Analysis of Model Clark Wilson to Adopt to the Database of the Civil Registry of Ecuador

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Abstract—The Clark Wilson model was analyzed for its strengths to mitigate the integrity of the data, prior to the adoption to the database of the Civil Registry of Ecuador using a conceptual model. The objective is to develop a prototype based on the Clark Wilson model to mitigate the integrity of the database of the Civil Registry of Ecuador. The deductive method was used to synthesize the information of the reviewed scientific articles referring to the safety models. The result of this research was the general prototype for the validation of the information, definition of a general scheme for the access to the system by means of the adoption of the model Clark Wilson, information query by the user adopted for the Civil Registry of Ecuador. The following was concluded: The general prototype obtained allows the visualization of processes the transformation and verification of users for access. The access to the system with the adoption of the Clark Wilson model is strengthened to verify credentials that are correct or incorrect. The trends defined in the articles reviewed with reference to the strengths of the Clark Wilson model are the basis for the development of the prototype for the Civil Registry of Ecuador to guarantee its mission, vision, strategic objectives where it is identified that its priority is the integrity of the data for its management.

I. INTRODUCTION

Database security is important and strategic for all organizations, institutions, NGOs, small businesses, corporations, among others; at the global level is considered the main asset to ensure the continuity of the business or its mission for which it was created; there are different alternatives to mitigate database security at the software, hardware, security policy, conceptual models, security models, among others with confidentiality, integrity, availability (CID), identity, authentication, authorization and auditing (IAAA).

The problems of integrity of a database for a certain segment of organizations or institutions by their mission, vision, strategic objectives become a priority for their management. In this investigation, the Ecuadorian Civil Registry database is considered as a case study under a distributed environment to mitigate the integrity of its data.

Database integrity problems were analyzed and compared to the Civil Registry of the United States, China, India, among other countries, which is based on the reference[1], different issues that have been identified through the written and spoken

media of Ecuador, speeches by several politicians on duty, the information issued by this body does not support the credibility of Ecuadorian citizens and foreigners residing in this territory.

Once the problem of integrity of the database has been identified, it has proceeded to evaluate in general form the different models of security; among the Bell-LaPaluda, China Wall, Biba, Clark-Wilson models. To define the appropriate model, consider the strength that each has to mitigate the integrity of a database.

Why it is necessary to carry out the Analysis of the Clark Wilson Model to Adopt to the Civil Registry Database of Ecuador?

To mitigate the security integrity of a distributed architecture database.

The objective is to develop a prototype based on the Clark Wilson model to mitigate the integrity of the database of the Civil Registry of Ecuador.

The revised papers related to the research topic are as follows.

Extending the Clark-Wilson Security Model for Digital Long-Term Preservation Use-cases[2], Secure Databases : An Analysis of Clark-Wilson[3], Transforming Commodity Security Policies to Enforce Clark-Wilson Integrity[4] ,Toward a universal integrity model[5], Configuring Clark-Wilson Integrity Model to Enforce Flexible Protection[6], SCWIM An Integrity Model for SOA Networks[7], A Context-Based Integrity Framework[8], A Comparison of Commercial and Military Computer Security Policies[9], Implementing Commercial Data Integrity with Secure Capabilities[10], Practical Assessment of Biba Integrity for TCG-enabled Platforms[11], Security Evaluation Model for Virtual Learning Environments[12], Securing Cloud Workflows Using Aggressive Chinese Wall Security Policy[13].

The method used in this research is the deductive and exploratory investigation of the information available in the medium.

The result of this research are: General prototype for the validation of the information, definition of a general scheme for

the access to the system by means of the adoption of the model Clark Wilson, information query by the user adopted for the Civil Registry of Ecuador.

Conclusions obtained:

- The general prototype obtained allows the visualization of processes the transformation and verification of users for access.

- The access to the system with the adoption of the Clark Wilson model is strengthened to verify credentials that are correct or incorrect.

- The trends defined in the articles reviewed with reference to the strengths of the Clark Wilson model are the basis for the development of the prototype for the Civil Registry of Ecuador to guarantee its mission, vision, strategic objectives where it is identified that its priority is the integrity of the data for its management.

II. MATERIAL AND METHODS

To carry out this research, the deductive method and the exploratory research were used; to synthesize the information of the reviewed scientific articles referring to the security models.

The materials used in this research are related articles to mitigate the security of data integrity in a public or private organization.

