

## **Research Article**

### **Case Study of Earthworks Management on Hu-Shan Reservoir**

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**Abstract:** Present study investigated the earthworks (storage and transportation) management on large scale project (Hu-Shan reservoir) performance (cost and time). After apply the planning structure which developed in present study. Compare to the previous earthworks projects. Results showed the cost and time were reduced about 8% and 7%, respectively. For large scale earthworks project, this result means saving a lot of money and time. Further, this result also might suggest that this planning structure could apply to others large scale earthworks projects of bridge, harbor, disaster prevention, and dredge engineering.

**Keywords:** Earthwork management; Project performance.

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#### **INTRODUCTION**

Construction works is the pioneer of the economic activities. The construction works included foundation engineering, earthworks, main structure, renovation engineering, and affiliated facilities engineering. In addition to tradition construction work, there are many special projects, such as reservoir, bridge, harbor, disaster prevention, and dredge engineering. These construction works might not include renovation engineering, but the foundation engineering and earthworks might massive. In 2003, the Executive Yuan give impetus to construct Hu-Shan reservoir to solve the water needed of agricultural irrigation and aquaculture fisheries, and the extraction of groundwater and subsidence problems in central Taiwan areas.

Generally, earthmoving work of a reservoir project includes: (1) Pure excavation: according to the design of the excavation line to excavate; (2) Pure backfill: backfill the earthworks into the designate location; (3) Both of excavation and backfill: backfill the earthworks after excavation.

The catchment area and the planned water storage capacity of Hu-Shan reservoir were about 6.58 KM<sup>2</sup> and 56.76 million M<sup>3</sup>, respectively. The length of main dam, auxiliary dam, and south dam were about 615 M, 394 M, and 648 M, respectively. The total dam volume was about

12.95 million M<sup>3</sup>. Furthermore, the total dam volume was the largest among all reservoirs in Taiwan. Due to the main structure design of Hu-Shan reservoir is an earthwork dam. Thus, the earthworks (storage and transportation) management is the main factor that might affect the project performance (cost and time).

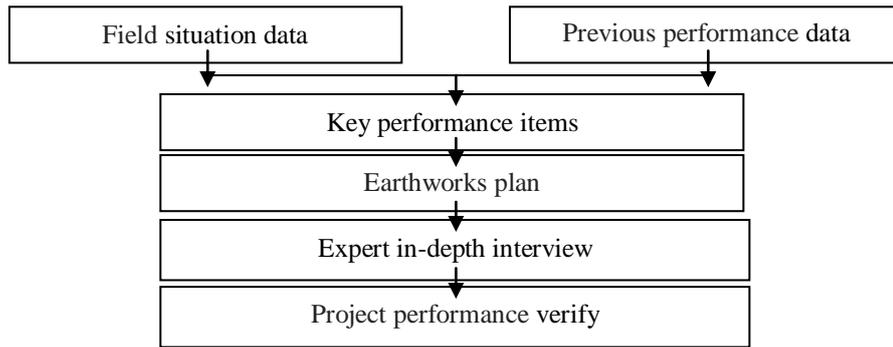
Though, there are some studies had concerned on construction management [1-4]. However, practical research about large scale earthworks management is lack. Therefore, there is needed to investigate the earthworks management on large scale project performance.

#### **RESEARCH PROCEDURE**

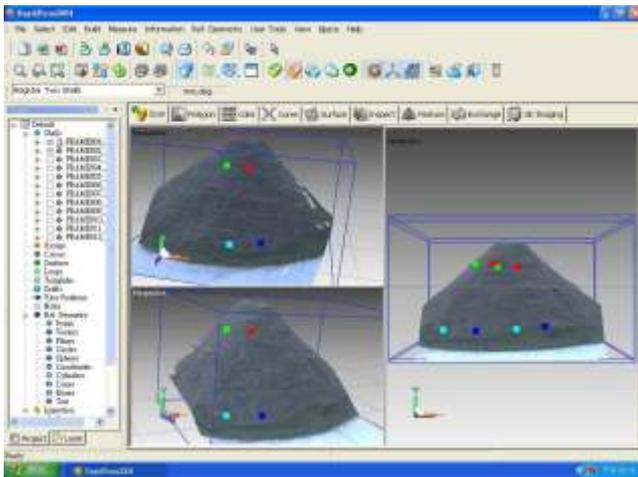
Figure 1 shows the planning structure of present study which includes: field situation data, previous performance data, key performance items, earthworks plan, expert interview, and project performance verify.

