Construction Economics - The Economic Impact Of A Resident Geomatic Engineer

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SUMMARY

This paper offers a comprehensive exploration of cost-saving strategies in the construction of multiple mine infrastructural projects for one of the distinguished mining companies in Ghana. This paper highlights distinct procedures used to cut down and save unforeseen and unbudgeted costs.

In these projects, the resident Geomatic Engineer plays a key role with respect to Construction Economics. There have been projects on the same mine in the past that significantly exceeded budget due to the absence of a resident Geomatic Engineer.

The mine earlier expressed some reluctance to having a resident Geomatic Engineer as their primary focus was on mining productions.

The team managed to extensively convince the company that budgets for the projects can be economized to a large extent if a Geomatic Engineer is resident on-site.

As Geomatic Engineers, the models for these projects were generated with Computer Aided Design Software (CAD) such as AutoCAD Civil 3D, giving 3D models of the projects' end product. This provided various detailed sections of the end products. All possible occurrences of the various projects were also brought to light.

After running topographical surveys, planning became more precise, ensuring objectives are met with minimal margin for error. Also, GNSS played a pivotal role in the seamless execution of setting out construction parameters.

The economic benefits are substantial, resulting in remarkable cost savings and streamlined operations.

This paper highlights the role a of Geomatic Engineer, the impact of a resident Geomatic Engineer on-site as well as, in practicality, how these projects are executed.

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1. BACKGROUND

1.1 Economics is derived from the Greek word 'Oikonomia' (Oikos = house + Nomos = laws) meaning managing the home. The definition of economics is the "Social science that studies the production, distribution and consumption of goods and services". The modern definition according to Lionel Robbins in 1932 states economics as a "*science which studies human behavior as a relationship between ends and scarce means which have alternate uses*".

1.2 Construction economics is a branch of general economics. So, in construction, it consists of application of techniques and expertise of economics to the particular area of construction industry. Construction economics is concerned with man's needs for shelter and the suitable and appropriate conditions in which to work and live. It seeks to ensure the efficient use of available resources and to increase the rate of growth of construction in the most efficient manner.

1.3 In the past, construction projects often proceeded without the continuous presence of a resident Geomatic Engineer on-site. The history context of construction without a dedicated Geomatic Engineer involved various factors, ranging from the limited availability of advanced surveying technologies to a less pronounced understanding of the role and benefits of Geomatic Engineering.

1.4 Now, in the advent of more geospatial technologies and deep exposure to the necessity of having a resident Geomatic Engineer on-site, it is evident that the past narrative is shifted in the right direction.

1.5 Furthermore, in recent years, with a growing understanding of the economic and operation advantages that Geomatic Engineers bring to projects, there has a been a change towards realizing the relevance of having them on-site. Today, it is more common to see Geomatic Engineers integrated into project teams, providing their expertise to reconnaissance stage to project completion, contributing to better decision-making and minimizing risks linked with inaccurate spatial data.

2. THE GEOMATIC ENGINEER ROLE

Geomatic engineer plays a crucial role on construction sites, utilizing specialized skills and tools to manage spatial information and contribute to the planning, design, and execution of various construction projects. The role involves a combination of surveying, mapping, and spatial analysis to ensure accurate and precise spatial data. Here are key aspects of the role of a Geomatic engineer on a construction site:

2.1 Topographic Surveys:

Conducting topographic surveys to gather detailed information about the terrain, existing features, and elevation of the construction site. Providing accurate topographic maps that aid in site planning, design and various forms of analysis.

2.2 Site Layout and Design:

Collaborating with architects, engineers, and other stakeholders to assist in the layout and design of the construction site. Ensuring that structures are positioned accurately according to project specifications and design plans.

2.3 Construction Surveys:

Conducting construction surveys to monitor and verify the placement of structures and infrastructure elements during the construction process. Providing real-time spatial data to ensure that construction activities align with design specifications.

2.4 Quality Control and Assurance:

Verifying the quality and accuracy of construction work through continuous monitoring and assessment. Identifying deviations from design plans and working with the project team to rectify any discrepancies promptly.

2.5 Utility Mapping:

Mapping and identifying existing utility lines (e.g., water, gas, electricity) on the construction site to prevent accidental damage during excavation and construction activities. Collaborating with utility companies to ensure accurate information and avoid disruptions. This also aids in planning and analysis for new projects around such regions.

2.6 Geospatial Data Management:

Managing geospatial data related to the construction site using Geographic Information System (GIS) tools. Creating and maintaining a comprehensive database of spatial information for effective decision-making.

2.4 Technology Integration:
Utilizing advanced technologies such as Global Positioning System (GPS), Total Stations, Drones and 3D laser scanners to enhance data collection and mapping accuracy. Integrating Building Information Modeling (BIM) and Computer-Aided Design (CAD) for a more collaborative and data-driven approach to construction projects.

2.5 As-Built Surveys:
Conducting as-built surveys to capture the final position and dimensions of structures after construction completion. Providing accurate as-built documentation for record-keeping and future reference.