Literatures related to the research topic:

The authors refers to the integrity and authenticity of the data that must be preserved through the generation of a Clark Wilson security model; for the creation of this model considers: Subject, use-case, roles, objects, operations/actions, rights, verified entities; defines the exemplary security mechanisms in terms of security policies[2]. The authors mention that the integrity of the data is oriented to commercial companies in conventional databases; the Clark-Wilson security model is derived from commercial data-processing practices that serve complete security systems; the Clark Wilson model in 1987 proposed this security model for data integrity, but Biba also defined data integrity based on subject and object classification; conventional DBMSs support many of the Clark-Wilson mechanisms for access authorization and control. However, implementations based on standard SQL require some compromises[3]. In this work, they developed an automated method to transform a set of MAC policies into a system-wide policy that proactively protects the integrity of the system, approaching the Clark-Wilson integrity model[4]. Clark - Wilson identifies with the integrity of the data with the objective of control to be a reliable security system[5]. The Clark-Wilson model radicalizes in the unauthorized modifications; presents an improved Clark-Wilson model based on database integrity for modifying objects and procedures; is based on modification of access control mechanism, integration of multi-level protection feature, enhancement of integrity rules[6]. In this paper we propose the Clark-Wilson integrity model service (SCWIM), an SOA

integrity model capable of describing sufficient conditions to protect data integrity in any SOA implementation; services Clark-Wilson integrity model (SCWIM) security models is the abstraction that states that they remain an instructive for the evaluation[7]. The confidentiality and availability of the data is important, Clark - Wilson and Biba security models consider data integrity as a priority; our frame of reference is based on context vector, model integrity, data, probabilistic model, fusion[8]. The Department of Defense has developed several alternatives to mitigate information security to control its internal and external environment concerned with data integrity; for this reason issued a security policy for the integrity of the data; considers that the integrity of data in commercial enterprises is important and necessary to ensure the management of the organization; for this reason suggests the implementation of rules in the system with the Clark - Wilson model; likewise defines that military institutions should apply the model mentioned and the Bell-Lapaluda security model[9]. The implementation of the Clark Wilson model is efficient but also complex in its execution in commercial companies considering all its subsystems; however, it considers the difficulty of implementing the C2 rule that it requires for all TPs; in the implementation of the Clark model and is based on protected subsystems to build CDIs of abstract data types[10]. The method defined by Trusted Computing Group is to evaluate the fingerprints of hardware and software components; the architecture in the measurement of integrity reduces by the policies (PRIMA); for this difficulty the Biba model is considered; in the background this model considers integrity fundamentals, access control, integrity analysis, IMA and PRIMA; considers the following approach to the problem motivations, goal, attack model; the design is based on the idea is to follow the PRIMA processing in the verification and construction of a flow chart information[11]. For the security of web applications they propose the design and construction of a security model for virtual environments (VLE); to do this consider the basics of web security, related jobs; the methodology used is based on guidelines, rules and standards to identify security criteria in web applications; the result obtained is the safety evaluation of Moodle and Dokeos VLEs with the proposed model[12]. The author considers the use of WtMSs as critical and strategic applications that is common in the business and scientific sector due to the constant threats against the integrity, authorization and availability of data; the Chinese Wall security policy (ACWSP) aims to mitigate conflicts of interest; the Wall China security policy addresses the confidentiality, integrity and security of conflicts of interest in the commercial sector[13].

Why was considered the alternative to make a prototype based on the model Clark Wilson:

In reference to the articles reviewed in this research and based on the mission, vision, strategic objectives of the Civil Registry of Ecuador; to date there are problems in the integrity of the database such as: Adulterated ages, players with false ages, voting dead among others; it is sought that this information is integrated with the purpose of making correct decisions in the public policies for the generation of: Public hospitals, universities, schools, popular housing, among others. As

discussed above in relation to the Clark Wilson model and based on the articles of the reference below the following information is described.

Integrity

Integrity models are used to describe the requirements needed to enforce integrity policies. Verification of security integrity, critical data and mediation at program entry points is required[4]. Integrity policies are based on 3 objectives: Preventing data modification by unauthorized personnel, maintaining consistency both internally and externally, preventing improper modifications by authorized personnel; to achieve the objectives of integrity, a set of security services are required that incorporate the necessary properties for integrity as well as a framework; which allows such properties to be included. The security properties required for integrity are: access control, audits, and accountability; the Clark-Wilson (CW) model is an application-level integrity model that seeks to ensure integrity properties in commercial data by providing a framework for security assessment in commercial application systems[4].

