International Journal of Engineering Trends and Technology
ISSN: 2231–5381 / https://doi.org/10.14445/22315381/IJETT-V71I10P229

Volume 71 Issue 10, 326-335, October 2023

Original Article

Implementation of Business Intelligence for Decision Making in the Inventory Process of the Logistics Area

Christian Salvador-Callalli[1], Laberiano Andrade-Arenas[2]

[1,2]*Faculty of Sciences and Engineering, Universidad de Ciencias y Humanidades, Lima, Perú.*

[2]*Corresponding Author : landrade@uch.edu.pe*

Received: 22 July 2023 Revised: 12 September 2023 Accepted: 13 September 2023 Published: 03 October 2023

Abstract *- Due to technological progress, organizations tend to improve in the technological aspect, emphasizing the logistics sector; this represents an advantage in the market due to the agility of its procedures. Companies belonging to the logistics sector or those that have this area in their organizational structure lack intelligent technology in their inventory process, so the logistics area is exposed to common errors of workers in terms of maintaining adequate supply, the rapid execution in the way of how to send a certain item and reliability in the classic Excel books for their ability to generate small reports. Based on the above, the main motive of the present research work is implementing a business intelligence solution to support the mentioned process, mainly by effectively using historical data stored on the company's server. During the project's development, the Kimball methodology was used, which is precisely designed to delimit step by step the complete procedure for the management of analytical projects, which influences the design of the most relevant information for the company. The implementation of this solution is intended to achieve the objective of this work, to generate high competitiveness in logistics through the automation of manual activities and help in decision-making.*

Keywords *- Logistics sector, Kimball methodology, Business intelligence, Data visualization, Decision making.*

1. Introduction

The term Business Intelligence (BI) represents a strategy that is becoming increasingly necessary in companies due to the understanding of technologies and application mode in its ability to gather all possible information resulting in the quality analysis [1] being a significant value in problem-solving, which allows working with large volumes of data, thus obtaining more information in less time [2]. The modernization of the world implies having a strategic planning of agile management oriented to obtain knowledge based on information [3], which is verified through Key Performance Indicators (KPI).

Since the logistics sector in Peru is considered an important element in the productivity and marketing for the sale or consumption of goods or services production, the inventory acts directly with the financial factor of the company [4]; therefore, it is considered that an adequate level of inventory allows guaranteeing and optimizing the operational activities. Taking this into account, with the application of ICTs in the mentioned process will mean an accelerated pace in the development of the company in the dynamic and volatile environment of the markets [5], resulting in not only the satisfaction of the demand but also a reduction of costs, thus generating greater profitability in the company.

Currently, companies nationwide maintain strategic planning in carrying out their activities, although, in some situations, the technological potential is left aside and continue to opt for the human force in automatable situations; for the purposes of this paper, we will focus on the logistics area.

The current situation presents a series of inconveniences within the inventory process, explained in the following sequence. Initially, the operations manager receives a request for product transportation, detailing what product, how much, and to what destination, among others, and then the logistics coordinator takes care of two important activities: the verification of sufficient product stock and the planning of the route and means of transportation, Both actions are performed manually, so that the warehouse manager can then pack the order and ship it, in addition to preparing an inventory report. Finally, the logistics manager reviews the inventory report that has originated throughout the week, which is considered an excessive amount of time in the case of verifying how effective the inventory area was.

The problem in the process described above is based on the steps of a) verification of sufficient product stock, b) route planning and means of transportation and c) review of the weekly inventory report. Taking into account that both are

done manually, this represents a slow process, in addition to the fact that in a) it happens that on several occasions the detection is late, or there is no product, or there is not enough to make the transfer, similar to b) due to the determination of where and how the product will be transferred takes a long time, being both a critical point in the inventory flow, finally, in c) having a summary of productivity is favorable, but not if something happened the first days of the week, where instead of taking quick action, the decision making is not effective, thus, all these problems cause instability in the successful execution of the inventory process.

According to the overview of the current situation, the following objective of the research work is raised:

To increase logistics performance by implementing BI based on the use of historical data for effective decision-making in the inventory process in the company's process.

On the other hand, the justification of the research is presented, which has as its central axis to provide added value to the company through the automation of manual activities and shortage of reports in the shortest possible time, where the problems were identified in the inventory process because, in the logistics area, there is a large concentration and flow of valuable information that should be available whenever it is needed for greater speed and accuracy in the process mentioned. Thus, computer equipment will be used to perform the corresponding configuration of one of the business intelligence software, as well as a connection to the database to establish the delimitations of the data to be used to be analyzed correctly and end up with valuable visualizations.

2. Literature Review

According to the paper arguing for the reliability of data in international logistics, an application of Bayesian networks explains that BI is based on efficient decision-making, which is considered fundamental to maintaining high competitiveness related to sustainable growth due to the rapid development of ICTs [6], data collection and analysis are increasingly essential, thus increasing the number of academic studies on big data and BI; however, these terms are not understood or used by companies. So, a study was conducted to understand them as an integrated system that serves as a decision support contemplated in the logistics of a courier company so that the profitability became based on the collection, analysis and real-time data results. As the authors said, the term business intelligence is not very present or is not given the necessary attention by companies, but this represents a weakness in competition with other entities in technological issues because it is living in constant evolution, not being at the forefront of this, it is impossible to enjoy the benefits that can result from the proper use of data, a good enriched by the potential decisions that can be generated.

