Business Intelligence for E-commerce:
Survey and Research Directions

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Abstract. The increase of online shopping has allowed e-commerce to become an usual concept. However, companies still have little knowledge about their customers and the most appropriate and effective processes they should apply to create a perfect fit between costumers' needs and companies' offers. To solve this problem, it is important to merge e-commerce with business intelligence, because this would enable to obtain knowledge about e-commerce platforms' customers, allowing the analysis of customers' behavior, discovering purchasing patterns, improve relationship management with customer, get better stock management, support to create marketing actions, better financial performance and so forth. This paper provides a review of the literature, suggests new research directions, and proposes an architecture to combine e-commerce with business intelligence.

Keywords: Business intelligence · E-commerce · Business value

1 Introduction

In the last years, there has been a huge increase in the use of the Internet by users around the world and the contents are growing in an exponential basis. Today, the challenge is to extract relevant information from this big amount of data and to assign meaning to the data, by creating information to help making better decisions. With the competitiveness that exists actually, it is crucial to make better decisions so that companies can overcome their difficulties and reach their goals. Business Intelligence allows to deal with this challenge by gathering important information from the data to be analyzed and, consequently, to provide knowledge to the organization [1].

As a result of the increased use of the Internet there has been an increase in electronic commerce, usually referred to as e-commerce, since the brands are in transformation, opening their distribution channels to direct online sales, it is expected that until 2017 the brands that are establishing direct sales channels via e-commerce will position themselves as e-commerce giants [2]. Although e-commerce technologies may be

available hypothetically in all industries and organizations, an efficient usage of e-commerce is closely related to a comprehensive implementation of more sophisticated solutions, e.g., online procurement and better customer relationship management. Due of this growth, it has become imperative for organizations to respond to user requirements by recognizing which are the processes within the organization are not working properly and trying to improve their understanding on their customers' profiles.

The combination of these two technologies (Business Intelligence and e-commerce) enables companies to gain insight into their customers' behavior, patterns of buying and market trends, enabling more efficient management of customer interests and needs, assistance in the creation of campaigns and greater control over stock management. Summarizing, the union of these concepts solves the problem of several organizations that have electronic commerce, allowing them to become more competitive and increase their market share.

This paper presents a literature review and proposes an architecture which merges business intelligence with e-commerce. New future research directions are also described, yet to be explored, in which this topic can be extended.

The present paper is organized as follows. Section 2 presents the concept of Business Intelligence and e-commerce, as well as its advantages and inhibitors to development. Section 3 presents application examples of Business Intelligence and e-commerce. Section 4 explains the combination of Business Intelligence and e-commerce, how this union can be beneficial to organizations and a new architecture is proposed. Section 5 describes related work, Sect. 6 contains research directions and, finally, Sect. 7 presents the conclusions and future work.

2   Business Intelligence and E-commerce

Business Intelligence (BI) is defined as a set of techniques and tools to assist in transforming raw data into meaningful and useful information in order to analyze the business [3]. In general, BI helps managers to make better decisions.

BI tools have three key capabilities: (1) relevant access to information; (2) analytics and (3) reporting capability. It is, therefore, necessary to define the vision, strategy, the goals and targets for the success of the BI system and to explain the key performance indicators (KPIs) in order to allow real-time performance management [4].
The following activities are associated with BI systems [4, 5]:

- Prepare forecasts based on historical and current organization information;
- Create alternative scenarios;
- Respond to issues that are not pre-defined through ad-hoc query to data;
- Knowledge of the organization in detail.

BI systems have applied the functionality, scalability, and security of existing database management systems to build Data Warehouses (DW) that are analyzed using Online Analytical Processing (OLAP) and Data Mining techniques [6]. A Data Warehouse is a repository for storing organization information in a valid and consistent format, allowing users to perform data analysis [7]. OLAP technology allows the

