

The Development of a Business Intelligence Web Application to Support the Decision-Making Process Regarding Absenteeism in the Workplace

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Abstract. Nowadays, one of the biggest concerns of industries all over the world is situations regarding absenteeism, since it has a great impact on the productivity and economy of companies, as well as on the health of their employees. The major causes of absenteeism appear to be work accidents and sickness, which lead to the attempt, by the companies, of understanding how the workload is related to the health of collaborators and, consequently, to absenteeism. Thus, this paper proposes the design and development of a Web Application based on Business Intelligence indicators in order to help the health and human resources professionals of a Portuguese company analyse the relation between absenteeism and the health and lifestyle of employees, with the intention of concluding whether the work executed on the company is harming workers' health. Furthermore, it is intended to discover the principal motives for the numerous and more frequent absences in this company, so that it is possible to decrease the absenteeism rate and, hence, improve the decision-making process. This platform will also provide higher quality healthcare and the possibility to find patterns in the absence of collaborators, as well as reduce time-waste and errors.

Keywords: Information and Communication Technology, Business Intelligence, Decision-Making Process, Absenteeism, Web Application, Health and Human Resources Professionals.

1 Introduction

Absenteeism refers to the absence of individuals to work and it can be caused by work accidents, personal illness, and family issues, among others [1]. It has a tremendous influence on industries, since it decreases their productivity and economy, which highly concerns companies. Consequently, it creates the necessity to analyse this issue with the aim of comprehending the main motives so that it is possible to justify and decrease high absenteeism rates, as well as understand if workload is somehow related to the absences and causing harm to the health of workers [2].

Thus, in order to help health and human resources professionals of a Portuguese company analyse absenteeism, a solution was proposed. It consisted in designing and developing a Web application based on Business Intelligence (BI) indicators. This platform will allow the identification of the causes for an increasing absenteeism rate and the analysis of the relation between the great number of absences and the health and lifestyle of collaborators. Furthermore, it is also planned to find patterns in the absences of workers, as well as solutions to decrease such rate.

Regarding the structure of this paper, the state of art related to this project is described in Section 2. Thereafter, in Section 3, the research strategies chosen to conduct this study are briefly presented. Then, in Section 4, the case study is discussed with the intention of revealing the main issues faced by the company, as well as validate the pertinence of this work. Subsequently, Section 5 demonstrates the results achieved, which contain the architecture for the Web application and the BI indicators created. In Section 6, a discussion of the results is presented and, lastly, in Section 7, the principal conclusions are enhanced and future work is suggested.

2 State of the Art

Over the last few years, Health Information and Communication Technology (ICT) was proved to be essential to healthcare facilities. ICT consists in the use of electronic tools that allows the processing, transmission, storage, access, and use of medical data in order to provide an easier and faster manipulation of data in healthcare organizations [3]. Besides that, health ICT has the capability of increasing access, quality, and efficiency of healthcare processes, as well as reducing time-waste, clinical errors, and costs [3 – 55].

Business Intelligence (BI) is the most relevant ICT concept, since it enables the collection, transformation, analysis, and organization of data from multiple internal and external sources of information for a faster and more effective decision-making process [6 – 9]. Thus, BI transforms a large amount of raw data into valuable knowledge, which provides the possibility of making fact-based decisions [10, 11].

On the top of that, BI offers numerous tools, including the Extract, Transform, and Load (ETL) process that is capable of extracting information from one or more sources, clean-up and normalize the data and, finally, load the data into a data warehouse (DW) [12, 13]. Moreover, BI also resorts on data warehousing, which is a tool that is able to store and organize the previously treated data [14]. Additionally, this technology allows the visualization and interpretation of information through Reporting, Data Mining (DM), and Online Analytical Processing (OLAP) processes, which enable the elaboration of reports, the definition of patterns, and the study and manipulation of data stored in the DW from different perspectives, respectively [15 – 17].

Nevertheless, in spite of the increasing adoption of BI systems in healthcare facilities, there are still great challenges that must be overcome in order to implement this technology in healthcare organizations, such as technical issues and familiarity with ICT [3, 7]. Therefore, it is necessary to investigate this problem in order to understand how to apply successfully the BI methodology in the healthcare industry [4, 18].

3 Research Strategies

It was fundamental to select a methodology that would conduct this project within an organized path and well-defined rules and, consequently, guarantee its success. Thus, the research strategy that is being followed is Design Science Research (DSR), since it is the most adequate methodology for ICT research projects.

