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Original Article

Business Intelligence to Optimize Decision-Making in a Telecommunication Company

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Abstract *- This article presents an implementation of business intelligence in the sales area with the objective of optimizing decision-making in a telecommunications company because there is not good quality of reports and satisfaction in the use of reports is not suitable for correct decision-making due to the lengthy time it takes to do it manually, in addition, the quality is not optimal for data analysis. A Data Mart was developed under the Ralph Kimball methodology adapted to the agile Scrum methodology. Finally, software quality tests were carried out for BI implementation according to ISO/IEC 25010. The expected results were obtained regarding the improvement in report generation time of 97.22 %, an improvement in the data quality of the reports by 29.08%, an improvement in user satisfaction by 40% and finally, the perception in decision-making was optimized by 38.66%, according to the results it was concluded that business intelligence provides notable benefits regarding the quality of information, report generation time to make optimal decisions and improvement of decision making. For the telecommunications scenario, this research is important since, in the literature review, it is not observed papers that narrate the implementation of a business intelligence solution applied to the telecommunications sector.*

Keywords *- Business intelligence, Decision making, Telecommunications, Ralph Kimball, ISO/IEC 25010.*

1. Introduction

Telecommunications companies require numerous relational tables [1] to represent the enormous volume of data that is generated in the oriented industry to network traffic, calls, billing and customers; also, the lack of unifying data that is scattered across your various data sources makes applying data analytics more complex [2].

A big problem in these companies is that they have dispersed data in their different databases and flat files, which are not exploited. If they do, they do it manually, taking many hours to develop reports for the correct data analysis for decision-making. In addition, this industry is highly competitive [3], even more so with the increase in remote jobs as a result of the confinement caused by COVID-19, for which the need to retain customers is something of the utmost importance, which is why it is necessary to have tools that can help make better decisions to increase your profits and competitiveness by exploiting your data sets organized in dashboards that are easy to understand and intuitive to use [4]-[5]. Through the systematic review of the literature, limitations were found since there is no extensive research in the telecommunications industry, and the existing ones are more focused on network analysis and customer loyalty, which in future research should propose Bi solutions to other areas or processes of these companies to improve the performance of the company. In addition, the investigations found do not use statistical methods to validate the BI software developed to measure end-user compliance and the quality of the software project.

This research work will be carried out with the intention of adding to the body of knowledge regarding the use of business intelligence as a tool for better decision-making in telecommunications companies, providing a procedural contribution for the use of business intelligence as a reference or background for future work by demonstrating how it is applied to improve decision-making using the Ralph Kimball methodology as implementation methodology and the Scrum methodology as a work methodology to which a Sprint has been proposed for each stage of the methodology proposed by KIMBALL for the development of a business intelligence solution [6] and establish a Data Mart meeting the organizational requirements of the company [7]. Since BI tools produce good quality information, it has been shown

over time that business intelligence is essential to make the right decisions in each of the internal processes of a company or in a specific area that can have an influence substantial on companies [8].

2. Literature Review

2.1. Review Methodology

For the development of this research, a systematic review of the literature (SRL) was carried out based on guidelines proposed by Kitchenham and Charter [9]. These guidelines were applied since it has a more organized methodology to inform the state of the literature; these works, in this case, business intelligence aimed at improving the services provided in a company, are examined, evaluated and synthesized. The data sources that were used were bibliographic databases that contain information for scientific research, Scopus, Ieee Xplore, ScienceDirect, ACM, and Google Scholar filtered between the years 2015 to 2023 were taken into account.

The following search string was established to filter the articles necessary for this investigation:

("business intelligence") AND (telecommunications OR telecom) AND ("decisions making")

2.1.1. Planning Review

To carry out the literary review, the following research questions were posed:

Q1

What techniques are used together with business intelligence for decision-making in the telecommunications sector?

Q2

What are the latest visualization tools that were used for the implementation of business intelligence to optimize decision-making in the telecommunications sector?

Q3

What are the benefits of applying business intelligence to optimize decision-making in the telecommunications sector?

According to the approach, some selection criteria were taken into account, and articles related to business intelligence in telecommunications were chosen, which answer one of the three research questions found in indexed magazines in the English language. Regarding exclusion criteria, duplicate articles found in different repositories, articles that were not clearly related to business intelligence, and investigations that did not have results or conclusions were taken into account. As a result of the review, 21 relevant articles were obtained for the present investigation. The first question (Q1) its purpose is to identify business intelligence support techniques used in telecommunications companies. The second question (Q2) aims to identify visualization tools used in business intelligence implementations for telecommunications companies. The third question (Q3) its purpose is to identify the benefits of implementing business intelligence in telecommunications companies—finally, the third question.

Throughout this article, questions Q1, Q2 and Q3 will be answered.

2.2. Q1: What Techniques are used together with Business Intelligence for Decision-Making in the Telecommunications Sector?

Some business intelligence techniques identified in this systematic review of the literature in relation to the telecommunications industry were obtained as follows:

2.2.1. Data Mining

The extraction of information acquired from the unification of data from different sources allows the discovery of functional patterns using data analysis tools [44]. In addition, according to [11], Data Mining is discovering the answers that you did not know and that you were looking for in advance is what data mining is about as [12]; that it can predict and provide critical information for the retention of star employees in addition to being able to identify a clustered picture of consumer types as concluded [13] in their research. It was also possible to understand the customer life cycle and provide efficient and personalized services for their customer as in the investigations of [14] and [15] that propose clustering models to help telecommunication companies to see the changes in the value and behavior of the client like [16] in their research they identified 4 clusters where a first type of client rarely used the services, the second constantly used the services considering them loyal clients, a third client that despite not being a loyal customer consumed more expensive packages, and a fourth group that had the same characteristics as the first group.

2.2.2. Reporting

The Reporting technique has different forms of use since the designed reports have various strategic indicators and designs according to each business or business area, developing from static reports to interactive panels with different indicators related to integrated analysis and intuitive visual graphics. According to the client's needs and as [17] who identified the most influential factors in the telecommunications sector, such as income from services offered, client satisfaction, equipment sales volume, formation of the client base, quality of the base analysis, network analysis in Morocco according to [18], statistically analyze the use of internet data by displaying the key indicators in interactive Dashboards as it was done in Bangladesh [19] and compare the effectiveness of agile

methodologies and the waterwall method according to [4] used surveys of 265 users from medium-sized and large companies to translate them into BI reports, obtaining knowledge finally.

2.2.3. OLAP

OLAP techniques typically take advantage of the data kept in a data warehouse because they offer quick answers to queries that combine a lot of detailed data to look for trends and patterns. OLAP tools conceptualize information as multidimensional data cubes, where facts and dimensions are separated from the data [20], as in his research in Malaysia, where [8]'s work enabled decision-makers to query and analyze data properly.