In the words of the paper based on the logistic indicators could improve the logistic performance of hospitals; it is based on the fact that, in hospitals, a large number of significant transactions are carried out in the field of logistics being this a concern given the great variety of proportions in a limited period of time. That is why the description of main hospital logistics indicators helped improves hospital logistics performance [7]; in addition to taking variables such as logistics management and logistics performance, the improvement would be more noticeable when applied to logistics business intelligence.

Through what the author explained, they can deduce that where there is a large flow of data, business intelligence should prevail, not only because it helps us to understand the current situation but also to evaluate how effective the development is being in the organization, such evaluation is done by means of the precise indicators for good analysis.

According to the article based on the Integrated Understanding of Big Data, Big Data Analysis and Business Intelligence: A Logistics Case Study, it is emphasized that the evolution in BI technologies is constant, and its application is an indispensable resource for companies located in a dynamic business environment with today [8]. Therefore, the relationship between BI solutions and the predictive model in the effectiveness of BI was verified; this represents a critical point to evaluate since it determines the success of the implementation of BI in companies. It also allows these organizations to manage the effectiveness of the solution.

This quote was taken as a reference because there are methods to calculate the impact of an application based on BI; although it is true that with its mere existence, it already generates an added value, the measurement of success has to be measurable for these companies that live in constant change, in addition to taking into account the resources needed to implement it and result in a competitive advantage thanks to the advantages of this analysis technology.

According to the article whose study was about the Datamart of Business Intelligence for the Sales area of a Peruvian Tourist Company is based on the following: the investigation carried out by the tourism agency URPI SUMAC Tours SR L entailed the development of a Datamart to improve the sales process through integrated graphics in dashboards that allowed analyzing defined indicators [9], which favored to create the OLAP cube in the precise delimitation of analysis in the sales management and administrative area.

Thus, they obtained a broader and more reliable vision of tourism thanks to the results of indicators, in addition to accelerating the delivery of reports, contributing to sales in a significant way.

According to the article argued in the business intelligence system in a health organization using the Kimball

methodology, it is exposed that the proposed design of an intelligence system for a health organization arose due to the improvement of processes and decisions at various levels of the entity, intending to generate information advantage and new opportunities [10], which improved through the analysis of indicators with the availability of information oriented to add value to business decisions, which would result in the progress of management and productivity.

According to the perspective of the authors in the thesis elaborated under the context of a proposal for the application of a BI model oriented to the logistics service in aid of decision-making, it is commented that the application of a model based on this methodology in a logistics company made through the development of a proposal where the components, benefits and methodologies were considered, as well as the delimitation in the descriptive scope and the qualitative approach [11]. So, the result was a series of indicators developed according to the organization's needs, focused on a dashboard to visualize them more accurately and on time, ensuring the quality of the information.

According to these words expressed by the authors, through the establishment of what includes applying this tool, such as how it will be done, what you really want to analyze, and how it can influence the company, are key points to have the correct vision in the information that will be represented in the final visualization of results.

Taking into account the thesis based on the implementation of BI directed to the head of logistics under the BEGA methodology, it is considered that technological changes and new technologies in transportation demand a faster response and higher quality through business intelligence applied to an administrative and operational environment [12], the head of logistics can make better decisions in the company, which directly influences the satisfaction of customer demands, the implementation allows to know the attendance trends, use the information for future predictions and plan more advanced solutions.

As pointed out by the authors, the transportation industry is going through an evolutionary process in technology, including customers who need better attention. In this situation, the option was to include business intelligence in their environment, which allows them to maintain better control over the flow of sales, including a possible prediction according to historical data.

Using the words of the thesis contemplated in the application of BI, whose objective was focused on decision-making towards SMEs located in the province of Pasco, it is expressed that the adoption of business intelligence in small and medium enterprises in the province of Pasco is a path that should be evaluated for a successful business strategy, this also provides a broader vision and get better decisions that favor sales and profits [13]. Thus, a datamart design was applied. The knowledge in this solution is beneficial due to the updated information of each day and the synthesis that can be achieved through reports, allowing us to perform a complete analysis and make the right decision.

These authors were referenced due to the substantiation of the importance of business intelligence in all sizes of companies, so there is no limitation in addition to mentioning important benefits to companies, especially highlighting something essential, decision-making supported by the generation of reports on the latest information available, which allows to act quickly to the problems that arise.

With respect to the article justified in Business Intelligence directed towards the study of road accidents in the city of Popayán, it is detailed that, due to the high rates of traffic accidents in the city of Popayán, a proposed solution based on Business Intelligence was made, whose application was to analyze and interpret road accident data, so that, the necessary knowledge was generated and contribute to preventing these accidents that became one of the main concerns of the city [14, 15], with the provision of data by the Municipality of Transit was applied as necessary to obtain reports that laid the groundwork in establishing possible solutions to the problem mentioned.

The text of the article justified the raw material stock control system of a pharmaceutical company for inventory control and production planning: the proposal of a data warehouse system was of great importance for the production program and requirements planning in the materials of the pharmaceutical company, since it allowed monitoring the stock of raw materials and finished products through the integration of several sources with different types of data [16], which located in a data warehouse, provided reports with greater speed and extensive detail to the main summary information board.

3. Methodology

In Figure 1, the selected framework under which this work will be carried out is the Kimball methodology because of its broad approach to carrying out and managing in great detail the projects related to the management of volumes of oriented data so that they can be directed towards a large warehouse so that, from this space, it is possible to participate in the synthesis of business information in an agile and effective way.