DSR has the main goal of creating and evaluating innovative ICT artefacts with the aim of solving organizational problems [19, 20]. Therefore, this research strategy is consisted by the following steps: “Problem Identification and Motivation”, “Definition of the Objectives for a Solution”, “Design and Development”, “Demonstration”, “Evaluation”, and “Communication” [19].

For the first three steps, it was needed to perform interviews and meetings with the target audience, i.e., health and human resources professionals. The information acquired through these steps was essential to identify the principal challenges and to establish the objectives in order to execute an adequate solution.

The fourth and fifth steps are currently being accomplished. The application is being presented to the target audience as it is being developed with the intention of understanding if the defined objectives are being encountered and if there is the necessity of modifications. Additionally, it is important to mention that a Proof of Concept (PoC) was performed in order to analyse the impact of the proposed solution in the company.

Lastly, the final step of DSR is also being executed, which consists in announcing the novelty and value of this work, being the intention of this paper.

It is important to refer that ethical issues are being taken into consideration in order to guarantee the safety and confidentiality of all of the information provided.

4 Case Study

The case study presented in this paper consists of a problem concerning absenteeism in a Portuguese company that produces various types of tires, which is being managed by a German multinational company (Continental). The issues and main challenges that motivated the development of the proposed solution will be discussed in this section.

It was necessary to reunite with the health and human resources professionals of the referred company in order to visualize the way absenteeism has been analysed for the past few years and to comprehend their needs and the problems that must be solved. As a result of that, it is possible to list the challenges faced by these professionals:

- The company has the entire data concerning absenteeism in Excel files. This situation makes the analysis of information and the decision-making process a lot more difficult and time-consuming, since the data are disorganized and harder to interpret;
- There is the necessity of attempting to identify patterns within the absences of collaborators and this analysis can lead to errors, since the Excel file method makes the study of absenteeism and, consequently, of a vast amount of data more confusing;

- The analysis of absenteeism through Excel files is harder due to the fact that all the recorded data of the employees, i.e., personal, health, and absence information, are kept in various files.

Thereby, it was proven the necessity that these professionals have for a solution that will allow them to analyse the problem of absenteeism in a faster and more efficient way. The proposed solution is, as previously mentioned, the design and development of a Web application with BI clinical and performance indicators in order to facilitate the finding of patterns in the absences of collaborators and the analysis of the absenteeism rate and, consequently, improve the decision-making process so that it is possible to enhance the healthcare provided and reduce the absenteeism rate.

5 Results

In the present section, the results of the proposed solution are described. The first subsection, Subsection 5.1, presents the architecture of the Web application and all of the functionalities available for its users. Thereafter, some of the BI indicators created in order to support the analysis of absenteeism and the decision-making process are shown and discussed in Subsection 5.2.

5.1 Architecture of the Web Application

Before designing the Web application, a database had to be created in order to store all the necessary data since the company for which the solution is being developed has all the information related to absenteeism in Excel files and, consequently, does not have any database implemented. The MySQL database was selected due to the fact that it is a secure and reliable relational database. Thus, a DW was created through the ETL process. The DW contains absence, health, and personal information of the employees.

Moreover, the Web application is being developed with the ReactJS library, which is a JavaScript library written in JSX, i.e., a syntax extension to JavaScript [21]. Additionally, the sharing of information between the application and the DW is made through a REST API in NodeJS with SQL queries, more precisely in ExpressJS [22]. In Figure 1, it is presented a schematic representation of the architecture of the application.

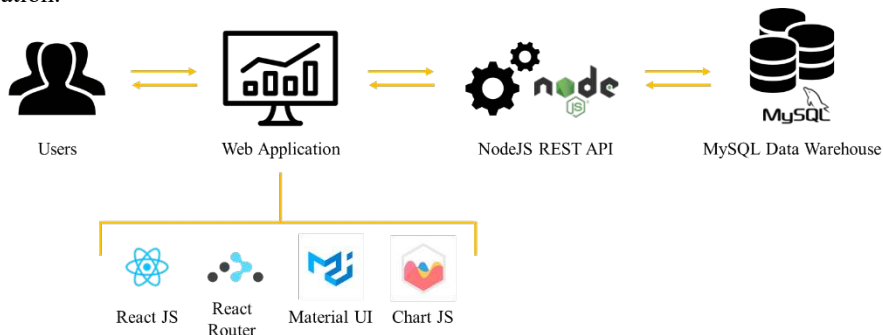


Fig. 1. Schematic representation of the architecture of the Web application.

