

IMPACT OF POORLY DESIGNED STRUCTURES ON GROWTH OF A COUNTRY

Apurv Agarwal

Budhia Bhawan, 2nd Floor, Sati Jaymati Road, Athgaon, Guwahati, Assam

DOI: 10.46609/IJSSER.2021.v06i12.017 URL: <https://doi.org/10.46609/IJSSER.2021.v06i12.017>

Received: 9 Dec. 2021 / Accepted: 25 Dec. 2021 / Published: 31 Dec. 2021

ABSTRACT

In recent times we have noticed quite a lot of economic loss by countries due to poorly designed mega structures which collapsed before time, unable to fulfil the purpose they were built for. This research focuses on identifying and analysing failure of mega structures while also looking at the factors behind the failure. While sometimes the faulty structures in the past have not only cost money and human lives but have become a tourist attraction and wonder of the world like The Leaning Tower of Pisa. This paper is written to help the population and the authorities realise that it is not just the loss of human lives and assets due to the failure of mega structures but can also result in long term repercussions in long economic loss.

The paper uses secondary research methodology looking into both failed and successful structure and their impact on the country's economy.

The paper talks about the reason for a country to develop its infrastructure and the reasons why a country focuses on building structures. A country develops its infrastructure for faster development and builds mega structures for tourism which helps them to increase their GDP and also builds up faith in other countries to help them build mega structures which helps them to gain reputation. The paper also talks about the consequences which a country has to face if a structure fails to succeed. In addition with consequences, the paper talks about the cause of the failure made by the engineer or the builders.

Introduction

The research paper talks about how the countries are related to structures. The profits achieved by the countries for each success and loss faced for each failure. This will be provided in context

with examples and reasons for the failure. Instead of directly starting with the paper, the reason why a structure fails is due to poor design and mistakes made by the builders or the engineers which leads to loss of economy and the reputation of the country.

Why do the Mega Projects Fail? What are the Reasons Behind these Failures?

It is obvious that the engineers associated with the work of planning, designing, construction and execution of the structure are competent or knowledgeable enough to analyze and address various conditions while the construction of the structure. The main aspect of the structure of proper stability is not forsaken even if the reengineering is required while the construction takes place. The engineers should have a basic foundation to understand the Law of Gravity, Law of equilibrium, static and dynamic, Newton's Laws of Motion, linear or circular, Laws of Friction, static and dynamic, Laws of Thermodynamics, Faraday's Law of Electricity, Law of Fluids, Stress, etc. No proper knowledge of the above laws is itself a reason which does not occur frequently. Reasons for failure is because of-

- Low Decision-Making Behavior- This mistake has an effect on the structure because if the right decision is not taken on time may lead to loss of lives later.
- Obeying The Design Without Any Changes Until Asked by The Engineer- As we learnt the case of collapse of building in Mumbai because a builder did not follow the instructions of the Design and raised the stilts and added stories leading to excessive load on the columns.
- Cost Cutting- Proper materials should be used while constructing. Just to reduce the amount of expenditure on materials and keep the rest of money in the pocket, lives of people should not be hampered.
- Pressure of Deadline- If proper materials for a structure is not available, the pressure of deadline and penalty for not completing the structure on time makes the builders use weak material which again leads to failures of projects.

Impact on the Project and on the Economy Due to Above Reasons.

The impact on the project for such blunders made by the humans involved in the project are directly attacking the lives of the citizens who use the structures on a daily basis. The mistakes only make the structures weak which in result may not last long. The builders who try to add their own ideas and not follow the design plays with the engineering of the structure which makes it more unstable. The pressure of the deadline makes the workers work faster which may

lead to an unconscious mistake. These small mistakes only and only have a consequence on the citizens. The structure, when it fails, has an extra cost of rebuilding or cleaning the area which not only creates a traffic jam or something smaller, but it puts the nation or the state in a huge debt. The loan which the country borrowed from the World Bank in a guarantee of a successful structure with complete trust on engineers and builders failed which not only puts the country in a debt but also gives a bad impression to other countries. If the project had the usage of bad quality materials even if the engineering is perfect, it drops the life expectancy of the structure by at least 20 years.

