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Elaborating the Role of Business Intelligence (BI) in Healthcare Management

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ABSTRACT The sector of healthcare is one of the most growing and developing sector of the current economy. The leaders of healthcare system need keys that would help them to advance business processes, decision-making, communication between physicians, administration and patients, as-well-as effective data access. In this case, Business Intelligence (BI) systems may be useful.

BI is a new multidisciplinary research field that is being used in a variety of industries. It entails extracting information from large amounts of data and delivering it to stakeholders in a decision-making context that is correct. Many BI applications in the healthcare industry attempt to analysing data, predictions, supporting decision-making, and attaining total sector improvements. In today's rapidly evolving health-care industry, decision-makers must cope with increasing demands for administrative and clinical data in order to meet regulatory and public-specific standards. The application of BI is realized as a viable resolution to this problem.

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As the current data on BI is mainly focusing on the area of industry, So the aim of the current input is to adapt and translate the present research findings for the health-care industry.
For this reason, various BI definitions are explored and consolidated into a framework. The objective of this review is to give an overview of how to use BI to aid decision-making in healthcare companies. Along these the sector specific requisites for effective BI-application and role in future are discussed.

KEYWORDS: Business Intelligence; BI; Healthcare; Management; Medical

1. INTRODUCTION

The rapid growth of technology use in the business environment has generated huge amounts of digital data resulting from the volume of transactions. Technological advances have made the use of Information Technology (IT) tools and techniques a necessity for streamlining operations in all businesses and industries (Goodman et al., 2010). Not only for business operation and development, but also for supporting decision-making based on real information through the adoption of BI technologies. Every organization intends to become an intelligent and successful organization and gain a modest advantage on their market by applying new technologies and inventive BI-solutions especially in the healthcare sector (Ashrafi et al., 2014; Gurjar & Rathore, 2013).

The healthcare sector involves a variety of numerous stakeholders, including physicians, medical personals, government, insurance-companies, service providers, regulating-agencies, medical providers, and people that are looking for dependable and safe services (Olszak & Batko, 2012). Maintaining and dealing with, all these relationships between all stakeholders is very challenging task without use of new technology. Moreover, because these relationships include human life and wellness, they are more sensitive than those in other industries and businesses. For these motives, it is important to implement information technology (IT) in health-care industry to achieve the advantages of using IT toward improving services and facilitating-processes (Singh, 2012).

From the previous literature, the healthcare sector has huge amounts of data, and there is dire need to gather and process this information to make accurate and timely decisions-based on current data. One of the solutions to improve the decision-making process is BI tools is used to transform raw data into smart information and knowledge (JINPON et al., 2011). BI technologies capture the organization's strategy and apply their tools to help and manage and refine business information to make more effective business decisions in various scopes (Rouhani et al., 2012). They give the healthcare industry the ability to transmit large amounts of data from multiple sources into a single repository, allowing for analysis and drill-down into certain elements while also ensuring operational procedure prudence and providing a decision-making mechanism.

As BI becomes more important for the industry of health-care, it is the objective of this review to show an actual image of the BI in healthcare context. We trust that a well knowledge of the perspectives and meaning of BI might improve communication gap between the many organizations and individuals that uses the term of BI and probably increase its adoption. For this purpose, we looked at a variety of 'intelligence' definitions. As the portion of the BI literature focuses on industrial sector, we considered its importance in healthcare context in order to generate the ideas about applying BI in a healthcare sector. Finally, the review will discuss the future consequences of BI in healthcare management and provide an outlook for future research in the field

2. BUSINESS INTELLIGENCE (BI)

In 1865, the term "Business Intelligence (BI)" was coined, and now, after 157 years, it is tough to see a business today without a BI tools, especially while dealing with huge amount of digital electronic information (Tavera Romero et al., 2021). In today's world, a digital BI system is crucial in collecting, analysing, and processing business digital information in different fields including healthcare (Shao et al., 2022).

To explore the benefits of adopting BI in the healthcare, this review must first define the BI and its core concept techniques and technologies. The expression BI was introduced by an IBM scientist in 1958, as he defined it as

the "ability to understand the interrelatedness of current data in many sides as to lead decision in respect of a wanted purpose and gain the competitive advantage" (Luhn, 1958). In recent years, BI was described as "concepts, methods and tools to improve and restructure the organization process and decision" (Kumari, 2013). BI was also well-defined by, Zeng et al. as "the process of extraction, handling, and diffusion and analysis of information that has an objective, the reduction of uncertainty when making strategic decisions" (Zeng et al., 2006).

