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Traffic Safety on the Roads of Republika Srpska

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Abstract The monitoring and analysis of traffic safety is an important part of a process in the area of traffic safety control. In a relatively long period of time, based on the analysis in a real time frame, there can be seen some changes of parameters in traffic safety which gives us the insight in the success of so far activities and the prediction of future traffic accidents can be done. Based on the most recent experience and best practices, it is desirable to analyze as many cases as we can in order to understand and interpret the tendencies in traffic safety correctly. However, this requires the constant monitoring of cases, examination of general tendencies and their analyses. This paper analyses the indicators of traffic safety (the number of traffic accidents with casualties, the number of killed and injured) from 2012 to 2017 on the roads of Republika Srpska entity. Special attention, beside traffic accidents, is given to regulations, the costs of traffic accidents and to the performance audit.

Keywords Traffic Accidents, Causes, Cases, Regulations, Costs

1. Introduction

Every year in the world, especially in underdeveloped and developing countries, 1.3 million people die in traffic accidents, and over 50 million people suffer minor or severe injuries. Therefore, traffic road deaths are the leading cause of premature deaths in the world [11].

The research done by the EuroRAP characterized the roads of Bosnia and Herzegovina as the least safe, and more than half traffic roads are said to be high-risk roads where traffic accidents with fatal outcomes happen two to three times more than on the roads of Europa [4]. From 2012 to 2017, there were 223997 traffic accidents in Bosnia and Herzegovina (BIH) in which 1952 people lost their lives and 61119 people suffered some injuries.

The media in the Republika Srpska entity (RS) almost every day are reporting about traffic accidents, their causes and consequences, and places on which the accidents are the most frequent. Beside the number of injured people, the material damages as a result of traffic accidents are in the focus of public.

Traffic accidents are recognized over the world as a global, health, social and economic problem. The United Nation (UN), the World Health Organization, the Global Alliance of NGOs for Road Safety, the World Bank and many other important organizations prepared many documents (resolutions, directives, plans, strategies and recommendations) aiming at reducing the death rate in traffic accidents on the world's roads, especially in the developing countries.

The Republika Srpska entity, together with other members of UN, accepted a series of resolutions about traffic safety of the United Nation General Assembly, among which the most important is Resolution 64/225, adopted in May 2010. This resolution is determined by the UN document 'The Decade of Action for Road Safety 2011-2020'.

'The Road safety strategy 2013-2022' was adopted in May 19th 2013 by The National Assembly of Republika Srpska. Both the strategy and action plan are designed to be in line with the new recommendations of the United Nation General Assembly and with the recommendations of the World Health Organization for developing countries and with the highest international practice.

Both documents are aiming at multiple efforts (within the relevant private and public sectors in Republic of Srpska) of reducing the rate of dead and injured people on the roads of Republic of Srpska entity. All activities are centered around the most important risk factors: alcohol, speeding, seat belt legislation, creating a safe environment for pedestrians, traffic education in schools, increasing public awareness on risks, improving safety of vehicles and the environment, and also proper post-crash care.

If all activities, defined by the strategy, are to be implemented consistently, 586 human lives can be saved, 7033 people can be saved from severe injuries, 41082 people can be saved from minor injuries, and the amount of 582 million BAM for economic costs can be saved [10].

Table 1. Traffic accidents and casualties in RS (from 2012 to 2017)

THE STRUCTURE OF TRAFFIC ACCIDENTS AND CASUALTIES	YEAR						Σ
	2012	2013	2014	2015	2016	2017	
THE NUMBER OF TRAFFIC ACCIDENTS	9378	8441	8588	8581	9.295	9783	54066
• with killed persons	150	130	146	123	135	121	805
• with severe injuries	577	538	495	534	604	575	3323
• with minor injuries	1526	1314	1472	1505	1660	1723	9200
• with material damages	7125	6459	6475	6419	6896	7364	40738
PERSONS KILLED OR INJURED/CASUALTIES	3382	2960	3089	3155	3644	3711	19941
• killed	163	140	153	131	150	130	867
• seriously injured persons	702	651	602	632	752	703	4042
• slightly injured person	2517	2169	2334	2392	2742	2878	15052

2. Traffic Accidents on the Roads of the Republika Srpska Entity

By observing traffic accidents over a longer period of time, the dynamics of their occurrence can be confirmed, and the number of accidents during a certain period of time in the observed area. Based on those indicators, the prediction of their occurrences for the next period can be made.

According to the reports of the Ministry of Interior of Republika Srpska, from 2012 to 2017, there were 54066 traffic accidents in the Republika Srpska entity in which 867 people lost their lives, 4042 people had severe injuries and 15032 people had slight injuries (Table 1). And when it comes to the economic losses, the Republika Srpska entity lost more than 1 billion and 44 million BAM (more than 55 million €). There is no economy in the world that could endure such big losses every year [3].

When it comes to the number of traffic accidents in the Republika Srpska entity, it can be said that their number has not decreased yet, but that there is an oscillating trend in the total number of traffic accidents. This is the characteristic of countries that do not have stable and strong traffic safety systems. Therefore, it is of a high importance to improve the capacity and integrity of a person or institution who/which carries out measures and activities for reducing traffic injuries and deaths.

If one wants positive results in reducing the number and severity of traffic accidents, it is necessary to continuously monitor the state of security in a particular area and promptly response to changes happening in traffic.

A qualitative analysis aims to show causative factors and to determine the degree of impact of each of them on traffic. In this research, the characteristics of the causes and factors by elements are usually emphasized in the first place. The science which studies the causes of traffic accidents is called etiology.

Improper speed, regardless of road conditions or of speed limit, is without any doubt, one of the main cases of traffic accidents in the Republika Srpska entity (around 30.78%). After them, there are traffic accidents caused by some actions of vehicle in traffic, violation of right-of-way, tailgating, and some other cases stated as the causes of traffic accidents in the reports of Ministry Interior of RS (Table 2).

In practice and in literature too, the causes and manifestations often do not differ (etiology and phenomenology). However, the cause of a traffic accident is what directly affected the inner behavior of driver to make a manifestation like improper overtaking, improper speed, etc. In the reports of Ministry interior, it is stated that the cause of an accident is improper speed or overtaking or violation of right-of-way, etc. This misinterpretation of causes and manifestations hinders the identification of real causes of traffic accidents and creates misconception, because manifestations are said to be causes. In that way, measures of social intervention are directed towards prevention of manifestations instead of suppression of the real causes of accidents. Therefore, it is necessary to try to more fully differentiate between the manifestations and causes of traffic accidents in the context of statistical monitoring, and that people who engage in any form of statistical procedure (recorded, analyzed or concluded) understand the difference between manifestations and causes of traffic accidents. In that way, and by eliminating some other deficiencies in the way of data collection (unevenness of criteria, estimation and defining), one would come to a more useful and beneficial statistics which would give a more realistic picture of the actual state than the existing one.

Table 2. The causes of traffic accidents stated in the reports of the Ministry of Interior of Republika Srpska (from 2012 to 2017)

	CAUSE	THE NUMBER OF TRAFFIC ACCIDENTS						Σ	%
		2012	2013	2014	2015	2016	2017		
1.	Actions with vehicle in traffic	2773	2486	2339	2015	2613	2479	**14705**	**27.24**
2.	Improper speed	2675	2747	2761	2735	2789	2935	**16642**	**30.78**
3.	Violation of the right-of-way	1132	1004	1087	1032	1156	1293	**6704**	**12.39**
4.	Tailgating	1041	922	1016	998	1056	1343	**6376**	**11.79**
5.	Wrong-way driving				768	206	451	**1425**	**2.63**
6.	Improper moving by a vehicle from opposite directions	522	364	358	259	307	267	**2077**	**3.84**
7.	Improper overtaking	285	219	215	212	246	259	**1436**	**2.65**
8.	Pedestrians faults	53	52	48	47	53	47	**300**	**0.55**
9.	Improper passing of a non-moving vehicle	52	35	41	52	57	63	**300**	**0.55**
10.	Road factor	26	24	24	24	26	22	**146**	**0.28**
11.	Technical malfunction of the vehicle	16	14	15	15	16	22	**98**	**0.18**
12.	Motorcyclists faults		13	6	5	5	5	**34**	**0.06**
13.	Bicyclist faults	16	10	14	9	14	13	**76**	**0.14**
14.	Moped drivers faults		13	5	5	7	1	**31**	**0.06**
15.	Other causes	787	538	659	405	744	583	**3716**	**6.86**
Σ		**9378**	**8441**	**8588**	**8581**	**9295**	**9783**	**54066**	**100**

For successful prevention of traffic accidents, it is necessary to determine first the causes of their occurrences, and then design an effective reaction of the society. It is a rare case that traffic accidents happen for just one cause. They are usually a result of one complex, intertwined, simultaneous effect of a number of different objective and subjective factors: causes, conditions, reasons, states, circumstances, elements, habits, attitudes, beliefs, social and biological motives and numerous other factors. These factors are not limited only to human actions and behavior, but also to some objective factors. When it comes to objective factors, various social, technical and natural factors are most commonly intertwined with each other at the same time. However, based on previous research, it can be said with certainty that the role of human factor is most important [7]. The subjective factor (man) is attributed to 80-95% of all traffic accidents, while the remaining 5-20% is an objective factor (vehicle and road).

According to the data in Table 2, in the structure of the causes of traffic accidents on Republika Srpska's roads, 99.54% of traffic accidents are assigned to the subjective factor (man). However, that doesn't mean that the human mistake is always the only cause of a traffic accident. Although mistakes of subjective nature have been dominant, a large percentage of accidents is often attributed to man because the society transfers some of its guilt to an individual by requiring them to adjust their behavior to conditions that are not optimal, and to compensate for the deficiencies with increased attention. In addition, a subjective mistake often comes as a consequence of objective circumstances (road and vehicle) such as, for example, feeling tired faster than usual due to a bad road or uncomfortable vehicle, etc.

In the structure of the causes of traffic accidents on the Republika Srpska's roads, technical factors (road and vehicle) have the percentage of 0.46 (Table 2). This small percentage of objective (technical) factors in the statistics is a consequence of the habit Ministry of Interior (hereinafter, MUP RS) to cite only one cause (factor) in the statistical report, and ignore many other factors that, observing together, are of the high importance. In addition, the members of MUP RS are not fond of entering objective factors, because then there won't be any court process (there is no subjective responsibilities), where the truth can be better established by the presentation of various pieces of evidence, and they can be accused for being subjective. The main reason for small percentage of objective factors (road and vehicle) is that it is difficult to determine on the

spot the structure, interaction, causal relationships, and the legitimacy of many factors.

According to the statistic data of MUP RS, the effect of technical factors (road and vehicle) on the occurrence of traffic accidents is ignored. In the period from 2012 to 2017, the road as a main cause of traffic accidents is mentioned in 0.28% of accidents (Table 2). Having in mind the whole road network, the road must have been the main cause more often than registered.

In the same way, the vehicle as a main cause of traffic accidents was mentioned in 0.18% of accidents what is unacceptable having in mind that the age structure of vehicles wasn't very promising. On the other hand, the technical safety of vehicle was endangered by other factors such as problems with spare parts, motor fuel, etc. If we also take into account that bad roads contribute to faster destroying of vehicle's technical safety, it is clear that the effect of vehicle is ignored as a cause of traffic accidents on roads of Republika Srpska.

Traffic accidents are one complex phenomenon and it cannot be simplified to just simple formulas and mechanisms such as man, road, vehicle. They are the result of extensive and intertwined combinations of various factors. Some crucial, first-hand factors would have stayed without a concrete realization if there hadn't been other causes, circumstances and elements. Without an exact methodology and deeper studying of real causes and mechanisms of accidents' occurrences, it is not possible to determine for sure which factor, and in what measure, contributes to the occurrence of traffic accidents.

3. Legal Regulations and Levels of Responsibilities in the System

The field of traffic safety on the roads of Republika Srpska is regulated by the Law of Traffic Safety on roads in BiH and by the Law of Traffic Safety on roads of Republika Srpska. However, for this very field there are some other important laws, strategic documents, and some bylaws in the form of decisions, regulations, programs, instructions, guidelines, etc.

Traffic safety on the roads of Republika Srpska represents a complex system, with numerous elements, authorities and responsibilities. According to the Law of traffic safety on roads of Republika Srpska, the administrative authority and institutions responsible for the traffic safety state are the Ministry of Transport and Communication, the Ministry of Interior, the Ministry of Education and Culture, the Ministry of health and Social care, the Agency, the Republic Administration for Inspection activities, the Auto-moto association of Republika Srpska, public companies entrusted with management of the road network and local self-government units.

Responsibilities and obligations of institutions according to the Law of Traffic Safety on roads of Republika Srpska and other relevant regulations are:

- The Government of Republika Srpska directly, or through Road safety council and line ministries, supervises the work of the republic institutions in the system of traffic safety, considers issues, suggests measures for improving traffic safety, and initiates the creation and adoption of laws and other acts.
- Traffic police, or authorized persons, directly monitor the state of traffic on roads, check persons and vehicles in the sense of respecting laws and regulations adopted on the basis of the law. They also make preventive and repressive control over the traffic and within it they educate and warn drivers. They apply protective measures and issue misdemeanor warrants. They also register, investigate and punish all irregular behaviors in traffic.
- Road managers have responsibility to secure that all public roads intended for traffic are constructed in accordance with traffic safety requirements. Public roads must be maintained so as to meet traffic safety requirements. New roads must pass the system of revision, and the old ones the system of safety checking. Road managers are obliged to organize permanent control of road condition and the maintenance of public roads, objects, traffic signs and other equipment on roads for the safe and undisturbed traffic. They are obliged to check the state of traffic safety on roads, to make analysis of dangerous places on the road and take measures to eliminate them.
- Local authorities control the condition and maintenance of roads they cover, objects, traffic signs and equipment on the roads in a way that the traffic is safe and undisturbed. They are responsible for removing all the problems on roads which can provoke a traffic accident, and all other tasks determined by the law. They are obliged to form local councils for traffic safety, and to make strategic plans and programs of traffic safety.

4. Costs of Traffic Accidents in Republika Srpska

Road traffic safety is a problem in the whole world and numerous countries try to reduce the number of dead and injured persons on their roads. When coming to that issue, the first step is to examine the actual and potential losses which are the result of traffic accidents.

The socioeconomic losses resulting as a consequence of traffic accidents on Republika Srpska roads are calculated by the gross Output Method (Human capital approach-Ex post approach)-a methodological approach used in many

countries [3]. By applying this method the following costs are estimated: costs of administration, proper care of injured, damage on property, lost productivity of dead and injured, as well as compensation for physical pain, mental pain and trauma. The most important results of this research are shown below.

Individual costs components in each category of traffic accidents and casualties are shown in Table 3. If rough estimation of physical pain, mental pain and trauma is calculated in this calculation, human costs are 520950 BAM for each person killed in traffic accidents, 20776 BAM for each severely injured person, and 693 BAM for each person with minor injuries. Even in the cases where physical pain, mental pain and trauma are excluded, the cost for each person killed in traffic accidents will be 372000 BAM.

Table 3. Losses for every casualty of traffic accident according to the degree of severity in Republika Srspka

CONSEQUENCES	COSTS	
	BAM	EUROS
Killed	520950	266358
Seriously injured	20776	10621
Slightly injured	693	354

In the most of cases, more than one casualty is involved, so when calculating the costs on the basis of one traffic accident, the number of casualties according to the consequence of the accident must be determined. Table 4 shows the average number (rate) of casualties for each class of accident based on the estimated number of casualties and estimated number of traffic accidents. Having in mind that in the traffic accidents resulting with injuries there are more than one casualty, the estimated cost is 620618 BAM per accident with killed persons, 66683 BAM per accident with severely injured persons, and 6221 BAM per accident with slightly injured persons, while in traffic accidents resulting just in material damage on property the cost is 3258BAM.

It should be noted that the values of economic losses shown above are the minimum ones. If the approach 'willingness to pay' is used in this process, the values would be two or three times higher. However, the mentioned approach requires an extensive examination of opinions, and its implementation would be very expensive, long-term and complicated. For those reasons, many countries use the 'human capital' approach (the same is done in Republika Srpska), knowing that the calculation has absolutely minimal value, and that if these findings can justify intervention, then they would be even more justified by using any other method of calculating costs.

Table 4. Losses per each traffic accident according to the degree of severity in Republika Srpska

THE DEGREE OF SEVERITY OF TRAFFIC ACCIDENT	COSTS	
	BAM	EUROS
Accidents with killed persons	620618	317317
Accidents with severely injured persons	66683	34094
Accidents with slightly injured persons	6221	3181
Accidents with only material damages on property	3258	1666

5. Performance Audit

In 2013, the Supreme Office for Public Sector Auditing in Republika Srpska carried out a performance audit called 'Traffic safety on Republika Srpska's roads'. The aim of this audit was to investigate and estimate whether the responsible institutions effectively work on the prevention of traffic accidents, on reducing the number of dead and injured persons, and whether the expected results are achieved.

The audit came to the following results:

Traffic police controls in the observed period of time didn't reduce the leading causes of traffic accidents.

The current way of checking speed and driving under the influence of alcohol is not efficient; the expected results are not achieved.

Planning of traffic police controls is done without any objective criteria and without an overall tracking of some indicators which would help to determine priorities and expected results.

Traffic police in the observed period of time didn't modernize the controls, and the existing resources were not equally located between traffic safety stations.

Neither a functional system of data exchange among institutions in traffic safety system has been established yet, nor the data base on all important traffic safety indicators have been established fully.

Road managers in Republika Srpska didn't identify, mark or remove dangerous places on the roads in the observed period of time.

A clearly defined way of controlling, analyzing of adequacy and matching the existing speed limits on roads wasn't established.

Most of the roads in Republika Srpska have neither projects of traffic signalization nor elaborates on planned speed.

Road managers rarely used some traffic calming measures, and even less often those measures were applied on the basis of traffic accidents indicators.