Impact on The Goodwill and The Economy of The Country.

Whenever a structure collapses in a country, the news is spread around the world. The citizens and the President of other countries will start doubting the country. This will make other countries avoid asking for help whether it be for materials or labour or the engineer. The direct impact after collapse of the structure leads to loss of millions of rupees which does not include demolishing charges. The country might end up in a huge debt by the World Bank which will again affect the reputation of the engineers and the country. To regain the architectural credibility and the original market value, the country would have to come up with something unique and more intuitive.

What do the Countries Face if the Structure Fails or Succeeds?

If the Structure Succeeds

If a structure made by any country succeeds, there are multiple benefits coming up for the country. The country will be well reputed and trusted by other countries as they will start to believe that the engineers and workers have a good experience to make a successful structure. They will start to believe that the engineers have kept everything well planned and have left no aspect in the checklist, whether it be the quality of lands or materials to be used or the places nearby the structure and the foundation which may cause threat not only to the structure but nearby people as well. This will help the country get more projects and which may help them with financial issues. Also, these structures will create tourism in the country helping it to develop at a faster rate.

If the Structure Fail

In contrast, if the structure made by any country fails, the country will face appalling consequences. The bar of the faith on the country by others will decrease, the countries will stop

asking for materials or workers due to lack of trust. When the structure fails, the country will have to bear extra charges of cleaning the area, furthermore, the countries will go on a humongous debt by the World Bank which gave them a loan with a guarantee of a successful structure. The country will lose tourism and will have to brainstorm to get out of debt. To retain the reputation, trust, tourism and various sources of income, the country will have to build another innovative structure which will get the country back into competition.

Research Methodology

As mentioned earlier the paper uses secondary research methodology looking into both.

Secondary Research Methodology is basically summarising the already existing data in other research papers or libraries or websites or already filled surveys. This way of research is cost effective as it is already present there online. The only cost which is to be considered is a working place.

The only drawback with this way is that the data in the research is already present and this does not give the reader any new information which primary research gives. This data is basically not unique like the data in the primary research papers.

Literature Review

Provoke Insights: Provoke insights is a full service global brand strategy and market research company headquarters in New York. While researching, the number of errors is to be reduced as much as possible, this task can be completed with the help of Provoke insights.

Business Insider: Business Insider is an American Financial and a business news website founded in 2007. It has millions of visitors for a core reason of bankers, traders and tech geeks.

Matec-Conferences: Matec Web of conferences is an Open Application Publication Series dedicated to archiving conference proceedings dealing with all fundamental and applied research aspects related to Materials science, Engineering and Chemistry.

Cultural Survival: Cultural Survival is a nonprofit group based in Cambridge, Massachusetts, United States, which is dedicated to defending the human rights of indigenous peoples.

Borgen Project: Borgen Projects believes that leaders of the most powerful country should be doing more to address poverty. Borgen Project are the innovative, national campaign that is working to make poverty a focus of U.S. foreign policy.

International Trade Administration: It creates prosperity by strengthening the international competitiveness of U.S. industry, promoting trade and investment, ensuring fair trade and compliance with trade laws and agreement.

IBEF: IBEF is a knowledge centre of global investors, international policy-makers and world media seeking updated, accurate and comprehensive information on the Indian economy, states and sectors.

Deccan Herald: Deccan Herald is an Indian English language daily newspaper published from the Indian state of Karnataka by the Printers Mysore Private Limited, a privately help company owned by the Nettakallapa family.

International Nuclear Information System: INIS holds one of the largest collections of published information on the peaceful uses of nuclear science and technology.

Analysis

Some Major Projects Having a Catastrophic Ending:

A) The Tacoma Narrows Bridge Failure.

