Polices To Improve the Sector'S Performance', *International Journal of Development and Economic Sustainability*, 1(1), pp. 56–72. Available at: https://www.mendeley.com/research/construction-industry-linkages-ghanaian-economypolices-improve-sectors-performance/?utm_source=desktop&utm_medium=1.15.2&utm_campaign=open_catalog&userDocumentId={734c8d10-4792-4dc7-8b7f-04949f16bf28}.

Pearce, D. (2003) *The Social and Economic Value of Construction*, *nCRISP*. doi: http://scholar.google.com/scholar?hl=en&btnG=Search&q=intitle:The+Social+And+Economic+Value+of+Construction#1.

Pucker, J., Allouche, E. N. and Sterling, R. L. (2006) *Social Costs Associated with Trenchless Projects: Case Histories in North America and Europe*.

Rahman, S., Vanier, D. J. and Newton, L. A. (2005) *MIIP Report: Social Cost Considerations for Municipal Infrastructure Management*, *NRC Publications Archive*. Ottawa. doi: 10.4224/20377011.

Rameezdeen, T. and Rameezdeen, R. (2006) 'Study of Linkages Between Construction Sector and Other Sectors of The Sri Lankan Economy', *Built Environment*, 6(2), pp. 1–15. Available at: http://citeseerx.ist.psu.edu/viewdoc/summary?doi=10.1.1.163.1561.

Read, G. F. and Vickridge, I. (2004) 'Social or Indirect Costs of Public Utility Works', in *Sewers: Replacement and New Construction*. Elsevier.

Sarkis, J., Meade, L. and Presley, a (2009) 'Sustainability in the Built Environment: Factors and a Decision Framework', *Handbook of Corporate Sustainability: Frameworks, Strategies and Tools*, (October 2015), p. 113.

Sev, A. (2009) 'How can the construction industry contribute to sustainable development? A conceptual framework', *Sustainable Development*. John Wiley & Sons, Ltd., 17(3), pp. 161–173. doi: 10.1002/sd.373.

Tanwani, R. (2011) *Social Costs of Traditional Construction Methods | Gunda Corporation*, *Gunda Corporation*. Available at: http://gundacorp.com/2012/04/19/social-costs-of-traditional-construction-methods/.

Teo, M. M. M. and Loosemore, M. (2001) 'A theory of waste behaviour in the construction industry', *Construction Management and Economics*. Taylor & Francis Group, 19(7), pp. 741–751. doi: 10.1080/01446190110067037.

Wang, R. (2011) 'Autos, transit and bicycles: Comparing the costs in large Chinese cities', *Transport Policy*, 18(1), pp. 139–146. doi: 10.1016/j.tranpol.2010.07.003.

Wong, E. O. W. and Yip, R. C. P. (2004) 'Promoting sustainable construction waste management in Hong Kong', *Construction Management and Economics*. Taylor & Francis Group, 22(6), pp. 563–

566. doi: 10.1080/0144619042000226270.

Woskie, S. R., Kalil, A., Bello, D. and Virji, M. A. (2002) 'Exposures to quartz, diesel, dust, and welding fumes during heavy and highway construction.', *AIHA journal : a journal for the science of occupational and environmental health and safety*, 63(4), pp. 447–457. doi: 10.1080/15428110208984733.

Xueqing, W. X. W., Bingsheng, L. B. L., Allouche, E. N. and Xiaoyan, L. X. L. (2008) 'Practical bid evaluation method considering social costs in urban infrastructure projects', *2008 4th IEEE International Conference on Management of Innovation and Technology*, (2000), pp. 617–622. doi: 10.1109/ICMIT.2008.4654436.

Yu, W.-D. and Lo, S.-S. (2005) 'Time-dependent construction social costs model', *Construction Management and Economics*. Taylor & Francis Group, 23(3), pp. 327–337. doi: 10.1080/01446190500040281.

Yuan, Q.-M., Cui, D.-J. and Jiang, W. (2013) 'Study on evaluation methods of the social cost of green building projects', in Jun, W., Yanbin, L., Jinfeng, W., and Fouad, R. H. (eds) *Advances in Industrial Engineering, Information and Water Resources*. Southampton: WIT press.

Zainul Abidin Nazirah, N. (2010) 'Investigating the awareness and application of sustainable construction concept by Malaysian developers', *Habitat International*, 34(4), pp. 421–426. doi: 10.1016/j.habitatint.2009.11.011.