The findings of the audit indicate the existence of a significant space for improving the safety of traffic on the roads of the Republika Srpska, and therefore for reducing the number of people killed and seriously injured in traffic accidents, as well as for reducing the social costs of the consequences of traffic accidents.

6. Conclusions

In comparison with other countries in the region, especially with developed ones, traffic road network in Republika Srpska is relatively inefficient and unsafe. When we talk about international standards, the rate of traffic accidents, especially those with fatal consequences, is unacceptably high.

The growing problem of traffic accidents and human victims has made traffic safety as one of the most important state problem, and thus it became a component of road projects in Repubika Srpska, which are financed by World Bank loans.

Republika Srpska is still in an early phase of developing traffic safety on its roads, and the basic possibilities, activities and resources are still not available to the key entities or to the existing system in Republika Srpska. Before the key system and knowledge are set to its place, a lot of effort will be required to enforce capacity, practice and activities important for establishing an efficient work in the field of traffic safety.

Some important steps have been taken in the last six years in Republika Srpska on establishing the system of traffic safety management. The Law of Traffic Safety on the roads of Republika Srpska was adopted, the World Bank project 'Improvement Of Road Safety Management And Conditions In the Republika Srpska' was fulfilled, a new Traffic Safety Council and the Traffic Safety Agency were formed.

Within the project 'Improvement Of Road Safety Management And Conditions In the Republika Srpska', in the presence of all representatives of traffic safety system and with the technical support of consulting team, all sectors of traffic safety were analyzed and on the basis of that, The Strategy and Program of traffic safety for Republika Srpska were adopted. Within this project, The Economics Institute from Banja Luka made a research on losses which the economy of Republika Srpska endures due to traffic accidents. From the reports on cost of traffic accidents in Republika Srpska, it can be seen that those costs are very high, even when a conservative estimation method was used. The values would be two or three times higher if the estimation method was 'willingness-to pay'.

Taking into account those annual losses, the authorities should invest more in exploring the traffic safety on the roads, in order to better understand the causes of traffic accidents. Investing in road safety should be considered as an 'investment' rather than 'cost'.

All activities would give a positive result and reduce the number of casualties on the roads of Republika Srpska if there is a support for implementation of Traffic Safety Program , not just political one, but also financial and professional support, and also the readiness of all traffic safety entities to work together to implement measures of traffic safety.

The experience of highly developed countries, especially European ones, shows that the number of traffic accidents and the killed persons can be reduced through strategically designed and systemic efforts within the key sectors, with good political and financial support. This can be used in the realization of strategy and program of traffic safety. Having in mind that this is a global problem, which many countries faced with and learnt very expensive lessons, the authorities of Republika Srpska should learn from their experience. Namely, there are some rich experiences and proved solutions which can be used for improving the traffic safety on roads. Efficient solutions are well-known and available for solving this global problem. It only takes resources and readiness to apply them, and also there should be clearly clarified responsibilities for effective activities in order to achieve success.

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Elementary School Planning in Japan: A Historical Study for Regulations

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Abstract This article surveys the history, laws, and social background of elementary school facility planning in Japan and proposes a planning method for elementary school facilities in a society with an aging, decreasing population and lower birthrate. The mass construction of schools began before the 1980s and many of the current elementary school facilities were constructed around this period. The study is based on the surveys regarding history and laws related to the planning of elementary school facilities in Japan. The history was divided into six periods and the planning characteristics of each period were discussed. The first period was the initial development of laws and standards and the second period was the emergency steps after World War II. In the third and fourth periods many subsidy systems were established for the mass development of schools. The fifth period was for qualitative development, where various subsidies began to support school quality improvement. The sixth period was a stage where schools were closed and surplus spaces occurred due to the recent low birthrate. The elementary school planning theory before 2000 was for new construction of schools, but in recent years a planning theory for the renewal of school buildings such as renovation or conversion of the buildings has become necessary.

Keywords Elementary School, Facility Planning Method, Japan, Depopulating Society, History

1. Introduction

In this paper, the object of the research is public elementary schools. Outline of elementary school education and administration in Japan are as follows.

There are about twenty three thousand elementary schools in Japan, 99% of which are public elementary schools and 1% are private elementary schools. The elementary school is a six-year system for 6 to 12 years old, and 9 years including compulsory education is 9 years, including 3 years at junior high school. Most of the public elementary schools are established, operated, and managed by local governments, and only about 70 schools are national elementary schools. The nation establishes a system including installation standards. In addition, the government burdens 1/2 - 1/3 of the cost of constructing elementary schools and 1/3 of the salary of faculty staff. The number of children per class of elementary school the country prescribes is 35 students in first grade primary school and 40 students in second to sixth grade. The area of a general classroom is about 60 m². School distance is within walking distance except for areas with less population such as rural areas. Except for a few municipalities, the child enters an elementary school designated by a municipality that is located within the residential area.

Japan's rapid economic growth from the 1950's to the beginning of the 1970's enabled the construction of many public facilities in the 1960's to 1970's, including the mass development of elementary schools. However, from the 1980's, Japan has faced an aging population and lower birthrate. The population ratio of children under 15 has been decreasing not only in Japan but also in Korea and China. Among western countries, an aging population and lower birthrate has been observed also in Germany. On the other hand, in the United States, the UK and France, the proportion of elderly people has not increased so much (Figure 1, source: United Nations, World Population Prospects, The 2012 Revision, http://www.un.org/en/development/desa/population/). In Japan, the number of children is decreasing, and more and more elementary schools have surplus capacity. So far, the conversion of surplus classrooms and reorganization of the schools have been considered individually.

2. Objectives

A new comprehensive planning proposal that takes into account the historical background, existing stock conditions, and the changes in demographic demand is now required.

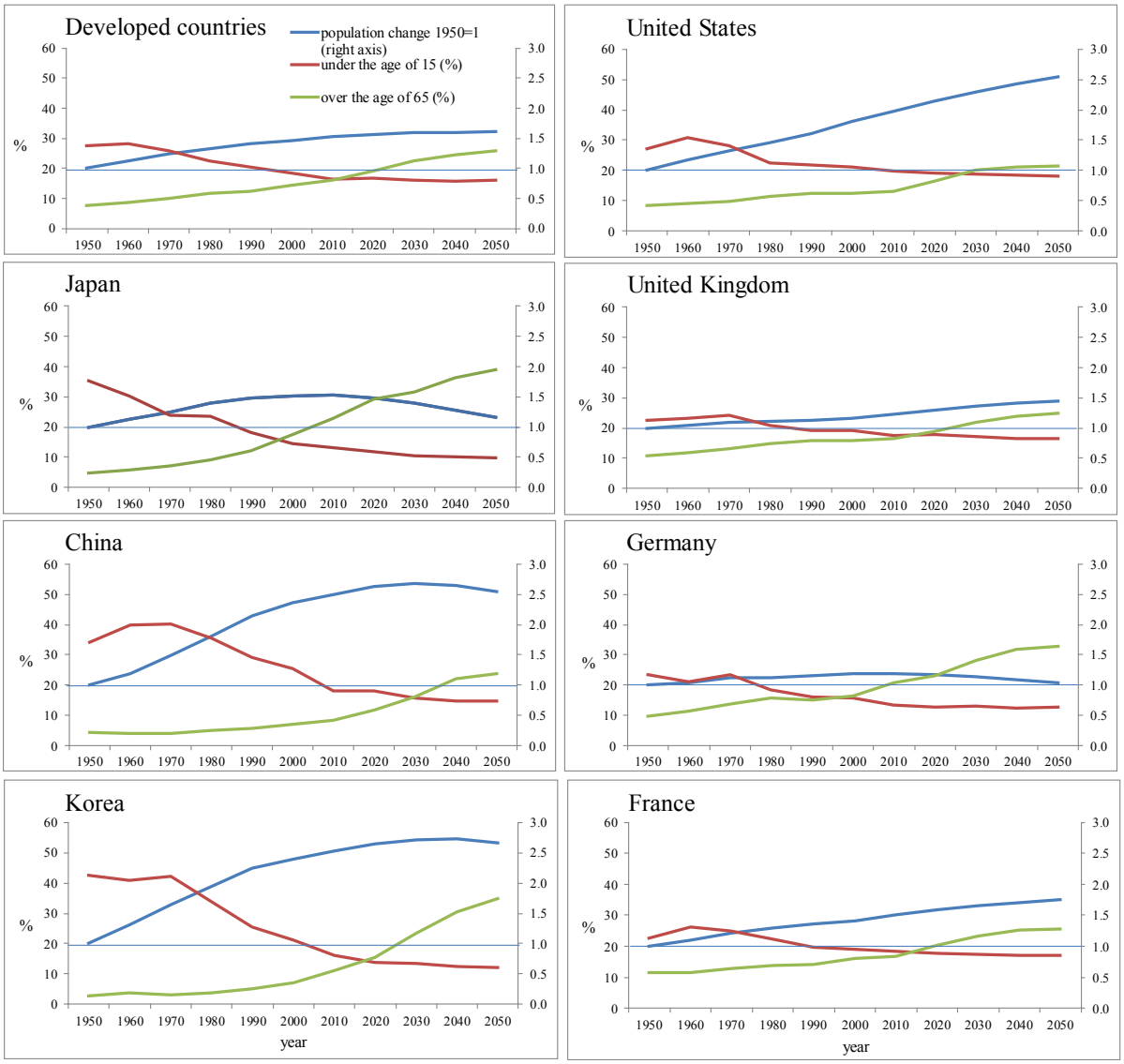

Figure 1. Population movements and forecast in Developed countries, Japan, China, Korea, the United States, the UK, Germany and France

The objectives of this research for Japanese public elementary schools are as follows.

1. To overview the trends in number of classes and classes since the 1950s and the situation of elementary school facilities stock.
2. To Classify and organize the laws, institutions, etc. in 1892 or later, in which elementary schools were institutionalized in Japan, by age.
3. To discuss changes in social situations and issues related to elementary school facilities by age.
4. To identify the issues surrounding current elementary school facilities and the necessary planning methods.

3. Materials and Methods

The content and references were studied and classified in (3.1.) and revealed changes school planning after 1892 and the background to those changes. Then existing and future problems related to elementary school facilities were extracted from the references in (3.2.).

3.1. References for Changes in School Planning after 1892 and the Background

The following three references and the webpage of the Ministry of Education, Culture, Sports, Science and Technology were surveyed.

a "Shin Kenchikugaku Taikei 21 (New Architectonics: Local Facility Planning)," Shokokusha, 1984, 394 pages (in Japanese). [1]

b "Shin Kenchikugaku Taikei 29 (New Architectonics: School design)," Shokokusha, 1983, 332 pages (in Japanese). [2]

c "Gakko Kenchiku (School Architecture): Planning and design," Architectural Institute of Japan, 1979, 733 pages (in Japanese). [3]

References a and b are part of "New Kenchikugaku

Taikei" series (50 volumes), which is a basic summary of Japan's architectonics and was written by researchers representing various fields. Reference c was edited and issued by the Architectural Institute of Japan, the largest and most powerful organization of architectonics in Japan, and is highly reliable.

The webpage of the Ministry of Education, Culture, Sports, Science and Technology (http://www.mext.go.jp/english/) was used to extract related laws. Statistical data of schools were taken from annual school survey statistics made by the Statistics Bureau, Ministry of Internal Affairs and Communications (http://www.e-stat.go.jp/SG1/estat/List.do?bid=00000101 5843&cycode=0).

3.2. References for Existing and Future Problems Related to Elementary School Facilities

The problems were extracted from Reference d and Document e issued by the Ministry of Education, Culture, Sports, Science and Technology.

- d "Utilization of school buildings: Renewal and renovation manual for schools," Tokyo Metropolitan University, 2007, 102 pages (in Japanese). [4]
- e "Current situation of school facilities (2014)" (in Japanese) [5]

"Guideline of appropriate size and allocation of public elementary and junior high schools (2015)" (in Japanese) [6], etc.

4. Results

4.1. Change in the Number of Children and Classes and Situation of Elementary School Facilities in Japan

Figure 2 shows the number of children and classes and the construction period of elementary school facilities. Japan has had two baby booms and the number of children reached a peak in the second half of the 1950's and in the first half of the 1980's. The number of classes changes with the number of children. In the 1950's, the number of classes was small relative to the number of children since there were more children in a class. The number of children has been decreasing and the number of closed schools has been increasing since the second half of the 1980's (Figure 3).

The mass construction of schools began before the 1980's and many of the current elementary school facilities were constructed around this period. About 20% of the elementary school facilities were constructed in or before 1973 and are now at least 45 years old. Local governments are considering rebuilding the facilities but reconstruction is difficult because of budget shortfalls.

4.2. Change of Planning Theories in Japan

4.2.1. History of the School District System

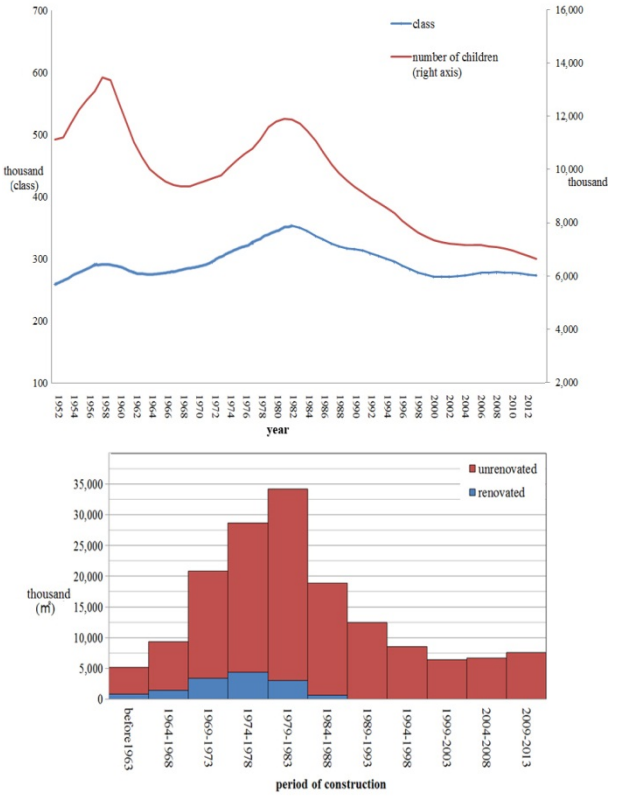

Figure 2. Number of classes and children, and construction period of elementary school facilities

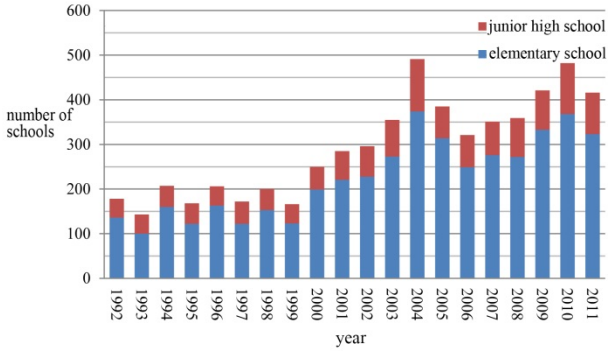

Figure 3. Number of closed junior high and elementary schools

The current elementary school system of Japan started in 1892 and, standards on the number of classes and the commuting distance relevant to the school district were developed and changed from time to time.

Elementary school allocation and district planning in Japan were greatly influenced by the neighborhood unit theory according to C. A. Perry[7], (1929) For example, the development of Senri Newtown, which was planned in the 1960s and is now a typical developed town in Japan,

was based on Perry's neighborhood unit theory. Since then, the arrangement of elementary schools in Japan has been examined based on the neighborhood unit theory and one public elementary school per school district has been the basic school configuration. In addition, local government support organizations and resident organizations tended to be developed on the basis of these elementary school districts. Also, in many cases, community centers were built in each school district.

4.2.2. Change in School Size and Commuting Distance

In 1897, the Ministry of Education, Culture, Sports, Science and Technology designated the number of classes to be a maximum of 10. However, the policy was changed several times: "a maximum of 12" in 1900, "a maximum of 18" in 1909, and "a maximum of 24" in 1926. The School Education Law came into force in 1947 but the size of schools was not designated. In 1958, the enforcement ordinance of the School Education Law designated that the standard number of classes should be no fewer than 12 and no more than 18 and this ordinance is still valid.

In 1927, Japan School Healthcare Committee designated that the commuting distance should be within 2km and 30 minutes for lower grades and 3km and 50 minutes for higher grades. In 1958, the commuting distance for elementary schools was designated to be within approximately 4km by the National Liability Law and the Ordinance on Compulsory Education School Facility Expenses. The neighborhood unit theory states that the standard commuting distance is about 800m and can be more than 1,200m in low population areas. Therefore the distance designated by law is significantly larger than the distance specified by the theory.

4.2.3. Change in Laws and Systems for Elementary School Facility Development

As shown in Table 1, the history from second elementary school ordinance in 1892 to the present can be divided into six periods, based on the situation in Japan such as prewar, postwar, and high-growth period, and the state of formulation of the legal system related to school. The first period was the initial development of laws and standards and the second period was the emergency steps after World War II. In the third and fourth periods many subsidy systems were established for the mass development of schools. The fifth period was for qualitative development, where various subsidies began to support school quality improvement. The six period was a stage where schools were closed and surplus spaces occurred due to the recent low birthrate.

- **First period:** Initial development of laws and standards - 1892-1944

The school system began and standards on the school size and the commuting distance were developed in this period.

- **Second period:** Emergency steps after World War II - 1945-1949

A subsidy for the recovery of damaged school buildings was provided and the Fundamentals of Education Act and School Education Law were established.

- **Third period:** Preceding mass development and extraordinary measures law enrichment (subsidy) - 1950-**1957**

Japan experienced its first baby boom in 1947-49 and the number of children reached a peak in the second half of the 1950's. Accordingly in 1953, a national subsidy system for school construction was established. In 1955, a subsidy was provided for new or additional construction of school buildings to avoid "abnormal classes" where the classroom capacity is largely exceeded.