BI by its definition contains of three (03) main stages: data-storage-integration, analysis, and information presentation stages (Bordeleau et al., 2018). Currently, various BI components are used to support decision-making as a part of integrated systems and suites or as distinct technologies.

The core BI components are (Aruldoss et al., 2014; Lee et al., 2022) i). Data Warehousing (DW), which provides thematic storage space for integrated, aggregated, and analysed data. ii). Extract Transform Load (ETL) tools, which transfer the data from transaction or operational systems to DWs. iii). On Line Analytical Processing (OLAP) tools which allow operators access to analyse and model business problems and share the stored information from DW. iv). Data Mining (DM) tools are used to determine the patterns, regularities, generalizations, and rules in data-resources. v). Ad-hoc inquiry and reporting tools for utilizing and creating different reports; and presentation which includes multimedia and graphical interfaces to provide operators with info in a accessible and comfortable form.

BI package aids users in comprehending complicated relationships and processes. through easily customized, assimilated graphic reports that help in making informed and timely decisions, taking actions that will improve further performance, and recognizing how their activities effect the entire company (Lale, 2022). BI dashboard solutions are commonly used in the presentation phase of many business sectors to communicate information to stakeholders and end-users (Monteiro, 2021).

BI tools are used presently to help the healthcare sector in making precise diagnosis and treatment, both in short and long-term care (Johnson et al., 2021). In many cases, they are used to estimate alternative treatments based on data analysis. In addition, they are also utilized for the administrative healthcare institute's perspective to assess and report on the cost and benefit of many operations in departments and units (Ameen et al., 2018).

BI in Healthcare Industry

The healthcare system has seen significant disturbances in recent years due to over dependence on medical services (Azizi et al., 2019). In addition, the COVID-19 pandemic brought about a number of difficulties that nearly took down the healthcare systems in many nations globally (Malik, 2022). As a result, adopting tech-driven techniques to enhance and optimize their operations became crucial for healthcare businesses. However, the demand for BI application development services in the healthcare industry has significantly increased. Due to the pandemic of COVID-19, the global Healthcare Business Intelligence market size is predictable to be worth 4.75 USD billion in 2022 and is forecast to a readjusted size of USD 8.37 billion by 2028 with a CAGR of 9.9% during the review period **(Figure. 1)** (Al-Sarawi et al., 2020).

In 2021, North America dominated the market, accounting for 43.4 percent of total sales followed by Europe (19.75%), Asia Pacific (18.13%), Middle East (9.52%), and

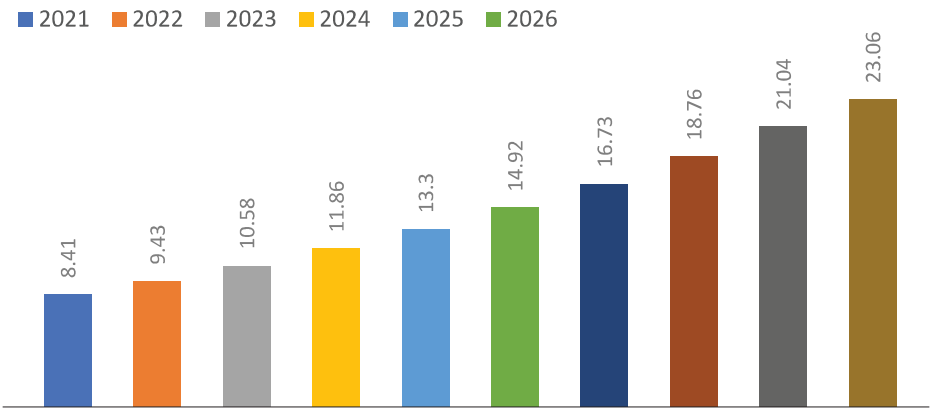

Figure 1. The global healthcare business intelligence market size, 2021–30 (USD Billions).

Latin America (9.2%) (THUO, 2021). The rise of the healthcare industry is attributable to the growth of the healthcare BI market in North America. According to forecast, the Asia-Pacific region is expected to grow the fastest. The healthcare BI market growth in this region is being influenced by giving awareness regarding BI tools and solutions in healthcare infrastructures. Additionally, the local government is also working to expand the healthcare industry, which is fuelling the region's healthcare BI market. Furthermore, the local government is also investing in the growth of healthcare BI **(Figure. 2)** (Bu & Wu, 2022).

