

## TREP computer system of the Tribunal Supremo Electoral

In the process of the 2023 general elections in the Republic of Guatemala, a system was implemented for the capture and registration of records no. 4 of the electoral process with the tabulated data of the information captured in them. The system must therefore have a referential and auditable integrity in order to guarantee that this information has not been altered in any way, so signatures based on HASH codes were implemented, within a blockchain system, accessible publicly, to make it more transparent, since the chain of blocks becomes unalterable and the content of the chain is the document as such.

This system has at least four applications to operate, the public site to make information accessible to the general public, the site for typing with exclusive access to the staff of the digitation center, the mobile application for taking the photograph of record No. 4 in the voting centers, the central administration system for the TSE.

### System quality analysis

The public consultation system lacks maximum usability to facilitate the reading of the data and interpretation having left essential information of the progress of the process until the end of the page, a map with very little usability to navigate between departments and municipalities, occupying a primordial space, the data that are loaded for the application are excessively heavy in each operation, with the aim of making less requested, but more loaded, for example loading the first 152 tables of the presidency, with a file of 3.5 MB, despite only wanting to see one, showing design and optimization problems, which impact on data transfer costs for each operation no matter how simple it is, without a way to predict that the data is transcendental for future consultations. The performance provided by TREP services is good, in ideal high-speed conditions of the Internet service of end users, since it is hosted on Amazon Web Services (AWS) servers. It may have deficiencies in the interpretation of the data due to lack of fundamental clarifications by the TSE as the regulatory body and responsible for how this is transmitted to the general population.

### Security and tracking issues

The system has a BlockChain, which allows to verify the validity of the documents, but there is no log with traceability to validate the origin of the documents, the person responsible for the documents as authorized table president, and in the chain of blocks at the end you can register files to what any authority of the system likes, there is no link back to the minutes and a global report of all the documents, its blocks and any other data that allows the files to be feasibly audited.

### General Operating Costs in the short and long term

In the following analysis, the costs of the system are estimated according to the general aspects within the electoral process, for unification of costs the values are estimated in US dollars, and will be compared with the cost for the Supreme Electoral Tribunal converting it from quetzals to dollars. Extreme data transfer scenarios are considered, due to the high demand of the interested population in the 48 hours of both main events of the electoral process. This analysis does not include the operating costs in the Bitcoin BlockChain, since the transactions that accumulate in a block have an operation cost value, but it is still pending to make a complete audit of the 122,925

documents as they were attached in the BlockChain in order to determine the costs of offer paid per file, when uploading them to the system.

### Estimated Development Costs

An estimate of the development of the applications, according to the level of complexity and the man hours that this could mean, with sufficient time of slack for design, development, quality control and implementation. The hourly price includes taxes and labor costs, which a development company can charge at standard market pricing at the corporate level.

Name	Hours	Hourly Price	Total
Portal	160	\$ 100.00	\$16,000.00
Mobile App	80	\$ 100.00	\$8,000.00
Capturing App	120	\$ 100.00	\$12,000.00
Administrative App	200	\$ 100.00	\$20,000.00
Total			<b>\$36,000.00</b>

### System Operation Costs

An estimate of the operating costs of the system hosted on Amazon Web Services, with an availability of the information for the next 5 years, considering the demand of the first months to be able to store the information of the first round with the five types of elections and the second round for the presidency

#### Amazon Cloud Front

10 TB CDN-like high availability service for the public	<b>\$1,868.64</b>
First month 10.240 GB (10 TB) x \$0.085	\$870.40
Additional 11 months, 1,024 GB (1 TB) per month x \$0.085	\$957.44
4 final years as 10GB file per month x \$0.085	\$40.80

#### Amazon S3 File Storage

Storage of 42 GB of total document files for 60 months	<b>\$57.96</b>
60 months 35 GB x \$0.023	\$57.96

#### Amazon EC2 Elastic Content

Hosting highly available and elastic websites	<b>\$ 229,32.82</b>
M6G Level (\$65.04 per day), two months, first and second round	\$3,902.40
Level A1 (\$10,776 per day), next 58 months (1766 days)	<u>\$19,030.42</u>

**Total** **\$ 24,859.42**

### General Computer Center Operating Costs

The data center can be rented for the three months considered from the first to the second round in the electoral process. An estimated maximum of about 50 typists to be able to receive the minutes of the 24,585 tables of the 3,852 voting centers, with a total of 122,925 documents of the first round, and 24,585 documents of the second round, for a total of 147,510 records.

50 typists for 2 days at Q200.00/\$26.66 per day (exchange rate 7.5) **\$2,666.67**

Equipment required for typists

The typists require equipment to work for the two days that will be in charge of the process of capturing information, configuration, data backup, cleaning and others, for each of the processes of the first and second round, plus the dead time between these two dates, estimating three months

50 computers at Q500.00/\$66.66 per month (exchange rate 7.5) **\$10,000.00**

Computer Center Rental

For the operations of this equipment and keep it safe for three months guaranteeing the security of the network, its installation, operations and others with capacity for about 70 people, it could cost about \$ 5,000 per month.

3-month leases at \$5,000 per month **\$ 15,000.00**

Summary of Total Costs

Application development	\$ 36,000.00
System deployment on AWS for 5 years	\$ 24,859.42
Digitizer Costs	\$ 10,000.00
Equipment Rental for 3 months	\$ 2,666.67
Computer Center Rental for 3 months	\$ 15,000.00
<b>TOTAL</b>	<b>\$ 88,526.09</b>

Conclusions

For the system was paid **Q 148 million 850 thousand 250**, which at an exchange rate of Q7.50/US\$, the value of US\$ **19,846,700** to be able to register the votes for a maximum of 9,361,068 people registered, the cost per person is Q 15.90 or US\$ 2.12. The intangible value of recording this information partly justifies the price, but comparing the possible \$ 88,526.09 cost of the system, if the Supreme Electoral Tribunal had paid it in an internal development, 22,419.04% of the estimated real cost of the system has been disbursed, with enough slack for the payment of the Blockchain, even having security and traceability flaws of the data, the documents have shown that the greatest investment should have been made in the training of the people who were at the tables, so that everything recorded in the minutes had the highest quality and accuracy, having had draft sheets to record the correct values before transferring them to Minute No. 4, so as not to be tested, nor have problems that they were not legible, being errors more of the users, that, of the system as such, and giving margin to all the errors of interpretation that allow it to be considered that there could be intentional failures in the records of the votes.