In 1950, a standard design of steel-reinforced concrete school buildings was designed. In the 1960's and afterwards, the materials used for the construction of school buildings were switched from wood to steel-reinforced concrete to make the buildings fireproof. In that period, the main concern was to provide measures to protect the building structure against natural disasters and fires.

- **Fourth period:** Mass production, reconsideration of school size, and response to increasing population - 1958-1980

In 1958, a law was established to change the standard number of students per class from 50 to 45.

Also in the School Health Law established that year, standards on ventilation, daylighting, lighting, heat retention, and healthcare for planning schools were provided.

In the 1970's when the second baby boom occurred, plans were promoted for the development of large schools and for allowing future additional construction. In this period, the development of large new towns and remarkable population concentrations in cities accelerated the mass development. In 1971, a special development project was launched to respond to the increasing population.

- **Fifth period:** Qualitative development - 1981

The Revised Building Standards Act was established in 1981 for new quake-resistant standards. Also various subsidies for quality improvement such as multi-purpose spaces and information education were provided.

- **Sixth period:** School closing and surplus spaces due to declining birthrate - Around 2000

Table 1. Timeline of laws, systems, and subsidies related to elementary school development

		Name of laws, systems, subsidies	Subsidy	Size of school and class	Commuting distance	Structure and quality	Remarks
First period: Initial development of laws and standards	1892	Second Elementary School Ordinance		○			Current elementary school system began. (Six-year old children enter elementary schools. This rule applied to all children in Japan.)
	1897	Instructions of the Ministry of Education, Science, Sports and Culture		○			School size: No more than 10 classes
	1900	Enforcement regulations of Elementary School Ordinance		○			School size: 12 classes or less
	1909	Enforcement regulations of Elementary School Ordinance partially revised		○			School size: 18 classes or less
	1926	Enforcement regulations of Elementary School Ordinance partially revised		○			School size: 24 classes or less
	1927	National school health council			○		Commuting distance: Within 2km and 30 minutes for lower grades and within 3km and 50 minutes for higher grades
	1934	Land Reallocation, City Planning Division, Ministry of Home Affairs: School site design standards for urban elementary schools			○		Commuting distance: Within 1km. Standard distance of 0.7km.
Second period: Emergency step after World War II	1941	Enforcement regulations of Elementary School Ordinance		○			School size: 24 classes or less
	1946	Basic plan of school allocation in land planning					
		Recovery policy of war-damaged school buildings	○				
	1947	Fundamentals of Education Act					
		School Education Law		○			School size: No ordinance (Enforcement ordinance of School Education Law)
	1949	Japan Building Standards "JES building 1302, wooden elementary buildings" established				○	
Third period: Preceding term of mass development and extraordinary measures law enrichment (subsidy)	1950	Building Standards Act				○	
		Standard design of steel-reinforced concrete school buildings				○	Five kinds of school building layouts, 7x9M classrooms, 3M corridor
	1953	Act on Temporary Measures for Renovation Promotion of Dangerous School Buildings	○				
		Government Financial Contribution to Public School Facilities Act	○				
	1954	Government Financial Contribution to Public School Facilities Act partially revised	○				Area standards updated
						○	Development of light-gauge steel school buildings
	1955	Act on Temporary Measures for Promotion of Elimination of Extraordinary Classes of Public	○				To eliminate shortage of school buildings
	1956	Subsidy for development of consolidated facilities of public elementary and junior high schools	○		○		Commuting distance: 4km max (Central Education Council: Policy of reorganization of public elementary and junior high schools)
Fourth period: Later term of mass production, reconsideration of school size, and response to increasing population	1958	Enforcement ordinance of School Education Law		○			Standard school size: No fewer than 12 and no more than 18 classes
		Laws on Class Organization and Authorized Number of Teachers of Public Compulsory	○	○			Standard number of students in class: 50 to 45
		National Contribution Law and Enforcement Ordinance of Facility Expenses of Compulsory	○		○		Commuting distance: Within about 4km for elementary school students
		School Health Law				○	Standards on ventilation, daylighting, lighting, heat retention, and healthcare
	1963	Report from Inquiry Committee on Standards of School Facilities			○		Commuting distance: Optimal distance is within 0.5km and 10 minutes in cities, and within 1km and 15 minutes in rural areas.
	1971	Special Development Project of Public Elementary School Facilities owned by Cities, Towns, and Villages with Increasing Number of Children	○				
Fifth period: Qualitative development	1981	Building Standards Act partially revised				○	New quake-resistant design standard
	1983	Outline of provision of subsidy for school facility environment improvement	○			○	Renovation works for old facilities
	1985	Subsidy for internal renovation work for diversification of education content and method	○			○	
	1988	Subsidy for works against asbestos started	○			○	
	1989	Expansion of subsidy target works for information education	○			○	
	1994	Subsidy for air conditioner works and barrier-free works started	○			○	
		Subsidy for seismic strengthening works started	○			○	
Sixth period: School closing and surplus spaces due to declining birthrate	2000	Subsidy for in-school LAN construction started	○			○	
	2002	Subsidy for safety control facility development works (structure, crime prevention) started	○			○	
	2005	Building Standards Act partially revised				○	Elimination of 3M ceiling height standard
	2011	Revised Compulsory Education Standardization Act		○			No more than 35 students for first grade
		Subsidy for eco-retrofit project started	○			○	
	2015	Manual for appropriate size and allocation of public elementary and junior high schools		○			Referring to consolidation based on the number of classes, etc.

From around 2000, the number of children began to decrease due to the declining birthrate and the number of school closures began to increase. Many elementary schools now have unused classrooms and utilization of the rooms is a serious issue.

4.3. Change in Social Situation and Problems of Elementary School Facilities

The influence of social situation on school planning after the rapid economic growth period is shown below in chronological order.

Mass development - 1950's to around 1980

As stated above, the number of children peaked in the second half of the 1950's during the period of rapid economic growth. In this period, while the mass development of school buildings was pursued, a law was established in 1958 to change the maximum number of students per class from 50 to 45. In the 1960's, there was a shortage of elementary school building facilities in specific areas due to the development of large new towns and population concentration in cities. In city areas, new elementary schools were built by dividing existing school districts and additional facilities were constructed to supplement existing school buildings.

Anti-seismic renovation - 1995 to now

The Building Standards Act was revised in 1981 and the quake-resistant standards were updated. In 1995, the Act for Promotion of Renovation for Earthquake-Resistant Structures was established and an obligation to make efforts to retrofit school facilities with anti-seismic measures was imposed. By April 2015, seismic retrofits of about 95% of elementary and junior high schools over the country had been completed.

Decreasing number of children - 1990's to now

The number of children has been decreasing after the second baby boom generation in the first half of the 1980's. In Japan, as shown in Figure 1, the population and the birthrate are declining.

Care for global environment - Second half of 1990's to now

In 1997, the Kyoto Protocol was concluded to prevent global warming, and since then, school facilities that take the environment into consideration (eco schools) have been developed. Pilot model projects were approved and conducted for 1,564 elementary and junior high schools in 1997 through March 2015.

Anticrime measure for schools - Around 2000 to now

In 2001, a suspicious individual with a knife entered Ikeda Elementary School in Osaka Prefecture through the car gate. He killed eight children and injured thirteen children and two teachers. In response, in 2002 a subsidy began to be provided for the construction of safety measures in elementary school facilities.

Use of school facilities as local government assets - Around 2010 to now

In 2013, Detroit city went bankrupt, attracting worldwide attention. In Japan, Yubari City in Hokkaido went bankrupt in 2007. During this period, the facility management of public facilities and the effective use and reorganization of school facilities were examined.

Use of schools as shelters - 2011 to now

In the Great East Japan Earthquake in 2011, school facilities played a significant role as shelters, suggesting that schools could play an increased role as local shelters nationwide in the future.

4.4. Current Problems of School Facilities and Necessary Planning Method

As a summary of previous sections, Figure 4 shows the changes of the planning theory from the new construction of school buildings before 2000 to "renewal" including renovation and conversion. There was "mass development by new construction" until around 1980 and then "quality-oriented development by new construction," which gradually changed to "quality-oriented development by renewal." Currently there is no considerable change in the school district system, which is based on the neighborhood unit theory, but in future, reorganization of schools and expansion of the school districts will be conducted to respond to the decreasing number of children.

Table 2. Social events influential to elementary school planning

year	affair / event
1954	period of rapid economic rrowth
	population concentration in urban cities
1973	
1981	Revised quake-resistant standards
	birthrate declining
1997	Kyoto Protocol
2001	Ikeda Primary School Massacre
2007	Yubari city bankruptcy
2011	the Great East Japan Earthquake

According to the changes of the planning theories, the necessary planning method is as follows:

- **Reorganization and consolidation:** Development of reorganization theory and use of closed schools (including conversion method)

- **Use of surplus spaces by local community:** Facility management in municipalities, crime prevention, partial conversion, adding multiple functions
- **Response to changes of educational methods and social situation:** Considered when necessary

Surplus spaces in schools have not been used much by local communities since 1981. In the 1960's, use of school yards, gymnasiums, and other sports facilities by local communities was accelerated to compensate for the shortage of local sports facilities. In future, it will be necessary to add functionality to surplus classrooms that children do not use so that they can be used for ordinary classes.

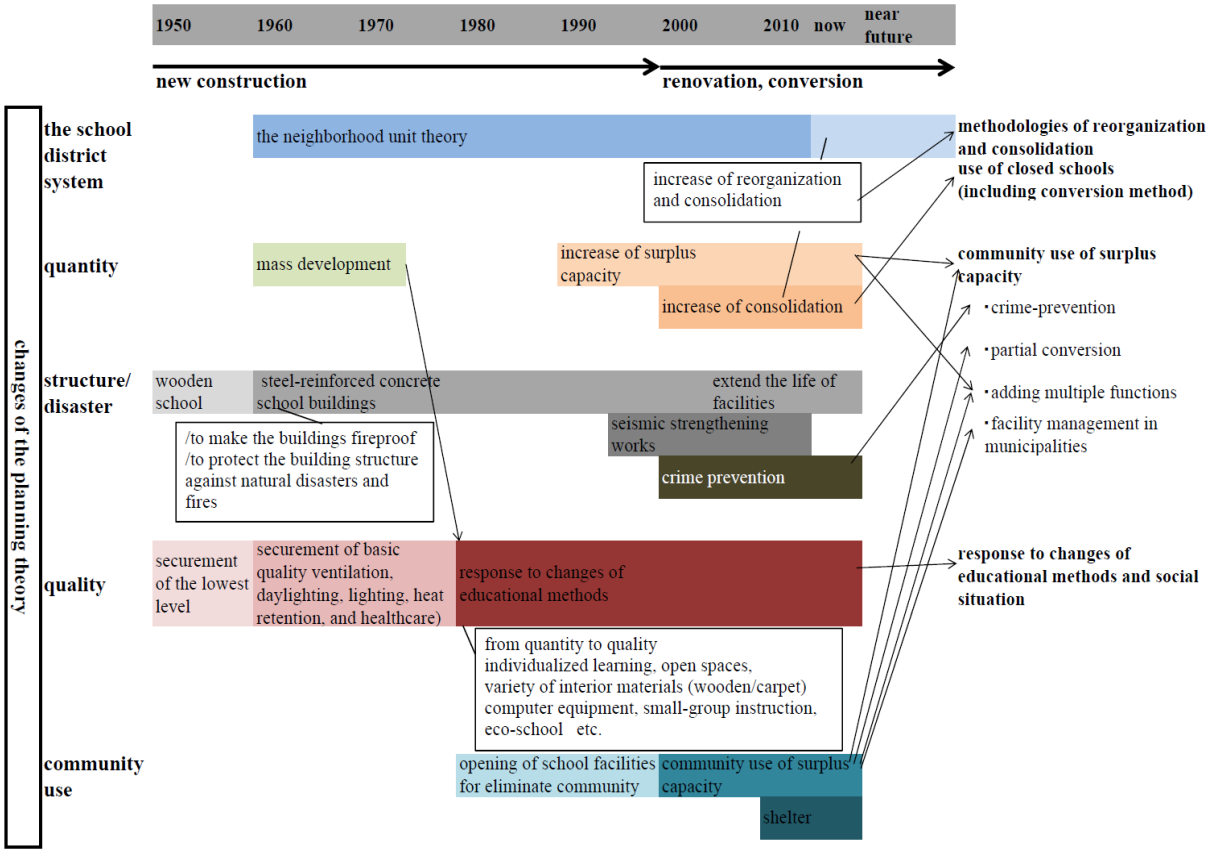

Figure 4. Changes of the planning theory

5. Conclusions

First, regarding the current elementary school facility stock, the largest number was constructed around 1980 when the number of children reached the second peak. Until this time, emphasis was placed on quantitative improvement in Japan. About 20% of the elementary school facilities were constructed in or before 1973 and are now at least 45 years old. Local governments are considering rebuilding the facilities but reconstruction is difficult because of budget shortfalls.

Next, the history was divided into six periods, and organized the features of each period. The summary of each period is as follows: first term (1982-1944) was initial development of laws and standards, second stage (1945-1949) was the emergency steps after World War II, third and fourth periods (1950-1957, 1958-1980) many subsidy systems were established for the mass development of schools. The fifth period was for qualitative development, where various subsidies began to support school quality improvement. The sixth period was a stage where schools were closed and surplus spaces occurred due to the recent low birthrate.

Also examined the relationship between changes in social situation and issues related to elementary school facilities.First, many elementary schools were newly established in the 1960s, Due to the development of large new towns and population concentration in cities, facilities in elementary schools were short in specific areas.

In 1981, due to the revision of The Building Standards Act, the earthquake resistance criteria were revised, and earthquake-proof construction was preferentially carried out when renovating school facilities. Since the 1990s, the declining birthrate and the aging of society became remarkable. In addition to the necessity of facility management of public facilities, the utilization of the surplus space of elementary school facilities due to the decrease in the number of children is an issue.

In addition the vulnerability of the elementary school facility on the crime prevention side became a problem after the case of a child killing case by a suspicious person at the Ikeda elementary school in 2001, and in 2002 a subsidy for the safety management facility construction work started. Also, in the Great East Japan Earthquake in 2011, school facilities played a significant role as shelters, suggesting schools could play an increased role as local shelters nationwide in the future.

The elementary school planning theory before 2000 was for new construction of schools, but in recent years a planning theory for the renewal of school buildings such as renovation or conversion of the buildings has become necessary. In future it is necessary to study the consolidation and closure of schools and the use of surplus spaces by taking account of the educational influence on children, crime prevention, school management, and elementary school capacity.

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Analysis and Solution for Fallout Repair and Tunneling in Sandy Soil Conditions for a Wine Cave in Southern California

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Abstract The design and construction of wine caves can be difficult due to low ground cover, weak rock or soil, presence of sand and complicated by the elaborate curves and labyrinth-style floor plans. This paper will focus on southern California's first wine cave in the Temecula wine region that was constructed by mining techniques. An excavation procedure was needed to reinstate tunneling excavation at the Oak Mountain Winery in Temecula, CA USA after a fallout with an estimated 6.1 meter diameter and 6.71 meters overburden. Sandy soils with low cohesive properties and low saturation have created difficult tunneling and safety conditions. The proposed excavation sequence was divided into four stages using spilling if needed until less sandy or stronger material was encountered The following analyses were performed to provide supporting calculations and information to provide safe tunnel excavation conditions as required by mining regulatory oversight. Analyses using cellular concrete for fallout conditions were also modeled. Results, recommendations and conclusions are presented.

Keywords Wine Cave, Sandy Excavation, Numerical Modeling, Fallout, Tunnel

1. Introduction

Over the last three decades, the California wine industry has experienced a growing interest in the development of wine caves and other underground structures. Wine Caves help maintain the correct humidity and temperatures for wine barrel storage, create beneficial land use and create marketing venues and opportunities for wineries. Hence, an increasing number of wine caves are being constructed throughout California.

Safely tunneling through partially stable soft ground conditions can be very difficult. Sandy soils can present issues with shotcrete adhesion, unstable ground and roof fallout potential. Recently, these issues were experienced while tunneling the Oak Mountain Winery wine cave in Temecula, CA USA. This paper presents the results of a geological and geotechnical engineering study performed in order to provide conclusions and recommendations for the remediation of fallout conditions and the presence of sandy soil in a new underground wine cave (tunnel) complex adjacent to the existing Oak Mountain Winery. Previous investigations and studies relating to sandy soil tunneling and underground excavations can be found in references [1], [2] and [3]. The following analyses were performed to provide supporting calculations and information to ensure safe tunnel excavation conditions. Analyses using cellular concrete for fallout conditions were also modeled. Further information regarding cellular concrete can be found in Hamad [4] and Kim, et al [5]. Results, recommendations and conclusions are presented.

2. Geological and Tunnel Background

The significant findings from the geological investigations before and during tunnel construction included surface soil overlying sandstone and siltstone of the Pauba Formation. The sandstone was logged as slightly cemented and generally thinly bedded and ranged from soft to low hardness. It was also moderately to severely weathered, and widely to closely fracture. Blow counts using a California Modified sampler in the sandstone ranged from 29 to 84. Sandy soils with low cohesive properties and low saturation created difficult tunneling and safety conditions prior and subsequent to the fallout event.

After sandy conditions were recognized, probe testing was performed at the Oak Mountain Winery using a 6.8 kilograms (15 lbs. hammer) with 1.27 centimeter (½ inch) diameter 1.524 meter (5-feet) long coupled rods and this

was driven with an electric percussion drill head from the ground surface to the approximate tunnel depth. This pseudo-hand held SPT device was necessitated due to the presence of and existing vineyard overlying the tunnel and the inability to use a standard drill rig. The site plan for probe locations is shown in Figure 1 where the highlighted light blue area indicates fallout section. Probe numbers 2, 3, 11, 12 along Tunnel A indicate an advancement rate between 36.1 and 912.1 seconds/meter in the longitudinal direction of tunnel advancement. Probe 12 (at the mining face beyond the fallout) has the slowest advancement rate of 912.1 seconds/meter and indicates better mining ground conditions.