3. HOW DOES BI WORKS?

BI supports in operational and strategic decision-making. According to Gartner research,

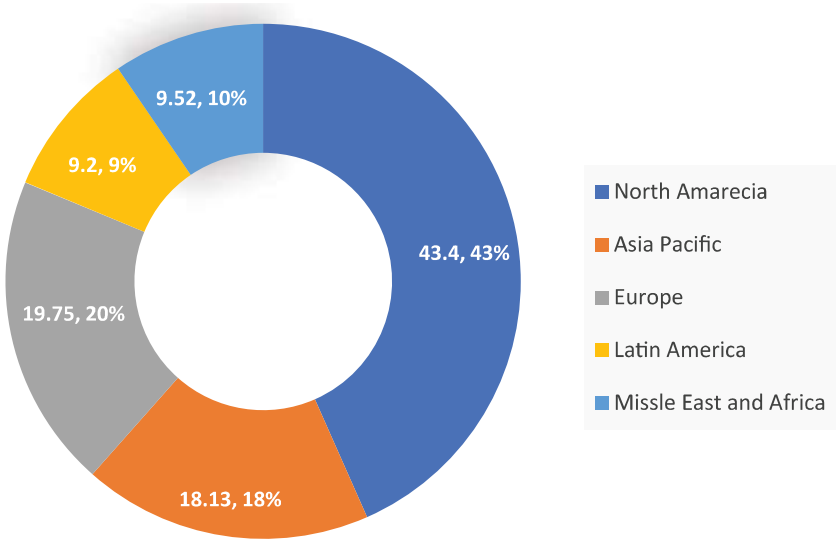

Figure 2. The global healthcare business intelligence market share, 2021 (%).

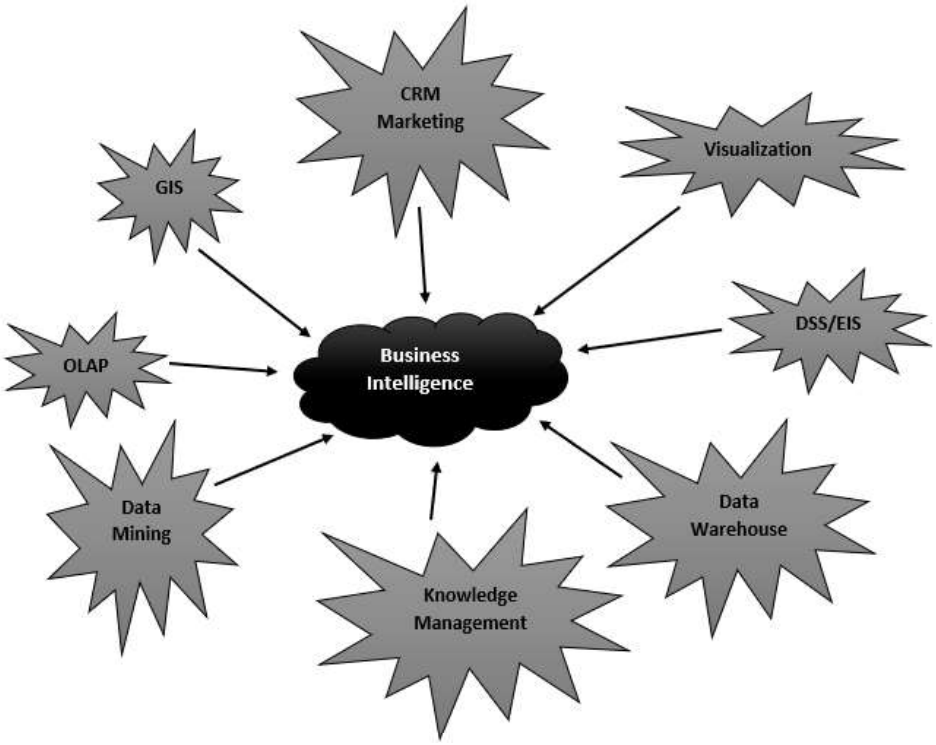

Figure 3. Relationship of Business Intelligence to other Information Systems.

CRM: Customer Relationship Management, GIS: Geographic Information Systems, OLAP: On-Line Data Processing, DSS: Decision Support Systems.