##### **Field situation data**

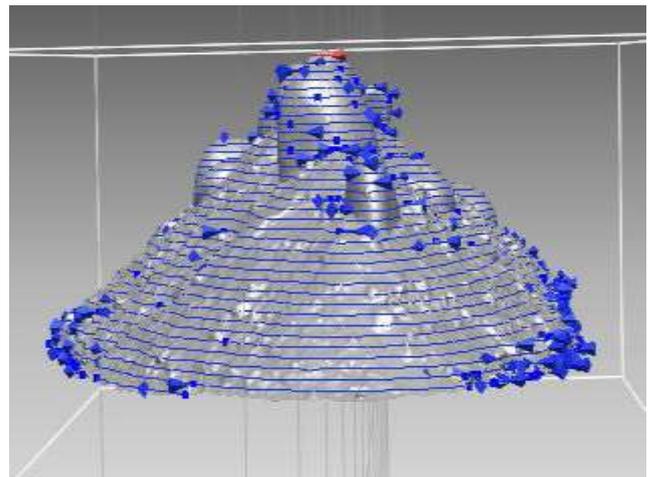
The present study collected the field situation data of Hu-Shan reservoir, which includes: estimate the amount of earthworks, survey the surrounding environment and road conditions, and so on. Figure 2 shows the 3D scanning method to estimate the amount of earthworks and Figure 3 shows the surrounding environment of Hu-Shan reservoir.



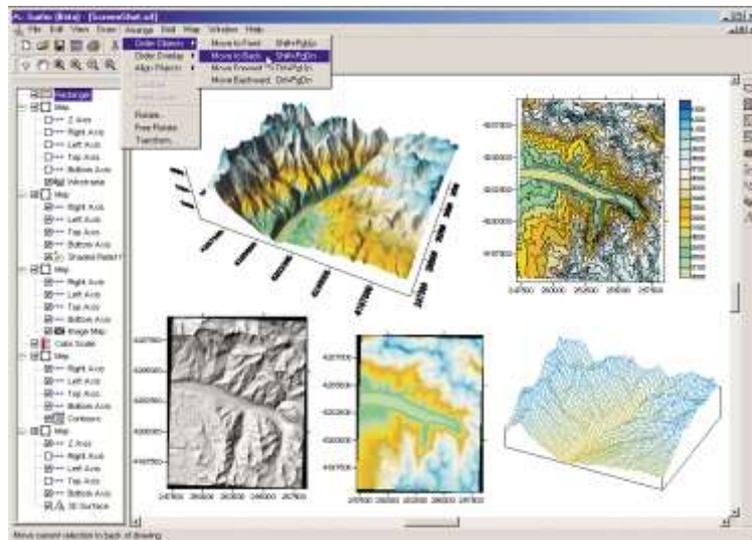
**Fig-1: Flowchart of planning structure**



