

Civil engineering works, a fundamental basis for social change

Las obras de ingeniería civil, base fundamental para cambios sociales

Camila A. Ramírez D.

Universidad Distrital Francisco José de Caldas
caramirezd@correo.udistrital.edu.co

Lizeth D. Güiza B.

Universidad Distrital Francisco José de Caldas
ldguizab@correo.udistrital.edu.co

Jesús D. Echeverría G.

Universidad Distrital Francisco José de Caldas
jdecheverriag@correo.udistrital.edu.co

Civil works are of vital importance for the development of individuals' lives since they generate changes in the natural environment in response to a specific need of a certain group of people. Each one of these constructions brings with it a social impact in the face of concrete activities. Factors such as the economy, demography, and culture allow us to talk about positive and negative impacts. Finally, the awareness of civil engineers regarding the responsibility of safeguarding the life of other individuals becomes fundamental; executing projects with excellent planning is the first step to avoid the diverse difficulties in which a work may be involved, but more important than this, imparting the premise of a correct exercise of civil engineering seems to be a mandatory need.

Keywords: Building, culture, development, social impact

Las obras civiles son de vital importancia para el desarrollo de la vida de los individuos, ya que estas generan cambios en el entorno natural respondiendo a una necesidad específica de un determinado grupo de personas. Cada una de estas construcciones trae consigo un impacto social frente a actividades concretas. Factores como la economía, la demografía y la cultura permiten hablar sobre los impactos positivos y negativos. Finalmente la concientización hacia los ingenieros civiles en cuanto a la responsabilidad de salvaguardar la vida de los demás individuos se torna fundamental, ejecutar proyectos con excelente planeación es el primer paso para evitar las diversas dificultades en las cuales se puede ver involucrada una obra, pero más importante que esto, impartir la premisa de un correcto ejercicio de la ingeniería civil parece ser una necesidad de obligatorio cumplimiento.

Palabras clave: Construcción, cultura, desarrollo, impacto social

Article typology: Research

Date manuscript received: December 6, 2017

Date manuscript acceptance: December 15, 2017

Research funded by: Universidad Distrital Francisco José de Caldas.

How to cite: Ramírez, C., Güiza, L., Echeverría, J. (2018). *Civil engineering works, a fundamental basis for social change*. Tekhnê, 15(1), 27 -38.

Introduction

Through this article we want to make known to all people the role that civil engineering (specifically its works) plays in society (Murray & Ross, 2014). The intervention of the human being's physical environment originates structural changes both in the daily life of individuals and in their habits, customs and ways of doing their activities; circumstances that have been affected positively and negatively (Bao, Meng, & Seo, 2014; Becerik-Gerber et al., 2014).

Each of the interventions made by this branch of engineering seeks to provide a solution to a specific need of the community, at the level of communication, trade, transport, among others (Johansen, Horney, & Tien, 2017; Uihlein, 2017). For this reason, it is very easy to associate the development of a city in terms of economic and infrastructure benefits, with the completion of a construction project (Armstrong, Baillie, & Cumming-Potvin, 2014; Mostafavi, Huff, Abraham, Oakes, & Zoltowski, 2016).

Civil engineering works are the subject of various writings, some of which refer to the way construction is carried out, the materials, and lately, there is more thought given to writing about the impacts that each of these transformations brings to the environment where people live, but in this writing, it will be mentioned how important it is to know the changes that arise at a social level before, during and after starting a civil construction project (Ahn et al., 2015; Garcia, Castro, Parbole, & Ballester, 2015; Monchau et al., 2014).

The relation that will allow defining which were the modifications in the habits, customs or ways of doing the activities of the members of a society is the urban, economic development and in the infrastructure of the constructions, the change in all the sense of the word because through this it is noticed the influence on the perspective of the reality of each one of the individuals of the place where the project was carried out (Basu, Misra, & Puppala, 2014; Roohnavaz, 2016).

Social impact of a civil work

Social changes generated by civil works

Talking about the impact of civil work has always been of great curiosity for people, it seems obvious to say that before, during and after construction is finished there are always going to be different changes that directly affect their lives, however, these transformations in the natural environment of a population sometimes are not observable at first sight by the individuals of the intervened places and therefore, a little despised.

As a result of the above, several specialized studies have been generated on the subject, to learn about the voluntary or

involuntary reactions of men and women to the changes they are involved in as a result of a civil engineering project.

Everyone's perception is very different about the variations in all aspects generated by constructive work, despite being very good for the development of cities, which has a large number of factors and positive and negative aspects that act directly on the community (Martínez, Hernández, & Rendón, 2017). We know beforehand that work arises as a response to specific needs of people in a certain sector, this work will directly affect their environment and daily life, a fact that makes the work of the engineer more complex, who apart from performing the various structural calculations and testing of each material must foresee with his team the inconveniences that will arise to start the construction, these tasks are performed to avoid as much as possible misunderstandings between those responsible for the work and the inhabitants of the sector.

We clarify that the work of the engineer and his workers does not end on the day of completion of the work, the contract may specify maintenance and periodic reviews, but something that is a constant omission by the engineer is the impact of its construction on the people of the place. As mentioned before, changes do not only occur at the beginning of the projects, but the most important moment to define the type of impact is when the new construction begins to be used, which gives rise to their studies. To know how construction has a social impact, methods have been created to make known what happened in a population after its natural environment was intervened, following different parameters to define what the social changes were concerning the execution and completion of the project. Generally, direct questions are asked as a survey or census to individuals in the community about the conditions present in that situation. The results of the studies can have three approaches: economic, demographic, and cultural.