Firstly, the user needs to sign into the Web application with his login credentials in order to use the application. It must be mentioned that the login information of all the users is stored in the DW. Furthermore, the application must be accessed using a Web browser and it is distributed to all the health and human resources professionals through the Intranet, which is the private network of the company.

Then, the user may access the modules and functionalities available in the application, namely:

- **Dashboard:** it displays basic data related to the absenteeism in the company, such as the absenteeism rate in the previous 12 months, the latest five absent collaborators, and the three principal motives of absence, among others;
- **Management of Absence Records:** it allows the visualization of the absence entries of each collaborator. Additionally, the human resources professionals can add, update or exclude absence records;
- **Management of the Collaborators:** it enables the visualization of the personal information of each collaborator. Moreover, the human resources professionals can add, update or exclude collaborators from the list;
- **BI Indicators Page:** this module presents all of the BI clinical and performance indicators related to the number of collaborators missing and the absenteeism rate so that it is possible for the user to analyse the relation between the health and lifestyle of the employees and the absenteeism in the company, as well as to identify the causes for the increasing rate and understand how to decrease such rate;
- **Management of Notifications:** the user may consult the notifications received and also select the type of alerts he wants to receive, such as when a collaborator is missing for 30 days or more, when a collaborator from a determined department initiates an absence, among others;
- **Registration of Users:** the users with administrator accounts are able to register new accounts for health and human resources professionals, as well as edit and delete, since the application is restricted to these professionals and cannot be accessed by the entire company;
- **Profile:** it is possible for the user to view and update his personal data;
- **Sign out:** it allows the user to sign out of his account.

5.2 Business Intelligence Indicators

In order to accomplish the previously stated objectives, it was necessary to create BI indicators, since it will help with the analysis of the problem, as well as with the decision-making process. Therefore, these indicators were created with the ChartJS library, a flexible and simple JavaScript charting library that can be used on ReactJS applications with the data stored in the MySQL database [23]. Moreover, a RESTful API written in ExpressJS, a NodeJS Web framework, with SQL queries is being developed with the aim of enabling the sharing of data between the frontend application and the backend DW [24].

Thus, the next sixteen BI indicators were created:

- Number of absent collaborators by month;

- Number of absent collaborators by cause of absence;
- Number of absent collaborators by academic level;
- Number of absent collaborators by city of residence;
- Number of absent collaborators by body mass index;
- Number of absent collaborators by disease;
- Number of absent collaborators by period of absence;
- Absenteeism rate by gender;
- Absenteeism rate by age group;
- Absenteeism rate by department;
- Absenteeism rate by smokers and non-smokers;
- Absenteeism rate by years of work in the company;
- Absenteeism rate by parents and non-parents;
- Absenteeism rate by who wear glasses and who does not;
- Absenteeism rate by those who exercise regularly and those who do not;
- Absenteeism rate by those who do rotating shifts and those who do not.

However, it must be mentioned that some of the previously stated BI indicators were not created yet since there is not enough data available. On the other hand, it is important to refer that these BI indicators were built considering all 2018 and 2019 until the month of august (included).

One of the BI indicators created is presented in Figure 2.

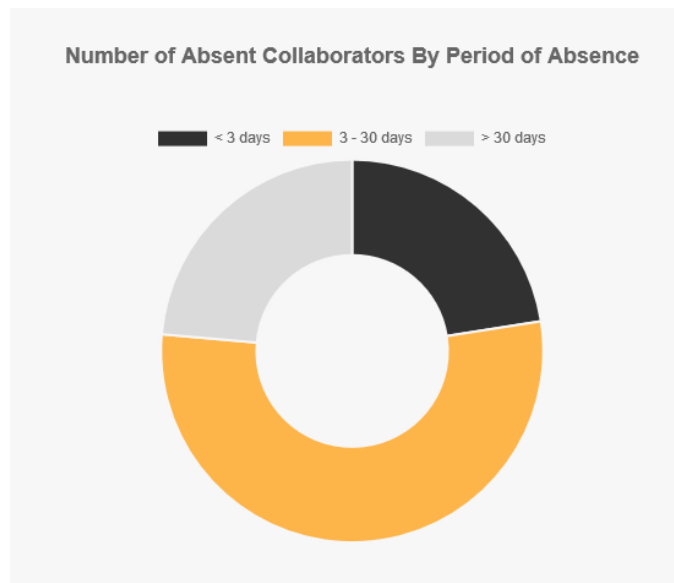


Fig. 2. Business Intelligence indicator concerning the number of absent collaborators by period of absence in the year of 2018.