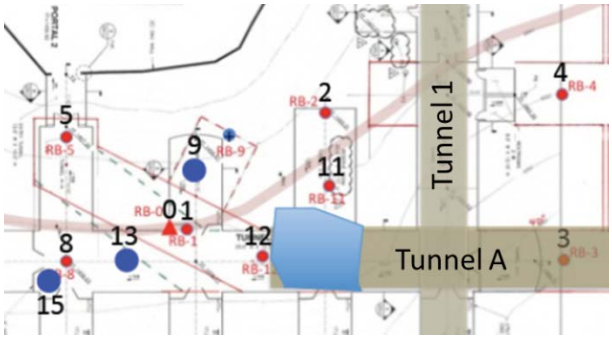


Figure 1. Probe rod locations

The longest tunnel, Tunnel A, connects between four other tunnels, and is approximately 6.1 meters width x 3.9 meters height. The tunnels were excavated full-face using the sequential excavation method (SEM) of tunneling. The maximum tunnel advance distance prior to initial liner installation will be a function of the "stand-up time" based on observations on site, the length of time that the ground can remain unsupported, and the tunnel contractor's means and methods. The initial shotcrete layer (5.08 centimeters of shotcrete) was applied to the new open ground of the tunnel perimeter each day. The second sub-layer of initial shotcrete layer (approximate 2 inches of shotcrete with one layer of welded wire fabric (WWF) 4 x 4 – W4.0 x W4.0 WWF) was installed closely behind the tunnel working face based on the construction schedule. The contractor advanced the tunnel and placed the initial shotcrete liner over the exposed ground as specified. The design of liners and structural system were confirmed during construction based on observed overburden, weathering conditions, and geologic materials.

In Tunnel A, a fallout of sandy material with an estimated 6.1 meters diameter and 6.71 meters overburden occurred while excavating the face heading (Figure 2a and 2b). The fallout and sandy conditions caused interruption in the construction of the tunnel and exhibited safety hazards. An excavation procedure was needed to reinstate tunneling excavation at the Oak Mountain Winery in Temecula, CA. Following the fallout and sandy soil conditions, a mitigation procedure was created to repair the fallout section of the tunnel with cellular concrete (Figure 3a and 3b) and enhance the sequential excavation method using the diagram provided in the discussion section of this paper. For further background information please refer to Condor geotechnical study [6].

Figure 2a. Looking at sand fallout along tunnel bearing.

Figure 2b. Looking down into the tunnel; vine vegetation and wires from trellises on the surface fell into the opening.

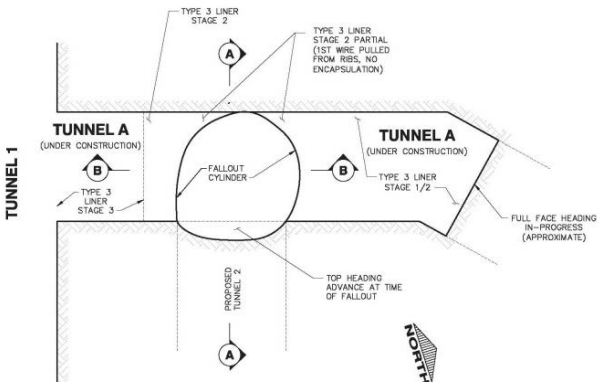


Figure 3a. Site plan of fallout area

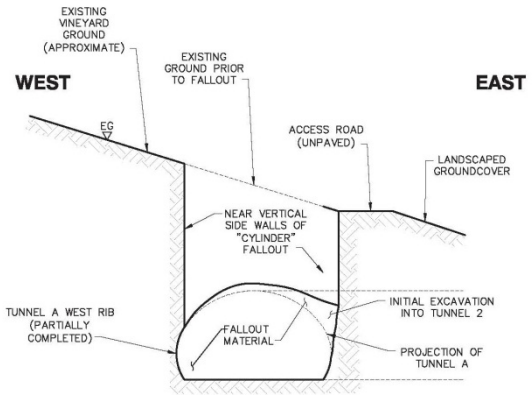


Figure 3b. Cross section of fallout in Tunnel A.

3. Data Analysis

In order to fully understand the soil and tunnel liner conditions, the Rocscience finite element analysis program Phase 2 [7] was utilized to model the use of cellular concrete, ground stress, displacement and tunnel liner performance. The tunnel liners and soil properties were modeled using the Mohr-Coulomb failure criteria and plastic conditions. The liner structural design approaches described in Federal Highway Administration [8] were followed during the analyses as well as the in-situ properties Sheorey [9]. Modeling techniques mentioned in Vlachopoulos and Diederichs [10] were utilized. The following section will discuss the input parameters and results of the models.

3.1. Material Properties

Based on site observations, previous investigations, and more recent probe data, the ground conditions above the proposed crown of Tunnel A appeared to consist of material properties with almost no cohesion and a friction angle of 35 degrees. The low cohesion and friction angle were used to simulate field conditions of sandy material for the weaker material anticipated for the actual range of likely ground conditions. Since the tunnel conditions experienced a fallout indicating low horizontal stresses, a K ratio value of 0.33 was utilized. Concrete properties were collected from laboratory results. The material properties compiled are shown in Table 1 below.

3.2. "Q" System Estimation for Liner Support

Although the Q System Barton et al, [11] was developed for rock blocks and rock like conditions in tunnels, the Q System analysis provided an estimate for reinforcement needed for tunnel support in weak rock prior to encountering sandy conditions. A sensitivity analysis was performed to understand how the results differed relating to stress conditions, height and tunnel span and alteration of the material. All Q values calculated provided similar results (within the range of the sensitivity of the analysis) regarding reinforcement and tunnel liner thickness. All values suggested the need for a fiber reinforced shotcrete liner with a thickness of 15.24 centimeters or greater. Since the project plans require the use of WWF, the objectives of the fiber reinforced shotcrete were achieved. The following sections provide the analyses performed for sandy soil conditions since the Q system would be not applicable.

3.3. Stress and Displacement Conditions

From figure 4, the stresses applied at the tunnel crown are approximately 129.2 to 157.9 kPa in the vertical direction. The estimated stresses at the tunnel crown exhibit a radial stress of 12.0 kPa indicating the material at the tunnel crown is in tension.

Figure 5 displays the vertical displacement calculated by Phase 2 modeling for a 6.1 meter wide tunnel with no liner. From the plot, the displacement at the crown of the tunnel is very large (18.3 meters) indicating the model has failed and the material above the crown has fallen out. The model indicated the soil close to FOS = 1 around the tunnel which is expected with no liner; however, when modeling a tunnel with smaller width the factor of safety at tunnel crown is above one indicating stable conditions for excavation.

Table 1. Summary of Properties

Excavation According to Drawing	Soil Properties				Concrete Properties			
	Unit Weight (kN/m3)	Friction Angle (deg.)	Cohesion (kPa)	Modulus of Elasticity (kPa)	Unit Weight (kN/m3)	Compressive Strength (MPa)	Liner Thickness (cm)	Reinforcement
0	18.9	35	0.239	34466	23.6	N/A	N/A	N/A
1	18.9	35	0.239	34466	23.6	3.5	5.08	None
2	18.9	35	0.239	34466	23.6	6.9	10.16	1 Layer - WWF
3	18.9	35	0.239	34466	23.6	13.8	15.24	2 Layer - WWF
4	18.9	35	0.239	34466	23.6	27.6	20.32	2 Layer - WWF

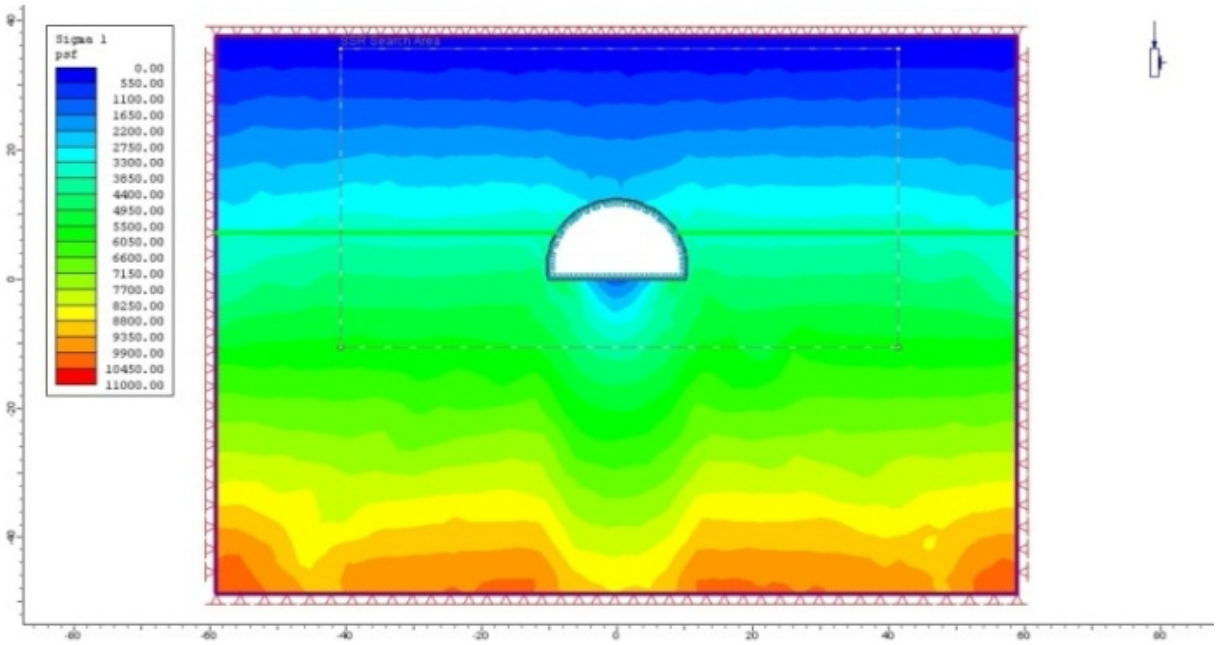
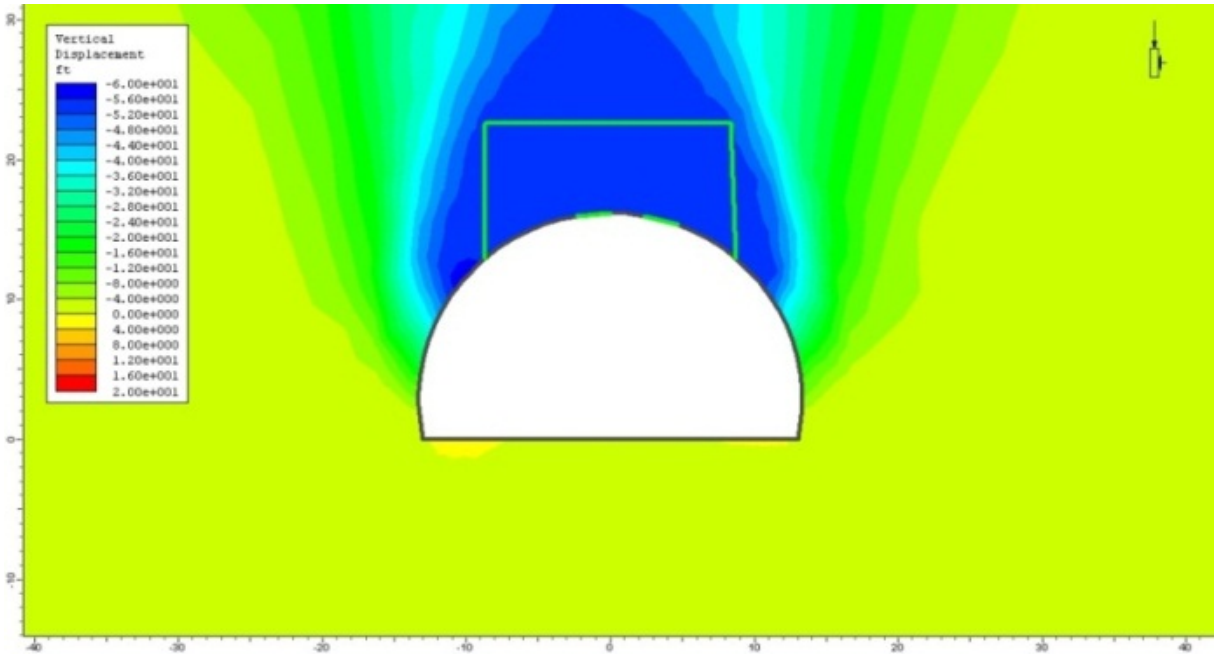


Figure 4. Sigma 1 (Vertical Stress) in sandy soil



F**igure 5**. Vertical displacement for a 6.1 meters wide tunnel with no liner using basic factor of safety calculations.

3.4. Four Stage Excavation Sequence Model

Four models (for of the excavation stages) were constructed to examine the liner and liner reinforcement shear and moment capacities and the soil displacement. The materical properties were assumed as shown in Table 1. The final shotcrete wall was a Type III liner, 20.32 centimeters thick with two layers of welded wire fabric (WWF) reinforcement. The first stage utilizes a 5.08 centimeters thick shotcrete wall with no reinforcement. The second stage adds 5.08 centimeters of shotcrete with one layer 4 x 4 WWF to maintain a shotcrete wall thickness of 10.16 centimeters. The third stage of the excavation adds 2 inches of shotcrete for a total of 15.24 centimeters as well as a second layer of 4 x 4 WWF. Stage four of the excavation sequence adds final 5.08 centimeters shotcrete layer totaling to 20.32 centimeters. The following plots for each excavation state are the shear and moment capacity plots for each liner and reinforcement layer (Figure 6 – 9). Table 2 exhibits a summary of results and factor of safety for the reinforcement WWF as well as the shotcreteed structural liner.