creation of quick responses to analytical queries of a dimensional nature, which are obtained through cubes that allow analyzing information through different dimensions [8]. The architecture of the Business Intelligence support technology infrastructure proposed by Han and Kamber [9] is presented in Fig. 1.
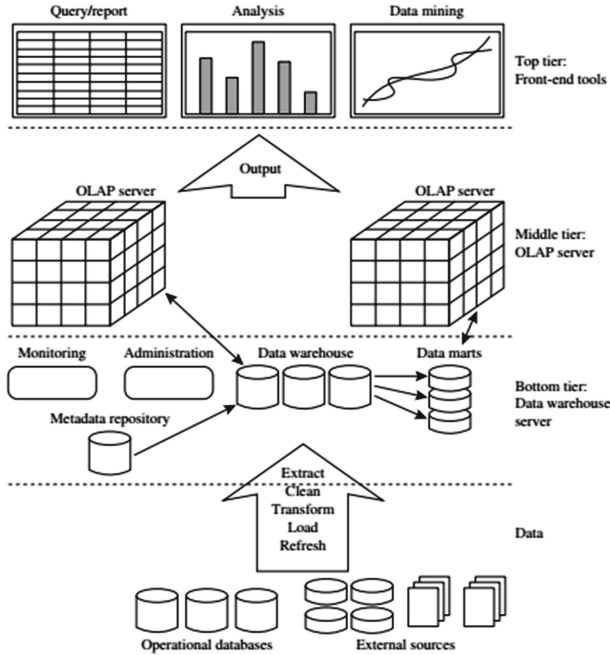

Fig. 1. Architecture of the BI support technology infrastructure [9].

The architecture consists of three levels:

- *Level 1 - Data Warehouse Server:* integrates the organization's DW and Data Marts, loaded from the ETL tools. The DW is used in this architecture because of its query performance improving;
- *Level 2 - OLAP Server:* the various cubes are visualized, allowing to analyze the information and get answers to questions about the data, generate reports and identify trends and patterns;
- *Level 3 - Front-end tools:* After processing the data, reports and graphs are generated based on previously defined performance indicators and data mining techniques are also applied [9].

BI systems may reveal the position of the company compared to its competitors; changes in costumer behavior; market conditions; future trends and what are other companies in the market are doing; BI has, therefore, several advantages such as increasing business competitiveness, increased business knowledge, help in making more efficient decisions and improving business processes [10].

E-commerce is a concept applicable to any type of business or trade transaction that allows consumers to transact goods and services electronically without prevent of time or distance. This concept has been expanding very quickly in recent years and is expected to continue to expand at a significant increase in growth [11].

There are several types of e-commerce, the most important of which are the following: Business to Business (B2B), Business to Consumer (B2C), Consumer to Consumer (C2C) and mobile-Commerce (m-Commerce). Business to Business (B2B) describes business transactions between companies, and is also used in the context of communication and collaboration when it occurs among its employees. Business to Consumer (B2C) describes the business activities carried out between the producing company, the seller or service provider and the final consumer. Consumer to Consumer (C2C) consists of trading between two individuals, usually established through an intermediary such as the popular 'ebay' e-commerce website. M-Commerce is to establish a business transaction with the use of a mobile device [12].

The main advantages of e-commerce are the following [13]:

- Greater convenience in purchasing the product or service;
- No standing in queue or being placed on hold evermore;
- 24-hour availability;
- Access at any time for devices with an Internet connection;
- Access to stores located remotely;
- Easier to compare prices;
- Reduce employee costs.

However, this type of business also has several development inhibitors described below [13]:

- Need for an Internet access device and connection;
- Inability to experience the product before purchase;
- Vulnerability of confidential data;
- Technical problems;
- Possible delays or product damage during delivery.

With the increasing demand for e-commerce by customers, there is a growth and stimulation in relationships and interactions between individuals. In order for business and customer satisfaction to increase, it becomes crucial to gain knowledge to understand the trends and to gain advantage over competitors.

3   Applications' Examples

In this section, several examples of practical application of Business Intelligence and e-commerce are presented.

The authors in [14], based their research on a case study of two remote villages in China, to demonstrate how Information and Communication Technology (ICT) can empower a marginalized community, giving rise to a rural e-commerce ecosystem that can aid self-development. They identify the critical actors of a rural e-commerce

ecosystem and how they use ICTs and illustrate how the same ICT can be used for different affordances by the actors in the evolution of a rural e-commerce ecosystem. This study suggests a definition that encompasses the broad array of actors and roles that constitute an e-commerce ecosystem.