The social impact generated by any type of project (including civil works) can also be measured through SROI (social return on investment). Although the SROI is a tool that serves to measure many things, since it is based on the financial principles of ROI (return on investment), it has proven to be particularly useful in the evaluation and comparison of different social project alternatives.

In this way it is easier to identify which could be the effects of the engineering works in the populations where the construction was established, besides SROI the statistical studies carried out from the collection on the results of the intervention are very useful to analyze the type of impact present in the certain community taking into account key aspects to obtain a good analysis on the social impact such as Indigenous peoples, Resettlement, Impacts on subsistence, social integrity, Labour exploitation, Labour conditions,

health and safety, and non-discrimination, Cultural goods and practices, Gender equity.

Each of these terms is very important to specifically differentiate the contributions or damages that can be created from civil engineering projects or other dependencies.

Generally, the state entities in charge of statistics in Colombia, DANE, have the results of the census carried out to have a better idea of the issues of interest and also of great importance to know what the effects of the phenomenon are. Such as the one carried out at the beginning of 2017 concerning the buildings where the areas in the process of construction are shown (Fig. 1).

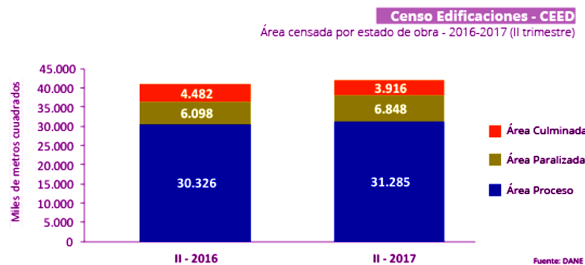


Figure 1. Construction census for the quarter April - June 2017 (31,284,790 m² with an annual variation of 3.2%) (DANE, 2015).

However, constructions in cities are carried out by different branches of civil engineering, they fulfill very specific functions for the development of a population and in addition to this, their impact on the approaches already mentioned can be categorized. To understand much better the impact of civil works, the aspects that affect people’s daily lives will be described.

Economic Impact

As for the economic impact, it is known that these are the changes or effects created by different activities to increase or reduce investment, productivity, and employment associated with the various jobs sustained in a country’s economy. According to the previous contextualization, the civil engineering works reflected in each of the Colombian cities with representations such as buildings, roads, sewers, among others, generally increase the GDP of the country where the value of goods and services produced in a year is located.

During the second quarter of the year, investment in civil works in Colombia increased by 6.4% compared to the same period in 2016. Two of the five groups of civil works grew in the second quarter, led by the group of engineering works such as parks, stadiums, and other sports facilities, as well as constructions for mining, power plants and transport pipes, said the National Department of Statistics (DANE) in a statement (DANE, 2015).

Civil works are a key indicator for the domestic economy, thus showing the role that civil constructions play in the analysis of a country’s economic development. But sometimes the construction sector presents decreases in its contribution to the GDP (Fig. 2).

Así fue la variación del PIB por sectores

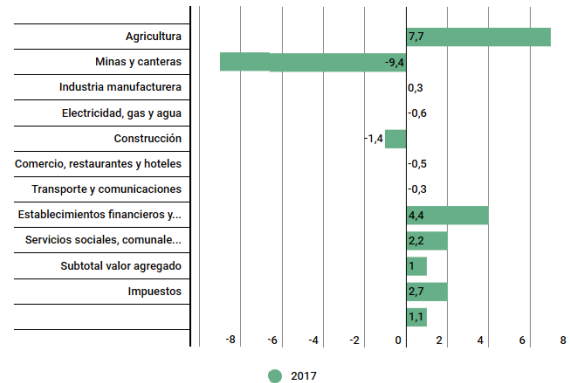


Figure 2. Growth of economic sectors in 2017 (DANE, 2017b).

The economic part in the works of civil engineering has great influence because thanks to them in the country the doors are opened to new national and international markets to obtain greater positioning in the commercial sector, in addition to this for the construction of a project it is very necessary to have personnel in charge in the development of certain functions which generates vacancies thus allowing that the people of that place can accede to work, also, one talks about the costs of intervention, the positive or negative economic consequences that will arise throughout the execution of the construction and the benefits after having finished activities.

Demographic impact

As far as demographics are concerned, it has been shown since previous years that due to the development of new construction, by generating greater job opportunities, people living in places far away from the work site decide to move to the place where the project will be located, contemplating the idea of having better opportunities to undertake their lives due to the direct relationship between the infrastructure systems, development, and financial stability, thus creating the increase of the population in that territory.

This growth in the urbanization of nations is a product of the localization of development, industrialization, and migratory processes. Colombia has an urban population close to 80% (mainly in Bogotá, Medellín, Cali, and Barranquilla), which will increase due to the social and economic gap between the countryside and the city

(Portafolio, 2017a). This generates large increases in the demographic index that occurs every year in the country.

Cultural impact

It is one of the changes that are rarely mentioned, but this type of transformation to the natural environment of the people allows variations in the cultural environment because thanks to the constructive processes as already mentioned the focuses of development are identified which facilitates the acquisition of better knowledge, new perceptions of reality, greater relationship with other individuals in the community.

After referencing the perspectives that will be taken throughout the text to understand the transformations, causes, and possible solutions to the impact generated by civil works, we will continue with the description of the changes generated by each of the branches of civil engineering that promote greater development in society.

Structures

In the case of structures, reference is made to the analysis and calculations that come with it, to use them in the construction of bridges, houses, schools, buildings, etc. economically it helps to manage the commercial sector since using them, referring to the bridges they communicate marine or terrestrial routes with different municipalities facilitating the transport of materials or merchandise which allows developing and powers the financial resources of the country, it is a generator of jobs; the demographic growth is facilitated from these works and in the cultural part thanks to the mobilization of the population it allows to know the diverse places in the national territory acquiring this way different knowledge that enriches the culture of the people, besides with the elaboration of the schools they harness the education of the youngest. It is very important to know that here the impact can be measured utilizing a statistical survey on each situation and by stratification according to the location of the project.