Elements of the model

Clark-Wilson is a widely used model to protect commercial information against unauthorized modification. In the CW model, the data in the system are partitioned into two groups:

- Clark-Wilson is a widely used model to protect commercial information against unauthorized modification. In the CW model, data in the system is partitioned into two groups: Restricted data elements (CDIs) that are elements or objects whose integrity must be maintained.
- Unrestricted data elements (UDIs) that are elements or objects that are not covered by the integrity policy, such as input data, but which are relevant since they can be transformed into CDIs.

Two procedures are applied to this data to provide protection:

The first, integrity verification procedure (IVP), is intended to confirm that all CDIs are in a valid state. The IVP serves for internal consistency and for consistency with external reality according to the vision of that reality. The particular view of reality is known as the integrity domain.

The second procedure, the transformation procedure (TP), consisting of a set of model operations, represents the well-formed transactions, those that manipulate the CDIs since they transform a set of them from one valid state to another. If only the transformation procedures can change the data, the integrity of the data can be maintained. The system must ensure that only the TPs can manipulate the CDIs. TPs and IVPs must be certified with respect to a specific integrity policy. The TP must meet its specifications and these must be correct. In addition, the system must require that all transformation procedures be recorded in the logs, providing a tracking and auditing mechanism for all changes[6].

Integrity rules

In order to ensure that integrity is achieved and preserved, the CW model has nine rules that define an integrity enforcement system: Monitoring-integrity rules (certification rules) and preservation-integrity rules (execution rules).

The execution rules (E), are of independent application, are easy to implement in the system. They are rules guaranteed by the system.

The following rules relate the internal and external consistency:

- C1 (IVP Certification): All IVPs must appropriately ensure that CDIs are in a valid state at the time the IVP is running.
- C2 (Validity): All TPs must be certified to be valid. This means that they convert a CDI to a valid final state if the CDI is in a valid state at startup. Each TP must be certified for a specific set of CDIs.
- E1 (Execution of Validity): The system must maintain a list of the relations of rule C2 and must ensure that any manipulation of a CDI is through a TP and is authorized by some relation.

The additional rules that are required for the separation of the obligation are:

- E2 (Execution of Obligations Separation): The system must maintain a list of relations that bind the user, the TP and the CDIs that the TP must manipulate in favor of that user.
- C3: The list of relations of E2 must be certified to know the separation of the required obligation.

Four other rules complete the model

- E3 (User Identity): Users who invoke TPs must be authenticated.
- C4 (Log Certification): All TPs must be certified so they can have log entries.
- C5: TPs that convert UDIs to CDIs must be certified
- E4 (Initiation): Only certain designated users must specify the relationships[2].

III. RISKS AND RESULTS

The risks to adopt and implement a prototype based on the Clark Wilson model to mitigate the integrity of the Civil Registry database of Ecuador is to clearly identify all the subsystems of the institution, definition of security policies related to this model, mechanisms to implement these policies among others.

The results obtained from this research based on the Clark Wilson model are:

1) General prototype for the validation of the information

2) Definition of a general scheme for the access to the system by means of the adoption of the model Clark Wilson.

3) Information query by the user adopted for the Civil Registry of Ecuador.
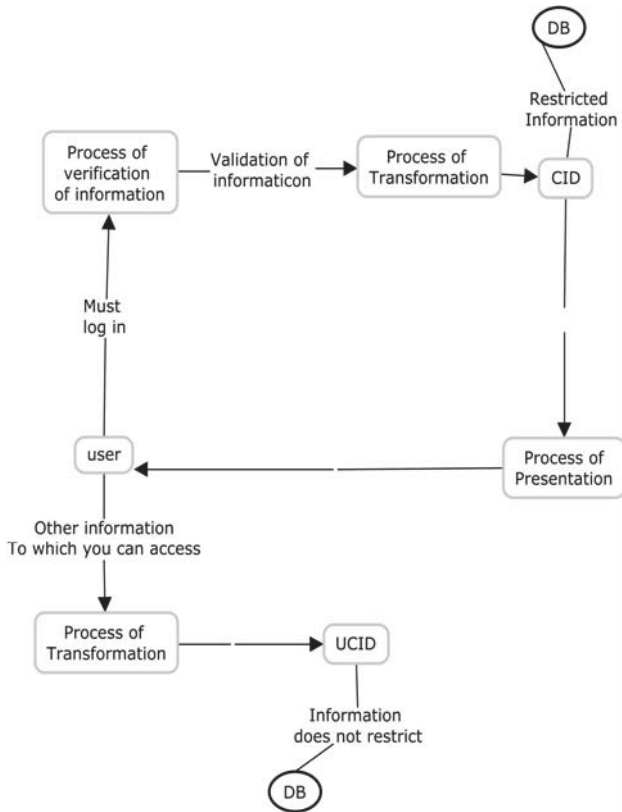
Description of the results obtained