In [15], the authors affirm that customers are changing their shopping preference from brick and mortar companies to e-commerce companies. Many brick and mortar companies are modifying their business models to suit to the new age Internet economy. These Internet oriented businesses generate millions of data and the authors discuss a simple schema of a DW to highlight the use of this technology to store data and later use it for taking informed decisions.

Groupon is a major e-commerce company and the authors in [16] say that Groupon engages the entire "lifestyle persona" of its users. Motivated by this, they consider the large-scale problem of mining such "lifestyle personas" from Groupon's activity data and their solution combines domain knowledge from e-commerce with data mining and graph theoretic methods.

The main objective of the paper [1] was to elaborate how Business Intelligence (BI) acting as a Knowledge Management (KM) tool could help consultants in providing professional services to the financial sector. Business Intelligence sustains the knowledge management to maintain and enhance the performance of financial organization. The leverage of Business Intelligence as a KM tool could be competitive advantages for the financial consultancy and the consultant have a competitive advantage to remain in the global market that keeps changing every time.

Hyperlinks, which connect web pages on the World Wide Web, are rich sources of hidden information. In [17], the authors analyze the structure of e-commerce websites (top 50 retail companies' e-commerce from Asia Pacific and USA), using webometric approach to uncover any hidden information from the hyperlinks. Their results found a positive relationship between the external inlinks count pointing to a retail company e-commerce website and one of its business measures (sales). But no association has been found between hyperlink metrics and business measure like revenue. The study has found that counts of links pointing to retail websites are positively correlated with the website age.

In a telecommunication network, hundreds of millions of call detail records are generated daily. Similarly, electronic commerce applications require the analysis of millions of shopping transaction records daily to guide personalized marketing, promotional campaigns, and fraud detection. The high data volumes and data flow rates pose serious scalability and performance challenges and the authors in [18] shown how a scalable data-warehouse/OLAP framework for customer profiling and pattern comparison can meet these performance requirements.

4   Business Intelligence for E-commerce

Most of the trading companies redefined their business strategy and started their sales in an electronic way. The e-commerce removes the obstacles of time and space, comparing with traditional businesses in physical locations.

E-commerce and Business Intelligence together form a very powerful set that helps website owners to know how to predict consumer behavior, identify market trends, find consumption patterns, define consumer targeted marketing campaigns, among others. The combination of these two technologies presents challenges such as high costs of implementation, support and maintenance; probability of failure to implement with lack of focus and little knowledge of the benefits of these areas and leading to resistance to the adoption of these technologies by organizations.

In order to address problems related to poorly defined focus on e-commerce implementation, performance indicators should be created to assist in solving organizational problems and improve their processes, such as total number of visits, pages visited and time on the site per user; total number of sales per day, month, year, season; abandonment rate of the shopping cart; top selling products; quantity in stock; period of the day/day of the week with more visits/purchases; percentage of deliveries on time; average time of problem solving; number of clicks that the user makes until the purchase of a product/ service; among others.

Business Intelligence for e-commerce at the level of the company-client relationship has great advantages because it leads to a better management of the relationship with customers, detect patterns of purchase and analyze the behavior of customers, allowing to create a better proximity with the client and consequently greater probability of loyalty.

In relation to the internal structure of the company, the combination of these two technologies (BI and e-commerce) permits to increase the company's competitiveness, improve stock management, optimize its processes, perceive market trends, increase financial performance and carry out more specific marketing campaigns to go against what customers buy most often.

Figure 2 illustrates our architecture proposal on business intelligence and e-commerce. The idea was based on the Data Warehouse architecture [9] (represented in Fig. 1) and the Data Webhouse architecture [19]. From the Data Webhouse architecture, the technologies/processes involved in web transactions were collected and these were added to the Data Warehouse architecture (architecture of the technological infrastructure to support Business Intelligence), thus forming the Business Intelligence and e-commerce architecture.

In the proposed architecture, the first phase consists in a costumer, using a browser, and accessing the e-commerce portal. After this phase the remaining processes that are part of the architecture are triggered.