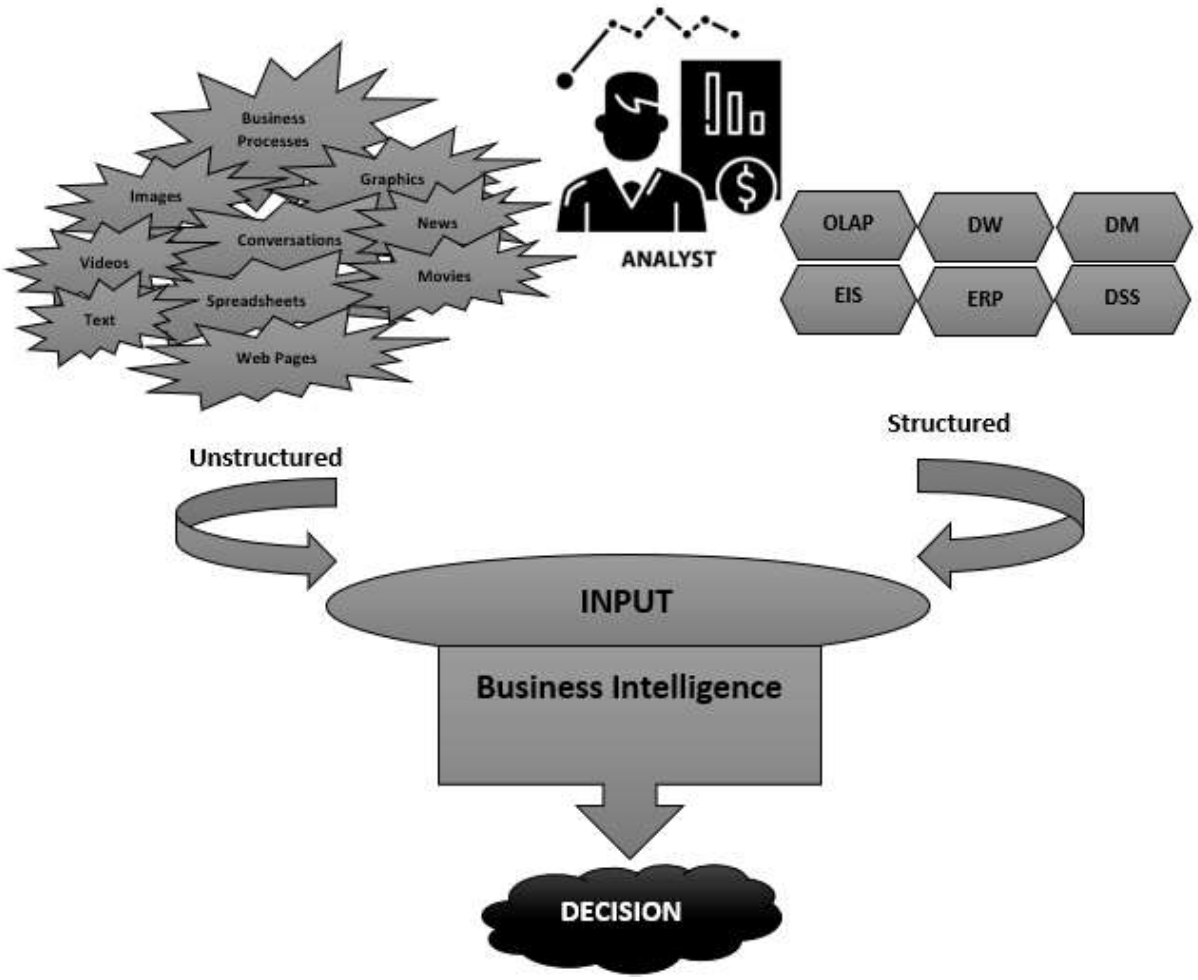

Figure 4. Structured and unstructured inputs to BI system and final decision-making.

DM: Data Mining, OLAP: On-Line Analytic Processing, EIS: Executive Information Systems, DW: Data Warehouse, ERP: Enterprise Requirement Planning.

the following is the hierarchy of strategic BI use (Massey, 2008):

1. Management of corporate performance.
2. Monitoring business activities, optimizing customer-relations, and support of traditional decision.
3. Standalone packaged BI solutions for specific strategies or operations.
4. Management reporting of BI.

One implication of this ranking is that it is insufficient to simply report on a company's and its competitor's performance, despite this being a strength of many existing software solutions. Another implication is that too many businesses still see BI as an inward-looking activity, just like DSS and EIS did before it.

BI is a logical progression from a number of earlier decision-supporting tools. Data warehouse development as a repository, the improvements in data cleaning that produced a single truth, increased hardware and software capabilities, and the boom of Internet technologies that provided the prevalent user interface, all came together to produce a richer BI environment than was previously available. BI gathers data from numerous different systems. The information systems that BI uses are shown in **Figure 3.**

BI transforms data into usable information that can then be analysed by humans to produce knowledge. Some of the tasks that are performed by BI are following:

- Making predictions based on historical facts, present and past performance, and predictions of directions in which the future will go.
- Impacts of changes and potential outcomes are analysed using "what if" questions.
- Ad-hoc access to the data to address particular, unusual questions.
- Strategic perception.

Figure 4 illustrates the assortment of information inputs that can be used to provide the intelligence required for decision-making.