**(a) Using 3D scanner to set point cloud**



**(b) Using point cloud to draw contour map**



**(c) Using software to estimate the amount of earthworks**

**Fig- 2: The 3D scanning method to estimate the amount of earthworks**

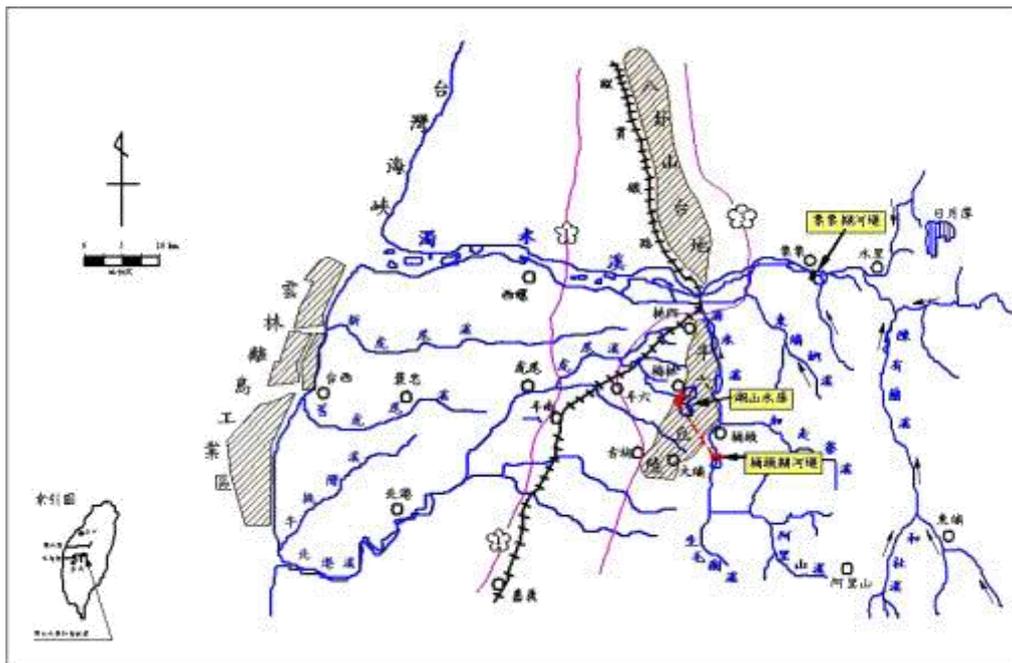


Fig-3: The surrounding environment of Hu-Shan reservoir

**Previous performance data**

The present study collected the performance (include the cost and time) data of previous relative projects.

**Key performance item**

According to the field situation data and previous performance data. This study established the key performance items that might affect the project performance (Table 1).

Table-1: Portion of the key performance items

Factors	Items
Quantity factors	Amount of earthworks
	Operation time and schedule
	Geological condition (rock layers, soft rock layer, sand layer, clay layer)
	Quantity of machines and tools
	Number of workers
Quality factors	Weather (typhoon, cloudburst)
	Design changes
	Protest of nearby residents
	Obtained of way right
Surrounding environment	Routing of off-highway trucks
	Earthworks staging area
Other factors	Number and utilization rate of excavators
	Number and utilization rate of skid steer loaders
	Number and utilization rate of off-highway trucks
	Number and utilization rate of roller
	Number and utilization rate of bulldozer

**Earthworks plan**

According to the key performance items and the construction regulations of Taiwan government. The present study established the plan of earthworks. The plan of earthworks includes: (1) Confirm the range of excavation area and leveling measurement; (2) Estimate the amount of excavation and backfill of earthworks;

(3) Planning the utilization rate of machines; (4) Planning the project schedule; (5) Planning the earthworks staging area; (6) and so on.

**Expert in-depth interview**

The present study in-depth interviewed 10 experts (Table 2) to confirm the plan of earthworks.

**Table-2: Experts' profile**

<b>Expert type</b>	<b>Project manager</b>	<b>Project engineer</b>	<b>Project design</b>
numbers	4	4	2
Average experience	15 years	7 years	16 years

**Project performance verify**

The case company is one of the contractors of Hu-Shan reservoir project and then executive the plan of earthworks to verify the effect of planning structure.

**RESULT AND RECOMMENDATION**

The purpose of present study is to develop planning structure of earthworks (storage and transportation) management to minimize the total cost (cost per M<sup>3</sup> of earthworks) and time. The present study proposed a planning structure for large scale earthworks management. Compare to the previous earthworks projects. Results showed the cost and time were reduced about 8% and 7%, respectively. For large scale earthworks project, this result means saving a lot of money and time.

Present study proposed the research structure of large scale of earthworks. Results showed that the project performance (time and cost) was significantly improved. This might suggest that the research structure which proposed in present study could apply to others earthworks projects, such as bridge, harbor, disaster prevention, and dredge engineering.

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