The architecture consists of four levels:

- *Level 1 - Data:* the Web Server makes clickstream logs available, from the e-commerce portal. These data sources go through a process of ETL that standardizes, cleans and loads the data into the DW;
- *Level 2 - Data Warehouse Server:* integrates the organization's DW and Data Marts, loaded from the ETL tools;
- *Level 3 - OLAP Server:* the various cubes are visualized, allowing to analyze information and get answers to questions about the data, generate reports and identify trends and patterns;

- *Level 4 – Business Intelligence Analytics:* After processing the data, reports and graphs are generated based on previously defined performance indicators and data mining techniques are also applied [9].
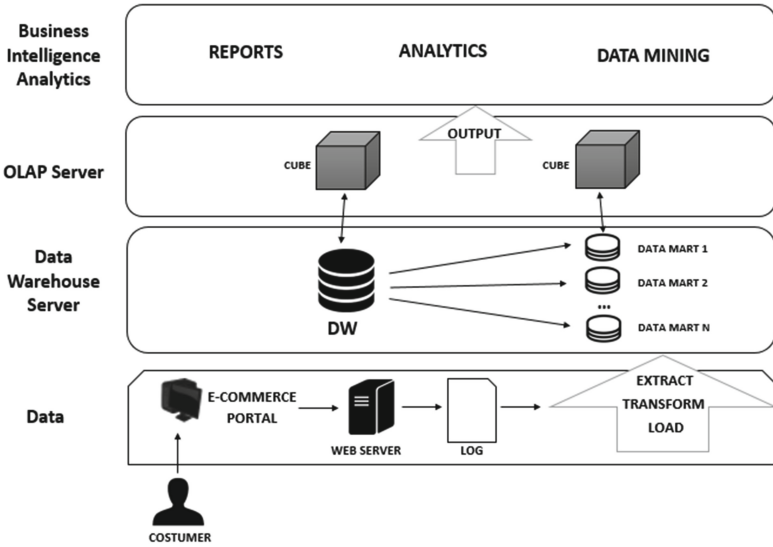

Fig. 2. Proposal of a business intelligence and e-commerce architecture.

This architecture allows transforming raw data, from the consumers of the e-commerce stores, into knowledge. The knowledge acquired with this architecture has as main objectives the improvement of the client-company relationship and better management of the internal processes of the company.

5   Related Work

The related work presented in this section permits to identify and evaluate current knowledge about business intelligence and e-commerce.

The paper in [20] reviews the growing body of research on electronic commerce from the perspective of economic analysis. The authors construct a new framework to understand electronic commerce research and to identify the range of applicable theory and current research in the context of the new conceptual model. According to the authors, the proposed framework is a valuable analytic tool that will prove ever more useful as new developments occur in electronic commerce that can be understood from the point of view of economic theory.

E-commerce optimizes and enhances the relationship and communications between the organization, producers, distributors and customers. The success in e-commerce depends upon determining effective factors in e-commerce. In [21], the authors proposed a model and framework to specifying the effective factors on e-commerce success. Based

on the results obtained, they concluded that customer satisfaction, the amount of costs, infrastructures and knowledge and information are the effective's factors which have a significant impact on e-commerce success. This work has a limitation because only participants from a single company were selected.

In many organizations, decisions are still made based on experience and intuition rather than on facts and rigorous approaches. The author in [22] review the concept of Business Intelligence as an open innovation strategy and address the importance of BI in revolutionizing knowledge towards economics and business sustainability, concluding that successful BI solutions provide businesspeople with the information they need to do their jobs more effectively.

The paper [23] focuses on the deployment of BI in the cloud, from the comparative advantage of design science research (DSR). The authors produce a state of the art of research pertaining to BI in the cloud, following the methodology of systematic literature review. The contributions are: a literature review may help DSR researchers get an overview of this active research domain; the two-dimensional framework facilitates the understanding of different research streams; and proposed future topics may guide researchers in identifying promising research avenues.

Business Intelligence and Analytics (BI&A) is about the development of technologies, systems, practices, and applications to analyze critical business data so as to gain new insights about business and markets. The aim of [24] is to review the state of the art techniques and models and to summarize their use in BI&A applications. For each research direction, we will also determine a few important questions to be addressed in future research.

The paper in [25] explores Big Data Analytics (BDA) in e-commerce by drawing on a systematic review of the literature and presents an interpretive framework that explores the definitional aspects, distinctive characteristics, types, business value and challenges of BDA in the e-commerce landscape. Also, triggers broader discussions regarding future research challenges and opportunities in theory and practice.