3.1 Benefits of Business Intelligence (BI) in Healthcare Domain

The advantages of BI include intelligent-data-analytics, cost-reduction, improved service quality, transparency, and greater visibility etc (Kamble & Gunasekaran, 2020). Monitors data in real-time and remotely. Creates graphic indicators for each process, monitor its evolution, and define strategic actions. Risk analysis and accurate information tracking. Anticipates fault identification. Monitors the evolution of what happens in the hospital.

Every day, technology changes the way we live. One of these shifts is taking place in the healthcare industry (Diamandis & Kotler, 2020). Healthcare setting is a business around for centuries with current medicine which helps to extend the lifespan. However, the new inventions are established to create this process pointedly more useful and user friendly (Liu et al., 2020).

BI is an innovation that states the assembled and usage of data to improve the strategic plannings and business operations. Healthcare BI made on this same context but in this situation, the patient data in question is assembled through different channels (Conboy et al., 2020). BI in context to healthcare management has a slightly different purpose than that explained prior with BI alone. With BI healthcare, different healthcare organizations are still trying to improve operations and reduce costs, but primarily focuses on the improvement of patient-care (Arefin et al., 2020). Below discussed are some benefits of BI in healthcare management.

3.1.1 Cost Reduction

Globally, the health-care is a business, while clinicians and doctors are in the role to helps the patients, but still money is a driver which must be acknowledged. Running a hospital or medical practice is expensive with tools, resource costs, pharmaceuticals, and equipment's, it all adds up. However, the healthcare BI packages can helps to reduce these costs different ways.

BI healthcare software package can track populations and accomplish analysis to better comprehend the probability of infections and illness in specific locations. BI healthcare tools can expand information and communication sharing among various organizations and even between the countries (Bordeleau et al., 2018).

3.1.2 Turning a Physician to a Data-Scientist

BI tools might be difficult to use and comprehend. However, as healthcare has evolved, so have the business intelligence systems that support it. Doctors and other healthcare professionals now have a simple way to extract data without having to know how to code or work with databases.

Front-line employees are more productive and effective when they use self-service tools. They give healthcare providers real-time access to information, allowing them to make better decisions and judgements faster. Furthermore, these self-service tools enable the patients for easy modification, allowing them to comprehend the information that are being offered (Ahn et al., 2019).

3.1.3 Personalized Medicine

In years back, Patient treatment used to be more of a guessing game than anything else. As the time proceeded and evidence and data were shared between clinicians, researcher, and physicians about what medications worked and what did not work when it came for the treatments of specific disease, better option for treatment were refined and discovered.

Healthcare data intelligence helps the clinicians, researcher, and physicians to understand why some treatment option that suitable for one patient might or might not work for another patient. Healthcare Business-analytics can further determine the risks of specific treatment options based on a patient's medication and condition. Now the treatments options can be personalized because of BI, based on definite genetic blueprints, allowing for more precise treatment (Alloghani et al., 2018).

3.1.4 Caregivers' Evaluation

As previously stated, healthcare is a business, and one of the fundamentals of business is customer service. Patients who visit a doctor or visit a medical facility are considered as customers in healthcare system. These patients are not only concerned with how they are treated in the healthcare facility, but also how much empathy is or is not shown in the given situation to the patient, the information they receive, and many more.

Like restaurants reviews, the healthcare facilities can also be reviewed by patients and information's like this are collected through different BI tools. Clinical business intelligence

software can analyse data about caregivers inside an organization and use it to improve patient care (Esteves et al., 2019).

3.1.5 Patient Satisfaction Improvements

Patient happiness and satisfaction is influenced by health analytics in several ways. Personalised and better treatment option ensures that the patients receive services focuses on their specific condition and diseases. Personalised treatment options results in enhanced patient outcomes, leading to overall better quality of life. In addition, hospital and clinical BI helps to make the healthcare facilities more effective and efficiently improving waiting times and overall the health service levels (Bordeleau et al., 2020).

1. Improving care of patient: BI offers complete data on the health of patient's by relating different types of medical records and reports. Understanding the current symptoms, history, inherited risks, and the probability of relapse permits clinicians to produce optimal-conditions for in-patient-care and accurately plan the home visits.
2. Guessing the requirements of patients: BI can guess the events at the macro and micro levels. For example, forecast of occurrence of the patients during flu-season and determination of patients who will requires hospitalization.
3. Individual treatment option: BI analyses and collects large amounts of the data, and findings hidden relationship. Which allows the physicians to adapt the treatment option for an individual patient according to their needs. For example, it will help to determine the current state of patient, the likelihood of death during a surgery, and the tendency to increased blood clotting.
4. Making quick decisions: BI rations the external and internal patient data in a single-core and offers easy access for different healthcare institutes. In serious cases, when the physicians do not have adequate information about patient, it is conceivable to receive information of the patient from other institutes and deliver timely assistance.
5. Financial planning: BI takes economical, operational, and clinical data, creating it easier to track key performance indicators (KPIs). For health staff, it is a prospect to find the feasibility of certain costs and invoicing, optimize calculation, and distribution of funds between departments.