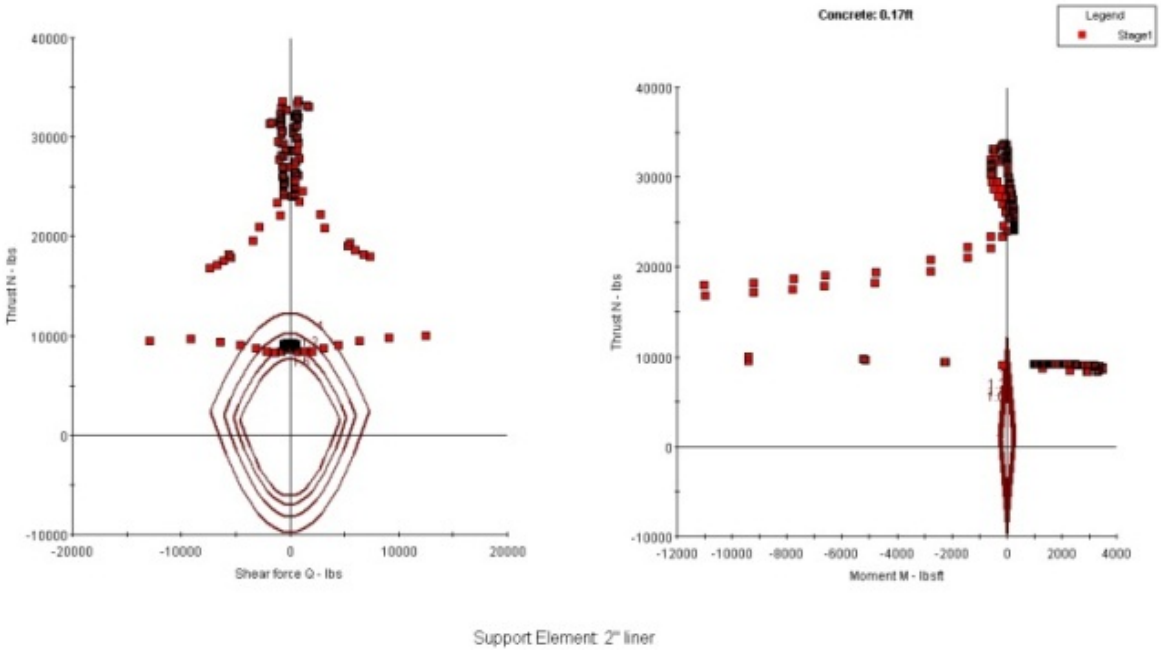


Figure 6. Shear/Moment Diagram Stage 1

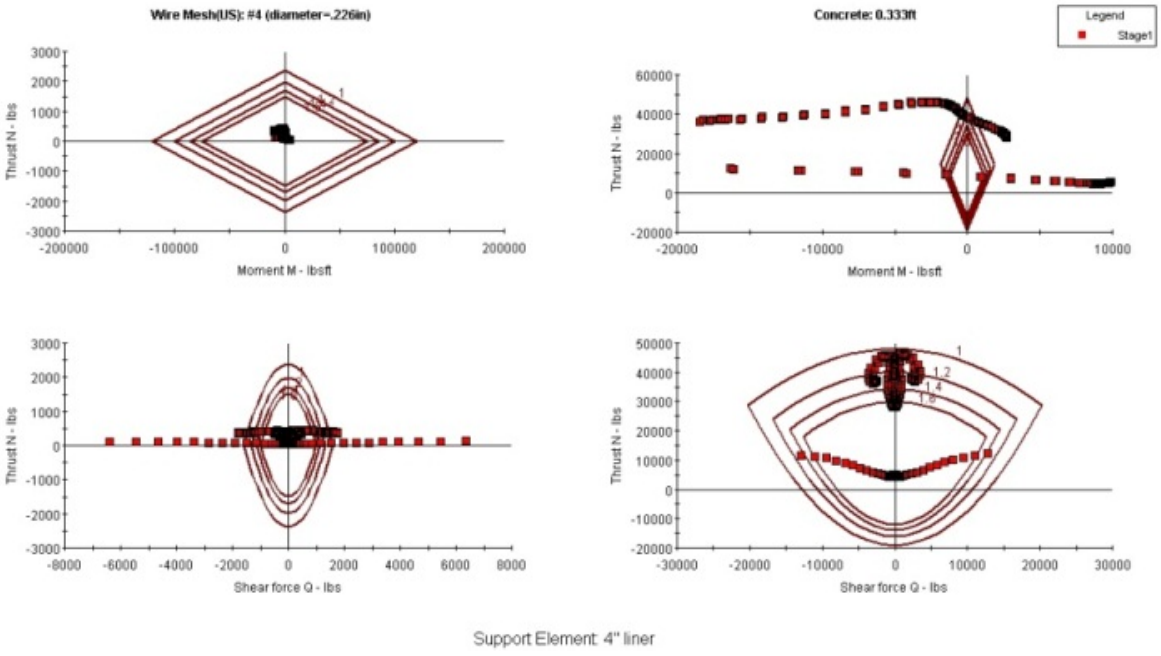


Figure 7. Shear/Moment Diagram Stage 2

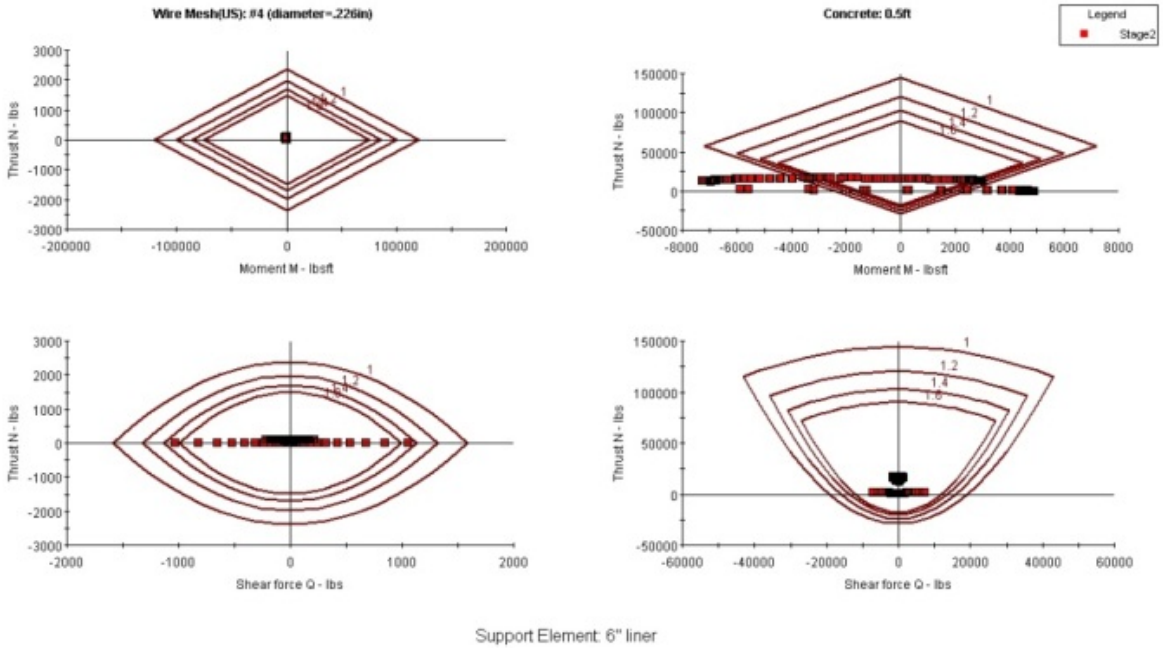


Figure 8. Shear/Moment Diagram Stage 3

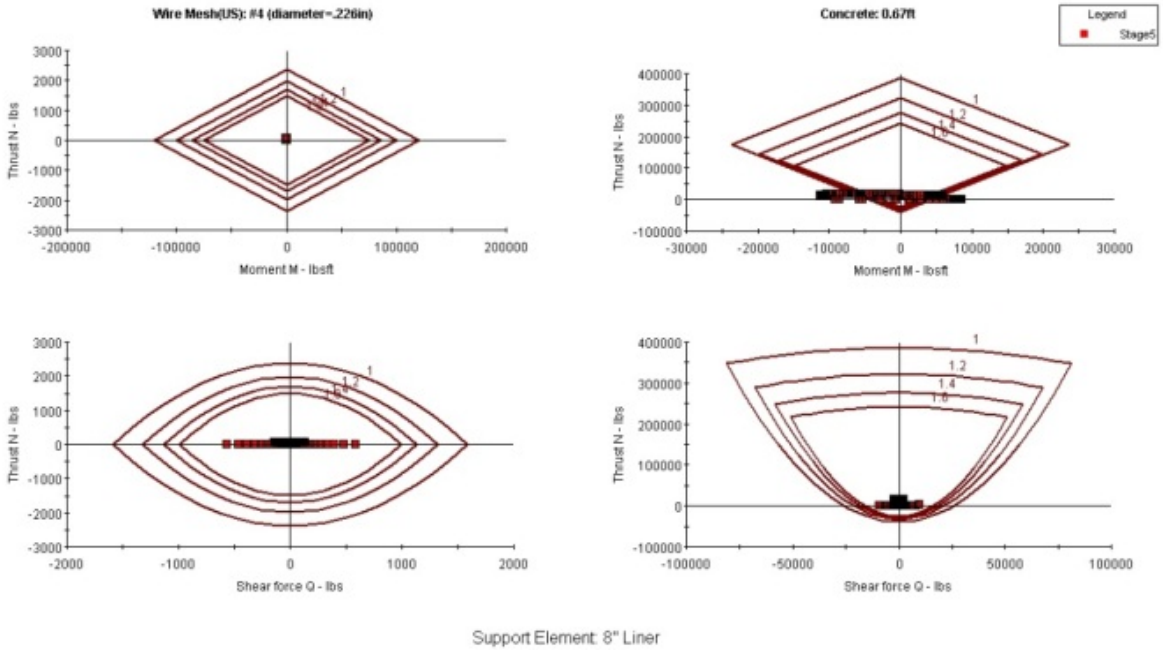


Figure 9. Shear/Moment Diagram Stage 4

Table 2. Summary of Results

Excavation Stage	Results						
	Soil Vertical Displacement (m)	Liner Thickness (cm)	Layers of Reinforcement	FOS Reinforcement Shear	FOS Reinforcement Moment	FOS Liner Shear	FOS Liner Moment
0	1.524	N/A	N/A	N/A	N/A	N/A	N/A
1	0.26	5.08	N/A	FOS < 1	FOS < 1	FOS < 1	FOS < 1
2	0.2	10.16	1	FOS > 1	FOS < 1	FOS < 1	FOS < 1
3	0.1	15.24	2	FOS > 1.4	FOS > 1.4	FOS > 1.4	FOS > 1.0
4	0.03	20.32	2	FOS > 1.6	FOS > 1.6	FOS > 1.6	FOS > 1.5

3.5. Fallout Using Cellular Concrete Model

Phase 2 modeling was performed on the fallout condition at Oak Mountain Winery using a 2D cross section of the fallout repair area. Although 3D modeling will provide more accurate results, this study only utilized 2D modeling due to time constraints, availability of modeling software and budget. For the model, a 5.49 meters width by 3.05 meters high region was created to simulate the cellular concrete installed in the fallout section at the tunnel crown. The same properties for the soil as stated above were used. The cellular concrete had a unit weight of 23.6 kN/m3 and compressive strength of 1.72 MPa. The following figures are the results from Phase 2.

Figure 10 was modeled for a 6.1 meters wide tunnel and the utilization of cellular concrete to support the fall out above Tunnel A with no liner. This shows the factor of safety values are well above 1 and the soil conditions are stable. Figure 11 indicates the maximum shear strain at the tunnel crest with the use of cellular concrete is zero. Since no shear strain is computed, this indicates the side friction of the geological material in the walls adjacent to the cellular concrete is sufficient.

4. Discussion

The foregoing analysis is an oversimplification of the actual sequential excavation that occurred at the project site. It should be noted, some points of the model results indicate factors of safety less than one. This represents tunneling corner conditions where a 2D model indicated high corner stress; hence, a lower factor of safety for some results for shear and moment diagrams. For more realistic results in tunnel corners, the authors suggest using a 3D finite element numerical modeling program. The analysis assumes that the entire tunnel length would be represented by one uniform liner type. This does not represent the sequential excavation and support construction that has proved successful in straight tunnels (thus far) when liner support closely follows excavation without the loss of wall liner where perpendicular tunnel advancement begins. This condition (perpendicular advancement) was the condition which was present at the time of the fallout. While displacements for Stages 1 and 2 indicate that some small amount (20.3 cm) of deflection will occur, the calculations indicate that until Stage 3 is provided, an acceptable factor of safety is not achieved for the structural liner. Therefore, the sequential excavation will require augmentation of additional temporary support for the length of excavated tunnel between the working face and Stage 3 liner construction. Figure 12 below shows the updated sequential method based on soil stand up time experienced in the field.

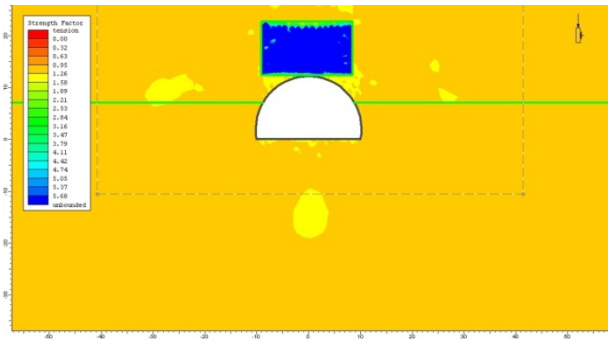


Figure 10. Strength factor (FOS) of soil with installed cellular concrete 6.1 meters wide tunnel

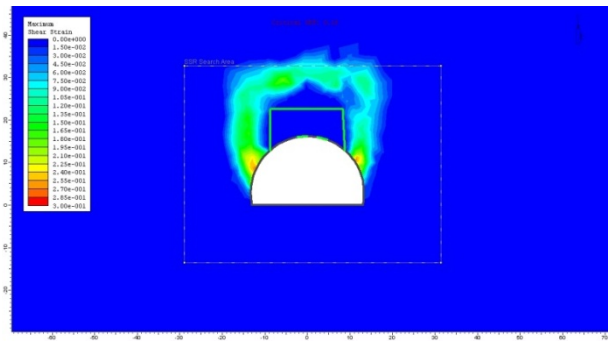


Figure 11. Maximum shear strain results for a 6.1 meters wide tunnel with no liner and cellular concrete installed

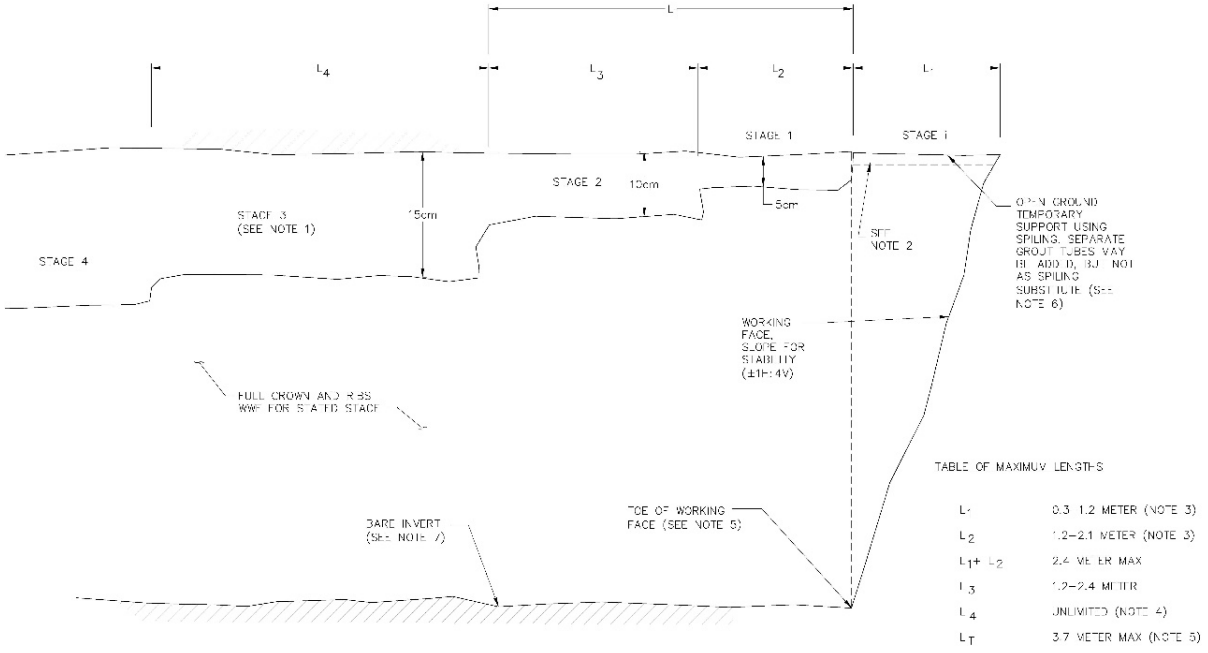
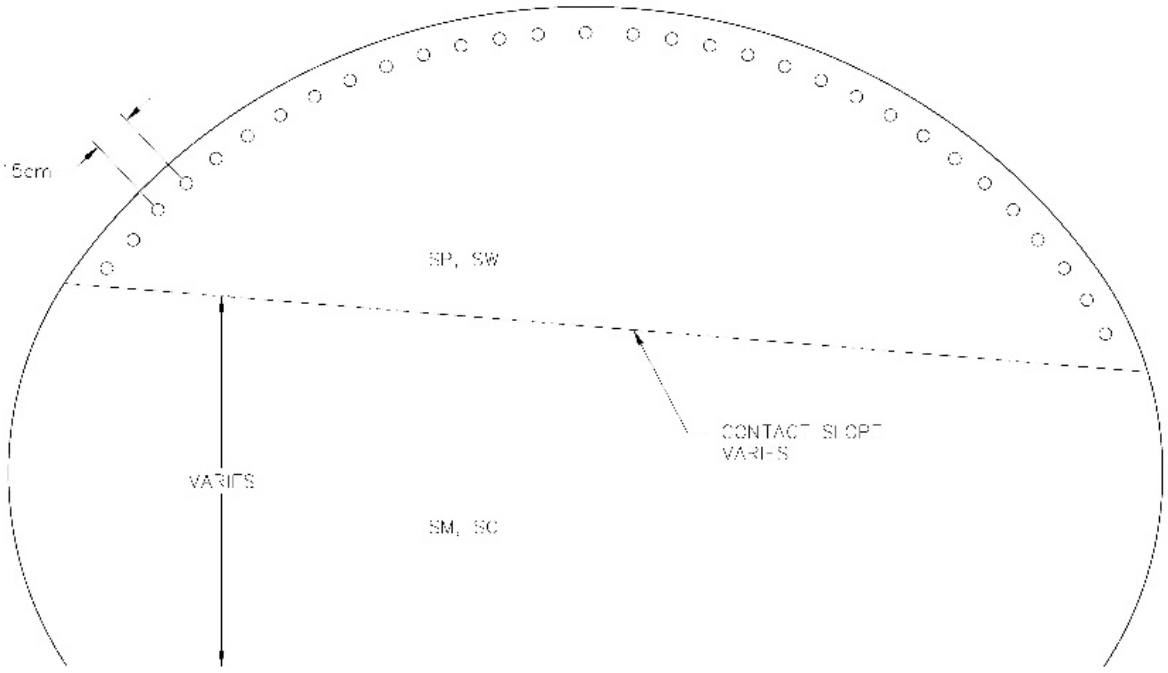


Figure 12. Updated sequential excavation plan for sandy soil conditions

For purposes of this review, a spiling detail (Figure 13) was developed with the contractor to incorporate this sequential excavation method to provide temporary support of the working face and the Stage 1 and Stage 2 areas. Strict adherence to the provided plans designating the maximum lengths for various stages was achieved to meet the stated factor of safety for Stage 3 liner. If the contractor was unable to meet the requirements of the provided plans for Temporary Support using the sequential excavations and spiling details, other means of temporary support were used, such as shielding, temporary steel sets, shotcrete-infilled steel sets, or other approved method. In the case of Stage 1 shotcrete, #6 rebars spaced 15.24 cm (6 in). on center in sandy zones (less than 20% passing no. 200 sieve) were utilized for spiling until stable tunneling conditions were encountered.