3.1. Planning Phase

In this first stage, the main activities to be carried out during the methodology development are determined, visualizing the nature of the business together with its purposes [17], the objectives to be achieved, the stakeholders or interested parties are identified, and the possible risks are organized. The most important activities are the following:

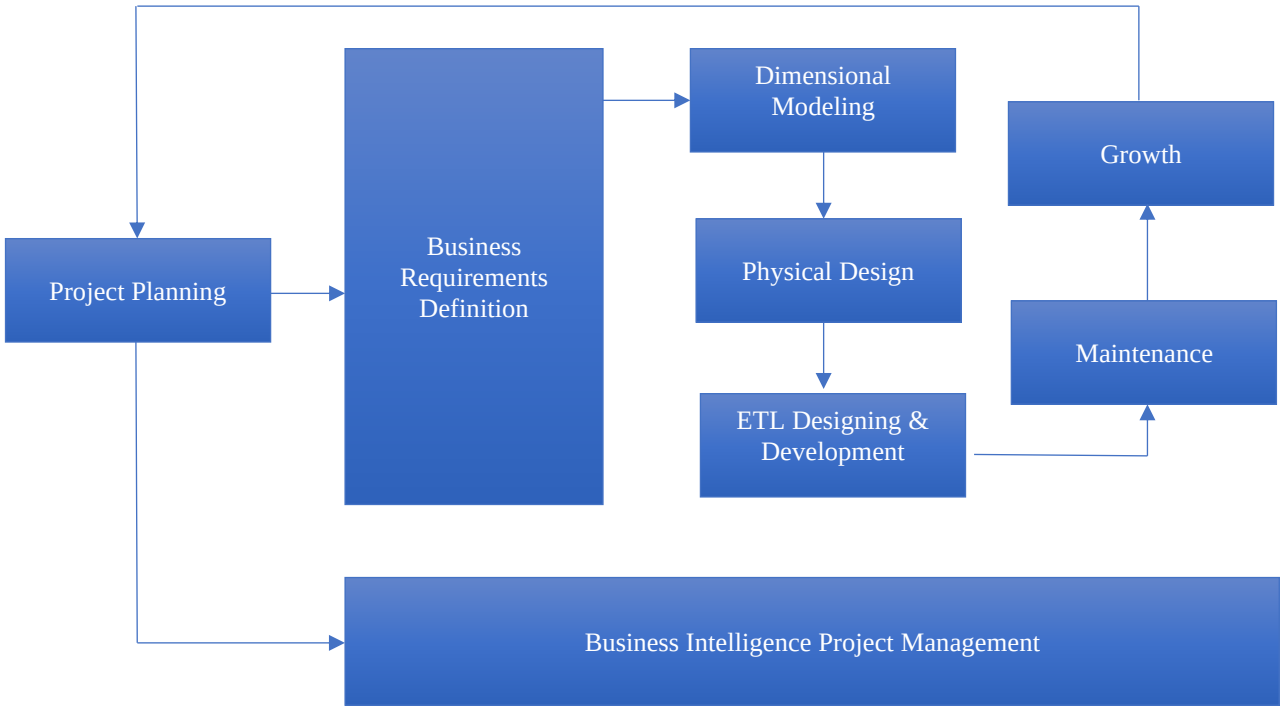

Fig. 1 Kimball methodology

- Limitation of the vision of the scope.
- Recognition and outlining of tasks.
- Scheduling of resources for appropriate use.
- Planning how resources will be used.
- Digitization of project plan information.

3.2. Requirements Definition Phase

The collection and analysis of the system requirements is a fundamental phase for the successful implementation of the project since they detail how the system should behave with respect to its desired functions and priorities in relation to the specific business process under which the study will be conducted [18], thus making it possible to understand the reality of what customers and users expect from the system.

This means that the requirements represent the reason for the system's existence, while the design defines how it will be developed [18].

Furthermore, a direct relationship is established between the precise explanation of the requirements and the cost of repair due to the existing increase in the case of the presence of errors in one phase after another, hence the characterization of the reduction of costs and risks within the framework of this methodology.

3.3. Dimensional Modeling Phase

The development of this stage is the basis for creating the Data Warehouse model, the large repository of useful data for analysis in the company. For this, a four-step procedure is needed [19], which are:

Selection of the business process. The first step consists of selecting the target process to generate the model, and the strategic area will have selected this process as a result of the determination of the requirements acquired and analyzed.

Limiting the level of granularity. In the second step, the level of detail on the precise explanation of the existence of the dimensional model is established. It will be assigned the tables of facts and dimensions, so the higher the level of detail, the lesser the drawbacks in the next sequences. Define the dimensions. The third step is based on recognizing the dimensions, being a product of the requirements evaluation and the level of granularity previously performed; these are considered entities composed of attributes that will serve as support for the fact table.

Establish the table of facts and measures. The fourth step consists of determining the facts; this table contains the calculations of the business process. Due to the numerical attributes with which it counts, the corresponding operations were performed from the previously chosen dimensions, obtaining, as a result, the necessary metrics to determine the historical progress of the business.

3.4. Physical Design Phase

The implementation to be carried out at this stage consists of translating the dimensional model already built into the physical model [20], which is why the sizing process must have been prepared as correctly as possible so that the dimensional model can handle the transactions determined, and it is also advisable to take into account the following:

- Determination of the sizing of the future Data Warehouse.
- Key elements requiring advanced configuration.
- Storage capacity limit on servers, amount of memory, backup system.