3.2 Tools of Business Intelligence in Healthcare Domain

BI software's of healthcare is a subset of BI-software beset to the healthcare-market. These tools allow medical professionals to review data from a variety of sources in a more efficient manner. These sources could include patient medical records and files, but they can also include extra information like financial records and more to help the facility better plan its care and treatment (Gastaldi et al., 2018). Healthcare BI tools interface with other software in a medical setting, but it's important to note that they're not the same as EMR and EHR software.

3.2.1 Tableau

Tableau is a market leader in the business intelligence field, it helps the healthcare setting to create and publish the dashboards in a very easy way. Tableau offers some built-in data preparation capabilities that makes gathering of information process easier. Tableau also includes several ready-to-use templates for healthcare consumers, which aids implementation even more by allowing firms to dive down into their data more rapidly.

It supports healthcare firms in becoming more data-driven in order to improve patient experiences and outcomes through confident decision-making aided by visual-analytics. The users of various degrees of technical expertise can easily use this platform to explore the data filtering by dragging and dropping and in natural language enquiries. Tableau provides both SaaS and self-hosted deployment options (Carlisle, 2018).

3.2.2 Power BI

Power BI is a Microsoft product; thus, it will be familiar to Office users. It also has direct integration with other Microsoft programs like as SharePoint, PowerPoint, Azure and Excel, and allow users' model, analyse, and graphically present the data in reports and dashboards of various types. With a built-in AI engine, the Power BI is quite intuitive and simple to use which allows users to analyse the patient's clinical data easily and quickly. Power BI enables to gain actionable and deeper insights that link the gaps between clinical data and decision-making. It is a popular choice for businesses of all sizes (from small businesses to large corporations) because of its cost-effectiveness, ease of use, and scalability (Powell, 2018).

3.2.3 Sisense

Sisense, like Tableau, offers healthcare-specific integrations. Sisense, on the other hand, goes a step further with a healthcare analytics module designed exclusively for healthcare data and information. Sisense allows user to pipe the data from different data sources so that user will integrate all of the various touchpoints in a single-interactive-dashboard.

Sisense is also a complete BI and data discovery platform that makes analytics available to everyone. Based on single-stack-technology, Sisense contains all the things that are important for data analysis, preparation, and visualizations in a single-architecture. It can do thousands of queries on large amounts of clinical data, returning results at a faster rate than in-memory processing, which allows the users for making decisions very quickly. Sisense's healthcare analytics module is created specifically to evaluate the healthcare data, which is one of the prime benefits for healthcare providers. Sisense is also one of the greatest data integration solutions on the market. Integration is not only viable, but also simple, when the users are connecting to data sources or other software such as ERP and invoicing software (Lousa et al., 2019).

4. FUTURE PERSPECTIVES

In various industries, BI is now widely regarded as a key driver for the better understanding organizational outputs and measuring them in real time in order to make improvements and changes. To make accountable decisions about the use of rare resources of the healthcare system it is important to recognise the tools or sources of efficiency, that can contribute more to improve the outcomes. Manager and users of healthcare sector, require real-time information to well manage the data and to make the knowledge and information which could improve the quality of health services and reduces the risks. Healthcare-specific analytical skills, on the other hand, are already incorporated in other fundamental operational applications as well as medical devices and equipment's. Occasionally they have been effectively put forth as stand-alone intelligence-applications (Tavera Romero et al., 2021). For example, significant-intelligence is built into Clinical-Decision-Support (CDS) applications, Computerized-Provider-Order-Entry (CPOE) systems, telemedicine devices and hand-held computing tablets seen everywhere in clinics, hospitals, and healthcare infrastructures. While the main aim of these technologies is not only analysis, but to make it more valuable (Bisheh et al., 2021).

The future of healthcare BI will be defined by the convergence of business and policy issues, as well as the deployment of increasing analytical capabilities to tackle these challenges. It appears that providing real-time data is essential. In near future BI will be taken in closer contact with healthcare system, if the managers and users want to effectively support the data management, evidence-based-practices and to understand the correlations between them. Safety and quality can be only improved and measured when variation in regional or local differences is eradicated, when the consequences are measured, and when teams from the multi-disciplines sing from the same song sheet. BI's worth for healthcare will therefore not primarily be in information provision and simplifying communication. Rather, its contribution is in enabling new ways of working, allowing the integration of organization and information and the measurement of outputs in real time (Tavera Romero et al., 2021).