In their articles [20] and [21], they develop a BI system in India in order to track the recurrence of the use of mobile devices within a region over a period of time, combining all their data sources from different companies about the mobile penetration of a region.

Market share comparisons were established, for which an OLAP cube built to carry out the OLAP processing of all possible perspectives for the decision-making of the clients of the different telecommunications companies in India was developed and avoid them leaving to use their services.

2.3. Q2: What are the Latest Visualization Tools Used for the Implementation of Business Intelligence to Optimize in the Telecommunications Sector?

The visualization tools that are used are support for the application of technology applied to the telecommunications sector. The articles filtered from the literature research present some technologies used in BI implementations.

2.3.1. Tableau

In their research [15], [17], [22], they used the Tableau tool for the development of a Dashboard for the analysis of their data; this tool is used in large telecommunications companies such as Rostelecom PJSC, and taking into account the solution more cost-effective, it integrates easily with storage systems, as well as with Microsoft Office packages and your internal systems.

2.3.2. Pentaho

In their investigations [8], [23] they implemented a Dashboard with Pentaho as a visualization tool where all the user information data of the Telkomsel regional network service in Indonesia is shown, the number of users, the products used, the number of users of 4G, 3G and 2G networks according to the regional area of Telkomsel.

2.3.3. SSIS

It is a SQL SERVER component that provides several functions to carry out the ETL process, which allows extracting information from heterogeneous sources, transforming them into compatible data and loading them into a data repository in BI projects used in the investigation of [15], which could exploit to improve decision making in the telecommunications company.

2.3.4. IBM Cognos Analytics

This software is used for front-end programming in Business Intelligence (BI) applications through which SQL queries are generated to run in Relational Data Base Management Systems for the final stage of final data visualization [24]-[25].

2.4. Q3: What are the Benefits of Applying Business Intelligence to Optimize Decision-Making in the Telecommunications Sector?

2.4.1. Churn of Costumers

Churn or customer abandonment has received a lot of attention since having new customers is more expensive than retaining a customer. In addition, it is one of the big problems within the telecommunications industry; abandonment prediction has become an important task to perform [26]. In their research [11], they developed a BI implementation in a telecommunications company where they could anticipate if a specific customer is about to dispense with their services and when it will happen to make assertive decisions to reduce the rate of customer abandonment.

2.4.2. Customer Satisfaction

In the theory and practice of contemporary marketing, the notion of customer satisfaction is important; it tells us that greater customer satisfaction will lead to better financial performance by reducing customer turnover, improving loyalty, improving the reputation of the company [17] and achieving a competitive advantage (sustainability) and expand profits [11]. The realization of this importance has led to a proliferation of customer satisfaction research in the past two decades.

In addition, BI systems allow companies to understand how customers interact with them and maintain comprehensive customer information [25]. They also allow identifying loyal customers, profitable customers and potential customers according to [12], support budgeting, planning, and performance monitoring processes to improve customer satisfaction and anticipate needs and provide them with a better particular service [27] through implementations BI.

2.4.3. Staff Analysis

In their research [28], they had positive results after implementing a business intelligence solution in a telecommunications company; the sales function empowered by BI has a significant positive relationship with employee values and financial values in general. A reward system can be used to encourage and reward in this area to increase employee value.

2.4.4. Network Administrator

The analysis of the network traffic of the services provided by the telecommunications companies must be constantly supervised by these companies, according to [11], in order to measure the performance of the network giving more precise information in case there is a loss of data packets [22], in addition to being able to identify the loss of data packets as detailed [23] in his research in Indonesia and analyze the data traffic of his clients in real-time to maintain constant radio traffic in space and time to satisfy customers it is millions of users [8].

2.4.5. Failure Identification

The identification of failures in the telecommunications industry can be understood as a process in which anomalies or errors in the operation of some part of the networks that a telecommunications company has can be identified. When all available sources of information are combined, these anomalies, which only have a local view of the network outage, cannot describe the outage until its effects are evident. [4].

In their research [18] and [2], they developed a business intelligence solution to analyze the equipment used by the company to detect failures and maintenance services that can be carried out for its correct operation or to prevent a failure from occurring.

2.4.6. Fraud Identification

Telecommunications companies have interconnected networks that allow their users to be connected all the time, but there are also some actions by unscrupulous people who, with due knowledge, try to use these telecommunications networks for their own benefit.

Table 1. Benefits, Techniques and BI support tools

Types	Item	Papers
Benefits	Customer Churn	[11], [15], [21], [25]–[28],[45]
	Customer Satisfaction	[11], [12], [17], [18], [19], [25], [27]
	Staff Analysis	[28]
	Failure identification	[2], [11], [26]
	Fraud Identification	[11]
	Network Administration	[8], [11], [12], [23]
Techniques	Data Mining	[11], [13]–[16]
	Reporting	[4], [8], [17], [19]
	OLAP	[8], [13], [14]
Tools	Tableau	[15], [17], [22]
	Pentaho	[8], [23]
	IBM Cognos Analytics	[25]
	SSIS	[15]

According to [11], he identified potentially fraudulent users and their atypical usage patterns (Subscription Fraud) and also identified attempts to obtain fraudulent access to customer accounts.

According to the systematic review of the literature, Table 1 was prepared, where we can see each of the articles that contributed to answering the three research questions Q1, Q2 and Q3. In the results of the investigation in Table 1, it can be seen that one of the most used techniques to support BI implementations in the telecommunications industry is data mining, which contributes to the prediction of customer loss.

2.5. Result of the Literature Review

According to the results obtained in Table 1, after reviewing the literature, the implemented BI projects opted for tools such as SSIS for the ETL process as it provides multiple functionalities for proper data cleaning and dashboard visualization tools like Pentaho and Tableau were the most used. Techniques such as Data Mining, OLAP and reporting were of the utmost importance to have quality information and be able to analyze their critical processes providing certain benefits at the level of network management (identification of failures, monitoring their networks and identifying fraud) as it allowed them to avoid signal falls to thus avoid the loss of customers. BI projects were also developed for staff analysis and customer satisfaction as they are of utmost importance to have a competitive business in the telecommunications sector.

3. Methodology

3.1. Theoretical Basic

3.1.1. Business Intelligence

Business intelligence is a procedure that allows the identification and analysis of a company's data in order to make sound business decisions. According to [30], BI provides easy access to the information collected from each of the transactional databases of a company through technologies and applications that perform the transformation, analysis and presentation of data to support better decision-making in the process. Appropriate time by company officials provides greater competitiveness, innovation and creativity when implemented [31]. As a result, it is essential to develop a data repository, also known as a data warehouse or data mart, with a design and operating methodology optimized for queries rather than atomic transactions.

3.1.2. Decision Making

Decision-making is based on the experience and knowledge acquired, which allows one to carry out actions considered correct, choosing the best alternative from several available alternatives, according to [32]. It is of the utmost importance to be able to exploit the data resources that a

company has and thus have a better overview of the company's current state and, based on the right decisions, be able to improve the company's processes.