Two of the five groups of civil works grew in the second quarter, led by the group of engineering works such as parks, stadiums and other sports facilities, as well as constructions for mining, power plants, and pipes for transport said the National Department of Statistics (DANE) in a statement.

The sanitary one is in charge of the interventions that have as a purpose the creation of sewers, treatment of residual waters, these works at the moment of initiating require great investments on the part of the state because it must guarantee these services to the society but after its construction it represents very high percentages in the assets of the government, promoting the arrival of new individuals to the cities because thus they improve the conditions (referring to those municipalities that by adverse circumstances do not have this type of services; the cultural part can be demonstrated of a quite clear form in those

populations where this type of work has not been able to be calculated.

A similar treatment is presented in hydraulics, but this one works intending to detect the sources of drinking water, the construction of dams, canals, hydroelectric plants, among others from where the same aspects mentioned in the previous paragraph can be obtained.

In the specific case of hydroelectric plants, they are very good in terms of the economic factor they represent because they provide energy thanks to the mechanical process the water undergoes when passing through the turbines, but to obtain constructions of this magnitude it is very necessary to adapt the site for this type of settlement; this is when the social impact of the work begins to be generated and at the same time cultural changes are created. During the construction phase, the projects use a large number of workers so new job opportunities are possible.

Finally, we will talk about the transport branch in civil engineering because the development of a city is specifically evidenced by the transport routes where mobility is generated in the city, a clear example of this is the construction of railways and roads to communicate territories. Economically they are very expensive for the state, but in the same way, they are a great source of income for the state where the processes of mercantile transfer occur generating a significant increase in the commercial sector of the country, this section of civil engineering has the same demographic and cultural impact except the educational issue.

Taking into account the above, to measure the impact on engineering specializations such as sanitary, hydraulic and transport, the processes generated by these works must be analyzed, such as the concepts of efficiency in these three branches and satisfaction of the need, facilitating the carrying out of a survey for this purpose.

Positive social impact of a civil work

Depending on the focus of the impacts, it can also be divided into two large positive or negative groups. In this section, emphasis will be placed on the benefits brought about by civil engineering works themselves because, as previously mentioned, constructions are very important for a country.

Civil works and its relationship with the economy

Firstly, to speak with greater certainty about the relationship between civil works and the economy, it is necessary to understand that construction activity comprises two sub-sectors: buildings and civil works (Fig. 3). The first refers to the construction, repair, adaptation, and maintenance of residential and non-residential buildings. Civil works, on the other hand, include the construction and maintenance of infrastructures such as roads, dams,

long-distance pipelines, constructions for mining, public service networks, and other civil works (El Tiempo, 2015b).

The two previous subsectors are the ones that have boosted development and increased the country's GDP in recent years because a little more is invested in the execution of projects in the construction sector and it is shown with statistical results made by the entities in charge of obtaining this type of information, as registered in one of the bulletins generated by DANE this year.

In the second quarter of April-June 2017, GDP at constant prices increased by 1.3% compared to the same quarter in 2016. An analysis of the result of value added by large branches of activity shows an increase of 0.3% in the value-added of the construction sector. This result is explained by the 7.4% decline in the buildings subsector and the 6.5% increase in the civil works subsector (Dinero, 2006).

This information regarding the Colombian GDP is very variable, so different analyses are made throughout the year, generally by quarters. From the above, it is shown that there was an improvement in the construction sector, which helped to increase its percentage in the GDP; the country's gross domestic product is the most representative form in which it can be observed that the construction sector is an engine of the economy of the Colombian territory. But civil works affect the economy at three levels: family, business, and state because it demands land, capital, labor, machinery, materials, goods, services, technology, public services, telecommunications, and financial resources. It carries out civil works and building works, which generate salaries, income, profits, interest, and taxes (Perez, 2013).

As for the family benefit generated by construction projects, there is a job offer to obtain the large civil engineering works that the territory has, so the real estate and construction activities are those who generate more employment in the country, at the end of 2016 these had an increase with 81 thousand jobs. In December 2016, 3.26 million people were employed in these unions, according to DANE numbers (DANE, 2017a).

It is considered a positive aspect the labor offer of the civil works because in this way it allows the individuals of the community to access formal employment and in this way, it will help substantially to the generation of income to be able to give a better quality of life to the members of their family group, which is related to the decrease of the unemployment of the country. Apart from satisfying the demand for labor, large investments must also be made to design work and in this way affect businesses or the state.

Besides, in recent years the number of people who can acquire a home has increased, as is evident in the year 2016. Housing finance in Colombia, both houses and apartments (new and used), continues to be on the rise and in the first

three months of 2016 Colombians bought nearly 30,000 units, an increase of 5.6% over the same period in 2015.

Colombian mortgage banks reported that the total amount of credits for financing new housing reached \$1.23 billion, which also shows a significant increase from last year when banks financed loans of \$1.18 billion (Portafolio, 2017b).

The capital employed by public or private entities is the engine that moves the other processes such as the hiring of human and physical resources to obtain better results, which will be recognized in the GDP studies and this is where the close relationship between civil works and the country's economy becomes evident.

The construction of places such as shopping malls and other infrastructure used to increase their capital are also taken into account for the economy, but, these places are already located in other sectors of the economy. However, the constructions can also generate another type of relationship with different factors inherent to the culture of the society for which the projects were designed.