However, three critical challenges must be addressed in order to comprehend the future direction of BI in healthcare: (a) The most critical business and policy issues in healthcare today; (b) The emerging trends in the field of business intelligence capabilities in healthcare sector; and (c) The potential analytical applications of healthcare that are now being overlooked. Parallel to this, there is a need to enhance emerging analytical capabilities in order to produce applications that can address these difficulties, particularly in areas like:

1. Patient satisfaction and service evaluation: including patient engagement, experience, loyalty, happiness, relationship measurement and the last and important one tracking and measuring the voice of patient.
2. Management of healthcare marketing: developing and measuring the growth of healthcare branding, trust management, reputation, customer and patient segmentation, patient lifetime value and profitability.
3. Financial stability in the healthcare sector: increase in productivity, maximizing profits, Streamlining the processing of claims, control of waste and costs, costs according to activity.
4. Analysis of healthcare operations: Measurement and management of partners,

opportunities for collaboration, improvement in agility, asset and working capital management.

5. Development of health-care personnel: provider commitment, measurement of the provider's experience, and analysis of the provider's voice, measurements of learning and development, knowledge, innovation, culture and analytics of intangible value.

REFERENCES

Ahn, S., Couture, S. V., Cuzzocrea, A., Dam, K., Grasso, G. M., Leung, C. K., McCormick, K. L., & Wodi, B. H. (2019). A fuzzy logic based machine learning tool for supporting big data business analytics in complex artificial intelligence environments. 2019 IEEE international conference on fuzzy systems (FUZZ-IEEE).

Al-Sarawi, S., Anbar, M., Abdullah, R., & Al Hawari, A. B. (2020). Internet of things market analysis forecasts, 2020–2030. 2020 Fourth World Conference on smart trends in systems, security and sustainability (WorldS4).

Alloghani, M., Al-Jumeily, D., Hussain, A., Aljaaf, A. J., Mustafina, J., & Petrov, E. (2018). Healthcare services innovations based on the state of the art technology trend industry 4.0. 2018 11th International Conference on Developments in eSystems Engineering (DeSE).

Ameen, A. M., Ahmed, M. F., & Abd Hafez, M. A. (2018). The impact of management accounting and how it can be implemented into the organizational culture. *Dutch Journal of Finance and Management*, *2*(1), 02.

Arefin, M. S., Hoque, M. R., & Rasul, T. (2020). Organizational learning culture and business intelligence systems of health-care organizations in an emerging economy. *Journal of Knowledge Management*.

Aruldoss, M., Travis, M. L., & Venkatesan, V. P. (2014). A survey on recent research in business intelligence. *Journal of Enterprise Information Management*.

Ashrafi, N., Kelleher, L., & Kuilboer, J.-P. (2014). The impact of business intelligence on healthcare delivery in the USA. *Interdisciplinary Journal of Information, Knowledge, and Management*, *9*, 117.

Azizi, S. M., Soroush, A., & Khatony, A. (2019). The relationship between social networking addiction and academic performance in Iranian students of medical sciences: a cross-sectional study. *BMC psychology*, *7*(1), 1–8.

Bisheh, M., Raissi, A., & Mokhtari, S. (2021). Combination of Backward and Forward Approaches for Future Prediction by Business Intelligence Tools. *American Journal of Engineering and Applied Sciences*.

Bordeleau, F.-E., Mosconi, E., & de Santa-Eulalia, L. A. (2020). Business intelligence and analytics value creation in Industry 4.0: a multiple case study in manufacturing medium enterprises. *Production Planning & Control*, *31*(2–3), 173–185.

Bordeleau, F.-E., Mosconi, E., & Santa-Eulalia, L. A. (2018). Business Intelligence in Industry 4.0: State of the art and research opportunities. Proceedings of the 51st Hawaii International Conference on System Sciences.

Bu, N., & Wu, T. (2022). The Asia-Pacific region: The new center of gravity for international business. In *International Business in the New Asia-Pacific* (pp. 3–29). Springer.

Carlisle, S. (2018). Software: Tableau and microsoft power bi. *Technology | Architecture+ Design*, *2*(2), 256–259.

Conboy, K., Mikalef, P., Dennehy, D., & Krogstie, J. (2020). Using business analytics to enhance dynamic capabilities in operations research: A case analysis and research agenda. *European Journal of Operational Research*, *281*(3), 656–672.