3.1.3. Ralph Kimball Methodology

It is a business intelligence implementation methodology based on the Data Warehouse life cycle as it provides a framework to organize a set of stages and tasks that will serve for a successful implementation. This methodology has a bottom-up approach, giving the possibility of developing a Data Mart for each specific area of the business and being able to unify it in a Data Warehouse, which is why it is one of the most used methodologies due to its easy adaptability when developing BI projects, for specific areas. According to [33], it is based on the elaboration of dimensional tables, which are those that contain all possible data on each of the indicators to be studied and are mainly focused on the life cycle of the Data Mart that will house the data.

3.1.4. Scrum Methodology

It is an agile project management support methodology that facilitates the coordination of activities or tasks that can be completed in a certain set time or Sprints, being able to monitor progress and replan meetings to develop a final product according to customer requirements interested. According to [34], with advantages such as the unlimited selection of needs for Sprints and without established procedures to follow, Scrum allows a personalized way of working on several projects with a diversity of requirements. Despite its widespread use, Scrum still has some key components that can make alternative approaches more effective. In business intelligence implementations, it cannot be alien to this methodology since it is required to be in constant communication with the final stakeholders since there may be certain changes in the business requirements and risks to complete a BI project.

3.1.5. ISO/IEC 25010

It is part of ISO/IEC 25000, which provides instructions for using SquaRE, or Software Product Quality Requirements and Evaluation [35]. The main objective of this document is to define standards for the specification of software quality requirements, their measurements and their evaluation. ISO/IEC 25010 provides quality metrics in terms of quality of use and quality of the software product to evaluate said software properties and thus satisfy the needs of stakeholders (functionality, reliability, security, portability, etc.), therefore, adding value [36].

3.2. Implementation and Work Methodology

The implementation methodology to be used will be that of Ralph Kimball, which is better for managing the life cycle of the Data Mart, adapting it with the agile scrum methodology because it supports the development of projects. Thus, a BI implementation provides communication between the development and the Product Owner, who in this case is the sales manager. In addition, delivery of value with opportunity to the stakeholders of the organization. The Ralph Kimball methodology was chosen because it was the one that best suits the business in terms of planning, business size, development time and the communication that will be had with the end customer as well as taking into account previous research [37] and [38], which is shown in Figure 1.

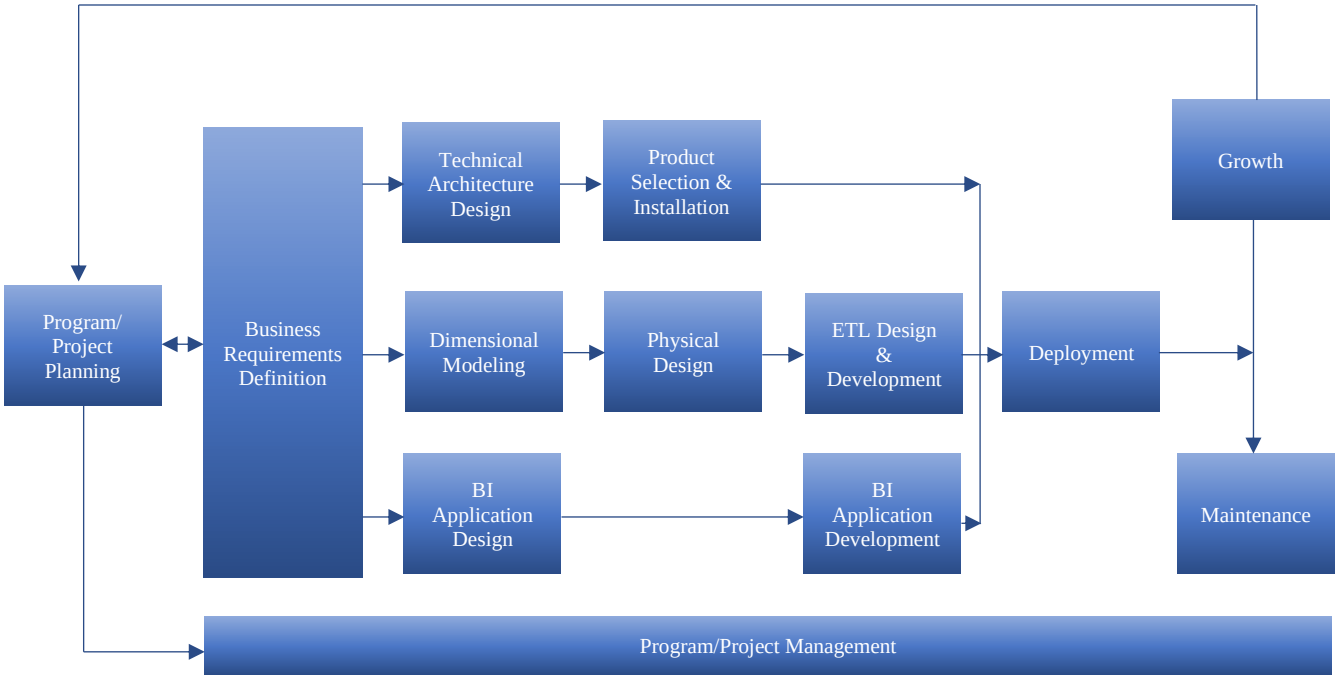


Fig. 1 Phases of the ralph kimball methodology taken from [12]

Table 2. Work methodology adapted to the life cycle of the data mart

Sprint	Development Phase
0	Project planning.
1	Definition of business requirements.
2	Technical architecture design.
3	Product selection and implementation.
4	Dimensional model.
5	Physical Design.
6	Design and implementation of the subsystem.
7	BI application specification.
8	Development of the BI solution.
9	Maintenance.

3.3. Project Planning

The objective of this investigation is to implement a business intelligence solution for the company's sales area for the development of a Dashboard and reports according to the requirements of end users. In addition, the approximate time of completion of this project is presented. Given these 7 phases obtained from the life cycle of a Data Mart corresponding to the Ralph Kimball methodology, this project having SCRUM as a work methodology, 7 Sprint were proposed corresponding to each of the phases as shown in Table 2.

3.4. Definitions of Requirements

3.4.1. Business Requirements

In sprint 1, interviews were conducted with management and area managers to identify the company's sales area requirements and define the indicators. In addition, the data sources of the sales area necessary to develop the business intelligence solution were obtained. For this Sprint 0, based on the interviews and data sources, certain requirements could be identified.

At a general level, 6 general requirements were found, from which more specific indicators or requirements are obtained from each of these.

- Requirements at a general level.
- Requirement at a geographical level or zones.
- Requirements at the vendor level.
- Service level requirements.
- Requirements at the Client level.
- Materials level requirements.