Civil works and the use of free time

Thanks to the engineering constructions, variations are made to the culture because from them it is possible to conceive new perspectives on the reality that each individual has, thus promoting cultural and social change, which is an aspect of great benefit to the community. Some projects are very useful in the search for social change through the use of free time.

Recreational parks. This type of construction is very good at the time of using the moments of leisure of the diverse members of the Colombian population because in its facilities the familiar bonds are fortified and the recreation in those places harnesses the interpersonal relations allowing to know more citizens with different ideologies causing this way cultural expansion, besides, it is very important for the human beings the times of leisure to conceive quality of life (El Tiempo, 2017a).

High performance sports centres. As is well known in Colombia the new generations are very involved in sports activities to enjoy their time off and can do so in the facilities offered by the country to meet this need that has brought so many benefits to the country by the achievements of Colombian athletes.

The large coliseums, stadiums, athletic tracks, velodromes, skating rinks, among other places for sports activities are the result of the intervention of civil engineering to obtain this kind of construction. Nowadays, it allows young people to choose these sites to spend their time and improve on a cultural level because in this kind of scenery it is very easy to get to know different customs and cultures from other departments, cities or countries.

There are sporting events that require the construction of new civil works as has been the case since the beginning of

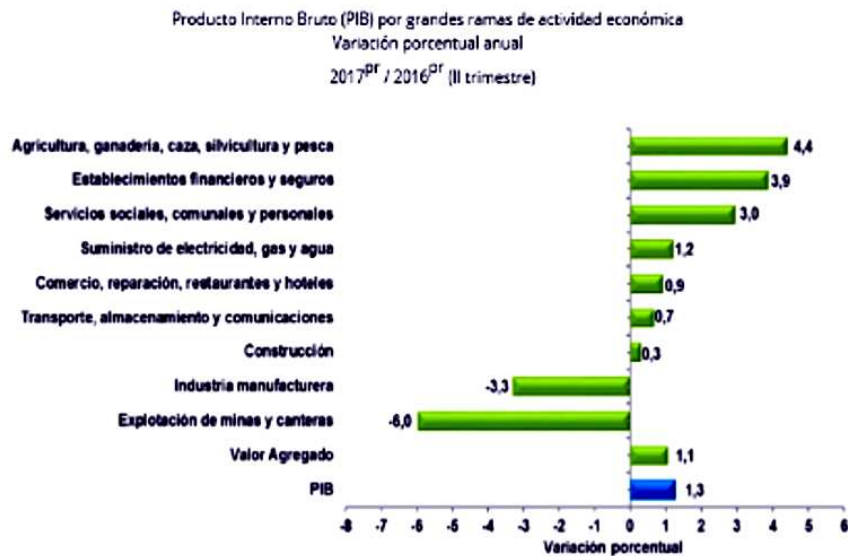


Figure 3. Gross domestic product by major branches of economic activity (Dinero, 2006).

the year on the Colombian coast. The construction of 12 sports venues for the XVIII Bolivarian Games, to be held from November 11 to 25 this year in Santa Marta where the total investment in sports venues will be 150 billion pesos, of which 90 billion are contributed by the National Government, through Coldeportes, and 60 billion by the District (El Tiempo, 2015a).

Libraries and theatres. These works were conceived to be places where the acquisition of knowledge is propitiated to have a culturally enriched society with the objective of generating changes both at a personal and group level; the country has motivated the employment and use of the same, generating more tools for people to consciously use their free time.

Shopping centres. Thanks to the construction of these establishments many families can share pleasant moments and achieve this goal the site must be welcoming.

While the pace of shopping center openings is increasing in the country, the old ones are retouching their facilities and, in some cases, making extensions so as not to be left behind when it comes to attracting visitors.

According to a report by the Association of Shopping Centres of Colombia (Acecolombia), there are currently 16 in 8 cities that are refreshing their image. Six of them will invest about \$1.7 billion in the next few years.

In this way, it is possible to evidence the role played by the intervention by the constructions in the cultural and social advance because the civil engineering through its works, in spite of the perspective that is had on the work developed by these professionals, is the motor for the acquisition of knowledge, interpersonal relations, historical appropriation of the country and culture (Melo, 2014).

Civil works and the development of a city

One of the most influential factors when it comes to knowing whether the country is developed or not is generally the infrastructure present in the territory, which is why there are various types of civil works in charge of satisfying specific needs in each of Colombia's places. Below, we will mention the different constructions used in the country to improve the quality of life of the inhabitants of these places.

Transport infrastructure. Here we find three types of works such as land, sea, and air.

- Land:

It corresponds to works that contribute to improving mobility, cargo transport, and mass transport of passengers. These are subdivided into road and rail. Where the first one is carried out to improve security, land interconnection between ports and different cities. These works include the construction of streets, roads, highways, bridges, viaducts, tunnels, and their associated works such as signaling, lighting, ventilation, pedestrian bridges, massive passenger transport systems such as Transmilenio, etc.

The delivery of the first kilometers of the mega road project in the plains allows us to see in broad strokes the potential development that can have the department of the goal through the number of road works that are being built to connect with other municipalities in the country (DANE, 2017c).

In the case of the railway, it fulfills the same function but is focused on the construction of metros, trams, railways, catenary construction and its associated works, passenger train stations, freight terminals, etc.

A clear example of road infrastructure is the design of two completely new roads that would allow the reduction of

travel times between Bucaramanga and Cúcuta. The first, on the Bucaramanga-Pamplona section, and the other, between Pamplona and Cúcuta (Umaña, 2003).

- Port maritime:

Works for construction and expansion of maritime terminals for cargo and passengers, docks, lighthouses, control centers for communications, beacons, buoys, etc.