There are several Business Intelligence tools. In [26] the authors evaluate three open source tools, concluding that Pentaho might be a better choice, because it has more resources available. In relation to commercial tools, the authors in [27] analyzed six commercial BI suites: beMemo, IBM, Microsoft, MicroStrategy, Oracle, and SAP. They concluded that the most effective BI platforms are IBM and MicroStrategy because both had a full validation in all analyzed functionalities.

The combination of BI and e-commerce concepts remains poorly-explored which inhibits its theoretical and practical development. The present paper presents new contributions, indicating future directions in this area presented in the next section.

6 Future Research Directions

The large amount of data generated in e-commerce makes it important to combine the concept of BI and e-commerce. This junction allows to create new research directions. The following are some proposals for future research directions:

- *Big Data:* due to the sheer volume of data, it is useful to add the Big Data concept. In this way, data analytics becomes faster and this concept has the advantage of being able to analyze unstructured data;
- *Cloud Computing:* the use of cloud computing may bring advantages, since it leads to infrastructures' expenses reduction and save time in maintenance;
- *Machine Learning:* consists of learning automatically, in which the machine builds algorithms that can learn and perform predictions. This method may be of value in this area because it can produce data analysis methods to faster and more accurate analysis. In this way, it can aid to decision making more efficiently and quickly without human interaction;
- *Privacy and Security:* one of the great challenges of data collection and analysis is to ensure privacy and data security. Data contains information about the users, which may be used in not appropriate ways and, therefore, should not be disclosed. BI and e-commerce have large volume of data and it would be advantageous to find data protection and security mechanisms so that they develop protection against computer attacks and do not allow information leakage.

With the combination of BI and e-commerce, there is an opportunity to mix and create new paradigms and concepts. The future directions described above allow to aid this creation.

7   Conclusions and Future Work

We provide a survey with an insight into business intelligence and e-commerce currently, concluding that their junction has not yet been described or clarified. Due to this gap, we propose the combination of these two technologies, showing the advantages of its application. An architecture was also proposed to illustrate this intersection and to emphasize its importance in order to be applied in real cases.

We concluded that the combination of these areas brings numerous advantages: enable to gather knowledge about the customers of e-commerce platforms; allow the analysis of behaviors; find purchasing patterns; develop a better relationship management with customer; better stock management; optimizing the organization's processes; support to create marketing actions; greater competitiveness; better financial performance; and so forth.

We also conclude that the proposed architecture permits to transform raw data, generated by the consumers in e-commerce stores, into knowledge: data comes from user accesses to the online store, and e-commerce stores collect a lot of information, such as the total number of visits, total sales, products sold, products viewed, followed recommendations, among others. With the application of Business Intelligence to this data it is possible to obtain the desired knowledge to better manage e-commerce.

Research future directions presented aim to help researchers to discover new paths, new paradigms, new concepts and possibly new architectures.

As future work, we intend to apply the combination of business intelligence and e-commerce to a real ecommerce company and analyze its benefits in the short and long term.