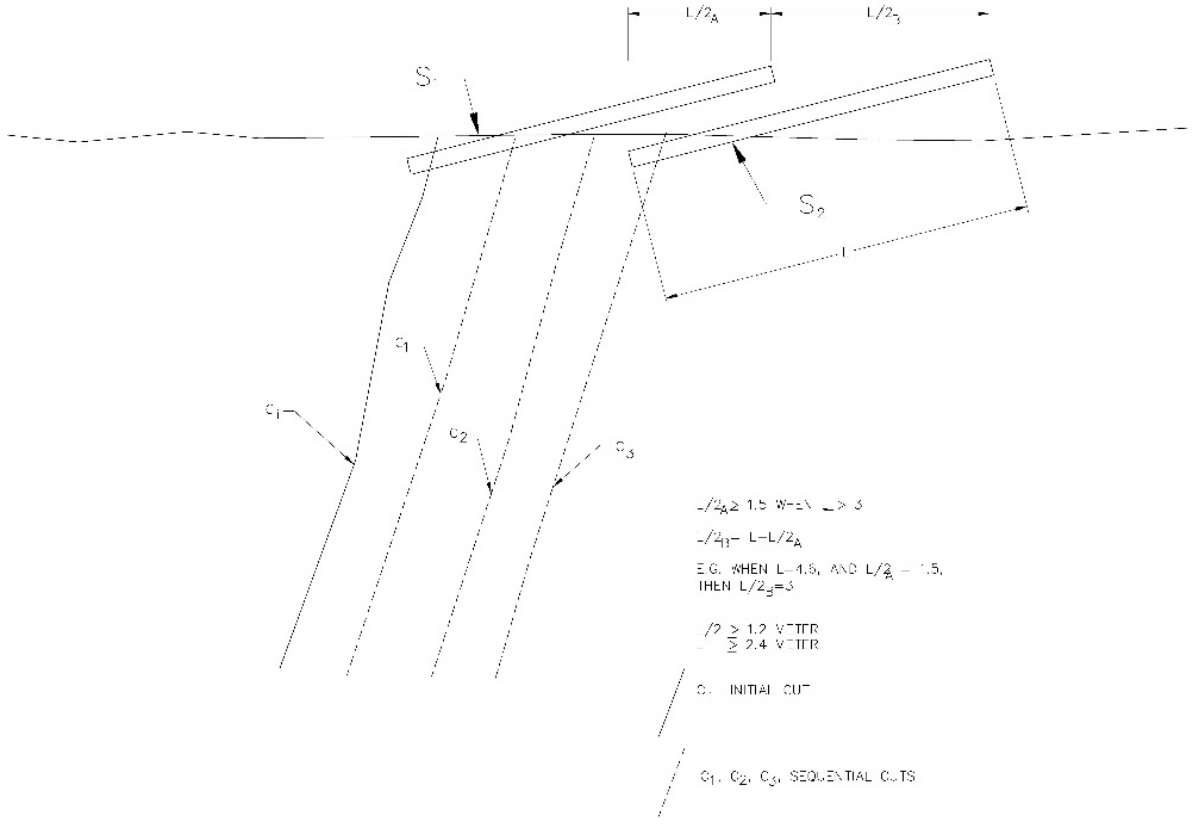


Figure 13. Spilling detail for tunnel crown

5. Conclusions

In summary, this paper was created from a general interest and professional experience for shallow tunneling in sandy soil conditions. The findings in this paper were used to exhibit successful method and analyses and may be advantageous in different mining scenarios. These key points are recommendations by the authors:

- Inexperienced or untrained personnel should receive training for dealing with unstable tunnel conditions and safety procedures if there is even the slightest probability that unstable conditions will be encountered;
- Always be aware of your surrounding and be conscious of unstable ground;
- Site investigation personnel should pay close attention to the local geology and ground conditions revealed by exploratory borings;
- Staged excavations should be considered if sandy soil is encountered;
- The use of cellular concrete proved to be worthy for fallout repair from both numerical modeling and site observations;
- The repair system conceived proved to be successful
- It would be beneficial to analyze the interaction of cellular concrete and the adjacent geological material using 3D numerical modeling
- Modeling can be used to estimate and for show if certain excavation methods will have the potential to succeed

The paper was constructed to help engineers, drillers and geologists better understand potentially unstable ground and how to determine which numerical and construction methods are the most appropriate for fallout situation as well as safe methods to continue tunneling. The methods discussed have shown great potential towards safe working areas in poor, sandy ground conditions when implemented successfully tunneling crews

Acknowledgements

The authors would like to show appreciation for Stephen and Valerie Andrews, owners of Oak Mountain Winery, for allowing us the opportunity to submit this paper. Without their help and understanding, this paper would not have been successfully completed. The authors would also like to express great thanks to all the workers at Magorian Mining Services of Auburn, CA USA most notably Don Magorian who was the tunneling contractor for the project. Magorian kept us on track and helped us succeed through the project end.

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Evaluation of Risk of Fluctuation Claim on Cost of Construction Projects in the South-South Zone of Nigeria

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Abstract Establishment and achievement of accurate project estimate is a major challenge facing the construction industry across the nations especially in the developing countries. Projects generally are one-off activities with very unique characteristics. Their acyclic nature further makes them practically difficult to repeat any section if that is completed, thereby subjecting their original schedule, budget and performance baselines to the prevailing project environment shaped by both known and unknown financial, technical and managerial risk factors. The study established the relationship between fluctuation cost and cost overrun of building construction projects in the South-South zone of Nigeria. The cost data on 20 completed public building construction projects in the study area were purposively sampled and adopted for the study. Data obtained were analysed using linear regression. The result revealed that fluctuation in the prices of construction materials and labour accounts for 97% on the cost overrun of building projects in the South-South zone of Nigeria. It is therefore recommended that practitioners in the construction sector should adequately provide for likely fluctuation of material and labour prices during project planning for successful implementation.

Keywords Building Project, Claims, Cost Variation, Fluctuation, Risk

1. Background of the Study

Construction industry is one of the major industries that contribute significantly to the growth of socio-economic development of a nation. Construction is an employment spinner. “Construction” covers a spectrum ranging from slow, certain, and simple (stodgy) projects on one end to quick, uncertain, and complex (dynamic) projects on the other

[4].The construction sector is responsible for construction of new houses, renovation of old structures, construction of roads, bridges, complex structures, among many other things. The construction industry is however associated with a high risk exposure which calls for risk management in order to ensure it success. A project is considered successful when it accomplishes its technical or performance requirements, maintains its schedule and remained within the budgetary baseline. For many successful project teams; their abandonment on project completion is regrettable, destabilizing,[12].This implies that, the degree to which a project meets its original planned cost, time and performance requirements determines its degree of success. Over the years, the difficulty in predicting future project events, with high level of precision has made the realization of successful project globally a nightmare.

Several parts of the world including Nigeria had witnessed many projects being cancelled before the completion date. Other projects being completed late and cost well over their original budgets. A comprehensive research made on cost overruns in global construction revealed that 9 out of 10 projects had overruns [10]. Survey conducted revealed that fifty-eight percent (58%) of respondents experienced time overrun on their projects with the length of delay averaging forty-eight days from the point of anticipated completion to the actual finishing date[6]. On the budget front, clients were critical of the industry’s inability to keep to the agreed contract budget; thirty-two percent (32%) of projects exceeding the agreed sum. Fifty-seven percent (57%) of clients experienced defects on their project sufficient to cause a delay to project handover [25].The trend of overrun is more severe in developing countries where these overruns exceed 100% of the anticipated cost of the project [3]. It is believed that the inability of project members and practitioners in the

construction industry particularly in the building sub-sector to meet these key baselines is due largely to their inability to predict and provide for the known and unknown risk events that should they occur will have serious impact on the project triple-constraints of time, cost and performance. This has resulted to added costs, poor quality, increased cost of rework and ultimately project abandonment.

Price fluctuation has been identified as one of the major risks causing cost overrun and it is attributed to inflation of price of material and labour in developing countries or the speculation of suppliers [16].The aim of this study therefore is to determine statistically the degree to which change in material and labour prices of construction projects affect the cost of building projects. In line with the objective of this study, the hypothesis is stated that: There is no significant correlation between fluctuation and project cost variation.

2. Statement of Hypothesis

H0: There is no significant correlation of fluctuation claim and project cost variation

H1: There is significant correlation of fluctuation claim and project cost variation

3. Literature Review and Conceptual Framework

This section contains a review of literature on the concept of risk management in construction, the difference between risk and uncertainty and various risk factors affecting construction project performance.

4. The Concept of Risk Management in Construction

"Risk" and "uncertainty" are synonymous terms and are often used interchangeably in the construction industry. [9] Described risk as the threat of a loss (e.g., financial, timescale, or performance) depending on whether a given event may or may not happen. [20] defined risk in construction as "a variable in the construction process whose variation results in uncertainty as to the final cost, duration and quality of the project". [17] viewed risk as the potential for complications and problems with respect to the completion of a project and the achievement of a project goal.Risk is a possible undesirable and unplanned event that could result in the project not meeting one or more of its objectives [28] [9] clearly described uncertainty as the difference between an anticipated or predicted outcome (e.g. a cost estimate) and the confirmed outcome (e.g. the actual cost). [11] Opined that, it is the lack of predictability about a problem structure, outcomes or consequences in a decision or planning situation that result to risk in projects. [22] Defined project risk as "an uncertain event or condition that, if occurs, has a positive or a negative effect on at least one project objectives, such as time, cost, scope, or quality". Researchers have established relationship between the two terms in the literature. According to [14] uncertainty creates risk and that the extent of the risk will depend on the level of uncertainty and its consequence for the project. One is measurable uncertainty; the other is immeasurable risk [21]. The two terms are however used interchangeably in the construction industry due to its peculiar characteristics compared to other industries.

Risk management is a management tool that aims at identifying sources of risk, determining their impact and developing appropriate responses [24] [26]defined risk management as an organisation process of identifying and measuring risk and then developing, selecting, implementing and managing options for addressing them. A manager of risk must therefore act explicitly in advance to prevent its occurrence or at worst minimize its impact on the baselines estimates of the project. The risk management process is concerned with identifying, analysing, and taking action against project risks, which also includes maximizing the results of positive events and minimizing the consequences of adverse or uncertain events[15]. [7] suggested that the processes of risk management to include identification, assessment, analyses (qualitative), analyses (quantitative), allocation, monitoring and control of risks. Risk identification is the first step of the risk management process that involves identifying, categorizing and recording potential risks, together with information on their cause(s) and possible effect(s), which might affect the project [27]. The primary aim with the risk identification process is to generate a list of risks with both negative and positive consequences, which are called risk, register [23]. Risk identification and analysis may indicate the need for redesign, more detailed design, or different methods of construction in order to reduce risk [15] The purpose of risk analysis is to quantify the effects of the identified risks. The risk analysis techniques can be separated into three categories: qualitative, semi quantitative and quantitative methods [13]. Risk evaluation measures each step of the risk management model, and is an important indicator of an organisational effectiveness and efficiency in dealing with each of the steps in the process. Risk control involves taking measures to minimize the possibility of the risk occurring and/or to minimize the effects of the risk event in case such an event actually occurs [1].

[2] Suggested generally four response types to cope with risk. These are avoided, transfer, mitigate and accept. An effective risk management methodology can help to understand not the types of risks, but also how to manage these risks in different phases of a project. Managing risk in construction projects has been recognized as a very important management process in order to achieve the project objectives in terms of time, cost, quality, safety and

environmental sustainability [30].

5. Risk Factors Affecting Construction Projects

Risk factors in construction project are enormous due to different activities involved, stakeholders, environment and the complex relationship among them.[15] attributed the causes of risks and uncertainties to performance of workers, material and quality, delays in supply of important materials to site, project budget and cost control, or the complexity of project procurement processes, which may threaten the project objectives.

[19] in a study of factors affecting construction costs in Mara large construction project identified 24 factors. [29] classified all construction risks into three levels, namely; country level risks which are external to the project and a function of the political and macroeconomic stability; market level risks which include availability of construction resources, complexity of regulatory processes and attitude of local and foreign governments towards the construction industry and project level risks which are specific to construction sites and include logistics constraints, improper design, site safety, proper quality control and environmental protection, etc.

[5] identified the risk factors affecting cost performance as tight project schedule, design variations, variations by the client, unsuitable construction programme planning, occurrence of dispute, price inflation of construction materials, excessive approval procedures in administrative government departments, incomplete approval and other documents, incomplete or inaccurate cost estimate and inadequate programme scheduling. [18] Conducted a research using exploratory survey method and broadly categorized risks in construction projects into internal and external sources. The internal risk sources, which fall under the control of clients, consultants and contractors, include those risk elements emanating from their acts or omissions in the project development process. While external risk sources, which are not within the control of clients and project team could be segregated into economic and globalisation, dynamics, unforeseen circumstances, force majeure, government, statutory, political controls, health and safety risk elements (which fall outside the control of the project team) and socio-cultural issues.

[8] Identified economic risk as the most significant in the Kuwaiti construction industry due to the boom in construction activities and inflationary trend of the market. Hence the study investigates the relationship between fluctuation cost and cost variation of building projects.

6. Research Methodology

The population of this study is made up of completed public building projects between 2015 and 2017 in the South-South zone of Nigeria. Twenty of the projects were purposively sampled and adopted for the study. The data collected from the contractors` contract documents includes: project original contract sum, final contract sum and approved fluctuation. Linear regression was adopted to predict fluctuation cost based on cost variation of building projects. All the analyses were carried out at 5% level of significance and 95% level of confidence. The relationships among the variables are depicted below:

VAC = a + bFLC (equation 1)

Where

y = VAC (cost variation)
a = Constant (co-efficient of intercept)
b = Regression Coefficient
FLC = fluctuation cost

7. Presentation and Analysis of Data

This section presents data for the study and empirical analysis of the relationship between fluctuation cost and cost variation of building projects. The obtained data is from completed public building projects between the periods of 2015 to 2017. The secondary data was organized using spread sheets and analyzed using SPSS version 17.0 as presented in Table 1.

8. Discussion of Results

The study sought to establish a relationship between fluctuation and cost variation of building projects. The result of the analysis shows that the linear relationship between fluctuation cost and cost variation of building construction project in South-South zone of Nigeria is VAC = 5.2950 + 1.3333FLC where VAC is the cost variation and FLC is fluctuation cost of building projects. The equation indicates that there is a direct relationship between cost variation of building projects and fluctuation in the prices of building materials and labour. The P-value of the slope of model 0.003 is less than α (0.05) therefore Ho is rejected and it is concluded that cost overrun of building project can be significantly explained by fluctuation in the prices of building materials and labour in the study area. The coefficient of determination or adjusted R^2 (0.970) shows the extent to which changes in the cost variation of building projects varies with the independent variables - fluctuation cost. This indicates that the total changes in cost variation can be explained 97 percent by the changes in the fluctuation cost. The adjusted R^2 value also indicates that the model (0.97) is perfect.

9. Conclusions and Recommendations

The study revealed that a positive relationship exists between cost variation and fluctuation cost in the zone as a

result of changes in the basic prices of materials and labour. Fluctuation which is occasioned principally by change in prices of materials and labour during the life of the construction period is a key determinant for effective project delivery. Its effect in most cases determines the success or failure of the project. The need to envisage with some reasonable degree of certainty, the likely changes in material and labour prices is very paramount in every construction project. This can be achieved with some degree of success by creating a material and labour price data base and using trend studies. Basic prices of construction materials and labour derived from archives of similar projects recently completed will help in assessing their impact with reasonable level of certainty. Finally, providing not only adequate but also reasonable contingency sum for construction projects will go a long way in absorbing cost sucks of cost variation resulting from fluctuation. It is recommended that there should be some levels of price forecast to enable tenderers absorb likely variation areas in the future before submitting final bid value. Project implementation should commence as soon as possible without delay by the stakeholders. Finance meant for the project must be made available before award of project.

Table 1. Final Cost (Account), Estimated Cost, Variation Cost and Fluctuation Cost

Projects	Final Account Mil.(₦)	Estimated Cost Mil.(₦)	Variation cost Mil.(₦)	Fluctuation Cost Mil.(₦)
1	733	568	165	112
2	70	56	14	8.5
3	226	185	41	20
4	86	68	18	7
5	50	40	10	7
6	150	142	28	17
7	155	130	25	20
8	66	48	18	10
9	40	35	5	5
10	1500	1380	120	90
11	28	22	6	4
12	28	19	9	5
13	145	100	45	40
14	30	25	5	3.5
15	18	12	6	3
16	12	9	3	2
17	3300	3060	240	180
18	82.5	60	22.5	20
19	165	142.5	22.5	10
20	331.5	234	97.5	56

Source: Surveyed data (2017)

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Transport and Accessibility Challenges Facing the Rural People Living Along Feeder Roads in Ghana

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Abstract This paper examines the accessibility and mobility needs of communities living along feeder roads in Ghana. It adopts a qualitative research approach where a total of eighteen (18) expert interviews were undertaken across Ghana from 2015 to 2017. In addition, primary data was collected by conducting five focus group discussions in five rural communities in two regions in Ghana. In all, a total of seventy-two (72) participants were involved during the focus group discussions. The study first found that Ghana has enough feeder roads as compared to other countries in the sub-region. From the responses, what needs to be done is to improve the level of services. This means that there is the need to improve the surface conditions and make sure that a lot of them are in good shape all year round. The responses gathered point to the fact that most rural or feeder roads are not appraised before their construction, and that may account for the reason why transport investments are not factored into the plan of most feeder roads. It is interesting to note that most of the roads that were appraised were either funded by donor partners or development partners other than government institutions and the models used do not place much premium on transport vehicles. It was again found that adoption of Intermediate Means of Transport (IMT) on a rural road is a good policy provided it is very cheap, economical, affordable and user- friendly. The challenges revealed by the respondents regarding the accessibility and mobility were not quite different from past studies. Challenges revealed include poor or low-quality equipment, poor paths or roads, lack of consumer appeal, the high cost of acquisition, and access to finance. It is recommended that the only way transport services can be considered in the development of rural road infrastructure is when the Ministries for Roads and Transport collaborate effectively.

Keywords Accessibility, Ghana, Mobility, Transport, and Rural

1. Introduction

The focus of Ministries of Transport across Africa and some developing countries has been on road construction and maintenance even though good transport systems depend not only on road infrastructure. An effective transport system depends on roads and appropriate vehicles which should be available in the right place and time [1]. Poor access affects the cost of living and life in the general well-being of the people involved. In most African countries, transport services are provided by small operators, a situation, which to some extent influences the quality of the services. Indeed, transportation in the rural areas, for example, tends to be expensive, unsafe, crowded due to lack of competition [2].

The lack of efficient transport on feeder roads in Ghana results in situations where many of the road users are not able to access health, economic, educational and other social needs. Reasons adduced for this worrying situation are quite puzzling. Many have proposed the use of Intermediate Means of Transport and have wondered why its use has not been readily patronised in sub–Saharan Africa, just as they have been accepted in certain parts of Asia.