- Aerial:

It includes the construction and modernization of airports, cargo terminals, control towers, communications, runway extension, signaling, beaconing, building, and parking facilities, security systems, baggage transport system (El País, 2016).

The Government has invested a record amount of almost \$6 billion in the expansion and modernization of 71 airports, including those under concession and contracted by Aerocivil. In the last 5 years, 7 airlines entered the market, reaching 27 in total, and the number of routes has increased from 68 to 80.

Projects include runway expansion, terminal modernization, and air conditioning, resurfacing, new parking lots, green areas, construction of new cargo and passenger terminals, new control towers, aircraft maintenance buildings and platform expansion, construction of service centers and the expansion or construction of international, private or cargo terminals, among others (Aguilar, 2000).

- Energy infrastructure:

These constructions seek to supply the territory with energy and for them, there are civil works of electrical networks, renewable energies, and hydrocarbons.

Electricity networks These are works that include the construction of Hydraulic, Thermal, or Combined Cycle Power Plants for the production of energy and the construction of electricity networks to supply and cover the required electricity demand due to population growth.

Renewable energy They include works such as maritime and terrestrial wind farms, photovoltaic farms, thermal solar plants, thermal plants for the production of hot water.

Hydrocarbons These are works built for the exploitation and transport of hydrocarbons from the drilling wells to the storage and processing areas. They include works such as oil pipelines, gas pipelines, refineries, compression stations, petrochemical plants, offshore plants, etc.

- Hydraulic infrastructure:

It includes works that help to improve the quality of life of the citizens allowing them to enjoy the drinking water, channeling, and treatment of their wastewater contributing to the improvement of their environmental and health conditions (El Tiempo, 2017b).

- Building infrastructure:

Here we can talk about urban or industrial infrastructure, the former are works aimed at providing a direct service

to citizens and improving their quality of life as hospital infrastructure (hospitals, clinics, health centers), also includes infrastructure for education (university campuses, schools), infrastructure for recreation and sport (sports venues, theme parks, resorts, SPA, etc.), buildings for housing, offices and shopping centers.

As for the industrial one, they are the works of industrial plants, warehouses, and industrial covers for plants such as Cement Factories, Iron and Steel Companies, Agrochemical Industry, Food, Pharmaceuticals, Automobile, Aerospace, Armament, Textile Mechanics, etc (Portafolio, 2017c).

Finally, the infrastructure for telecommunications will be discussed, since it is through telecommunications that new knowledge is acquired and each individual is kept connected to his or her social, family, and cultural environment. Examples of these works are telephone networks, terrestrial and underwater fiber-optic networks, television networks, the Internet, cellular telephony, satellites, repeater antennas, astronomical observatories, telecommunications control centers, etc.

The information provided in this section shows that each of the civil engineering projects in the country has the sole objective of improving the living conditions of the people who live in the places where the constructions will be carried out. It also shows the variety of infrastructure in the country, which tries to bring Colombia to a level of development that is comfortable for both the people and the state, giving priority to some of the specific needs that the different departments of the territory may have. Thanks to the number of works carried out, the relationship between civil works and the development of a city, a department and, why not, the whole country, is a little clearer.

Negative social impact of civil constructions

It is evident the enormous advantages that bring to the community the execution of civil works with the sufficient degree of technical planning, but it is also evident the number of present edges that entails approaching the topic of the social impact of a civil construction; this section will be dedicated to the negative social impact of the civil constructions; beforehand it is important to mention that the sector of the constructions is permeated by a great number of harmful factors that affect the society, the economic and cultural development of the territories and the own constructive system.

Construction, besides being indispensable for the development of society, is also one of the main responsible for the generation of waste, pollution, the transformation of the environment, and considerable use of energy (Acevedo, Vásquez, & Ramírez, 2012). It is no secret that the main negative effect produced by the execution of civil works has the environment as its epicenter. We are aware of the serious effects that transformation without the technical

rigor required to make these changes brings to the territories, but as previously clarified, we consider that articles on this type of problem abound, and it is not the aim of this text to deal with such saturated topics, but it is vitally important to make this type of clarification for a better understanding of our approaches.

We know that touching on this subject requires the greatest rigor and coherence, implementing negative value judgments towards our profession is something challenging and complex, but as an academic exercise, it helps to generate in us a critical and objective position, focusing on the things that must improve the future civil engineering of the country.

It is worth highlighting that due to the scientific nature of civil engineering, it is possible to execute works with the highest degree of planning, perfect execution and minimum negative impact; contrary to this, it is evident that Colombia does not have a very efficient construction system, it is known about all the recent bribery scandals for the awarding of contracts by foreign construction companies to our public officials; subcontracting and diversion of resources by territorial administrations are commonplace in the country's media; This current of analysis, would immediately take us to the scene of corruption and bad management of resources that afflict the country, in contrast to this, we have decided to focus our criticism on the scene of works with deficiencies in planning, and being more concrete, we raise our problem of investigation in the analysis of the plans of territorial ordering POT (seen as potential generators of social changes) pitifully badly executed in the country.

The Land Use Plan (POT) is a technical and normative instrument to organize the municipal or district territory. Law 388 of 1997 defines it as the set of objectives, guidelines, policies, strategies, goals, programs, actions and regulations, designed to guide and manage the physical development of the territory and land use (Cámara de Comercio, 2016). Knowing this definition we can observe the great importance of the POT in the development of the territories and the great influence it has on the relations of the people; besides this, it is pertinent to clarify that to carry out the POT is not a simple task and less so if this is focused on a city as large, diverse and somewhat disordered as Bogotá.