References

1. Muhammad, G., Ibrahim, J., Bhatti, Z., Waqas, A.: Business intelligence as a knowledge management tool in providing financial consultancy services. Am. J. Inf. Syst. **2**, 26–32 (2014)
2. The State of eCommerce in 2014: Is There Any Room for New eCommerce Models? http://www.brainsins.com/en/blog/state-ecommerce-2014-new-ecommerc-models/2643. Accessed 2 Dec 2016
3. Rud, O.P.: Business Intelligence Success Factors: Tools for Aligning Your Business in the Global Economy. Business, 1st edn. (2009)
4. Ranjan, J.: Business intelligence: concepts, components, techniques and benefits. J. Theor. Appl. Inf. Technol. **9**, 60 (2009)
5. Nedelcu, B.: Business intelligence systems. Database Syst. J. **IV**, 12–20 (2012)
6. Borges, L.C., Marques, V.M., Bernardino, J.: Comparison of data mining techniques and tools for data classification. In: C3S2E, pp. 113–116 (2013)
7. Almeida, R., Vieira, J., Vieira, M., Madeira, H., Bernardino, J.: Efficient data distribution for DWS. In: Song, I.-Y., Eder, J., Nguyen, T.M. (eds.) DaWaK 2008. LNCS, vol. 5182, pp. 75–86. Springer, Heidelberg (2008). doi:10.1007/978-3-540-85836-2_8
8. Bernardino, J., Madeira, H.: A new technique to speedup queries in data warehousing. In: ADBIS-DASFAA Symposium, pp. 21–32 (2000)
9. Jiawei, H., Kamber, M., Pei, J.: Data Mining: Concepts and Techniques. Morgan Kaufmann, San Francisco (2012). doi:10.1016/B978-0-12-381479-1.00001-0
10. Ranjan, J.: Business intelligence: concepts, components, techniques and benefits. J. Theor. Appl. Inf. Technol. **9**, 60 (2009)
11. Tassabehji, R.: Applying E-commerce in Business. SAGE Publications, Thousand Oaks (2003)
12. Turban, E., et al.: Overview of electronic commerce. In: Electronic Commerce 2008: A Managerial Perspective, chap. 1. Prentice Hall (2008). doi:10.1007/978-3-319-10091-3_1
13. Niranjanamurthy, M., Kavyashree, N., Jagannath, S., Chahar, D.: Analysis of e-commerce and m-commerce: advantages, limitations and security issues. Int. J. Adv. Res. Comput. Commun. Eng. **2**, 2360–2370 (2013)
14. Leong, C., Pan, S.L., Newell, S., Cui, L.: The emergence of self-organizing e-commerce ecosystems in remote villages of china: a tale of digital empowerment for rural development. MIS Q. **40**, 475–484 (2016)
15. Raj, S.N.V.: Applications of business intelligence in e-commerce websites – a theoretical overview of data warehouse schema design & usage. Int. J. Bus. Manag. **3**, 8–12 (2015)
16. Li, K., Deolalikar, V., Pradhan, N.: Mining lifestyle personas at scale in e-commerce. In: Proceedings of 2015 IEEE International Conference on Big Data, IEEE Big Data 2015, pp. 1254–1261 (2015). doi:10.1109/BigData.2015.7363880
17. Kannan, R., Govindan, M.: Hyperlink analysis of e-commerce websites for business intelligence: exploring websites of top retail companies of Asia Pacific and USA. J. Theor. Appl. Electron. Commer. Res. **6**, 97–108 (2011)
18. Chen, Q.M., Dayal, U., Hsu, M.: OLAP-based data mining for business intelligence applications in telecommunications and e-commerce. Databases Network. Inf. Syst. Proc. **1966**, 1–19 (2001)
19. Kimball, R., Merz, R.: The Data Webhouse Toolkit: Building the Web-Enabled Data Warehouse. Wiley, New York (2000)
20. Kauffman, R.J., Walden, E.A.: Economics and electronic commerce: survey and directions for research. Int. J. Electron. Commer. **5**, 5–116 (2001)

21. Choshin, M., Ghaffari, A.: An investigation of the impact of effective factors on the success of e-commerce in small- and medium-sized companies. Comput. Human Behav. **66**, 67–74 (2016)
22. Bernardino, J.: Open business intelligence for better decision-making. Int. J. Inf. Commun. Technol. Hum. Dev. **5**, 20–36 (2013)
23. Mwilu, O.S., Comyn-Wattiau, I., Prat, N.: Design science research contribution to business intelligence in the cloud - a systematic literature review. Futur. Gener. Comput. Syst. **63**, 108–122 (2016)
24. Lim, E.-P., Chen, H., Chen, G.: Business intelligence and analytics: research directions. ACM Trans. Manag. Inf. Syst. **3**, 1–10 (2013)
25. Akter, S., Wamba, S.F.: Big data analytics in E-commerce: a systematic review and agenda for future research. Electron. Mark. **26**, 173–194 (2016)
26. Bernardino, J., Ribeiro, P.: Open source business intelligence: an alternative to proprietary tools. Int. J. Electron. Bus. **9**, 219 (2011)
27. Lapa, J., Bernardino, J., Almeida, A.: Commercial business intelligence suites comparison. In: Rocha, A., Correia, A.M., Costanzo, S., Reis, L.P. (eds.) New Contributions in Information Systems and Technologies. AISC, vol. 353, pp. 237–246. Springer, Cham (2015). doi: 10.1007/978-3-319-16486-1_24