The Tacoma Bridge, a famous case study for today's professors and physics students. This bridge was in Tacoma, Washington. Constructed in 1940 with a cost of \$11 Million. This bridge was located over Puget River which was approximately a mile wide. With this length the bridge secured the third position for the longest suspension bridge. But its length is not the reason for it to be famous, the reason is for its flexibility. This bridge got a nickname "Galloping Gertie" because when a moderate wind would blow, it twisted like a sine wave and because of its collapsing incident by a 40-mph wind. With this high speed, most of us would be thinking that this incident was due to a natural disaster, but no, the reason it collapsed is that the engineer who intended to build the bridge with great stability in its standard design had to use a cheaper material as the materials held an exorbitant cost of \$200 Million. The cheaper material used was the plate girders which was only one-third of the height of the proposed trusses, leading to a disproportionate depth to width ratio. As a result, the bridge attained its flexibility. Then the famous date arrived, 7th November 1940, four months past the opening of the bridge for the use for citizens of Tacoma. A 40-mph wind blew, and the bridge started to swing. The support cables snapped followed by the dropping of a bridge in the river, taking lives of more than a thousand people.

B) The Roof of Kemper Arena.

The Kemper Arena located in the city of Kanas, Missouri was constructed in 1972-1974 which cost an amount of \$23 Million as a home to the Kings of Kanas was hailed as an innovative design. The architect of this structure won an Honor Award from the American Institute of Architects. But with this great innovation, there was a crystal-clear fault in the roof of this structure, the roof was built flat which raised some problems to handle the weather. Even though the structure contained a temporary reservoir, it had only 8 drains which would overflow after a meagre amount of 2-inch rain, the low number of 8 drains gave a concerning difference as the local code said that there should be at least 70 drains for this structure. And this Five years after the construction, in 1979, a storm came by which dumped a measure of double the amount of capacity of the roof. As a result, such an innovative, amazing structure collapsed due to the storm by the roof. Ironically, the architects from AIA visited this Arena just the day before the incident took place.

C) The Famous Leaning Tower of Pisa.

The Leaning Tower of Pisa, also known as one of the Wonders of The World, is in Pisa, Italy. This masterpiece was constructed in 1173-1372. It is situated behind the Pisa Cathedral, the original reason to build the tower was to house the bell of the Pisa Cathedral Complex. The reason for this structure to lean was because of an unstable foundation which is one of the key parts for a build. The foundation has only 3 layers which is 3 meters deep, whereas the engineers planned to build a total of 8 layers. This was because a war broke out when the third layer was completed which in result gave time for the foundation to settle. Not only this, but the limestone foundation was built in a dense clay bed which clearly implies that it was never meant to last. Thus, in 1378, the tower achieved its famous lean of 10 degrees. Thankfully, in 90's the authorities decided and added a total of 600 tons of counterweight to the base keeping the tower in balance.

D) The Collapse of the Banqiao Dam

The Banqiao Dam was built in China in Zhumadian City in 1951-1952. This dam was supervised by the Soviet Engineers. In 1954, a day arrived when a flood hit the dams in China and the government ordered to extend the dams and The Banqiao Dam was extended by 3 meters. Then some cracks appeared on the dam and by the advice of the Soviet Engineers, the cracks were repaired, and it was claimed the dam will be able to withstand a "Flood in 1000 Years". But the issue is not this, the Chief Engineer Chen Xing proposed to have 12 gates in the dam which would handle the overflow, but he was ignored, only 5 gates were built instead of 12. The year 1975 arrived and a measure of nearly 7.5 inches of rain was recorded which means 42 inches per

day which stained the dam to its limits. After 2 days, the dam broke, and a thousand people died initially. The government ordered other dams so that the flood may come under control, but it was too late. This resulted in the death of thousands more and the ones who survived were suffering from famines. A total of 200,000 died due to this catastrophe.

E) The Poorly Designed Viñoly's Building.