Fig. 1. General Prototype

In Fig. 1. Clark-Wilson's general model establishes that certain previous guidelines must be followed to ensure the integrity of the training, from a general point of view, this model indicates that the processes must be followed as: Verification and transformation process. The following is a general description.

- The user must log in to process the verification of the information.

- Valid the information to go to the next process

- From the process of information transformation to generates the constraint and can store a history in a database, the CID is the highest level.

- Returns the user through the generation of a presentation process.

- Take another alternative to enter other information that you can enter.

- To transform into restricted information with a process in the UCID, which can be stored in a database for histories.

In short, the verification process validates the integrity of the information while the transformation process is responsible for converting the report into objects to be presented to the user, these objects are called CDI.

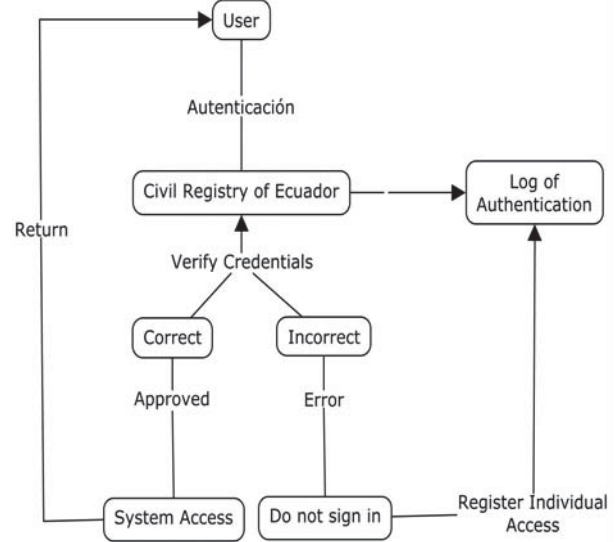Access to the system by applying Clark Wilson

Fig. 2. Access to the system by applying Clark Wilson

Description of the Fig. 2.

- The user must perform the authentication for the entry to the database of the Civil Registry of Ecuador where two options are generated.

- The first checks the credentials to define if it is approved or there is an error.

- If it is correct it is approved for access to the system and database, but an individual log of access is generated.

- Once the assigned tasks are executed, the user returns to his or her point of origin.

- If it is incorrect, an error is generated and the user is not prompted to perform any activity to store in the authentication log.

- The second is the registration of an authentication log

In summary if we want to apply to Clark-Wilson at the moment the user enters our system must keep a record of everything that happens in the system, so it is necessary to apply an authentication record to record the possible inadequate access to system.

Query information by the user

This model follows the principles of Fig. 1. but with the difference that the processes of verification of the information

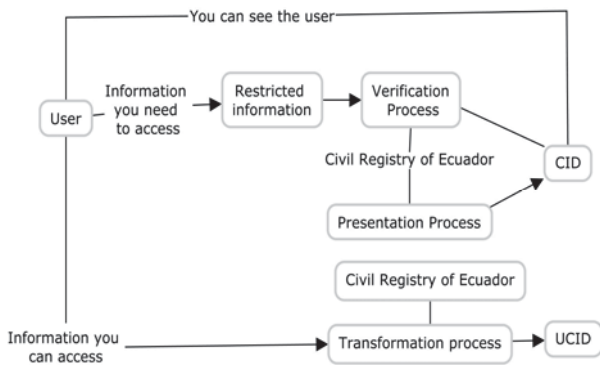and transformation of the same will be carried out by the Civil Registry of Ecuador.

Fig. 3. Query information by the user

Description of Fig. 3.

- The user requires to enter the database of the Civil Registry of Ecuador but has restriction, for that reason has to undergo a verification process.
- The process is presented by directing the ICD
- Another option is the information that the user can access through a transformation process that guarantees the UCID.