Diamandis, P. H., & Kotler, S. (2020). *The future is faster than you think: How converging technologies are transforming business, industries, and our lives*. Simon & Schuster.

Esteves, M., Abelha, A., & Machado, J. (2019). The development of a pervasive Web application to alert patients based on business intelligence clinical indicators: a case study in a health institution. *Wireless Networks*, 1–7.

Gastaldi, L., Pietrosi, A., Lessanibahri, S., Paparella, M., Scaccianoce, A., Provenzale, G., Corso, M., & Gridelli, B. (2018). Measuring the maturity of business intelligence in healthcare: Supporting the development of a roadmap toward precision medicine within ISMETT hospital. *Technological Forecasting and Social Change*, *128*, 84–103.

Goodman, J., Gorman, L., & Herrick, D. (2010). Health information technology: Benefits and problems. *National Center for Policy Analysis, Washington*.

Gurjar, Y. S., & Rathore, V. S. (2013). Cloud business intelligence–is what business

need today. *International Journal of Recent Technology and Engineering*, *1*(6), 81–86.

Jinpon, P., Jaroensutasinee, M., & Jaroensutasinee, K. (2011). Business intelligence and its applications in the public healthcare system. *Walailak Journal of Science and Technology (WJST)*, *8*(2), 97–110.

Johnson, K. B., Wei, W. Q., Weeraratne, D., Frisse, M. E., Misulis, K., Rhee, K., Zhao, J., & Snowdon, J. L. (2021). Precision medicine, AI, and the future of personalized health care. *Clinical and translational science*, *14*(1), 86–93.

Kamble, S. S., & Gunasekaran, A. (2020). Big data-driven supply chain performance measurement system: a review and framework for implementation. *International Journal of Production Research*, *58*(1), 65–86.

Kumari, N. (2013). Business intelligence in a nutshell. *International journal of innovative research in computer and communication engineering*, *1*(4), 969–975.

Lale, A. W. (2022). Business intelligence implementation in different organizational setup evidence from reviewed literatures. *Knowledge Engineering for Modern Information Systems: Methods, Models and Tools*, 173.

Lee, S., Lim, D., Moon, Y., Lee, H., & Lee, S. (2022). Designing a business intelligence system to support industry analysis and innovation policy. *Science and Public Policy*.

Liu, Y., Lee, J. M., & Lee, C. (2020). The challenges and opportunities of a global health crisis: the management and business implications of COVID-19 from an Asian perspective. *Asian Business & Management*, *19*(3), 277–297.

Lousa, A., Pedrosa, I., & Bernardino, J. (2019). Evaluation and Analysis of Business Intelligence Data Visualization Tools. 2019 14th Iberian Conference on Information Systems and Technologies (CISTI),

Luhn, H. P. (1958). A business intelligence system. *IBM Journal of research and development*, *2*(4), 314–319.

Malik, M. A. (2022). Fragility and challenges of health systems in pandemic: early lessons from India's second wave of coronavirus disease 2019 (COVID-19). *Global Health Journal*.

Massey, A. P. (2008). Collaborative Technologies. Handbook on Decision Support Systems 1. Editors: F. Burstein, CW Holsapple. In: Springer.

Monteiro, M. (2021). *Business Intelligence systems development in hospitals using an Agile Project Management approach*

Olszak, C. M., & Batko, K. (2012). The use of business intelligence systems in healthcare organizations in Poland. 2012 Federated Conference on Computer Science and Information Systems (FedCSIS),

Powell, B. (2018). *Mastering Microsoft Power BI: expert techniques for effective data analytics and business intelligence*. Packt Publishing Ltd.

Rouhani, S., Asgari, S., & Mirhosseini, S. V. (2012). Review study: business intelligence concepts and approaches. *American Journal of Scientific Research*, *50*(1), 62–75.

Shao, C., Yang, Y., Juneja, S., & GSeetharam, T. (2022). IoT data visualization for business intelligence in corporate finance. *Information Processing & Management*, *59*(1), 102736.

Singh, H. (2012). Implementation benefit to business intelligence using data mining techniques. *International Journal of Computing & Business Research*, 1–6.

Tavera Romero, C. A., Ortiz, J. H., Khalaf, O. I., & Ríos Prado, A. (2021). Business intelligence: business evolution after industry 4.0. *Sustainability*, *13*(18), 10026.

Thuo, D. N. (2021). Business Intelligence Systems And Performance Of Commercial.

Zeng, L., Xu, L., Shi, Z., Wang, M., & Wu, W. (2006). Techniques, process, and enterprise solutions of business intelligence. 2006 IEEE International Conference on Systems, Man and Cybernetics,