In Figure 2, it is demonstrated the BI indicator related to the number of absent collaborators by period of absence during 2018. It shows that there were 186, 445, and 195 collaborators absent for a period of three or less days, three to thirty days, and more than thirty days, respectively. Therefore, it is possible to conclude that the period for which the workers were commonly more absent was the mid-term absence, i.e., the period of three to thirty days. Furthermore, it can be assumed that most of the employees that missed work in 2018 did not have serious complicated health issues and were able to return to work in less than a month.

Another indicator was created in order to allow the study of the number of absent collaborators by cause of absence in 2018 and it enabled the discovery of the three principal causes of absence in the company, which were Short Term Disability (STD) – Natural Disease, Work Accident, and Parental Leave with 373, 143, and 136 absent employees, respectively. Thus, with this information, it can be concluded that the work done in this company is damaging the health of collaborators through working accidents and the development of diseases. Besides that, it is also possible to visualize that many collaborators are becoming parents.

Moreover, it was also created a BI indicator concerning the absenteeism rate by gender in the year of 2018 and it is possible to analyse that men and women had an absenteeism rate of 5.93% and 4.05%, respectively. Thereby, this data allows to determine that men had a higher absenteeism rate than women during 2018, which can also be explained by the fact that there are more men than women working at this company.

The formula that enabled the calculation of the absenteeism rate is demonstrated in following equation:

$$\frac{\text{Number of absent days}}{\text{Total number of collaborators} \times \text{Number of worked days}} \times 100\% \quad (1)$$

However, it is possible that the previously referred absenteeism rates are miscalculated, since the number of worked days is unknown and it was necessary to use an estimated value to calculate those percentages.

Moreover, it must be mentioned that it is planned to create more BI indicators in order to provide to the company an efficient and reliable analysis of the problem.

6 Discussion

In order to present the practicality, effectiveness, value, and quality of the Web application, a Proof of Concept (PoC) was made. Thus, a SWOT analysis was necessary in order to enhance the strengths and identify the weaknesses of the solution, which are internal factors, and to also acknowledge the opportunities and threats, which are external factors.

The main strengths of the Web application are the following:

- Enables the study of the absenteeism in the company and improves the quality of the decision-making process;
- Decreases times-loss and the number of errors occurred on the analysis of the problem comparing to the Excel file method;

- Easier access and visualization of the information and, consequently, faster interpretation of the data;
- Makes the attempt of discovering patterns in the absences of employees a simpler task;
- High usability due to the fact that it is an intuitive tool with the information displayed in an organized way;
- High scalability since new features can be easily inserted in the application.

On the other hand, one weakness of the Web application can be outlined:

- Required intranet connectivity to use the application.

Regarding the opportunities of the solution, the next points were identified:

- Implementation of a Data Mining (DM) module in order to allow the prediction of future tendencies on the absences of the collaborators with the help of past registries of absences;
- The development of new functionalities and modules with the aim of expanding the application;
- Elimination of the Excel files method, since it provides a higher risk of errors;
- Possibility of inserting new information in the DW, as well as of creating new BI clinical and performance indicators.

Finally, the threats for the proposed solution are as follow:

- Problems associated with the private network connection, i.e., Intranet;
- The potential lack of acceptance to use this solution by health and human resources professionals.

7 Conclusion and Future Work

The work described throughout this paper was created in order to help solving an absenteeism problem in a Portuguese company. So, a Web application with BI indicators was designed and developed with the aim of finding the causes to an increasing absenteeism rate and also of studying the possibility of the work done in the company be damaging the health of collaborators. Furthermore, it was also intended to analyse if the lifestyle of employees contribute to a more absent behavior.

Thus, through the analysis of some of the BI indicators created, it is possible to confirm and conclude that the workload of the company is causing harm to the health of collaborators, since two of the main causes of absence in the company are diseases and work accidents. This information also justifies the need of such application, proving that it is easier, faster, and less prone to errors to analyse absenteeism through the Web application, comparing to the Excel files method. However, there is not yet enough data in order to create more BI indicators to make more precise conclusions regarding the relation between absenteeism and the health and lifestyle of collaborators, as well as the actions needed to decrease such absenteeism rate.

So, regarding future work, it is intended to build more BI performance and clinical indicators as soon as more data are provided by the company. Additionally, it is also planned to implement a Data Mining (DM) module in order to help predicting future patterns and tendencies on absenteeism based on past records of absences. Finally, it is foreseen to test the application with the target audience so that it is possible to understand if the objectives are being accomplished and if changes are needed.

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