Table 3 shows the indicators by zone and vendor, and Table 4 shows the indicators of service, material and customers. Once the interviews were carried out, requirements were obtained according to tables 3 and 4, which the manager and sales manager approved.

3.4.2. Identification of Data Sources

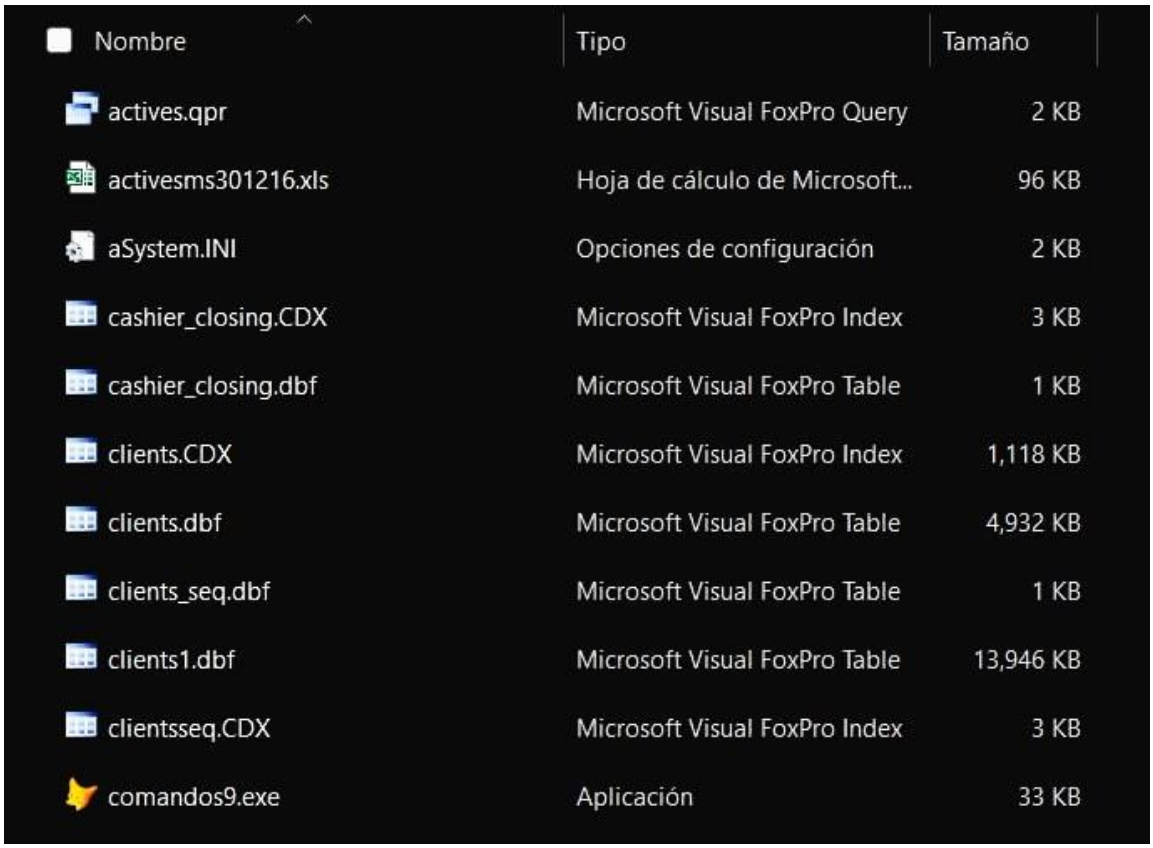
The sales area of the telecommunications company has a legacy system in Visual Fox Pro, as shown in Excel reports as shown in Figure 2. and web systems for managing its internal processes of the sales area, which has Api Rest to consume its data.

Table 3. General Indicators, Zone and Seller

Generals	Zone	Seller
R001: Amount of sales current and previous year. R002: Annual average amount of the last 5 years. R003: Amount for last year. R004: Amount of annual average sales for the last 5 years. R005: Sales trend. R006: Dispersion of amount of sales by year and months R007: Optimal sale current and previous year.	R008: Sales by streets in time. R009: Sales by sectors over time. R010: Sectors with high and low sales. R011: Streets with ups and downs. R012: Sales over time of each service by sector. R013: Sales over time of each service by street.	R014: Sales in units by the vendor over time. R015: Sales amount of the seller over time. R016: Total sales by seller. R017: Salespeople with better performance. R018: Optimal sale of weekly sale. R019: Dispersion of vendor sales over time.

Table 4. Indicators of Service, Materials and Customer

Service	Materials	Customer
R020: Sales of each service over time. R021: Number of customers per service. R022: Service with the highest and lowest sales per street R023: Monthly income for service R024: Frequency of services.	R025: Materials sold per street. R026: Materials sold by sector. R027: Best-selling materials. R028: Monthly income from equipment. R029: Frequency of use by material.	R030: Customer sales history. R031: Number of active clients. R032: Number of customers cut off this year. R033: Number of customers cut by sector. R034: Customers who make deposits. R035: Number of clients by age range.



Nombre	Tipo	Tamaño
actives.qpr	Microsoft Visual FoxPro Query	2 KB
activesms301216.xls	Hoja de cálculo de Microsoft...	96 KB
aSystem.INI	Opciones de configuración	2 KB
cashier_closing.CDX	Microsoft Visual FoxPro Index	3 KB
cashier_closing.dbf	Microsoft Visual FoxPro Table	1 KB
clients.CDX	Microsoft Visual FoxPro Index	1,118 KB
clients.dbf	Microsoft Visual FoxPro Table	4,932 KB
clients_seq.dbf	Microsoft Visual FoxPro Table	1 KB
clients1.dbf	Microsoft Visual FoxPro Table	13,946 KB
clientsseq.CDX	Microsoft Visual FoxPro Index	3 KB
comandos9.exe	Aplicación	33 KB

Fig. 2 Data source fox pro-free tables in BDF format

Fig. 3 Architecture BI

Once the data sources that the company has were identified, according to Figure 2, the Visual Studio 2019 Integration Services tool was used to develop the ETL packages that will be used to carry out the data extraction, transformation and loading process.

3.4.3. Architecture BI

The BI architecture was first designed with the identification of the data sources; later, the design and development of the ETL packages were carried out. A Staging Area was developed to support the process of incremental loading and error handling; after having ETL packages in production, the data is stored in DataMart. Finally, this data is loaded into visual reports with each of the requirements obtained in Sprint 1. Figure 3 shows the Architecture BI.

3.5. Physical Design

Once Sprint 4, the design of dimensions has been completed, and the next iteration will continue, which will begin with the configuration of the SQL server and Visual Studio 2019. Subsequently, the tables of the Data Mart, Staging Area and base will be created of SQL sales data and their respective primary and foreign keys. Finally, the sequences for each of the ETL subsystems will be created. Figure 4 shows the physical modeling of the sales data mart.