2.6 Environmental Impact Assessment:
Assessing the environmental impact of construction activities through geospatial analysis. Identifying potential environmental concerns and proposing solutions to mitigate negative effects.

2.7 Stakeholder Communication:
Facilitating communication and collaboration among various stakeholders, including architects, engineers, contractors, and regulatory bodies. Ensuring that all parties involved have access to accurate spatial information.

3. ECONOMIC IMPACT OF A RESIDENT GEOMATIC ENGINEER

"A lot of people don't think much about what land surveyors do. In a nutshell, we are the interpreters and providers of landmarks and records that directly impact real property", Mark Mason once said.
The economic impact of a resident Geomatic Engineer on site is significant and multifaceted. Here are several key impacts associated with having a resident Geomatic Engineer on-site:

3.1 Improved Accuracy and Efficiency:
Geomatic Engineers ensure accurate measurements, survey data and mapping, which minimizes errors in construction layout and designs. This accuracy seeks to prevent costly rework or revisions, saving both time and money.

3.2 Cost Savings:
By utilizing precise geospatial data and advanced surveying techniques, Geomatic Engineers optimize construction layouts, reducing material waste and improving resource utilization. This efficiency directly impacts the project's budget, potentially saving saving considerable costs.

3.3 Project Management:
In project management, the on-site Geomatic Engineer provides real-time and analysis for better decision-making, preventing delays and overruns, monitor progress and enhancing overall project efficiency.

3.4 Mitigation of Risks:
Resident Geomatic Engineer aid in identifying potential issues early on, such as encroachment and boundary disputes. Addressing these issues promptly prevents legal disputes or project interruptions, thereby preserving the project's economic viability.

3.5 Technological Advancements:
Employing a leverage cutting-edge technology, such as drones, GPS, LiDAR and GIS (Geographic Information Systems), which can streamline processes and data collection. These technologies often increase efficiency and accuracy while reducing labor costs.
3.6 Long-term Benefits:
Accurate survey data provided by Geomatic Engineers contributes to creating precise as-built documentation, which is crucial for future maintenance, renovation or expansions. This documentation saves money on future projects by providing reliable base for planning.

4. IN PRACTICALITY

The exploration of cost-saving strategies in mine infrastructural and construction projects underscores the crucial role of a resident Geomatic Engineer. In practicality, more focus would be on the construction of the Tailing Storage Facility (TSF).

4.1 The TSF Rehabilitation Project, guided by the resident Geomatic Engineer, demonstrated proactive surveying, technological utilization, and meticulous adjustments, resulting in substantial cost savings and adherence to the budget.

4.2 This compelling evidence emphasizes the indispensable contribution of resident Geomatic expertise to economic efficiency in construction projects. In this pivotal case study where a resident Geomatic Engineer was strategically placed, the use of Computer Aided Design Software like AutoCAD Civil 3D facilitated precise 3D modeling. This proactive approach allowed for real-time adjustments, preventing budget deviations. The systematic utilization of Global Navigation Satellite System (GNSS) further streamlined operations.

4.3 The TSF project was initiated with the precise establishment of a GNSS control network. Control points were strategically and evenly positioned across the area of interest to ensure optimal line-of-sight visibility and mitigate potential error sources. Extensive static observations, spanning multiple hours, led to the acquisition of highly accurate positioning data. Subsequent post-processing techniques were meticulously applied to refine this data, resulting in control coordinates (X, Y, Z) boasting millimeter-level accuracy.

4.4 After the GNSS baselines were firmly established, an as-built topographical survey was conducted which allowed us to gather detailed and accurate information about the natural and artificial features of the specified area. This survey provides a three-dimensional model representation of the terrain, including its elevations, contours, and various existing structures which includes power-lines and pole positions, cemetery, drains, channels and pipelines.

4.5 The detailed information ensures that the construction aligns with the natural landscape and complies with safe work standards. After the as-built topographical survey has been done with minimal error margins then we utilized advanced Computer-Aided Design (CAD) software, specifically AutoCAD Civil 3D, for generating detailed 3D models of project outcomes.
From these models we were able to generate specific and accurate positions and volumes of cut and fill material of all features relating to the TSF such as the Spillway, Decant tower, secondary confinement channels, seepage sumps, monitoring instruments and main embankment rock buttress. GNSS technology allowed for the precise setting out of construction parameters, such as location coordinates, elevations, and alignments.
4.6 This ensured that construction was carried out with high accuracy ensuring that the constructed elements closely adhered to the design specifications. Following the completion of the Tailing Storage Facility (TSF) construction, an as-built pick-up survey is conducted to compare the actual features with the design models. This comparison involves assessing the design cut and fill volumes against the as-built cut and fill volumes, elevations and extents, aiming to ascertain whether the construction aligns with the specified design requirements.

REFERENCES

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BIOGRAPHICAL NOTES

All authors work as part of the MULTIGEOMATICS team, Ghana, as resident Geomatic Engineers, with Richmond being the team Lead. We all have experience and high interest in engineering survey. However, there are individual special interest as well.
Richmond has interest in Engineering Survey and CAD software.
Eric has interest in GIS and Remote Sensing
Seyram on the hand has interest in CAD and GIS.

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