INCREASING EFFICIENCY BY INTRODUCING AUTOMATED SYSTEMS TO MANAGE TECHNICAL DOCUMENTATION IN ENERGY

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This paper presents a modern system for management of technical and economic information about energy installations. It shows the database for the storage of information, how the information is attached installations, how to structure information for easy retrieval of their. It shows how it is justified in economic terms, the implementation of such systems. Finally, efficiency indicators obtained for an application to CN TRANSELECTRICA SA are presented.

Keywords: efficiency, technical documentation, database.

1. Introduction

Implementation of modern systems for automated management of technical documentation is made with restraint because of the distrust that some managers show. In this paper, the authors present a functional system and, especially, how to justify it economically.
The technical information regarding energetic installations is stored on: paper documents, drawn planes and schemes, pictures, films, different file types (Word, Excel, PDF, DWG, etc.). Given these, the retrieval of information on a specific installation or component of it, is a very difficult process.
The difficulty consists of:

- The large volume of data needing to be searched
- Searching within each document for the needed information, when there is no additional information on a specific document
- The necessity to search for documents stored in different folders and different places
- Electronic information stored in multiple locations and formats (Word documents, PDF, DWG, Excel, etc.)

The current system for heterogeneous storage of information also has the following disadvantages:

- Due to the different formats and versions used in storing the information, it may have many duplicates

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- The access being hard to control, the safety of the information is affected
- Access to documentation is limited, especially in the case of units with installations distributed over large distances

For these reasons, the authors have designed and tested a high performance system for the fast storage and retrieval of technical and economical information on energetic installations [1]. The work of [2] presents the database, system configuration and test results. In the present study is presented how to obtain the justification of such systems and the results obtained for a particular situation [1].

2. Presentation system

The system contains two major components:

- Server database that stores the attachments installations
- Software loading and query documents

Server database (Oracle) must be large storage space (in the order TB - tens of TB).

The system will provide loading installations assisted hierarchical structure. Tree will be set by users on takeover. Basic information on installations are: the installation code / all functional / equipment, name of installation / all functional / equipment, the technical name of the component (according to a classification of installations), relevant nominal parameters (using catalogs), construction type (under construction classification types), higher installation code.

- Each overall functioning, installation, equipment will be attached to the level it serves or part.
- If a component is linked to two or more functional components, then it will be attached to the upper right component parts served
- At the company level (branch) will be attached buildings and non-technological facilities such as administrative buildings. Basic categories of technological facilities (lines and stations) will be attached to the same level

After loading, the structure of installation can be modified by adding new levels and components or by moving some parts from one level to another. At each facility / functional assembly / equipment will be able to attach documents. The document is any type of information contained in files such as AutoCAD (DWG, DXF), Acrobat (PDF), Microsoft Word (DOC), Microsoft Excel (XLS), Microsoft PowerPoint (PPT, PPS), image (BMP, JPG, TIF, WMF), text (TXT), video (MPG, WMV, AVI), audio (WAV, MP3), web pages (HTM). The number of types of documents is limited and the system must be defined and new types of document view. Number of documents attached to some installations is limited.

The system must allow the attachment, removal and modification of documents. Documents are characterized by the required attributes and optional attributes. Obligatorily attributes are necessary to identify, store and retrieve their: code document, code installation / assembly functional / equipment, type documents (DWG, PDF, DOC ,...), the user who uploaded the document, date uploaded, date of last update, brief description of the document, the original file name, file size (kB), class paper (according to a classification). Optional attributes are variable in number and complete the document with specific information. For retrieval, the types of optional attributes will be stored in a classification.

Technical documents attached to installations may be included in one of the following categories:

- raster map
- drawing or photographs detailing specific constructive or placement conditions;
- design documents
- records of parameters measured during maintenance operations (trial bulletins, measurement cards, etc.)
- acceptance documents
- documents regarding incidents
- documents regarding maintenance operations;
- equipment manufacturer documents (manuals, technical books, etc.)
- settlement documents (procedures, instructions)
- single line diagrams
- wiring diagrams

In the database, the documents will be stored as LOB (Large OBject) fields. The documents attached to the installations can be queried and retrieved:

- By the installation they belong to or
- By using a search pattern

When searching documents by installation the selection will be performed by going through the tree structure for each installation/ level. Displaying the attached documents is performed by double-clicking or by pressing a button corresponding to the record. The document list can be displayed for a single level and/ or for inferior levels. Grouping by document categories and alphabetical ordering by name are also used in the installation document list display.