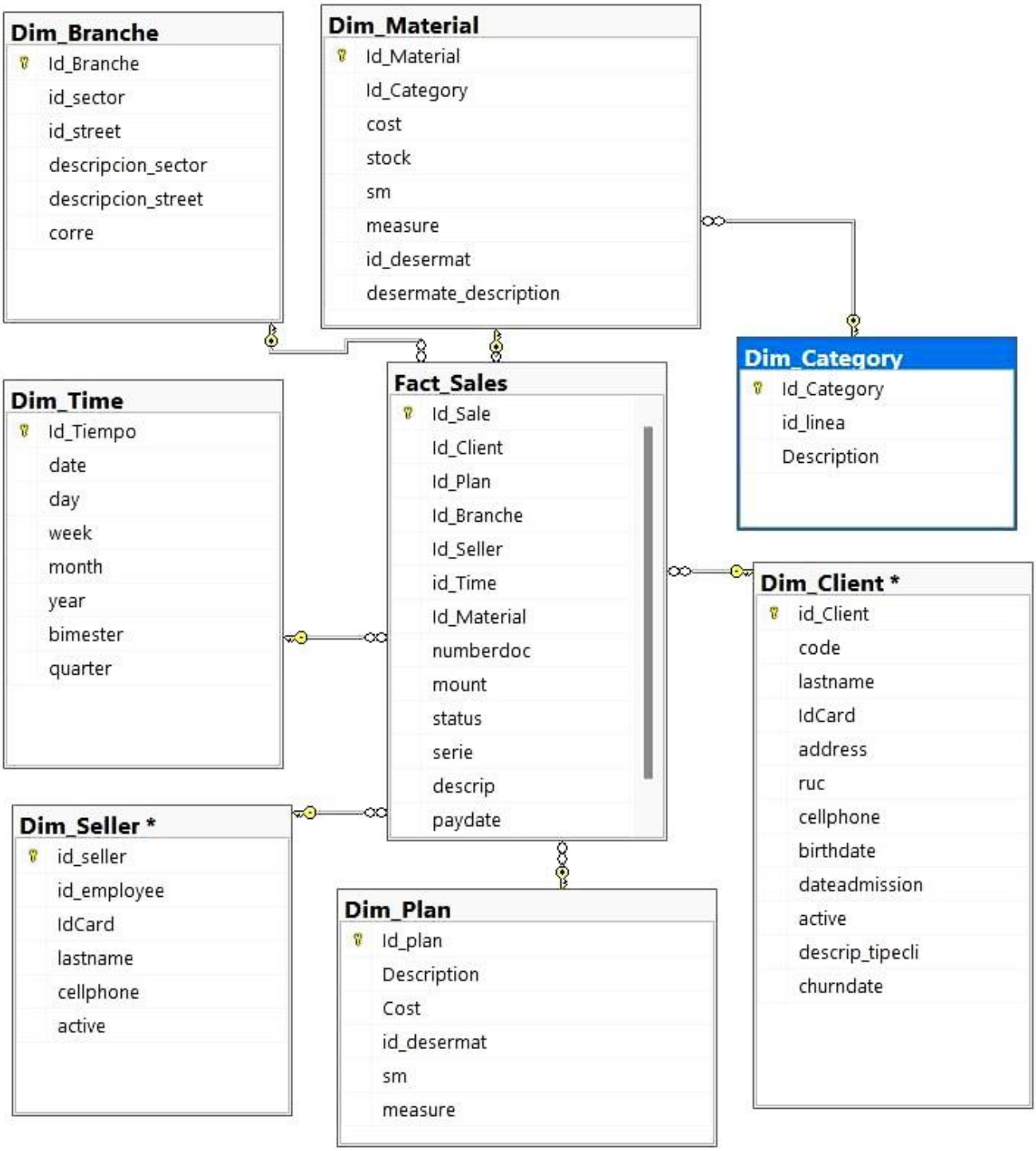


Fig. 4 Dimensional diagram of the datamart

3.6. Design and Implementation of the Subsystem

Once Sprint 5, the design of dimensions has been completed; the next iteration will continue, which will begin with the configuration of the SQL server and Visual Studio 2019. Subsequently, the tables of the Data Mart, Staging Area and base will be created of SQL sales data and their respective primary and foreign keys. Finally, the sequences were created for each ETL subsystem with their respective Data Flow for the Data Mart, sales database and Staging area. For the ETL phase, it was first necessary to migrate from Visual Fox Pro to SQL, as shown in Figure 5.