We know in advance that excessive population growth is a reality. The causes of this accelerated population growth are multiple, the main one being a decrease in mortality. The decrease has been produced as a consequence of the sanitary, economic, and technological advances that made possible the disappearance of epidemics and the diffusion of new industrial techniques. The expansion of this progress in developing countries occurred rapidly, parallel to the existence of high birth rates, giving rise to the phenomenon of the population explosion (López, Maca, & Gordillo, 2017; Wikipedia, 2017). These statements immediately generate

the thought that wanting to increase the size of the city would be a bad idea for its citizens and the perception they have of their territory; a wrong idea, since, having this as a reference, population growth is an indisputable reality and it becomes evident that we should not ask ourselves whether to grow or not, but on the contrary, we are obliged to ask ourselves the question: where are we going to grow and how are we going to do it?

Bogotá, Colombia (the capital of the country) is a fairly large city, currently has about 8 million inhabitants (according to DANE) and if a detailed analysis of every aspect involving social relations between its inhabitants, we would conclude that many people live in a small space, the transport system of the capital is not the most appropriate (even is one of the worst in the country), its mobility is slow, its health system leaves much to be desired, there are neighborhoods in precarious conditions as public services are concerned, among other things.

The incoming mayor's office, under the command of Enrique Peñalosa, has the challenge and the obligation to design the capital's POT that will be in force for the next 12 years, a not at all easy task due to the accelerated growth in the number of inhabitants of the capital territory. So far, Mayor Peñalosa's administration has had many detractors and the perception that most citizens have is not the best, this, a consequence of the very controversial bidding process of the elevated metro, which discarded important engineering studies conducted in the previous administration, and the also controversial construction in the Van Der Hammen reserve. These events seem to be obscuring the panorama of the future Land Use Plan for the country's capital.

Taking our city as a reference, we have evidenced that the harmful effects originated by bad territorial planning are a reality; entire citadels located to the south of the city are witnesses of the state abandonment, the deficient provision of public services and the seriousness of the consequences that this deficit in planning brought with it (Fig. 4).

To elaborate a discussion about all the harmful effects that bad planning has brought to the capital would be a too laborious and extensive task, each sector of the city would demand a deep technical analysis to determine the mistakes made and the impact that these caused in the social relations; said this, we have chosen to analyze only one case, based on the importance and conjuncture that this one has; the presented case of negative social impact on the capital is the landfill, Doña Juana.

The Doña Juana landfill is the main garbage dump in Bogotá, located in the town of Ciudad Bolívar, near the Doña Juana hill, between the Mochuelo Alto and Mochuelo Bajo sectors. The landfill has suffered some problems since it was put into operation, the most notable being the collapse that occurred on September 27, 1997, when an accumulation of gases and leachates produced a slide of more than 500,000



Figure 4. Bogotá's constructive growth (El Espectador, 2016).

tons of waste that obstructed the course of the Tunjuelo River. Another landslide occurred on October 2, 2015, with 550,000 cubic meters of waste at the top of the operation. Likewise, the urban expansion that the city has suffered in recent years has led to the settlement of communities near the landfill, which have been affected by the odors and insects coming from it, especially in the paths of Mochuelo Bajo and Mochuelo Alto (López et al., 2017; Wikipedia, 2017).

The living conditions of the people who live in the areas surrounding the landfill have been quite affected by the poor planning of the work. It is not possible that 40 years have not been enough to understand how to manage a large city and know how to manage its waste. A good measure to mitigate the negative impact of this project would be the total relocation of the inhabitants of the upper and lower Mochuelo villages, a proposal that has already been criticized by the inhabitants of Mochuelo itself; We hope that the management given to this situation will be the most adequate. Civil engineers and town planners must work as a team to provide the best solutions within the reach of a reasonable expenditure of resources, where the inhabitants who have had to endure these unacceptable living conditions are the ones who benefit the most. Bogotá, being the capital of the national territory, cannot allow the management of its waste to continue to be executed in such an inefficient manner. It is time to learn from mistakes and improve for the better, this, through an excellent application of civil engineering when designing our cities.

Conclusions

As already mentioned, civil works have a certain level of importance for the development of a slightly more pleasant life, because each of the constructions that surround human beings anywhere in the world was born as a response to a specific need of them. In addition to this, great interest has been shown in showing the impact on society that civil constructions have.

The construction systems in a community are an indicator of development, culture, and history because through the analysis of a civil engineering project it is possible to deduce the general conditions that a population could have had

before, during, and after the beginning of the construction. This type of impact on society makes the tasks used to achieve a building or civil work more interesting because thanks to this, great changes are generated in people's lives, which can be positive or negative as already mentioned in the content of the previous chapters where we wanted to make known the scope that the constructions could have from their objective.

Infrastructure is a key aspect of a country's economic and social development. Historically, Colombia has found it difficult to interconnect its various regions, due to the country's complex geography. Despite this, in recent times, the country has made significant progress in infrastructure development.

According to Dimitri Zaninovich, the country's infrastructure has become a very important aspect of the government since 2010. There the government realized that the development of infrastructure is a locomotive for the country. In fact, since then, the government has set itself important goals in this area, and various strategies have been implemented to encourage the growth of this sector. Now with the projects that are being carried out, it is expected that we will achieve greater integration at the national level, to be more competitive (El Tiempo, 2015c).

As expected, the construction of infrastructure plays a vital role now in these times because it is being sought to improve the country's productivity. Lately, to achieve these objectives, the Colombian state has invested more capital in the construction of 4G roads to improve its capacity to trade nationally and internationally.

Among the five major investments that must be made to boost the economy, without a doubt, the 4G tracks are consolidated as the greatest hope for generating more jobs; it is estimated, for example, that for this year about 313,784 new vacancies will be opened, which would generate a greater contribution to GDP growth, future reductions in logistics costs and better projections in the trade sector.