3.5. Implementation Phase

This last stage determines the data loading through the ETL process (Extraction, Transformation and Loading) [21], which is essential for the Data Warehouse to be formed; this consists of the initial collection of information from various sources such as files, structured or unstructured databases, web server repositories or the cloud, among others, linked to the business logic and requirements defined from the first stage, Thus, the data volumes will be processed in order to apply a necessary filter that contains the records located within the margin of the delimited degree of quality, in this way, the load of all processed information to the final model will be generated, which will be used for business intelligence to be applied and meet the satisfaction of the requirements determined.

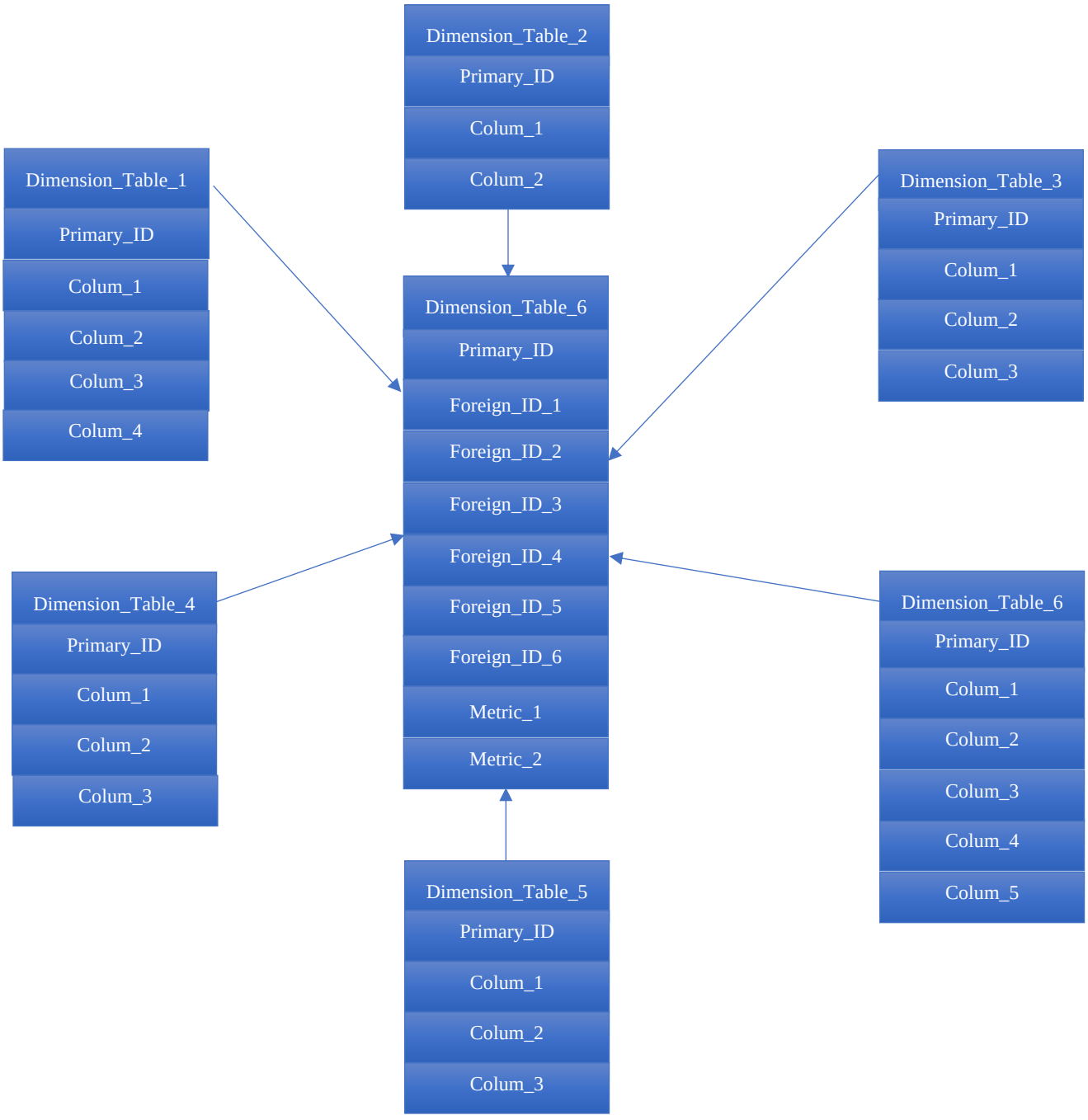

Fig. 2 Dimensional modeling

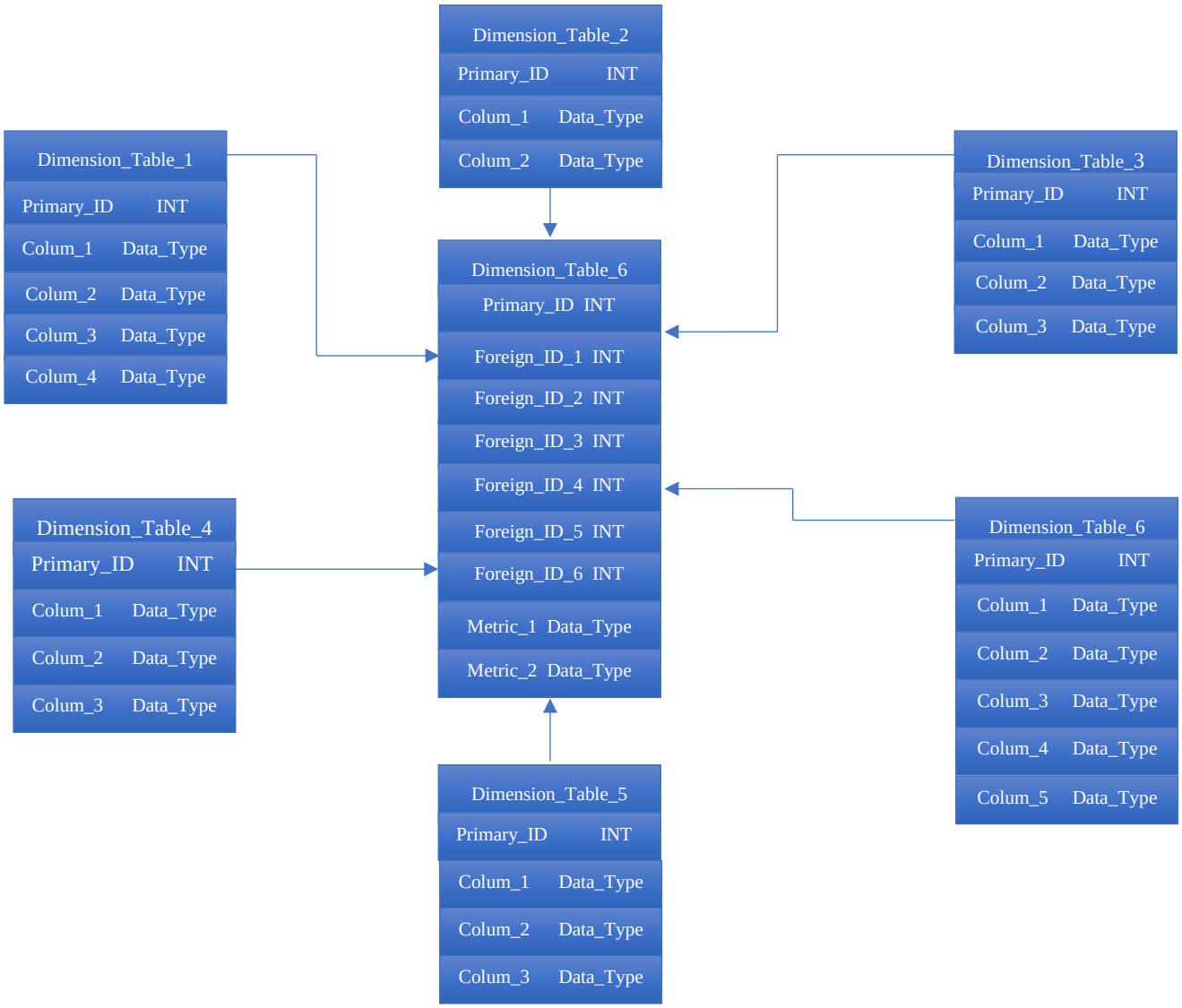

Fig. 3 Physical design

4. Results and Discussions

4.1. About the Prototypes

4.1.1. Dimensional Modeling

Figure 2 shows a basic conceptual idea, in a logical way, about the elaboration of the proposed dimensional modeling, whose purpose will be mainly to define how the volume of data located in the relational database and other sources will be related; for this, it is required to identify the dimensions and accurately analyze their relationship with the fact table, which represents the heart of the organization to be used in the next phases for the Business Intelligence system.

4.1.2. Physical Design

Similarly, Figure 3 shows in detail the physical design of the database where the necessary data will be stored in the consumption of accurate and necessary information in the generation of the OLAP cube due to the dimensions already created, represented in physical tables, the attributes provided for each of them, as well as the assignment of primary and foreign keys and data types, to comply with the relationships between these entities as modeled in the previous phase.

4.1.3. Implementation

Therefore, Figure 4 presents the prototype of implementing the subsystem or ETL process. Fundamental to filling the Data Warehouse, all the possible and required data will be extracted from the different data sources, applying rules for the benefit of quality and consolidating the transformation of the information; it is important to highlight the precision of the sequence of steps with which this must be implemented, due to the usefulness it will have in the generation of results in key metrics, which will allow measuring and projecting success to the users.