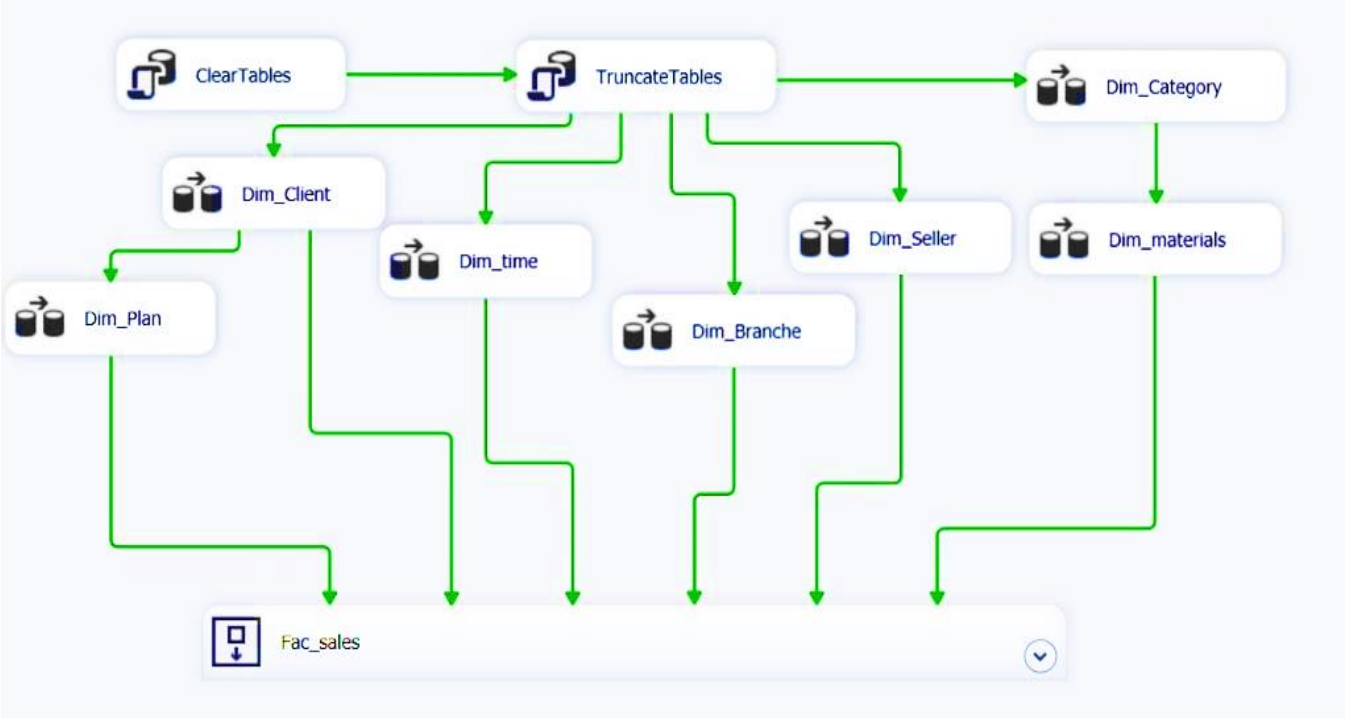


Fig. 5 ETL of the data mart

Fig. 6 Incremental Load

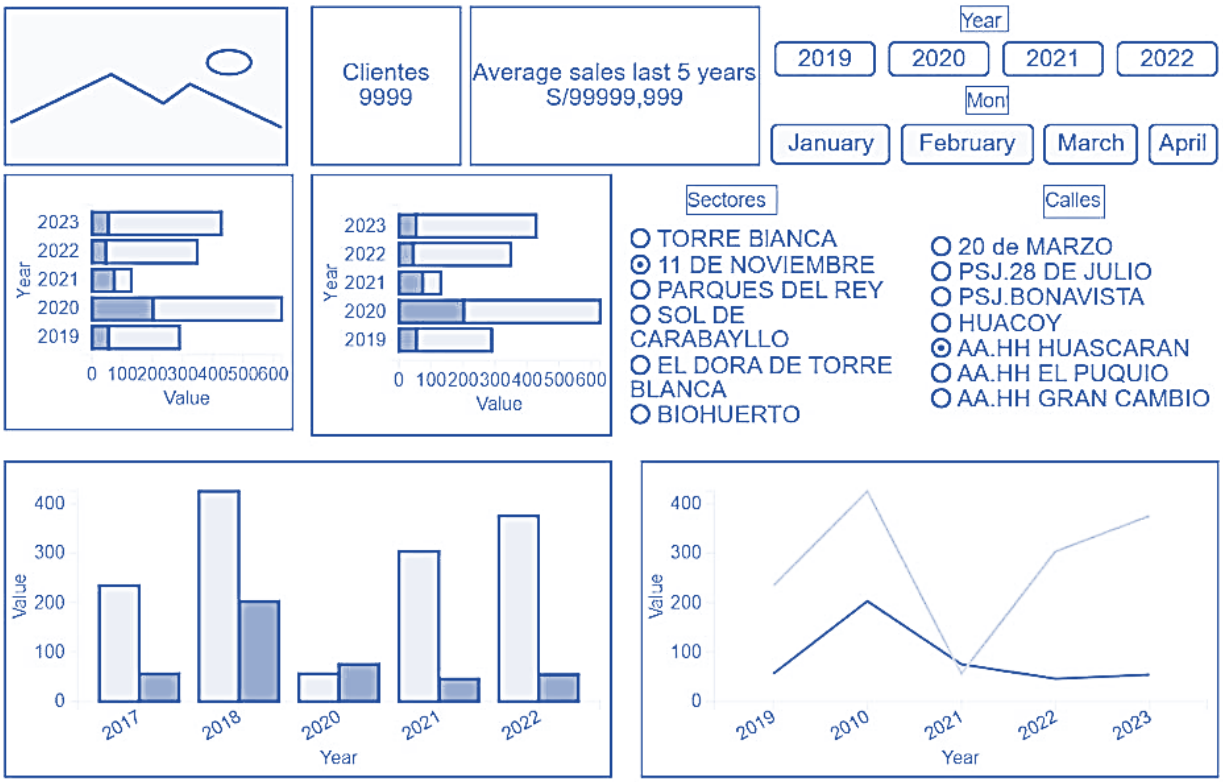


Fig. 7 Mockup dashboard "General sales"

Once the data sources were identified, the ETL for the data mart was developed, as seen in Figure 2 and later, for the data update, the incremental load, as seen in Figure 6.

Once the Data Mart has been deployed on the company's Server, it is necessary to add all the new records generated by the Visual Fox Pro system of the sales area, for which automated incremental loading will be carried out through SQL Jobs. In other words, if new records are added to the origin table, data inconsistency will be produced, which leads to data duplication. To avoid these inconveniences, only need to add the data carried out after the initial import; that is, the new records generated by the sales area in the course of their daily work will be sent to the Staging Area and later to the Data Mart.

3.7. Specification of the BI Solution

Once Sprint 6 has been completed, the design and implementation of the ETL subsystem, the next iteration, will continue, which will begin with the development of each of the dashboards according to the requirements established in Sprint 1 by the users. End of the sales area. Finally, each of the packages containing the ETL will be displayed.

3.7.1. Mockups

As a result of the tasks included in sprint 7, the mockups were developed. Each was shown to the end user through interviews and given the possibility of choosing colors, designs and visualizations, as seen in the Figure. 7.

3.8. Development of the BI Solution

Once the specification of the Sprint 7 BI application is completed, in this iteration, final dashboards are developed where indicators shown in Table 3 and Table 4 provide an overview of sales, which can be filtered by periods of time (year, month, quarter) as well as the sectors and streets in which the company provides its telecommunications services. Figure 8 shows performance indicators important for decision-making.

A total of 6 Dashboards were developed that cover each of the requirements represented with KPIs and which, depending on the type of user, have access to each of the Dashboards.

Fig. 8 Dashboard "General sales"

3.9. Maintenance

Once Sprint 7, the specification of the BI solution has been completed, the next iteration will continue, which will begin with the evaluation of the software quality of the BI project of this project using the reference model proposed by ISO/IEC 25010, which describes the activities that were carried out to guarantee the quality of the developed product, it was also supported by V-Aiken to quantify the relevance of the items (sub characteristics of each one of the characteristics chosen to measure the quality of the business intelligence systems by the expert judges).

3.9.1. Evaluation Model

The software quality assessment model of the research in Figure 9 was adapted from [39], where some tasks are proposed with the final objective of analyzing the quality metrics of the BI Project. First, the quality requirements of ISO/IEC 25010 must be evaluated, allowing the correct quality analysis of the BI system to be carried out.

Afterwards, the internal quality of the system is analyzed, taking into account the management of DataMart, that is, validating the development of mechanisms for managing errors of incremental data loading in DataMart. Subsequently, unit tests on the ETL packages to guarantee the data quality that enters DataMart. Finally, the external quality of the BI system must be evaluated; that is, the final Dashboards must be analyzed according to some characteristics shown in Table 5.