But in the progress of the 4G tracks, it seems that the picture has been changing. We were used to hearing widespread congratulations on this ambitious program that

comprises an investment dimension of nearly \$47 billion and more than 30 projects.

In the current scenario, there are concerns about the precarious progress of the works, the financial closures, and their impact on the economy. Projects such as Mulalo-Loboguerrero, one of the great feats for the Port of Buenaventura, is paralyzed and thus its economic impact on the region will be delayed. According to figures from the National Infrastructure Agency - ANI, there are four more projects with problems in prior consultation and five in contractual disputes.

At the financial level, the National Development Finance Company plays a very important role in rebuilding the confidence of local investors, strengthening relationships, and seeking more foreign investors and strategic funds; it would also be good to hear that the new fund between BlackRock and Fiduciaria Bancolombia is on its way. The blow to the Odebrecht case from the corruption scandal has been part of the need to energize negotiations and strengthen confidence in the program (Vanguardia, 2015).

The emerging economies of Latin America must project a model of infrastructure development that involves communities, but they must plan for the long term and not with an immediate vision.

To achieve infrastructure, the important thing is not only to put up the money but to have a future-proof infrastructure, how to make the cities grow more sustainably, that allows the cities to begin to spread and not have that disorderly expansion, because then there is no way to order it later, concluded Mr. Ijjás Vásquez.

However, in his diagnosis of what is happening in the country, he highlighted the progress in the development of some projects that are underway for mobility, with projects such as the Fourth Generation, and highlighted the implementation of the Highways for Prosperity project that is currently in the bidding stage in Colombia.

In the development of infrastructure projects for the country, but in particular for the cities, as discussed at the Seventh World Urban Forum UN-Habitat, it is of vital importance that the transport service is attended to and that guarantees of optimum and adequate mobility are considered in the communities, and from them with others. This is what Tomás Elejalde, Planning Manager of Metro de Medellín (Mass Transport Company of the Aburrá Valley), one of the companies with the greatest recognition and requests for information and advice during the Seventh World Urban Forum, considered and explained to Caracol Radio.

The theme of public transport is a very important chapter in the urban issues that have been addressed at this World Urban Forum. Specifically in this chapter, we have identified in the Forum the world current of thought on this subject that could be specified as being important for the cities of the future to generate high density in terms

of the transport lines that are already built to optimize the use of these large investments, the official explained (Clavijo, Alzate, & Mantilla, 2015).

This proves the importance of civil works in the economic development that in turn brings contributions to the culture of the population because of the interconnection between the country and the outskirts of it, the privileges of construction in front of the community for which the project was designed are too many if you think from the social perspective. As a benefit to the people, what it means for them to be able to count on these great civil engineering works in their territories.

Finally, this paper wishes to call attention to those who are generally in charge of development in construction works, which are one of the best indicators that Colombia has compared to other Latin American countries for the increase of GDP. It is very important to know how the work carried out by a group of civil engineers affects at a cultural level, for which it is necessary to dedicate some time to analyze the work carried out and put more effort in understanding which is their role in both cultural and social development because as it was already mentioned, the progress in works of a project generates certain annoying moments for a specific group of people when the project is finished, it must be started with the recognition of the problems that are presented in this text such as the focuses of poverty, the bad distribution of resources, among others.

To improve the scope of a civil engineering project it is necessary to improve the shortcomings that professionals have in this area of knowledge because the biggest difficulty that Colombia presents in the construction sector is the lack of planning or long-term planning that is done halfway thinking that it would not serve much to have a good scheme for the future of that project.

A relevant aspect that would be very good to mention is the planning of a project because thanks to bad execution of this type of work plan, so to speak, the different difficulties for the construction sector arise, making this profession the topic to talk about the common people who due to lack of knowledge misjudge the work of the civil engineer. And it is at that moment when we should think about the impact that civil works cause to the daily life of a certain population because, even though civil projects are born as a response to clear needs of the community when this type of modifications to the people's environment is made, some individuals will open up and dare to refer to the efficiency and the proportionate improvement of the living conditions of the place where the construction was developed, but, at the same time, there will be members of the community who will talk about the negative aspect of the project.

If for engineering students, their main desire is to know and apply their practical and intellectual capacities when working as members of this professional union, the

awareness of these new workers can be given in their training in the higher education institutions available in the country.

A civil engineer must be aware of the important role he plays in the development of a society. A professional of this branch of engineering has the responsibility to keep alive not only one person but more than one hundred people because through the elaboration of a constructive project the value of human life must be taken into account. For this purpose, the civil engineer must present a clearer structural design where the different specifications of the place will be shown with the objective of not having human losses throughout time due to a structural failure.

But the most important thing that a civil engineer must have throughout his professional life is the development of good ethics since it is through the full and correct exercise of this somewhat behavioral doctrine that individuals become more aware of the actions they take to generally obtain personal benefits such as recognition for the accomplishment of excellent work. Perhaps the most gratifying part of this type of work is to define how, from the development of a construction project, new ties are generated with other people, which in principle allows for a little more knowledge of society in certain parts of the country, cultural exchange from the trips made by people through the construction of civil works such as roads, ports, etc. They also play a vital role in enriching the cultural heritage of the members of the community and although changes are generated by the constructions, these can be negative, this helps the professional in charge of the evolution of this construction to decide to analyze the scope and response in the society of each of the processes used to meet the need for which the project was started.

Another factor for the awareness of civil engineers, also referring to professional ethics, is the bad distribution of resources because through the good management of inputs it is possible to reach the proposed objective and, also, more concrete results on the evolution of work will be shown.