Others have also attributed transport inefficiencies to issues like poverty, lack of regulation of transport operators, lack of adequate policies, the inadequacy of transport appraisal methodologies, the influence of Funding Agencies and other Developing Partners. Concerns have been raised by institutions like the Asian Development Bank, as to why resources should be expended on the construction of roads if there will be no guarantee of traffic that meet the very purpose the roads are constructed [3]. Road connectivity and transportation plays a significant role in the development of rural communities along feeder roads. These feeder roads expose most of these rural communities to regional or urban centres which are very vital for economic growth development [4, 5, 6, 7]. There seems to be a growing bias, particularly in developing countries, in the area of research regarding rural roads accessibility. It is interesting to note that there is limited studies on rural mobility issues or challenges particularly in Africa making a lot more people vulnerable and poor [8, 9]. It is therefore important for contemporary research to focus on addressing these gaps in the literature. This study

focuses on the opinions of in-Country Feeder Road Experts on accessibility and mobility issues during the design of feeder roads in Ghana. The study delves into the factors that influence the type of interventions they adopt during the appraisal of transport projects, as well as the contribution of IMTs in the absence of conventional transport system.

2. Background

Ghana is a developing country which gained middle-income status statistically in recent years. The Country discovered oil in large commercial quantities in 2007. It was anticipated that the discovery of oil would have catapulted the economy into higher levels of national income and bring into the Country needed resources to address its poverty and other challenges.

Despite the high expectations of many Ghanaians, Ghana is currently battling with frequent cuts in the supply of electric power, which is crippling the economy. The lack of adequate energy for industry and domestic consumption is one challenge facing the ordinary Ghanaian. This phenomenon has been christened “dumsor” in one of the popular Ghanaian languages. The unmet demand has increased so much that its effect is felt in the whole country to the extent that the term “dumsor” has gained international meaning. Discussions given on the inadequate and irregular supply of electric energy by the Ghanaian media, the need for an increase in the electric energy appeared to be the most critical problem facing the Ghanaian economy and thus receiving more attention from the Government. This crippling energy crisis facing the Country has relegated the diverse pressing needs of the citizenry to the background thus overshadowing the development of other sectors of the economy.

The population of Ghana is reported to have increased from six million since independence in1957 to about twenty-nine million by the end of 2018 [10].

The major problem facing the Ghana transport industry is because the supply of transport infrastructure is in short supply and of poor quality. The provision of road infrastructure has been a major component in the development agenda of Ghana and took about a third of the infrastructure budget. The principal mode of public transport in Ghana is by road; this is because the road transport carries 94% of the internal freight movement and 97 % of all passenger traffic in Ghana. Only about 6% of freight and 3% of passenger traffic are conveyed by other modes like rail and inland water transport [11]. Ghana has a planned road network estimated to be 74,000 kilometres as at the end of 2017, most parts of the road network are not accessible during the rainy seasons and require provisions of structures like surface pavement, culverts and bridges to make them passable in all seasons. The 74,000 Km of the national road network comprises of trunk roads, urban roads and feeder roads. The feeder roads networks are more than half of the total road network. These feeder roads link more significant parts of the rural communities where the majority of the population lives. In most of these rural areas, accessing transport services are major problems, and the lack of suitable transport systems hinder smooth movement of the goods and services.

The interventions from Government in the past have been focused on the provision of road infrastructure, and the attention of Government had been to improve the road infrastructure needs of the country. The ability to meet this challenge facing the country is a major political issue which has a significant influence on the electorates’ decision especially in rural areas where the need for all weather accessibility is very high. The decision to provide road infrastructure which is now political has led to the demand for transport services being relegated to the background. The rising population gives credence to the fact that the demand for transport is going to be increasing and the pressure on transport infrastructure and services will increase correspondingly.

However, besides electricity, the Country is in dire need of infrastructures like roads, hospitals, telecommunication, water and housing. Ghana will need a continuous massive investment in infrastructure if the vision of making Ghana the transport hub of the West African Sub- Region is to be realised. This vision entails the country investing in the transport infrastructure. The internal transport in Ghana for people and goods is about 98% by road. The demand for mobility across the country to address the transport needs is very high and tends to put political pressure on the Government as all areas of the country call for an equal share of the national income for infrastructure development. The limited resources place the Government in unplanned development and expenditure resulting in high budget deficits in an attempt to address the gaps in infrastructure.

3. Literature Review

The terms ‘’accessibility’’ and ‘’mobility’’ has been widely used in many kinds of literature with varying contextual meaning. *Accessibility* may be defined as the ease a facility or place can be reached from another location. While the emphasis on Accessibility is on the “ease”, the focus of *Mobility* is on the “ability”. Thus mobility places a premium on being able to move from one place to the other, that is, having the capacity to move from one place to the other. Perhaps a clearer description of accessibility has been provided by the Social Exclusive Unit of England (SEU). SEU sees accessibility as the ease of getting ‘key services at a reasonable cost in a reasonable time’. From the views of SEU, accessibility can be gauged by the existence of transport between the people and the service, the awareness of the transport service by the people. Also, one has to check if the transport service is

reliable, safe and trusted by the people. SEU is of the opinion that providing transport is not enough without locating the services at places where it is reachable financially and physically [12]. The ability to reach basic services with ease is quite crucial for the improvement of the livelihoods of the rural dwellers in Ghana. There is, therefore, the need to probe the absence of access and mobility to the basic needs of life in the rural areas.

All over the World, Infrastructure developments are seen as the basic foundation for the development of the economy for industrialisation to take off. As most economies of Developing Countries in the West African Sub Region depend on agriculture and raw materials, investment in infrastructure development becomes a key component in their desires to address poverty [13]. Accessibility and mobility largely depend on the availability of transport infrastructure. Lack of adequate infrastructure hinders access to the necessities of life. Infrastructure development provides the critical support for a country's economic development [14, 15]. Many countries face a daunting task with apportioning limited resources to meet the high demand for the development of energy, water, and housing infrastructure which are vital for the growth of their economies.

A country with sound infrastructural can attract investment growth and expansion of its economy as it becomes very attractive for further investment. Transport infrastructure has been in demand for many Developing Countries; there is the need for new construction and the maintenance of the existing roads. Lack of road access deprives many people of access to educational, health care and other economic activities and services. Poor transport infrastructure has contributed to many deaths, for this reason, transport needs became major discussions for consideration under the United Nations post-2015 agenda setting [16].

A sound investment in the transport infrastructure and services contributes to economic growth. Transport infrastructure, for example, is a key to tourism development. There is enough evidence that countries with a high level of investment in transport infrastructure have a comparatively high volume of trade. Generally, high investment in transport infrastructure also leads to lower transport cost [17, 18]. Infrastructure availability influences decisions made by individuals, households and entrepreneurs. The cost of transport, for instance, serves as incentives for firms and individuals to locate or relocation activities to given places. Transport is a necessary input for wealth creation and transformation of economies from lower income levels to higher ones.

Transport services in Africa are still provided by small private sector operators who cannot deliver to the expectations of the people. These unsatisfactory services tend to impact negatively on the activities of poor farmers with under-developed markets and poor infrastructure. Interestingly transport in these areas tends to be expensive and unsafe for the people with little or no competition [2]. Over the years, the call for Transport Planning in Africa has been enormous, particularly in the last two decades. Several studies and reviews have called for a concerted effort in examining the issue of mobility and proximity, not merely focusing on transport. This has been supported by studies conducted by the International Labour Organization (ILO) and the World Bank's Sub-Saharan Africa Transport Policy Program (SSATP). These studies have called for tools such as Integrated Rural Accessibility Planning (IRAP) and Accessibility Planning (AP) as a way of understanding the challenges faced by rural folks and how to set achievable priorities [19] Other tools, such as the Sustainable Livelihoods Approach, have also been used extensively in Transport Planning studies [8, 9]. For example, Bryce son et al. [9] used this framework in the assessing the social and economic benefits of mobility. The study by Bryce son et al. [9] on Zimbabwe and Uganda found that mobility varies with income and therefore the poor tend to rely on non-motorized transport, unlike other income groups. On the other hand, high and medium-income groups tend to like motorised transport. This implies that there is the need to strengthen non-motorized transport for the benefit of the poor in the short term while other interventions are used to increase their incomes to address the inequality.

4. Addressing Rural Transportation Services

IMTs provide solutions to the numerous transportation challenges faced by people to reduce labour cost associated with transport [2]. They are seen as intermediate because they are between human walking and large-scale transport. IMTs can improve transport of both small and medium loads which may be a bit difficult for human beings to carry. The recognition of the potentials of IMTs in Sub-Saharan Africa was discovered in the 1980's even though it is only in recent times that research and development have been enormous [2]. The dominant IMTs identified in the late 1980's include bicycles, tricycles, ox-carts and water carriers. IMTs have been adopted extensively in Asia. It is yet to make a similar impact in Africa due to differences in population density, income levels, industrial base, taxation and cultural factors [20]. For example, Gauthier and Hook [21] have found that the differences in the adoption of IMTs in Kenya and Zambia can be attributed to their taxation regimes. Whereas Kenya's reduced tax is positively affecting the adoption of IMTs, Zambia's tax system is creating a serious impediment in terms of adoption. As earlier indicated, most people in rural areas do not have the means to own a car, and therefore mobility is synonymous to walking or IMTs or, better still, public transport. Transport services in most rural settings along feeder roads are delivered by way of animal-drawn carts,

bicycles, motorcycles, tricycles or taxis. These are the main transport for rural in most countries. An interesting observation is that IMT as a means of transport is often ignored even though it plays a critical role in the mobility of rural people. While providing access to markets, healthcare and educational facilities, IMTs also provide employment for the operators [22; 23, 24; 25; 26].

Unfortunately, most government officials in Africa look down on IMTs as means of addressing the transportation problems facing rural people [2]. IMTs are not new in Africa. Several countries such as Angola, Ghana, Kenya, Nigeria, Uganda, Zambia and others have attempted to adopt them, even though they have been confronted with numerous challenges. Some of these challenges include poor or low-quality equipment, poor paths or roads, lack of consumer appeal, the high cost of acquisition, and access to finance. For example, the provision of poor or low-quality equipment has been a very significant challenge for most of these countries, especially Ghana. Most of the equipment provided for the implementation of the Village Infrastructure Projects was all inappropriate [22; 27]. Currently, the bicycles and the motorcycles are imported from Asia. China and India seem to be making headway as far as the introduction or adoption of IMTs is concerned. The assumption underlying the construction of roads in developing countries is that if roads are constructed, automatically the private sector will take advantage by developing transport services along the road. This continues to be a failure as in most cases the roads have been built, but only a few people are utilising them since there are no conventional transportation systems. It is important for governments in developing countries to look for innovative ways of addressing the transport challenges facing the rural people through proper and effective planning which has hitherto not been the case.

5. Research Methodology

The research Methodology provides step-by-step information about how research is conducted. Since the study is about peoples' opinions, perceptions and the quality of services relating to mobility and accessibility, the application of Qualitative Methods appeared to be more appropriate, and therefore the study adopts a Qualitative Research Approach. The reason for adopting a qualitative approach was the fact that the researcher sought to collect answers to open-ended questions with the intent of understanding the problem from Ghanaian perspectives as a contribution to literature. Cresswell [28] believes that a qualitative approach is the one where the researcher gathers information from multiple perspectives, with the view of developing a pattern which can explain a particular phenomenon. Qualitative approaches enable researchers to ask probing questions. The research participants are offered the flexibility and an opportunity to freely express themselves with the hope of addressing the study objectives.

The data used was collected from both primary and secondary sources. The primary data was collected through in-depth interviews. Using the expert interview to seek information from experts at the exploratory stage of research offers the opportunity to elicit and access information from individuals, organisations and institutions which may be ordinary difficulty to have using other qualitative methods or techniques [29]. According to Bogner, Littig and Menz [29], it is a quick way of gathering data as expert interviews, provided there are enough motivations for experts to participate and share their experiences. An enabling environment is often created if the interviewers and the experts have related or common professional backgrounds or experiences. Expert interviews serve as focal points to have concentrated data from the people by their experience and knowledge from positions they occupy or have occupied. It is relatively less expensive to use the formal structures like secretaries of experts to gain access to them. Where some experts are interested in the topic, they offer wider information and may make a recommendation to reach their colleagues in their network or cycle of experts. Contributions from experts are generally perceived as legitimate and serve as good motivation to gather more information in areas under the study. The interview questions were carefully crafted to cover the thematic areas of the study.

The respondents for this study were purposively selected by the positions they occupy in their organisations and the fact that the play varying roles in feeder roads construction and maintenance. Purposive sampling technique has been useful for this study because of the control it offers the researcher in selecting appropriate cases for the study. In order to make good use of the data collected, the recorded interviews from the field were transcribed for easy coding and further analysis. The data gathered from the interviews were analysed using Nvivo 12 Plus. The data were coded according to the core themes of the research after which the discussions followed.

6. Analysis and Discussion of Findings

The analysis was organised along five main themes namely;

- Feeder roads construction and maintenance,
- Types of vehicles on rural roads,
- Intermediate means of transport, transport appraisal models, and
- Users' benefits associated with improvement in their accessibility and mobility
- Accessibility and mobility challenges as presented in figure 1 attached.

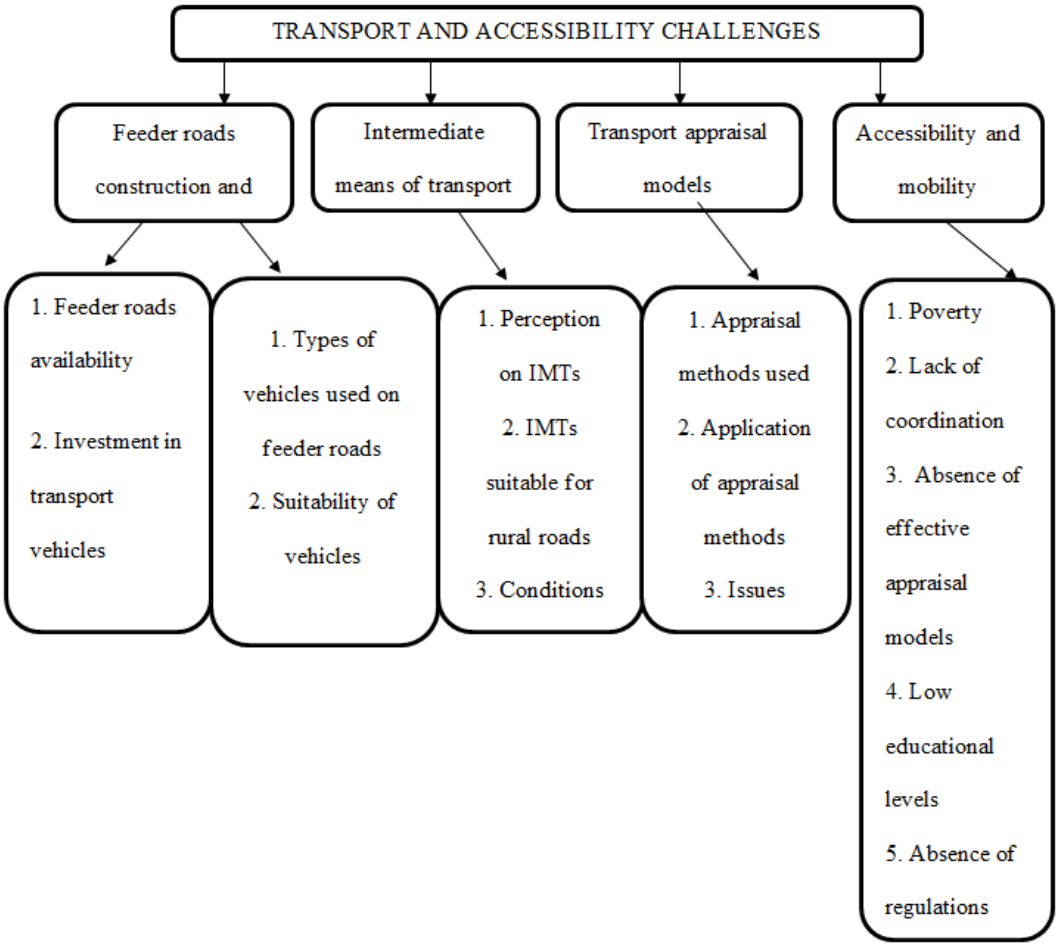

Figure 1. Major analysis themes and sub issues

7. Feeder Roads Construction and Maintenance

In this section, key issues that will be discussed include the availability of feeder roads, investment in transport vehicles and rural transport responsibility. Related issues include the types of vehicles used on feeder roads and the suitability thereof. The study first sought to determine whether or not Ghana has constructed enough feeder roads. Most of the respondents indicated that looking at the landscape of Ghana; enough feeder roads have been constructed. A respondent revealed that:

> *"I think so because if you look at the feeder road network (4200km plus) and you look at the land area of Ghana and you look at the connectivity, and you compare that to counties in sub-Saharan Africa, you will realise that we have done enough".*

In addition, a respondent added that: *"I think the number of roads we have in Ghana is enough, it is okay. Maybe we need to intensify our efforts on the maintenance of those existing roads".*

From these categories of respondents, what needs to be done is to improve the level of service which means there is the need to improve the condition and make sure that many roads are in good shape all year round. According to these respondents, once this is done, the country will be on its way to meet its transport needs. On the other hand, some respondents were of the view that there is still more to be done. For instance, a respondent stated *"Not at all, there are still more to explore, and even some of the communities are expanding. It is like more paths are being created which the people are expecting the government to develop them into proper engineered roads. We still have a long way to go*".

Another respondent hinted that there is the need to construct more roads provided funds be made available. This is what he had to say *"In fact, there is a need to construct more but based on the availability of funds. I think it would be prudent for us to concentrate on the maintenance of the existing ones because we have about 42000 km of feeder roads"*. These respondents believe that most of the rural roads networks are not engineered, and therefore they need to continuously maintain or upgrade them to make them motorable all year round. It is expected that every engineered road should see some minimum maintenance during the year. This tells the extent to which new roads should be constructed or the old ones

maintained.