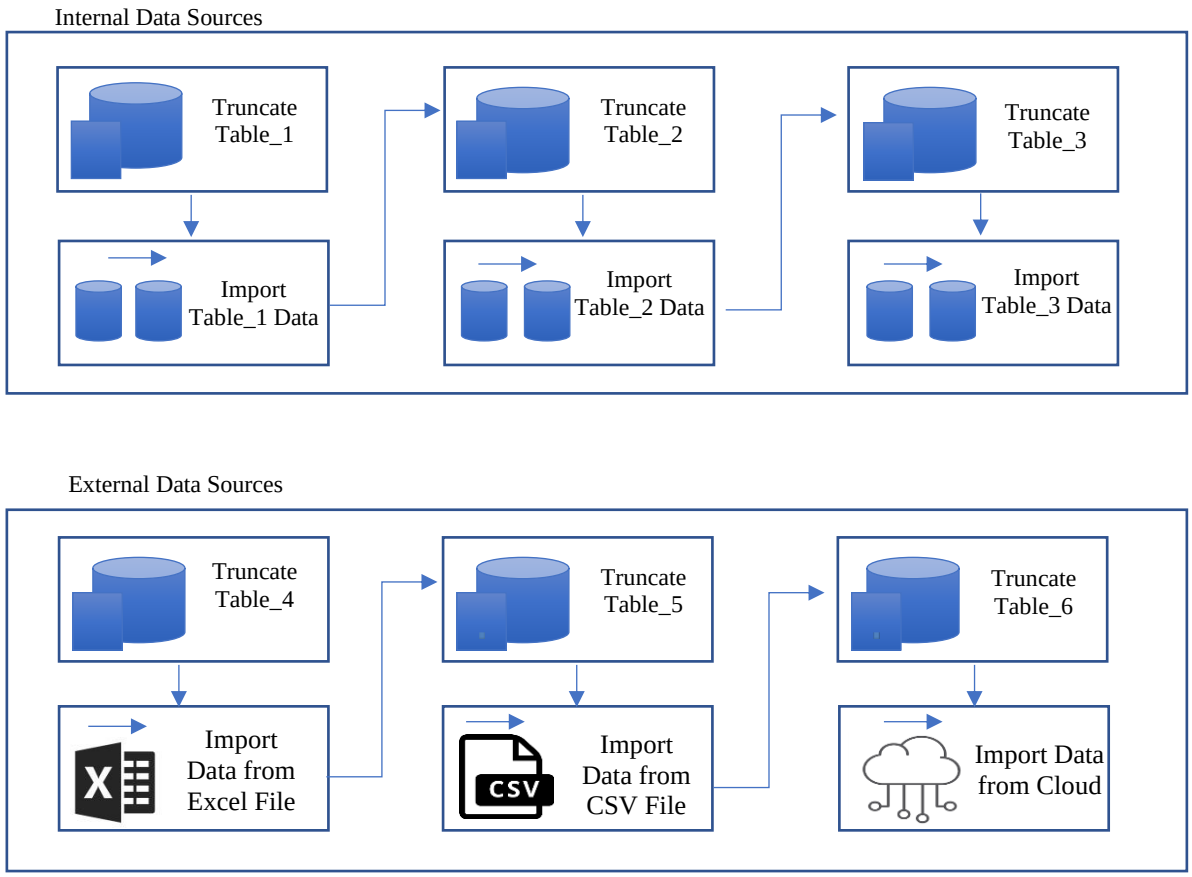

Fig. 4 Implementation of the ETL process

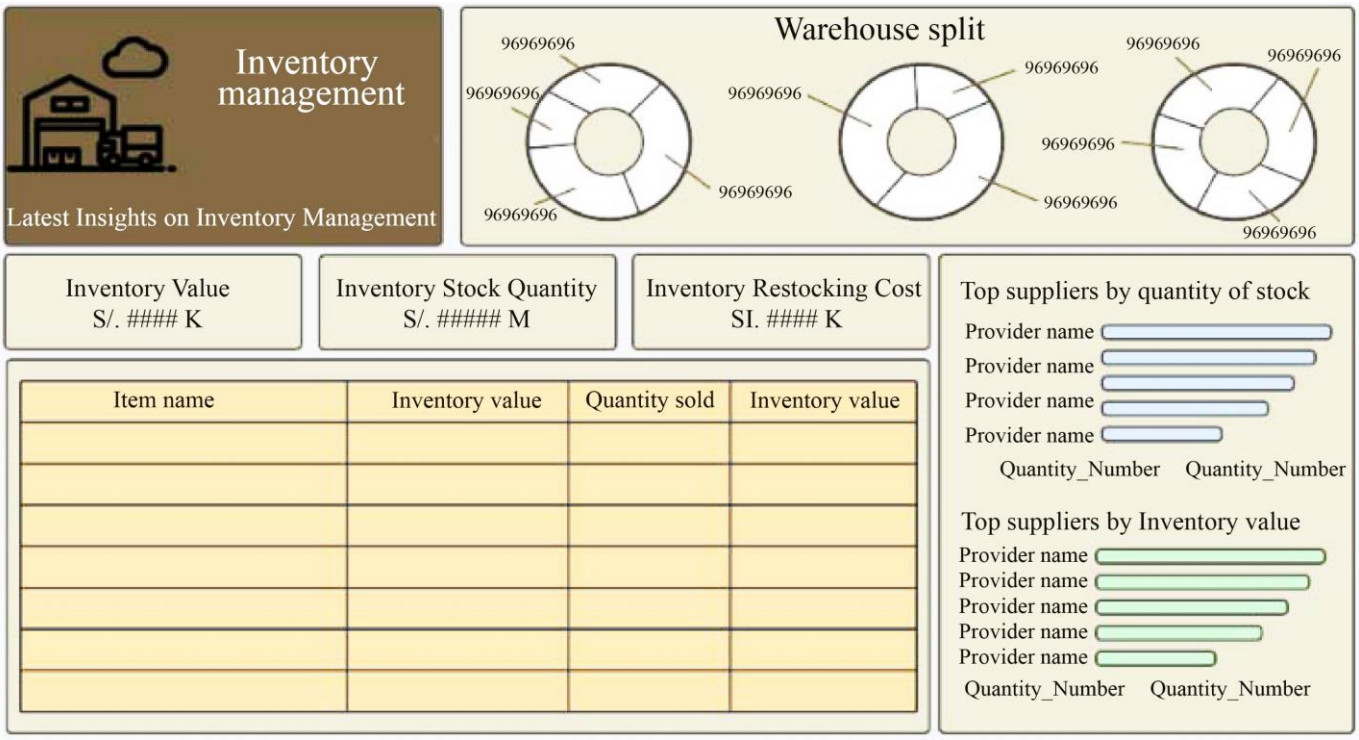

Fig. 5 Presentation of professional reports

Table. 1 Survey questions

N°	Question Formulation
1	Are you familiar with the concept of Business Intelligence?
	Yes (69.2%) = 36
	No (30.8%) = 16
2	Have you used any Business Intelligence tools in your workplace or studies?
	Yes (53.8%) = 28
	No (46.2%) = 24
3	Do you think that the use of Business Intelligence can improve the inventory process in the logistics area?
	Yes (100%) = 52
	No (0.0%) = 0
4	How important do you think access to real-time information is for inventory management?
	Nothing important (0.0%) = 0
	Not very important (7.7%) = 4
	Neutral (7.7%) = 4
	Important (15.4%) = 8
	Very important (69.2%) = 36
5	Do you think the implementation of Business Intelligence could reduce errors in the inventory process?
	Yes (84.6%) = 44
	No (15.4%) = 8
6	How efficient do you think decision-making in the logistics area would be if Business Intelligence were used?
	Not efficient (0.0%) = 0
	Not very efficient (7.7%) = 4
	Neutral (0.0%) = 0
	Efficient (53.8%) = 28
	Very efficient (38.5%) = 20
7	Do you consider that using Business Intelligence could help identify patterns and trends in inventory management?
	Yes (76.9%) = 40
	No (0.0%) = 0
	Maybe (23.1%) = 12
8	Have you received training on Business Intelligence at your workplace or school?
	Yes (53.8%) = 28
	No (0.0%) = 0
	Maybe (46.2%) = 24
9	Do you think implementing a solution such as Business Intelligence can improve current inventory management procedures?
	Yes (92.3%) = 48
	No (0.0%) = 0
	Maybe (7.7%) = 4
10	Do you know of any application solution based on data analysis?
	Yes (42.3%) = 22
	No (57.7%) = 30

4.2. About the Survey

The following is the elaboration of a survey with the purpose of knowing the public's perception of the main topic, directed mainly to university students and people who work in the logistics sector; for greater precision in the results, this survey obtained a response from 52 participants.

Table 1 shows the formulation of the 10 questions considered adequate in the questionnaire, and these are easy to understand without complexity beyond the basics of Business Intelligence related to the inventory process.

Similarly, the results of each of the responses to the survey are shown in percentages of the total number of participants to take into account the proportion of opinions.

4.3. About the Methodology

4.3.1. Advantages

The Kimball methodology is characterized by generating a low cost of implementation in any project; it also allows to provide good execution and monitoring of KPIs oriented to Data Marts to processes of specific areas in the company's business; it is not even necessary to have such a large development team to maintain all the Data Warehouse that needs to be created, which makes the methodology economical, finally, due to the rigor of the queries generated, the product can be predictable and controllable.