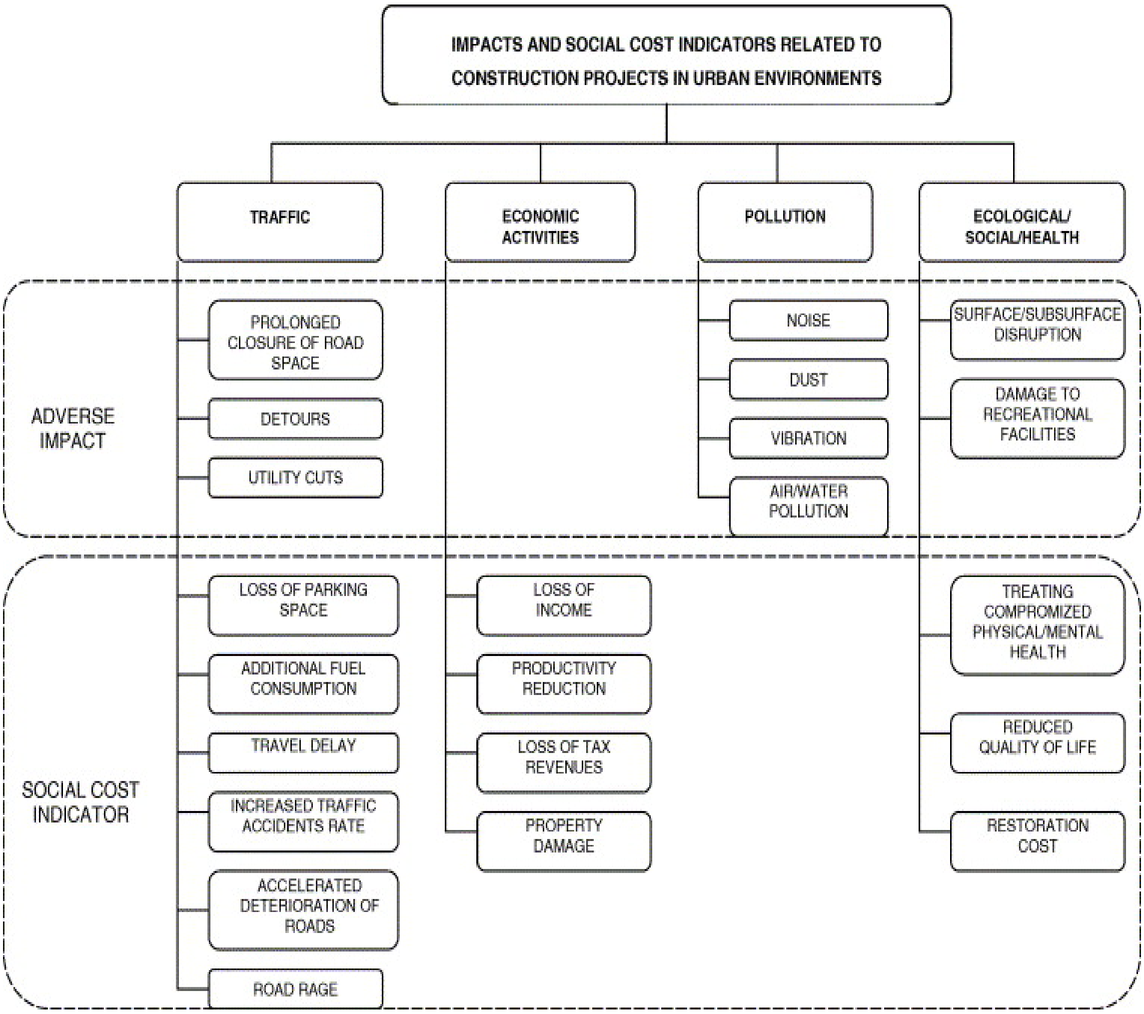


*Figure 1. Breakdown of potential impacts and social cost indicators associated with construction activities (Gilchrist and Allouche, 2005)*

# Social Cost in Construction Projects: A Review

Tolga ÇELIK[1], Saeed KAMALI[2], Yusuf ARAYICI[3]

[1, 3] School of Built Environment, University of Salford, Manchester, United Kingdom

[2] Civil Engineering Department, Middle East Technical University, Ankara, Turkey

[1] tolga.celik@emu.edu.tr, [2] saeedkamali2002@gmail.com, [3] y.arayici@salford.ac.uk

**Abstract.** Despite the fact that completion of construction projects has a direct positive impact on the growth of national and local economics as well as humans' wellbeing, construction projects, especially in the urban areas, generate serious environmental nuisances for the adjacent residents and have unintentional adverse impacts on their surrounding environment. Construction causative adverse impacts on the neighbouring communities are known as the social costs. This study aims to present a state-of-the-art overview of social costs in construction industry in terms of definition, consideration, classification and quantification. Furthermore, a definition for social costs in construction projects will be presented as well as a summarization of more recent researches.

**Keywords:** social cost; construction costs; construction management; construction adverse impact; social cost definition; social cost quantification.