When retrieving documents by using a search pattern we require at least one of the following types of fields:

- Installation related (the technical name of the component, voltage, constructive type); one field is either input from the keyboard or selected from the appropriate classified list

- Obligatorily attributes of the documents (document type – indicates the extension of the file containing the document, the user who loaded it, the date of the initial load – time interval, the date of the last modification – time interval, size range – in KB, category)
- Optional attributes. At least two optional attributes are selectable

The selection is made on the introductive form or on forms created through mechanisms like <Filter By Form> and <Filter By Selection>. The document list attached to the installation will be initially displayed in the reverse order of the date they were introduced into the system. The resulting document list can apply the <Sort By> mechanism to any field either through the toolbar or by clicking within the table header.

Within the document list resulted from the query, for each document we will find the installation structure it belongs to (a concatenation of installation names from the first level to the current level). After selecting the document list, the user is able to view a document by double-clicking it or by pressing a button attached to it. The selected document is downloaded from the database to the client computer, in the temporary files folder (for MS Windows OS). The document is viewed using viewing applications installed on the client's system and launched using the command line. The document types and corresponding viewing applications are written in configuration files. We prefer free or very low priced viewing programs which also have a high execution speed, such as MS Word Viewer, MS Excel Viewer, MS Power Point Viewer, Adobe Reader and others. We avoid viewing programs that allow the editing or saving of documents on the client system. We prefer applications which allow command line viewing options or menu customizing and, also, the printing of documents.

After the viewing, the documents are deleted from the client system.

Data can only be loaded/ queried by users with rights on one of the following 3 levels: system administrators, users with information loading/ editing rights and users with viewing rights. In their turn, the users with data loading rights and those with data viewing rights can be set with different viewing rights for certain categories of documents.

3. Elements taken into calculations of economic efficiency

For retrieval, the types of optional attributes will be stored in a classification:

A. Investing

$$I = I_0 + \sum_{i=1}^{T_s} I_i \cdot (1+a)^{-i} \quad [lei] \tag{1}$$

where

T_s – duration of the study [years], which is considered 5 years

I_0 – is the initial investment

I_i – is investment in year i. Typically, this investment relates to replace worn equipment, capacity expansion or upgrading database server software

a –actualization rate, 0.01.

B. Annual labor savings due to deployment of the system

The economy achieved annual, E_{year}:

$$E_{year} = N_u \cdot N_h \cdot N_w \cdot C_h \quad [lei/year] \tag{2}$$

where

N_u – number of users using the system for retrieval and query documents

N_h – reduction of labor on a weekly users [h / week · user], assessed at least 2 [h / week · user]

N_w – average number of weeks of the year in which a user uses the system, [weeks / year], with value 47 [weeks / year]

C_h – average hourly cost of a system user [lei / user · hour]

$$C_h = \frac{C_{year}}{N_u \cdot N_{dy} \cdot 8} \text{ [lei/user·hour]} \tag{3}$$

N_{dy} – average number of working days per year [days / year], with the average value of 255 [days / year]

C_{year} – trader's total annual expenditure on staff operating system [lei/year]

B. Annual savings by reducing the risk of loss of information

$$E_{doc} = N_{doc} \cdot N_u \cdot N_w \cdot N_{hd} \cdot R_{doc} \cdot C_h \text{ [lei/year]} \tag{4}$$

where

N_{doc} – average number of documents handled in a week of each of the N_u users

N_{hd} – average number of hours to create / restore a document, found at 6 [hour/doc]

R_{doc} – risk of loss of a document which is not stored in the automatically system, estimated statistically by consulting employees in 0001, ie 1 document of 1000 documents

D. Operating expenses system, C_{ex}

$$C_{ex} = C_{man} + C_{soft} + C_{\sup} \text{ [lei/year]} \tag{5}$$

C_{man} – Annual labor cost of system operation
C_{soft} – Annual software maintenance cost
C_{sup} – Annual material costs for system operation