The responses gathered point to the fact that most rural or feeder roads are not appraised thoroughly before their construction and that accounts for the reason why transport investments are not factored into the plan of most feeder roads. It is interesting to note that most of the roads that were appraised were either funded by donor partners or other development partners other than government institutions. Actually, for most of these agencies, Project Appraisal is a strong requirement if the project is to see the light of day. Highlighting how relevant Project Appraisal is though it is not often considered, an interviewee had this to share:

> *"Well, we try to do that, but under the RTTP (Rural Travel and Transport Program) funded by the World Bank, we were forced to do that. RTTP is a World Bank initiative that the Department of Feeder Roads took part and then we tried to look at both transport infrastructure and services. Under the current arrangements, the Ministry of Roads deals with road infrastructure, and the Ministry of Transport deals with transport services. So as you know, we are supposed to liaise closely, but I do not think we have done that in the past".*

It is instructive to note from the above responses that the only way transport services can be considered in the development of rural roads is when the Ministries of Roads and Transport collaborate effectively. The results of some Department of Feeder Roads projects sponsored by the World Bank, which aimed at promoting non-motorized transport services on rural networks in the Northern part of Ghana, showed that given a chance, non-motorized transport would at least provide some transport services on the rural network. It is generally assumed that if rural roads network is upgraded or developed, automatically people living along the roads will stop head-loading and transfer to motorised transport which is not the case always. This is because most of them do not have the means to take advantage of the opportunities provided by these road expansion projects. This means that they have to move slightly to non-motorized transport, raise their income levels before transferring it to motorised transport but you need something to break that inertia. There is the need for some subsidised services because urban transport is subsidised, but rural transport is not. Providing funding for people to buy non-motorized transport or subsidies will be in the right direction. It is clear that the Ministry of Transport is responsible for service, so it means the Ministry of Roads provides infrastructure. Interestingly, some respondents also felt that the Department of Feeder Roads should focus on the construction and leave out the transport issue to other agencies under the Transport Ministry.

Respondents were also asked to indicate whether or not there are specific types of vehicles that are suitable for rural roads. Some of the respondents responded positively because not all vehicles are suitable. A respondent revealed that *"Well, think ''yes'' of course, but this will differ from area to area, e.g. when you go to the northern sector you will see many people using bicycles, motor bicycles, donkeys, and few motor vehicles but if you come to Southern sector it's mostly motor vehicles, few bicycles and motorized tricycles".*

In support of the above, a respondent added that: *"I do not think there is any specific vehicle that would be suitable for the movement of goods on our feeder roads based on the types of feeder roads they are talking about. Because if it is a tarred road, I think all can pass on it, but if it is a rough road then I think four-wheel drives and pick-ups would be preferable during the rainy season than maybe a bus or van or whatever it is".*

This implies that, to some extent, the nature of the road and the weather conditions determine the kind of vehicles that can play a particular route at a point in time. Most of the respondents also believe that the promotion and development of road transport services should be the role of the Private Sector because Government or Public Sector organisations have not performed so well when it comes to transport services. According to one of the respondents:

> *"In Ghana, when it comes to transport, it is the private people who normally go into it. So I do not know if we still want Government to be involved, which to me ….. We have had some experience before. These Omnibus Service Authority (OSA)' buses some years back were mismanaged, and because of that, I would prefer private people to go into transport services and leave Government out of it. Seriously, I do not see the role of Government in there".*

It is therefore not surprising that transport services are mostly relegated to the background when discussing the development and maintenance of Rural or Feeder roads in Ghana. Generally, most of the people at the helm of affairs believe transport services should be the role of the private sector no matter what. This confirms the assertion made by previous studies particularly in Africa where the private sector provides the majority of transport services.

8. Intermediate Means of Transport (IMT)

Considering the economic conditions in most rural settings in Ghana, there are calls for the introduction of intermediate means of transport which can reduce some of the challenges associated with transport along feeder roads. This section, therefore, looks at respondents' perception on IMTs, IMTs suitable for rural roads and the conditions for IMT adoption in Ghana. IMTs are generally seen as anything between walking and relatively large-scale motorised transport.

On the role and use of IMTs, a respondent indicated that:

> *"IMTs are for short distance. They are most appropriate to use because you do not need to get a certain number of people. In terms of short distance, IMTs are needed. Eventually, IMTs are used for commercial purposes. Therefore, I see IMTs as good transport system on rural roads to carry goods"*.

A respondent also said: "*IMTs can serve several purposes as it can even be used in times of emergency. Some communities I have visited use IMTs for emergency services. From my experience, I feel it will be useful for the rural community. They can be used to carry goods, children, and other passengers."*

On the issue of IMT suitability, some respondents indicated that IMTs are suitable in communities where conventional transport systems are ineffective or absent. To these respondents, the suitability depends on the availability of other forms of transport as well as the nature of the road network. A respondent reiterated that: *"In communities where they have no commercial means such as buses and taxis, IMTs can be used as a means of transport for both human beings and goods. They can serve emergency purposes. I am saying this because it is used to convey pregnant women in the rural areas"*.

Adding his voice to the above, a respondent illustrated how IMTs could be beneficial in the fight against poverty in rural areas. He shared this:

> *"To the rural folks, carrying the foodstuffs from the farming gate to the market centres is their aim, and it is not the means. In view of that whether it is bicycles, tri-cycles or donkeys; the most important thing is that it relieves the hardship of the rural folks. So instead of carrying it on the head, these non-motorised means will help. It saves them much time"*.

According to the responses, IMTs have been adopted in several African countries which imply that Ghana can also adopt them provided the right framework or policy is developed. Respondents see the adoption of IMTs on a rural road as a good policy on account of being very cheap, economical, affordable and user-friendly. In the absence of the conventional vehicle (like buses, taxi, etc.), IMTs can be used as the main vehicle on rural roads. All these can be achieved if road planning considers transport as well. Roads are meant for movement of goods and services using vehicles, so there is the need to investigate the type of vehicle the road for which the road is intended.

Asked why IMTs are not making the necessary impact in Ghana, respondents indicated some challenges confronting the promotion and subsequent adoption. A respondent shared that: "*Even though the cost of acquisition is not high as compared to motorised transport, there is the need for subsidies to be provided because a lot of them cannot afford to buy on their own. Loan schemes such as MASLOC (*Microfinance and Small Loans Centre) *can contribute in this arena"*.

Another respondent indicated that quality of equipment in the market and poor nature of some of the roads are also affecting the adoption of IMTs. He indicated that *"most of the supporting equipment is of inferior quality and therefore it does not last. Again most of the rural paths or roads are in bad shape such that donkeys or other animals will struggle to ply*".

Some respondents were quick to add that culture is playing a key role in the adoption and promotion of IMTs in Ghana. The adoption rate in the Northern part of Ghana is higher than the southern part primarily because the northerners are used to them. On the other hand, southerners prefer motorised transport to IMTs. A conscious effort at creating the needed awareness of its importance will be most appropriate for the entire country.

9. Transport Appraisal Models

It was important also to determine whether feeder roads projects are appraised to determine their viability. The responses show that the issue of viability does not matter because several factors other than viability are considered. An interviewee hinted:

> *"When we started Feeder Road Department, it was clear that communities were coming with their request and we were following up and developing them. We did that for a reasonable time of over 10 years. However, since my assumption of duty, I have seen that the politics of today influence this matter"*.

Indeed most of the respondents see the selection routes to be more political rather than technical. This implies that even if the appraisal shows that it is not viable, there are no way politicians will allow it to hold. A respondent retorted:

> *"As at now, selection of roads is not even done by the technical men here. The politicians do it. They bring their list and ask you to go and carry out your studies. So whether the study is good or bad, you have to carry out the instructions of politicians"*.

The responses show that Appraisal Models are not used most often even though their use can positively impact on the success of projects. Asked the dominant model used, a respondent stated:

> *"I think we use the Internal Rate of Return (IRR) because what we do is to look at "before" and "after". That is the situation before the road was constructed and when the road was constructed; what is the effect? Has it increase the output of food crops from the rural areas; what about lifestyle; has it been improved?"*

In reality, the appraisal models are supposed to provide some technical evidence for the decision made, but unfortunately, it is not the case. This accounts for the

absence of appraisal models in Government of Ghana funded road projects because the outcome of the appraisal cannot change the decision.

10. Accessibility and Mobility Challenges

Road Transport Planning and implementation has faced some challenges over the years.

This section analyses the challenges facing rural transport accessibility. Some of the challenges identified include

- Absence of effective appraisal models or tools,
- Low educational levels,
- Lack of political commitment,
- Absence of regulations and others.

On the issue of the challenges, some respondents indicated that poverty is the biggest challenge as it is the reason why most rural people cannot afford some forms of motorised transport and therefore had to resort to other means. An interviewee shared his thoughts:

> *"Many people resort to the use of motorised tri-cycles, especially in the South, because they either have no option or they cannot afford the other options', and these tri-cycles and motor-bikes are playing the role of taxis without obeying the rules and regulations".*

The actions or inactions have made tri-cycles or motorbikes very dangerous for people living along feeder roads in Ghana because of frequent accidents and claims innocent lives. Another respondent added his voice:

> *"I am not against it, but it has serious accident rate. The people need to be educated very well because, we often hear a lot of accidents by this tricycle, and in the night when you meet them, they appear like motorbikes because the whole body is not portrayed for on-coming vehicle or any pedestrian to know that what is coming is not just a motor bicycle but a tricycle. So, before you realise either it has knocked down a pedestrian or collided with an oncoming vehicle, and this can be disastrous. There have been many accidents. So there has to be more education, and maybe they need to put some light at the edges, so that, it can indicate or show the sides of the tri-cycle coming. In the night, you cannot identify it very easily, unless it gets closer to you".*

The responses show that lack of coordination is one of the key challenges affecting accessibility and mobility in rural Ghana. A respondent bemoaned how lack of coordination has affected Road Design, Maintenance and Planning in Ghana.

> *"Coordination is very important because I think that, there shouldn't have been any separation; the Transport Ministry and the Road and Highways should be one Ministry. In that case, we would have been able to address that issue and even design roads for specific means of transport because, though we talk to each other, I do not think it has been easy".*

The challenges revealed by the respondents regarding the accessibility and mobility were not quite different from past studies. Challenges such as poor or low-quality equipment, poor paths or roads, lack of consumer appeal, the high cost of acquisition, and access to finance. These have been confirmed by Porter [22] and Porter and Lyon [27]. Africa still relies on the Private Sector for Transport services though the Private Sector Transport Services operators do not have the capacity to deliver that mandate given the economic conditions in most of these countries.

Same can be said of Ghana as Transport Services are left in the hands of the small Private Sector operators. Most of these operators exploit the rural poor in their bid to provide these services. From the responses, it is pretty clear that the services rendered are unsatisfactory and impact negatively on the activities of poor farmers with under-developed markets and poor infrastructure. The transport provided by these operators is expensive and unsafe. The responses above call for concerted efforts in examining the issue of mobility and proximity not merely focusing on transport.

The responses show that given the necessary attention, rural transport can contribute significantly to the fight against poverty in rural Ghana. This has been supported by studies conducted by the International Labor Organization (ILO) and the World Bank's Sub-Saharan Africa Transport Policy Program (SSATP). These studies have called for tools such as Integrated Rural Accessibility Planning (IRAP) and Accessibility Planning (AP) as a way of understanding the challenges faced by rural folks and how to set achievable priorities [19, 30]. Generally high and middle income groups tend to like motorised transport. This implies that there is the need to strengthen motorised transport for the benefit of the poor.

What is a bit difficult to comprehend is the fact that the Private Sector is considered the engine of growth in Ghana and yet it is unable to deliver transport services in the rural area in Ghana effectively. This raises a serious question that needs to be answered. It looks like the absence of a comprehensive Appraisal Models that take into consideration the needs of people living along the feeder roads in the planning and implementation of rural roads projects and programmes is accounting for this failure. The responses show that the selection of feeder roads is mostly a political decision which normally fails to incorporate any technical decisions. Lack of coordination mentioned as one of the key challenges could be the reason why the Private Sector is failing in this regard.

The responses on the adoption of IMTs are not surprising as previous studies have confirmed the extent to which countries in Sub-Saharan Africa have adopted IMTs as a reliable means of transport both for goods and human

beings. From the study, the dominant IMTs include bicycles, tricycles, donkey-carts and water carriers even though it is yet to receive the full attention it deserves. The findings confirm the view held by scholars such as Ellis [20], Starkey, [2] and Gauthier and Hook [21] that IMTs are very popular in Asia, unlike Africa, primarily due to the differences in population density, income levels, industrial base, taxation and cultural factors. Most people in rural areas do not have the means to own a motorised transport, and therefore mobility is synonymous with walking. Transport services in most rural settings along feeder roads can be improved by resorting to the help of animal-drawn carts, water carriers and others, especially where conventional transport systems are absent. Despite the significant contributions of IMTs to rural transport in the world over, it is yet to make such impact in Ghana.

11. Users' Benefits Associated with Improvement in their Accessibility and Mobility

Most of the respondents were of the view that the construction and maintenance of feeder roads are very important to them due to the transfer of agricultural goods from the farmlands to the market areas. They added that construction of roads pave the way for vehicular movement of goods and services from one community to another community and allow drivers of vehicles to make prices affordable to the rural community dwellers. One respondent said that when roads are constructed, it reduces rural-urban migration.

They, however, indicated that there is the need to plan to ensure that the type of vehicle recommended using the feeder roads, do so to ensure that the roads are not destroyed by heavy loads. *"Now, we have access to vehicles at any time of the day which has helped in making movement easier. Hitherto, it was very difficult to get access to a vehicle as most drivers did not want to ply the road due to its bad state.*

Again, before, immediately there is an increase in petroleum prices, drivers increase the fare prices. They attribute the increase to the bad nature of the road. However, they hardly increase fare prices even if there is an increase in petroleum prices now". "Yes, feeder roads are important as they are needed to transport agricultural produce", he added.

The feedback from the respondent also indicated that once the roads are constructed and maintained the number of the vehicle would automatically increase and this will support the people in terms of health delivery and access to agricultural inputs and markets. This is because they attributed the successful marketing of foodstuff to the availability of adequate transport.

However, they were of the view that as long as the roads remain poor, the vehicle's maintenance always compels drivers to increase transport fares which is a major challenge. Also, the respondents were of the view that demand for particular vehicles depends on the type of roads available to the communities.

Another respondent, an expert from the Feeder roads said that transportation process is always considered when initiating any road policy, estimating the number of the vehicle as well as the type of vehicles expected to ply on the road to open up these places for economic activities. In doing so, the transportation system brings about the influx of vehicles to help develop the area through the provision of social amenities.

"*Before the construction of the road, drivers complained about the cost of maintaining their vehicles due to the nature of the road. As such, the increment in transport fares was quite regular. With the construction of the road, the situation has changed. Revenue accrued by the district assembly was low. This was because the bad nature of the road prevented people from coming to the market in Ofuman. The traders and farmers then are unable to sell more and pay the appropriate tax to the assembly. The construction of the road has helped in the delivery of healthcare. Again, it has made it possible for more vehicles to assess the community. This community is farming dominated one. Due to the bad nature of the road, some of the farms produce decay at the farms as transporting them to the main township is difficult*". (An Expert)

"*Yes, the essence of constructing roads in rural areas is to reduce poverty in these areas. As such, in constructing roads, it is important to provide means of transportation as without transport means; it would not be possible to transport foodstuff from the rural area to urban centres. So as much as we are concentrating on the road, we also have to be thinking about the type of vehicle*". He added

12. Conclusions

From the study, it was gathered that the provision of Transport Service should be in the realm of the Private Sector but supported by appropriate policies and regulations from the Government. Respondents also gave a good indication about the type of vehicles used on rural roads or suitable for rural roads. IMTs are generally seen as good because they are cheaper to acquire, economical and user-friendly. However, when it comes to the motorbikes, the concern is that the safety aspect should be important. In a motorcycle, we should be careful in the distinction between the motorised tricycle and the other ones. All over the world, many of the world's poor live in rural areas; these people lack basic infrastructure such as Roads, Healthcare, Markets and Education as well as transport services. The absence of effective transport services to these people comes with enormous challenges.

The finding of the study has shown that IMTs are assuming significant roles in developing countries such as

Ghana where it is playing a very significant role in the lives of the rural poor. Respondents believe IMTs are appropriate because it can be used anytime and can be used for commercial purposes in some cases. It is pretty clear that IMTs provident significant benefit to the rural from transportation of goods to improving human health. This implies that IMTs are very relevant and supportive to communities in the hinterlands. In the absence of conventional vehicles, emergency services situations like carrying patients in critical condition, most rural poor communities resort to innovative approach using bicycles, pedicabs and other IMTs to provide these essential services. It is also worthy to note that the adoption rate varies depending on the location of the country. For example, the adoption rate in the Northern part of Ghana is higher than the Southern part primarily because the northerners are used to them. On the other hand, IMTs are not common in the southern part because the people prefer motorised transport to IMTs primarily as a result of their cultural orientation. Most people prefer motorised transport because it is fast and it carries many goods, and it requires little human efforts as compared to IMTs.

In the past, very little attention has been paid to studies on the implications of transport investment in rural areas. Good roads can stimulate development, but road investment alone cannot bring about the needed development. This is because the poor may not be able to take advantage of the opportunities provided by good roads network. There is strong evidence to back the fact that good rural roads provide numerous economic and social benefits to surrounding communities which hitherto were lacking. Studies from countries such as Ghana, Ethiopia, Uganda, Bangladesh, India, Nepal, Pakistan, Morocco, Vietnam, China and others show that the upgrading of even footpaths to motorable roads has positive impacts on the rural poor. It can, therefore, be concluded that Governments and all other stakeholders should be concerned with transport services along feeder roads while giving their attention to other equally demanding infrastructure needs in order to bring qualitative change to the lives of the rural poor.

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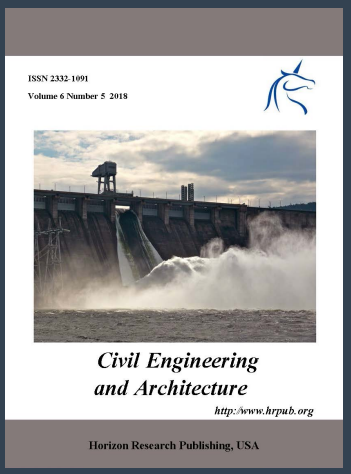

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