The Viñoly's Building in London is similar to the Vdara Hotel in Las Vegas. The Viñoly's Building was constructed in 2009-2014 with a cost of \$250 Million. This Building got the nickname "Death Ray Hotel" by the citizens because of its curved design. The reason behind this nickname was none other than the curved design because that curve would magnify the rays of the sun creating immense heat for the guests in the hotel. Adding to this, the curve shape not only troubled the hotel guests, but the curve shape magnified the rays at some distinct points on the road as well taking the temperature to 160 degrees Fahrenheit which melted a man's Jaguar and for the journalists were able to fry eggs on the street side. Due to this incident, Viñoly's Building was ordered to have put black screen on glass panes which controlled the magnifying effect of the building.

F) Excessive Load on the Columns of a Building.

A multi storied building in Hyderabad collapsed on 8th December 2016 killing a total of 11 citizens and critically injuring 2. The reason behind the failure is not again because of any natural disaster even though Mumbai faces a measure of 2205.8 mm of rain every year which has caused collapses several times. The reason behind this failure is because of weak supporting structure with inadequate design and excessive load on the columns and the foundation of the building which lead to a sudden failure. The foundation of the building was found to be located near a borewell, the design of the foundation was also asymmetrical leading to further instability. No proper placements of the footings of the columns also contributed to the instability. The main design of the building consisted only of the ground floor plus three, but the builder involved in the project raised the stilts, 5 additional floors and a penthouse. The site where the structure was built was also not properly examined before the construction as a sump after the collapse was found near the two rear columns which again added instability to the foundation. A great mistake made by the builders was that they did not place a column and a beam which was required. Adding to the point of not properly examining the site before construction, it was found that the building was placed quite near another building without any setback, this added more weight to the foundation of the building. These many problems regarding the foundation contributed to a collapse of the building.

Why do countries invest in Dams, Tunnels and Bridges and what are their importance?

The developing countries like Albania, Chile, Cuba, Mexico, India, etc are building more and more of these structures which helps the country develop at a faster rate. The bridges they build to help the transportation easier over the rivers or large water bodies which gives a direct way to the other end without wasting those precious time whether it be 30 minutes or 2 hours, this not only saves time but also reduces the fuel consumed by the carrier and eases the work for the trader.

Secondly, the dams are not built to stop or save the water at a particular place in its way, in contrast, the main purpose for the dam is to generate electricity with the help of natural force of water and not waste the petroleum to do the same work. This helps them to save those fuels for further use.

Lastly, tunnels are built to directly pass a hill or landscapes interfering the way of the trader. This gives them an easier, quicker and efficient way to travel instead of passing the hill for example by going around it. This also in above cases helps to save petroleum resources and time.

How big are the industries which are involved in this work?

The industries for obvious reasons are of different needs and of different sizes and demands in different countries. This information is listed below for some countries.

Albania: The infrastructure in Albania gave the emphasis on roads which were great as it now connects the key sections of the country and the capital, Tirana, and the port of Durres. These types of roads are generally known as the 'Highway Corridor.' Roads are not the only reason for a big infrastructure, electricity is yet another key part to it, which is mostly covered with the hydro power, or the electricity generated by the dams. Further, there is an issue regarding waste management which is related to the supply of clean water. The government passed \$10 billion in 2010 for proper filtering of water.

Morocco: The infrastructure in Morocco opened its eyes for the development of ports, airports, roads etc. The people in Morocco must be committed to their work for roads as their road systems are of the best road systems in the continent. Known from the studies, the government of Morocco has built approximately 1100 miles in the past 20 years connecting major cities via toll expressways. In addition, Morocco has 800 miles of railways with more than 100 stations for passengers. Morocco's 2040 Rail Strategy is a long-term development with a fund of \$37 billion

including all maintenance, materials, and extensions (if required). Furthermore, they are also building about 4 dams for electricity which will cost around \$694 million.

India: The infrastructure in India is currently the most resilient and plays a crucial role in overall development. The government of India initiates to spend an amount of \$32.02 billion for extending the transport availability to enhance the development. The government is doing this by launching Bharatmala Pariyojana- a new program for the highway sector which fills the gap of critical infrastructural gaps by building Economic corridors, Inter Corridors, etc. Adding to this, India is also boosting the railway infrastructure which is one of the best means of transport to enhance development. This is done by connecting some major cities which is Dadri, Delhi and Navi Mumbai with a 1443km long railroad and a 1839km long railroad from Punjab to West-Bengal.