4.3.2. Disadvantages

To develop a project under this methodology, it is important to keep in mind that there is a low flexibility towards change, so it is emphasized to be very detailed when determining the requirements for a successful final product.

4.3.3. Comparison

Compared to others, the Kimball methodology has the "Bottom-up" approach; the Data Marts are independent, and the reports are directed only to management positions. The Inmon methodology has the "Top-down" approach, with high cost and a path directed to first perform the Data Warehouse and then the Data Marts, representing a possible risk because the benefits are appreciated only in the last phase.

5. Conclusion

According to what has been studied in this research work, it is concluded that, despite the wide application that Business Intelligence can provide, this still denotes that it is not very popular in the national territory; it is clear that working under the traditional format of obtaining information and making decisions is acceptable, although this situation has a great potential to be improved to automate these key activities in a world increasingly contemplated by data, not only in the inventory process in the logistics area, but in many more areas, even in other sectors, since everything is based on data, which can be transformed into information, also become knowledge, and finally result in intelligence. In this way, it is induced towards future work through an opportunity to continue exploring and deepening more about this technological methodology for the management, interpretation and analysis of data, taking into account that in an era where the same objective can be met through different uses of business tools, which mainly is to achieve effective business decision making, not only in the logistics sector but also in others where the flow of information is abundant, since solutions can be obtained according to the needs of the company based on the data that is available, in addition to obtaining a vision of the future of the company.

References

[1] Ahmad Obidat, Zaid Alziyadat, and Zaid Alabaddi, "Assessing the Effect of Business Intelligence on Supply Chain Agility. A Perspective from the Jordanian Manufacturing Sector," *Uncertain Supply Chain Management*, vol. 11, no. 1, pp. 61–70, 2023. [CrossRef] [Google Scholar] [Publisher Link]

[2] Simone Caruso et al., "Artificial Intelligence to Counteract 'KPI Overload' in Business Process Monitoring: The Case of Anti-Corruption in Public Organizations," *Business Process Management Journal*, vol. 29, no. 4, pp. 1227–1248, 2023. [CrossRef] [Google Scholar] [Publisher Link]

[3] Jianwen Wang et al., "Business Intelligence Ability to Enhance Organizational Performance and Performance Evaluation Capabilities by Improving Data Mining Systems for Competitive Advantage," *Information Processing & Management*, vol. 59, no. 6, 2022. [CrossRef] [Google Scholar] [Publisher Link]