The awareness of the work of civil engineering lies in the correct handling of the professional ethics of each one of the students who are currently being trained as engineers because it is from their passage through the educational institutions where the sense of belonging is cultivated and good ethical practice in their professional life will be able to be ethical civil engineers for the society that demands so much the construction of increasingly sophisticated projects.

References

- Acevedo, H., Vásquez, A., & Ramírez, D. (2012). Sostenibilidad: Actualidad y necesidad en el sector de la construcción en Colombia. *Gestión y Ambiente*, 15(1), 105-118.
- Aguilar, L. (2000). *Impacto social y económico de los parques y la infraestructura recreativa*.
- Ahn, I.-S., Cheng, L., Fox, P., Wright, J., Patenaude, S., & Fujii, B. (2015). Material properties of large-size tire derived aggregate for civil engineering applications. *Journal of Materials in Civil Engineering*, 27(9).
- Armstrong, R., Baillie, C., & Cumming-Potvin, W. (2014). Mining and communities: Understanding the context of engineering practice. *Synthesis Lectures on Engineers, Technology, and Society*, 21, 1-150.
- Bao, Y., Meng, Q., & Seo, K. (2014). Research and analysis of damping control technology in civil engineering construction process. *Open Civil Engineering Journal*, 8(1), 406-409.
- Basu, D., Misra, A., & Puppala, A. (2014). Sustainability and geotechnical engineering: Perspectives and review. *Canadian Geotechnical Journal*, 52(1), 96-113.
- Becerik-Gerber, B., Siddiqui, M., Brilakis, I., El-Anwar, O., El-Gohary, N., Mahfouz, T., et al. (2014). Civil engineering grand challenges: Opportunities for data sensing, information analysis, and knowledge discovery. *Journal of Computing in Civil Engineering*, 28(4).
- Cámara de Comercio. (2016). *Plan de ordenamiento territorial*.
- Clavijo, H., Alzate, A., & Mantilla, I. (2015). *Análisis del sector infraestructura en Colombia*.
- DANE. (2015). *Estadísticas por temas de construcción de edificaciones*.
- DANE. (2017a). *Censo de edificaciones-ceed-*.
- DANE. (2017b). *Estadísticas procesos constructivos*.
- DANE. (2017c). *Producto interno bruto (pib) segundo trimestre 2017*.
- Dinero. (2006). *¿es posible medir el impacto social?*
- El Espectador. (2016). *¿llegó la hora de frenar el crecimiento de Bogotá?*
- El País. (2016). *Aumenta la venta de vivienda en Colombia*.
- El Tiempo. (2015a). *Así va el crecimiento de las ciudades en las regiones del mundo*.
- El Tiempo. (2015b). *Bogotá en expansión*.
- El Tiempo. (2015c). *Doble calzada al llano, obra ejemplo entregada con tres años de adelanto*.
- El Tiempo. (2017a). *Economía creció 1.1% en el primer trimestre*.
- El Tiempo. (2017b). *Santa Marta: carrera por los juegos bolivarianos 2017*.
- García, J., Castro, D., Parbole, P., & Ballester, F. (2015). Effects of sea water environment on glass fiber reinforced plastic materials used for marine civil engineering constructions. *Materials and Design*, 66(PA), 46-50.
- Johansen, C., Horney, J., & Tien, I. (2017). Metrics for evaluating and improving community resilience. *Journal of Infrastructure Systems*, 23(2).

- López, F., Maca, K., & Gordillo, L. (2017). More than garbage at the doña juana landfill. *Tekhnê*, 14(2), 23-42.
- Martínez, F., Hernández, C., & Rendón, A. (2017). A study on machine learning models for convergence time predictions in reactive navigation strategies. *Contemporary Engineering Sciences*, 10(25), 1223-1232.
- Melo, H. (2014). *Impacto del sector de la construcción en el pib de bogotá*.
- Monchau, J.-P., Marchetti, M., Ibos, L., Dumoulin, J., Feuillet, V., & Candau, Y. (2014). Infrared emissivity measurements of building and civil engineering materials: A new device for measuring emissivity. *International Journal of Thermophysics*, 35(9-10), 1817-1831.
- Mostafavi, A., Huff, J., Abraham, D., Oakes, W., & Zoltowski, C. (2016). Integrating service, learning, and professional practice: Toward the vision for civil engineering in 2025. *Journal of Professional Issues in Engineering Education and Practice*, 142(3).
- Murray, M., & Ross, S. (2014). National geographic: Understand civil engineering differently. *Proceedings of the Institution of Civil Engineers: Engineering Sustainability*, 167(2), 76-87.
- Perez, C. (2013). *Análisis del impacto social en proyectos de infraestructura*. Retrieved from http://www.fomin-events.com/pppamericas/2013/_upload/panelistas/2_0G1FQ.pdf
- Portafolio. (2017a). *Aumento en la inversión en infraestructura*.
- Portafolio. (2017b). *Inversión en obras civiles aumentó en segundo trimestre*.
- Portafolio. (2017c). *Millonaria inversión en modernización de centros comerciales en colombia*.
- Roohnavaz, C. (2016). Infrastructure construction in developing countries: A shared approach to sustainability. *Proceedings of the Institution of Civil Engineers: Engineering Sustainability*, 171(5), 223-237.
- Uihlein, M. (2017). Structural engineering participation in integrated design. *Practice Periodical on Structural Design and Construction*, 22(1).
- Umaña, Y. (2003). *El sector de la construcción: un sector líder*.
- Vanguardia. (2015). *Nuevas vías reducirán el viaje de bucaramanga a cúcuta*.
- Wikipedia. (2017). *Relleno sanitario doña juana*.