To mitigate the security of the data and information, it is necessary to define correctly the information that the user will have to access in a mandatory way and what not; all to guarantee the definition of the CID and UCID required by the Clark-Wilson model.

The contribution in this research phase is the general prototype for the validation of the user; definition of a general scheme for the access to the system by the application of Clark Wilson; information consultation by the user adopted for the Civil Registry of Ecuador; to mitigate the security of data integrity or information based on the Clark-Wilson model.

IV. DISCUSSION

It is considered one of the analyzes carried out by the United States, China, India, European Union among other countries of the world for the management of the identity of citizens with integrity, which consists of handling 15 to 17 digits to identify citizens, which was analyzed in the reference article[1]. The Civil Registry of Ecuador considers this analysis as a reference but it is not convenient to apply because it is a country that at the moment has 10 digits to identify the citizens and its number of inhabitants is small, is one of the reasons because it looks for another alternative as is to adopt the Clark Wilson model to the Ecuadorian Civil Registry database through a conceptual model to mitigate the integrity of the data.

The results obtained in this phase of investigation are: General prototype for the validation of the information, definition of a general scheme for the system by means of the adoption of the model Clark Wilson, information query by the user adopted for the Civil Registry of Ecuador; based on the model of Clark Wilson adopted to the Civil Registry of Ecuador to mitigate the integrity of the database.

In this phase the problem has not yet been solved to mitigate the integrity of the Ecuadorian Civil Registry database under a distributed environment; only a general scheme has been defined to adopt the model of Clark Wilson.

The results obtained for the adoption of the Clark Wilson model for the entry of the users to the database of the Civil Registry of Ecuador is based more on the criteria of the article Secure Databases: An Analysis of Clark-Wilson[3] and in article Configuring Clark-Wilson Integrity Model to Enforce Flexible Protection[6].

The theoretical results obtained can be applied in any organization or institution worldwide whose priority is to mitigate the integrity of the data; in the practical case it should be applied in the short term to the database of the Civil Registry of Ecuador.

The conclusions obtained are:

The trends defined in the articles reviewed with reference to the strengths of the Clark Wilson model are the basis for the development of the prototype for the Civil Registry of Ecuador to guarantee its mission, vision, strategic objectives where it is identified that its priority is the integrity of the data for its management.

The general prototype obtained allows the visualization of the processes of transformation and verification of the users for the access to the database of the users.

For access to the system was determined with the adoption of the Clark Wilson model that allows to strengthen verification of credentials if they are correct or incorrect.

For queries of the data and information of the database of the Civil Registry of Ecuador defined a user with the adoption of the Clark Wilson model will allow to define what information is restricted and what information can be accessed.

In this investigation the models of Bell-Lapaluda were not considered that is oriented to the confidential of the data and information used in the military field; the Biba security model that its strength is integrity policies industrial models; the Wall China security model also known as the China Wall is based on controls to minimize conflicts of interest in commercial organizations; to apply to the database of the Civil Registry of Ecuador in view of that these models their strengths are not in the data integrity that is the requirement of this institution.

Summary of evidence supporting the conclusions described above:

To consider the adoption of the Clark Wilson model for entry to the Civil Registry database is based on the articles of reference [2] [3] [4] [6] [8] [9] [10].

In order not to consider the security models Bell-Lapaluda, Biba, Wall China to adopt the database of the Civil Registry of Ecuador was based on the articles of reference [3] [5] [11] [12].

V. FUTURE WORKS AND CONCLUSION

To carry out a short-term integrated prototype with all the processes and sub processes of the Civil Registry of Ecuador with the adoption of the Clark-Wilson model in order to mitigate the integrity of the database and information. For the development of this prototype the analysis of the database must

be considered; conceptual models applying the IAAA, CID; definition of the conceptual model for data integrity; protocols and algorithms of adequate security; definition of vulnerabilities, threats, internal and external risks; definition of security policies and mechanisms to comply with policies; among others for this type of data and information management.

Conclusions obtained:

- The general prototype obtained allows the visualization of processes the transformation and verification of users for access.
- The access to the system with the adoption of the Clark Wilson model is strengthened to verify credentials that are correct or incorrect.
- The trends defined in the articles reviewed with reference to the strengths of the Clark Wilson model are the basis for the development of the prototype for the Civil Registry of Ecuador to guarantee its mission, vision, strategic objectives where it is identified that its priority is the integrity of the data for its management.

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