3. Indicators of economic efficiency

A. Net Present Value

$$NPV = -I_0 - \sum_{i=1}^{T_s} I_i \cdot (1+a)^{-i} + \sum_{i=1}^{T_s} \left(E_{year} + E_{doc} - C_{ex}\right) \cdot (1+a)^{-i} \text{ [lei]} \quad (6)$$

B. Internal Rate of Return

$$IRR = \{a \cdot 100 \mid VNA(a) = 0\} \text{ [\%]} \quad (7)$$

C. Profitability index

$$I_p = \frac{\sum_{i=1}^{T_s} \left(E_{year} + E_{doc}\right) \cdot (1+a)^{-i}}{I_0 + \sum_{i=1}^{T_s} I_i \cdot (1+a)^{-i} + \sum_{i=1}^{T_s} C_{ex} \cdot (1+a)^{-i}} \quad (8)$$

D. Duration of recovery updated

$$DRU = \{t \mid F(t) = 0\} \text{ [years]} \quad (9)$$

where

$$\begin{aligned} F(t) = & -I_0 - \sum_{i=1}^{T_s} I_i \cdot (1+a)^{-i} \cdot \Phi(t-i) + \\ & + \sum_{i=1}^{T_s} \left(E_{year} + E_{doc} - C_{ex}\right) \cdot (1+a)^{-i} \cdot \Phi(t-i) - \\ & - I_{[t+1]} \cdot (1+a)^{-t} \cdot (t-[t]) \cdot (1+a)^{-t} + \\ & + \left(E_{year} + E_{doc} - C_{ex}\right) \cdot (t-[t]) \cdot (1+a)^{-t} \end{aligned} \quad \text{[lei]} \quad (10)$$

is Net Present Value which is calculated exactly at time t, which includes full years plus the decimal;

$\Phi(t)$ - step function equal to 1 for t ≥ 0 and 0 for t <0.

[t] – the floor of t.

4. Results obtained

Table 1 shows the annual savings and costs.

Table 1

The main components of the calculation of money, duration of the study 5 years

No.	Name	Value [lei/year]
1.	The economy achieved annual, E_{year}	110449
2.	Annual savings by reducing the risk of loss of information, E_{doc}	16567
TOTAL:		127016
3.	Operating expenses system, C_{ex}	8089

Table 2 shows the main indicators of investment and efficiency:

Table 2

The main technical-economic indicators work, duration of the study 5 years

No	Indicator	UM	Value	
			LEI	EURO
1.	The total investment, I_0	Lei/Euro	300574	89594
2.	Duration of execution	luni	5	
3.	Storage capacity	GB	816	
4.	Net Present Value - NPV	Lei/Euro	150254	44788
5.	Internal Rate of Return - IRR	%	28.09	
6.	Profitability index – I_p		1.45	
7.	Duration of recovery updated, DRU	years	3.054	

It was considered that life duration is 5 years and that no longer make investments in this period.

From the results we see that in a period of 5 years to achieve a profitability of 45%, so basically, to recover the investment and obtain the additional 45% of its value. Duration of recovery, calculated with the actualization amount is relatively small, 3 years.

5. Conclusions

The data presented above show the following:

- The use of automated systems for storing and managing the technical documentation of energy instalations is imperative to increase labor productivity and reducing loss of documents.
- Storing information in an Oracle database provides attachment for retrieval of necessary information and easily retrieve them after the installation to which it belongs have been after a mock search.
- Implementing such a system arise as effective, even if considered a small number of people using the system, each saving 2 hours / week.
- The main indicators of efficiency for such investment have good values, even for a period of 5 years: Net Present Value NPV = 150254 lei, the internal rate of return IRR = 28.09 [%], the profitability index - Ip = 1.45, Duration of recovery updated, DRU = 3.054 [years].

R E F E R E N C E S

[1]. *G. Hazi, Aneta Hazi*, Sistem de arhivare a datelor rezultate din măsurători topo-cadastrale, Contract no. 8/12.03.2007, customer CN TRANSELECTRICA SA, ST Bacău.

[2]. *G. Hazi, Aneta Hazi*, *V. Mălâia*, "A System for the Storage and Retrieval of Technical Information Corresponding to Power Installations", in Proceedings of the WORLD ENERGY SYSTEM CONFERENCE 2008 – IASI, ROMANIA 2008, June 30- July 2, CD ROM.