The Expectations and Result.

The expectations of people when these projects like dams, bridges and tunnels are being executed are quite high as their trust on the government makes them feel that if the project has started, the probability of the success is 100%, people start to think that this will make there travelling and transporting easier by just struggling with the traffic jams for some period which motivates the government to do their job with great sincerity. After the construction the result has two paths to choose, success or failure. Most of the projects are successful which in result enhances the development, makes people feel that they live in a good place with such developments, but, what if the projects fail.

What if the projects fail?

If the projects fail, the loss contributed to the economy is humungous, considering the economy at the second place, the first place is the lives of the people, the lives of people due to these failures come to an end which is quite hard for the family members to come over. These failures contribute to the country by putting it in a major loan by the World Bank, the GDP of the country decreases due the death of the earning economy, the cost of the country to clear the area of the destruction and building a new road and many others. Examples of these events are observed in Kolkata in the year 2016 in which one of the longest bridge of length 150m collapsed in the mid-day taking lives of 27 people, the event of the collapsing of the London Bridge in 1281, the Typhoon Nina-Banqiao dam of China failed in 1975 which affected a number of more than 10 million people and many others.

Comparison

What do the Countries Face if the Structure Fails or Succeeds?

If the Structure Succeeds → If a structure made by any country succeeds, there are multiple benefits coming up for the country. The country will be well reputed and trusted by other countries as they will start to believe that the engineers and workers have a good experience to make a successful structure. They will start to believe that the engineers have kept everything well planned and have left no aspect in the checklist, whether it be the quality of lands or materials to be used or the places nearby the structure and the foundation which may cause threat not only to the structure but nearby people as well. This will help the country get more projects and which may help them with financial issues, also, these structures will create tourism in the country, helping it to develop at a faster rate.

If the Structure Fails → In contrast, if the structure made by any country fails, the country will face appalling consequences. The bar of the faith on the country by others will decrease, the countries will stop asking for materials or workers due to lack of trust. When the structure fails, the country will have to bear extra charges of cleaning the area, furthermore, the countries will go on a humongous debt by the World Bank which gave them a loan with a guarantee of a successful structure. The country will lose tourism and will have to brainstorm to get out of debt. To retain the reputation, trust, tourism and various source of income, the country will have to build another innovative structure which will get the country back into competition.

Conclusion

Summing up, we learnt that the countries spend huge amounts on structures like bridges, dams, tunnels for better and efficient development. This development helps a 3–4-hour work to be done in a comparatively negligible time of 30-45 minutes. These small reductions in time not only helps the country to develop internally but also gets a better source of income by the other countries as they will start to believe that the engineers and workers are trustworthy and better to ask for help.

When a country makes their first successful mega structure, the country will get great encouragement from the citizens of the country as well as from other countries which makes them build more and more structures and get offers or contracts to build structures in other countries also. This way the countries get massive income in the name of tourism and the income by building structures for other countries. These profits make the countries eligible for building more structures.

Even Though, structures are not enough for the country to develop, thus, the country is also able to spend sufficient amounts on agriculture and various other infrastructure, which help the country develop in complete 360 degrees instead of developing 120 degrees which is gained just by the structures built.

These building of structures does not have only positive side to it, instead, the building of structures keeps the country in a huge risk of going in debt by the World Bank if, and only if the structures fail, the loans by the world bank is just one part of the loss, the other part which the country has to face is to clear the collapsed structure as the road or the colony where the structure collapsed will get blocked which cannot remain blocked for a long time. The country will also have to face the cost if any nearby structure also gets damaged. Most importantly, the country loses some of its economy due to these failures. Furthermore, the country will also face a declining slope in the graph of income which the country used to get on the names of tourism.