Table 5. Software quality characteristics

Quality Characteristics	
Characteristics	**Selection motivation**
Functional adequacy	It is necessary to evaluate the fulfillment of the requirements in the BI system.
Security	It is necessary to have functions in charge of protecting the data and information handled by the BI system.
Usability	It is necessary to evaluate how understandable, easy to use and pleasant for the user regarding using the Dashboards.
Reliability	It is necessary to evaluate that the system has the functionalities of a BI system.
Portability	There is no requirement to evaluate a business intelligence product.

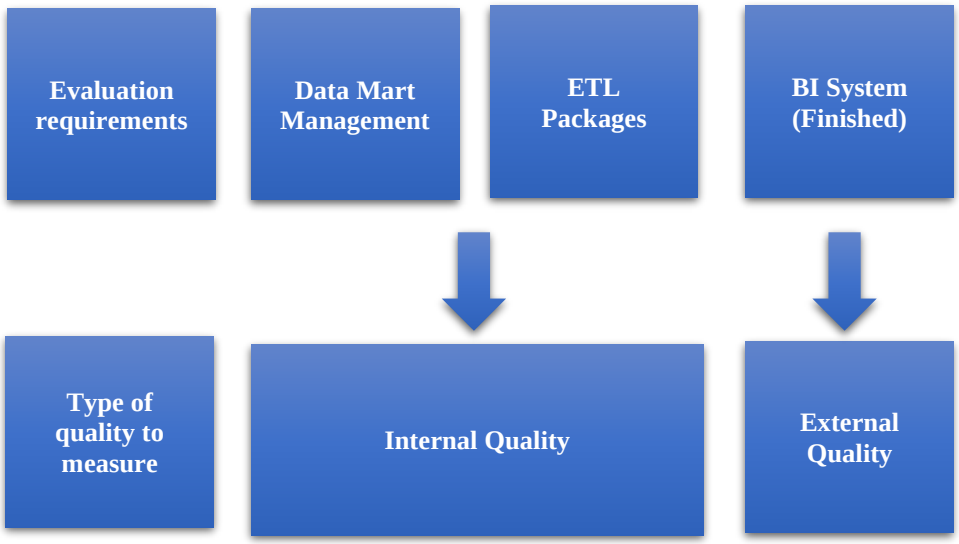


Fig. 9. Assessment model adapted from [32]

3.9.2. Specify the Evaluation

Some of the software product quality characteristics will serve as metrics to assess the quality of the BI software product.

For the quality analysis, each of the characteristics of the ISO/IEC 25010 shown in Table 5 were considered since these are adapted to the analysis of the BI System developed and were also adapted to previous investigations of [33].

3.9.3. Scoring Levels

Once the characteristics and sub-characteristics of the software quality have been established, each of these sub-characteristics will need to be scored, taking into account the subset suggested for the quality evaluation of the BI software product according to [41], for which scoring levels are proposed and thus know the status of the software quality level. For the score levels, a scale from 0 to 1 was used. Where A is a score from 1 to 0.9, this being considered very ideal, B is in a range of 0.89 to 0.7, considered recommendable; C is in a range of 0.69 to 0.5, considered normal; D is in a range of 0.49 to 0.25 considered minimum recommended and from 0.24 to 0 unacceptable. Finally, it is considered at a general level from 1 to 0.5 as satisfactory while from 0.49 to 0 not satisfactory.

3.9.4. Evaluation of Quality Characteristics

For the evaluation of the quality characteristics, 3 expert judges in BI were interviewed to analyze some characteristics mentioned in Table 4, giving as a result after conducting the survey of expert judges and taking the average value to obtain the table as a result. Table 6 shows the standards of an information security management system that has been considered to deploy the business intelligence solution.

Meetings were held with each of the expert judges to analyze the quality characteristics, and later, the surveys were sent to qualify the BI project through Google Forms.

Table 6. Final analysis of software quality

Characteristic	Sub-features	Resulting value per item	Resulting value per characteristic
Functional adequacy	functional completeness	0.93	0.96
	functional accuracy	1	
Security	Authenticity	0.93	0.93
	Integrity	0.93	
	Chance	0.93	
Reliability	Availability	0.86	0.9
	Fault tolerance	0.93	
Portability	Ease of installation	1	1
Usability	recognizability	1	0.94
	Learning capacity	1	
	Avoid user errors	1	
	User interface	0.8	
	Friendly	0.86	
	Accessibility	1	

4. Results and Discussion

Likewise, for the realization of this design, 3 indicators were identified where the improvement that the business intelligence model provides is analyzed; these are report generation time, quality of report information and user satisfaction in the use of reports.

4.1. Results

4.1.1. General Hypothesis

` The implementation of business intelligence will optimize decision-making in the sales area of a telecommunication company.

Likewise, other specific hypotheses can be inferred from the general hypothesis shown in section 4.1.2.

4.1.2. Specific Hypothesis

- The implementation of business intelligence will reduce the time it takes to generate reports in the sales area of a telecommunications company.
- The implementation of business intelligence will improve the level of information quality in the sales area of a telecommunications company.
- The implementation of business intelligence will improve the level of user satisfaction in the generation of reports in the sales area of a telecommunications company.

4.1.3. Expert Judgment

In order to validate the positive impact that the implementation of a business intelligence solution had in the sales area of the company, a survey consisting of 15 questions with a scale of 1 to 5 following the Likert scale was developed for the people involved who They are the manager, sales manager, sector managers and salespeople. Before carrying out the survey of those involved in the sales area, the validation method was carried out on 3 Expert Judges who work in the field of business intelligence. Therefore this validation method allowed for verifying the reliability and validity of the survey that will be used to validate the success of implementing business intelligence in the company's sales area. Table 7 shows the reliability of the survey.

Subsequently, the reliability test was carried out using the SPSS statistical computer program, resulting in a Cronbach's alpha of 0.842; this value is acceptable, for which the survey of the end users of the sales area will be carried out.

4.1.4. Calculation of PreTest and PostTest indicators

In this phase, the 3 specific hypotheses will be developed based on a tabulation of the answers provided by the end users of the sales area to later carry out the statistical validation of the PostTest survey. It is worth noting that applying a parametric or non-parametric test will depend on whether the data is normal. For which the p-value must be greater than 0.05.

Table 7. Results of reliability analysis using SPSS

Reliability statistics	
Cronbach's Alpha	**N of items**
0.842	15

Table 8. Normality test results

Instrument	Variable	Normal Distribution
Survey 1	Decision support (ATD).	0.158
	Quality of reporting information (CIR).	0.905
	Satisfaction with the use of reports (SUR).	0.064

4.1.5. Indicator Calculation Formula

For the calculation procedure of the different averages based on the frequencies of responses given by users during the surveys, use the following formulas. The indicator tabulation model was used for each of the responses with respect to the frequencies obtained from the responses to questions 1 to 5, 6 to 10 and 11 to 15 of the PreTest and Post Test survey that was carried out at end users and whose questions are associated with the specific's hypothesis.