[4] Uday Kulkarni, Jose A. Robles-Flores, and Ales Popovic, "Business Intelligence Capability: The Effect of Top Management and the Mediating Roles of User Participation and Analytical Decision Making Orientation," *Journal of the Association for Information Systems*, vol. 18, no. 7, pp. 516–541, 2017. [CrossRef] [Google Scholar] [Publisher Link]

[5] Luis David Huallpa Tapia et al., "Application of Business Intelligence to Improve Utilities by Increasing Customer Satisfaction in Restaurants," *Proceedings of the 17th LACCEI International Multi-Conference for Engineering, Education and Technology*, 2019. [CrossRef] [Google Scholar] [Publisher Link]

[6] Lingzhe Liu, Hennie Daniels, and Ron Triepels, "Auditing Data Reliability in International Logistics-An Application of Bayesian Networks," *Proceedings of the 16th International Conference on Enterprise Information Systems*, vol. 2, pp. 707-712, 2014. [CrossRef] [Google Scholar] [Publisher Link]

[7] Andre M.R. Wajong, "Logistics Indicators Could Improve Logistics Performance of Hospitals," *MATEC Web of Conferences*, vol. 108, 2017. [CrossRef] [Google Scholar] [Publisher Link]

[8] Dong-Hui Jin, and Hyun-Jung Kim, "Integrated Understanding of Big Data, Big Data Analysis, and Business Intelligence: A Case Study of Logistics," *Sustainability*, vol. 10, no. 10, pp. 1-15, 2018. [CrossRef] [Google Scholar] [Publisher Link]

[9] Pablo Castillo Chura et al., "Datamart of Business Intelligence for the Sales Area of a Peruvian Tourism Company," R. Silhavy, P. Silhavy, and Z. Prokopova (eds), *Data Science and Algorithms in Systems, CoMeSySo 2022*, Lecture Notes in Networks and Systems, Springer, Cham, vol. 597, pp. 415-429, 2022. [CrossRef] [Google Scholar] [Publisher Link]

[10] Alexi Delgado, Fernando Rosas, and Chiara Carbajal, "System of Business Intelligence in a Health Organization using the Kimball Methodology," *2019 IEEE CHILEAN Conference on Electrical, Electronics Engineering, Information and Communication Technologies, CHILECON*, pp. 1-5, 2019. [CrossRef] [Google Scholar] [Publisher Link]

[11] Ruiz Chan, and Yong Lopez, "*Analysis and Proposal for the Application of a Business Intelligence Model to Improve Decision Making in the Last Mile Logistics Service Case: Nirex*," Thesis, The Professional Tittle of Bachelor of Management with a Mention in Management Business, 2021. [Google Scholar] [Publisher Link]

[12] Jose Richard Barrenechea Minaya, "*Implementation of Business Intelligence with the BEGA Methodology for Decision Making by the Head of Logistics at the San Sebastián SAC Transport Company*," Thesis, Academic Degree of Master in Systems Engineering with a Mention in Information Technologies, 2020. [Google Scholar] [Publisher Link]

[13] Jimmy David Agüero Zevallos, "*Application of Business Intelligence for Decision Making in Small and Medium-Sized Businesses in the Province of Pasco*," Thesis, Computer and Systems Engineer, 2019. [Google Scholar] [Publisher Link]

[14] M. Carlos H. Bolaños et al., "Business Intelligence for the Analysis of Road Accidents in the City of Popayán," *Iberian Journal of Information Systems and Technologies*, 130–141, 2020. [Google Scholar] [Publisher Link]

[15] Youssra Riahi, "Business Intelligence: A Strategy for Business Development," *SSRG International Journal of Economics and Management Studies*, vol. 4, no. 9, pp. 1-5, 2017. [CrossRef] [Google Scholar] [Publisher Link]

[16] Abba Suganda Girsang, and Andhika Purwanto, "Controlling System for Stock Raw Material for Production Planning and Inventory Control in A Pharmacy Company," *International Review of Mechanical Engineering*, vol. 11, no. 11, pp. 855–861, 2017. [CrossRef] [Google Scholar] [Publisher Link]

[17] Wilson Castillo-Rojas, Fernando Medina Quispe, and Francisco Fariña Molina, "A Methodology for Data Warehousing Processes Based on Experience," *RISTI - Ibérica Magazine of Information Systems and Technologies*, pp. 83–103, 2018. [Google Scholar] [Publisher Link]

[18] A.M. Purnamasari et al., "Business Intelligent in an E-Commerce Industry," *IOP Conference Series: Materials Science and Engineering*, vol. 598, 2019. [CrossRef] [Google Scholar] [Publisher Link]

[19] Kiefer Stefano Ranti et al., "Data Warehouse for Analyzing Music Sales on a Digital Media Store," *Journal of Physics: Conference Series*, vol. 1477, 2020. [CrossRef] [Google Scholar] [Publisher Link]

[20] Forero-Castañeda Deivy Alexander, and Sánchez-Garcia Jorge Armando, "Introduction to Business Intelligence based on KIMBALL Methodology," *Revista Technology Investigación Academia TIA*, vol. 9, no. 1, pp. 5–17, 2022. [Google Scholar] [Publisher Link]

[21] Viktor László Takács et al., "Data Warehouse Hybrid Modeling Methodology," *Data Science Journal*, vol. 19, no. 1, pp. 1–23, 2020. [CrossRef] [Google Scholar] [Publisher Link]