There must be reasons for everything which happens in this world, thus, the reasons for a failure of a structure is none other than the practice of cost-cutting for personal profits, and the behaviour of low-decision making skills. The most unsafe of all is tampering with design made by the engineers without any knowledge of structures such as adding extra stilts to the structure, loss of beams and columns at places where it is required. This might give profits to the builders but at the cost of lives of people. These are the reasons which affect the reputation of renowned companies. Now the question arises – how do these companies bounce back? These companies have to bring something innovative and unique to the table, and get back to the competition.

Acknowledgment

The completion of this project could not have been possible without the participation and assistance of Mr. Vijayendra Khannah. His contributions are sincerely appreciated and gratefully acknowledged.

This research paper is important because it gives the readers the information of why development is required in a country, also, it makes the reader aware about the non-neglectable practises by the builders to complete their job.

I got inspired to do this research paper after I saw the famous hotel Burj-Al-Arab, this hotel gave me a thought of why countries spend on these structures and what motivates them to build more of these.

Bibliography

1. “Morocco - Infrastructure.” *International Trade Administration | Trade.gov*, <https://www.trade.gov/country-commercial-guides/morocco-infrastructure>.
2. “2016 Kolkata Flyover Collapse.” *Wikipedia*, Wikimedia Foundation, 25 June 2021,.
3. Aitken, Peter. “11 Of the Biggest Structural Failures in History.” *Business Insider*, 5 Dec. 2019,
4. Alvi, Irfan A., et al. “Human Factors in Structural Failures.” *STRUCTURE Magazine*,
5. Author Gill Maninder. “Dams and Resettlement as Development: A Case for Building Good Practice.” *Cultural Survival*, 1 Sept. 1999,
6. “Brand India.” *IBEF*,
7. Dhns. “Why Buildings Collapse: Blame It on Shoddy Construction, Lax Govt.”
8. *Deccan Herald*, DH News Service, 23 Oct. 2021,
9. Gan, Nectar. “China's Three Gorges Dam Is One of the Largest Ever Created. Was It Worth It?” *CNN*, Cable News Network, 1 Aug. 2020,
10. George Mendonca / TNN / Updated: Jul 14, 2021. “Navi Mumbai: 10 Labourers Injured as Nerul Building Scaffolding Collapses, Contractor Booked: Navi Mumbai News - Times of India.” *The Times of India*, TOI, <https://timesofindia.indiatimes.com/city/navi-mumbai/navi-mumbai-10-labourers-injured-as-nerul-building-scaffolding-collapses-contractor-booked/articleshow/84408283.cms>.
11. *Inis-Xa--616 Investigating Leaks in Dams & Reservoirs - IAEA*. https://inis.iaea.org/collection/NCLCollectionStore/_Public/34/028/34028298.pdf.
12. Jarzębowska, Elżbieta, and Michał Cichowski. “Dynamics Modeling and Performance Analysis of Underwater Vehicles Based on the Boltzmann-Hamel Equations Approach.” *MATEC Web of Conferences*, EDP Sciences, 2 Feb. 2018, https://www.matec-conferences.org/articles/mateconf/ref/2018/07/mateconf_icoev2018_03005/mateconf_icoev2018_03005.html
13. Koride Mahesh / TNN / Updated: Jan 8, 2017. “Poor Foundation Caused Collapse That Left 11 Dead!: Hyderabad News - Times of India.” *The Times of India*, TOI,

14. Project, Borgen. "Progress in Developing Infrastructure in Albania." *The Borgen Project*, BorgenProject https://Borgenproject.org/Wp-Content/Uploads/The_Borgen_Project_Logo_small.Jp g, 17 Dec. 2019,
15. "The Pros and Cons of Secondary Research." *Provoke Insights*, 14 Dec. 2020,
16. Žák, Jaroslav, and Jiří Žák. "Defects of Large Diameter Drilled Piles." *MATEC Web of Conferences*, EDP Sciences, 22 Dec. 2016, https://www.matec-conferences.org/articles/mateconf/ref/2017/07/mateconf_bd2017_01002/mateconf_bd2017_01002.html.