4.1.6. Pretest Normality Test

Since there are only 14 respondents, it is less than 50 respondents, for which the "Shapiro-Wilk" normality test is taken, and a significance of 0.064 is obtained. This determines if the distribution of your data set is normal or not; a distribution refers to a probability distribution in continuous variables, and the test results indicate whether or not the researcher should reject the viability of the samples.

Since the significances are greater than 0.05, the data distribution is normal; that is, a parametric T-Student test will be applied. These tests were performed for the 3 quantitative hypotheses, and Table 8 was obtained as a result.

Having performed the Shapiro-Wilk normality tests, the significances are greater than 0.05, and the data distribution is normal; a parametric T-Student test will be applied. Therefore each one of the null hypotheses for each variable was accepted. The T-Student test will be performed for the final validation of each of the hypotheses set out in sections 4.1.1 and 4.1.2.

4.1.7. PostTest Normality Test

Having validated the survey through expert judgment, the survey was sent to each of the end users of the business intelligence implementation, and it was obtained as a result of the said survey and captured in the SPSS software.

Table 9. Normality test for data related to decision making post test

Instrument	Variable	Normal Distribution
Survey 1	Decision support (ATD).	0.198
	Quality of reporting information (CIR).	0.142
	Satisfaction with the use of reports (SUR).	0.081

Variable Improvement in Decision Making

Since there are only 14 respondents, it is less than 50 respondents, for which the "Shapiro-Wilk" normality test is taken, and a significance of 0.198 is obtained. As seen in Table 9.

Since next > 0.05, then the data distribution is normal; that is, a parametric T-Student test will be applied, and therefore each of the null hypotheses for each variable is accepted, then the T-Student test will be performed for its final validation of each of the hypotheses raised in sections 4.1.1 and 4.1.2.

4.1.8. Calculation process of PostTest Indicators

In this phase, the 3 specific hypotheses indicators are mentioned for the responses provided by the end users of the sales area to later carry out the statistical validation of the PostTest survey.

4.1.9. Final Validation of Hypotheses

For the final validation of each of the hypotheses set out in sections 4.1.1 and 4.1.2, the T-Student test was performed to validate and thus reach the conclusion that each of the general and specific objectives could be met. According to [42], the t distribution is a collection of curves organized by a set of data from a certain set of samples. In the first instance, the null hypothesis and the alternative hypothesis must be formulated, establishing that there are no differences in the mean of the two independent samples and that if this difference exists, it is only due to chance. The null hypothesis will be disregarded if the computed t resulting from the two samples is excessive (p-value found in the relevant tables). It is important to remember that the result is based on the previously determined significance value of the evaluated variable. Table 10 shows the significance obtained.

Table 10. T-Student test results for the hypothesis using SPSS

95% confidence interval of the difference		
	t	**Sig. (2-tailed)**
Pair PreTestHG-PostTestHG	-11.2	0.000358
Pair PreTestH2-PostTestH2	-8.8	0.000921
Pair PreTestH3-PostTestH3	-14.16	0.000144

Since the significance of each of the hypotheses is less than 0.05, HG is accepted; that is, the means between PreTest and PostTest are significantly different, so it concludes that each of the hypotheses raised at the beginning of the investigation is accepted.

4.1.10. Quantitative Indicators Development Process

For the development of the variable "report generation time", a survey was carried out on each of the end users who used the business intelligence solution and measured the time it took them previously when the reports were generated manually. It currently takes them to generate reports using the business intelligence solution.

Based on interviews with the end users, in the first instance, the time each of them took to develop their reports manually was consulted, and an average value was taken according to the types of reports made. The time after BI implementation was significantly reduced, as shown in Table 11, which details the findings of the interviews with the end users of the sales area. This is because the BI system generates the information required for decision-making with the indicators shown by each Dashboard created with the Power BI tool, resulting in a significant reduction of 97.22%.

4.2. Discussions

The present investigation went far beyond implementation, and statistical methods were used to validate the data collection instruments by expert judges, as well as the causality between implementing business intelligence and optimizing decision making, giving positive results in terms of end-user satisfaction, reduction in report development and quality of reports. In addition, a BI software quality analysis was carried out according to ISO 25010, guaranteeing the occurrence of errors in the software production phase.

Table 11. Times before and after the implementation of business intelligence

Dashboards	Time before, Time after	Time before, Time after	Percentage difference
Total sales	1.3 h	0.067 h	97.09%
total sales 2	1.467 h	0.156 h	91.11%
Sales by seller	2.5h	0.050 h	98.57%
sales by service	1.217 h	0.043 h	98.05%
Sales by materials	1.257 h	0.051 h	95.98%
sales per customer	0.650 h	0.058 h	91.03%
Total	8.391	0.425 h	97.022%

The results of this research coincide with what was mentioned by [24], which indicates that the implementation of business intelligence allowed the use of visual analysis tools to optimize managerial decision-making in the field of management of the company's marketing and sales activities from the monitoring and visualization of the dynamics of the changes in an established set of indicators during a specific period of time, which provided a better overview of the current situation of the company of the telecommunications company where it was implemented.

Likewise, this research coincides with what was mentioned by [3], which indicates that the visual analysis tools provided by business intelligence provided a significant and positive impact on processing time and data quality, which provide the ability to manage better the integration of data and precision in the generated reports which allowed to provide a better service to the customer service in the telecommunications company where it was implemented.

In the same way, this research coincides with what was mentioned by [36] in their research, and the results showed that sales are another important function in CRM and that a business intelligence implementation has a significant positive relationship to employee values to improve that of satisfaction in the generation of reports. It also tells us that using sales business intelligence for CRM positively impacts reducing costs, improving sales performance and increasing revenue.

5. Conclusion

According to the results obtained from the development of the hypotheses raised at the beginning of this investigation, the decision-making level of end users was, on average, 2,093 (41.86% Bad) on the Likert scale from 1 to 5. (100%) and with the implementation of the business intelligence solution, reached an average of 4,026 points (80.52%), which on the Likert scale represents a significant increase of 38.66.%.

According to the results obtained, the average time in generating reports in the sales area was reduced by 92.73% (7.78h), that is, from 8.39 hours to 0.61 hours. According to the results obtained, the level of quality of the information of the elaborated reports increased from an average of 2,586 (51.72%) on the Likert scale from 1 to 5 (100%) to 4.04 (80.8%), which represents a significant increase of (29.08%).

According to the results obtained, the level of user satisfaction in the generation of reports increased from 2,093 (41.86%) on the Likert scale from 1 to 5 (100%) to 4,093 (81.86%) on the scale Likert represents a significant increase of 40%.

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