

Internet of Things and its impact on Business Analytics

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Abstract

Objectives: To study the Impact of IoT data on Business Analytics. **Methods/Statistical Analysis:** An exploratory research to study the Impact of IoT data on Business Analytics was conducted. Through the Literature review process, various preliminary information on IoT and Business Analytics including the Advanced Analytics was gathered. Research papers, Journals, Internet Sites and books were used to collate the relevant content on the subject. Analysis of all the relevant examples was done. The gaps in the area of research were identified to arrive at the problem statement and its impact on Organizations. **Findings:** World is moving very rapidly towards the Industry 4.0, where the most impactful position in almost all the areas would be of IoT (Internet of Things). Profoundly IoT allows the connection between people and things at any point and any given place with devices that can transmit data over the network. Thus, the Smart environment evolves which consists of Smart devices transmitting the real time data over Smart networks. Business Decision Making is facilitated with a greater accuracy with real time data transmitted coupled with the relevant information. IoT and Business Analytics based on IoT data is gaining a lot of significance and importance in larger organizations. Right decision making at the right time and at the right place is the key to successful businesses in today's dynamic environment. **Application:** The real time analytics becomes a reality with IoT data transmitted over the Internet and consumed by the Business Analytics. Use of Past data is to analyze and identify the hidden trends so that future predictability is built. Current data helps validate the relevancy of the Business Analytics Model. It also helps in taking some course corrections as and when required.

Keywords: Advanced Analytics, Big Data, Business Analytics, Industry 4.0., Internet of Things

1. Introduction

The most important and pivotal role in an economy is played by the Industries. The industries fundamentally are a combination of People, Processes and Technology, which synchronize together for a definitive output. Ever Since the beginning of Industrialization, the leaps that technology has taken has led to Paradigm, shifts named as Industrial Revolutions¹.

The Industry 1.0 was formed way-back in 1784, which comprised of Machines driven by Steam and Water. Industry 2.0 born around 1870 depended heavily on production of goods by mass production techniques using electrical as the source of energy. In the year 1969, the Industrial Revolution took the Industry to the next step of development where Information Technology (IT) was in practice for replicating and reproducing production at a much faster rate called as Automation. The advanced

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digitization with the combination of Internet technologies and future oriented technologies in the field of smart objects resulted in a new Paradigm shift. Finally, the era of Cyber Physical Systems arrived where the advancement of the Industrial revolution is termed as Industry 4.0. The vision of the future contains modular, but efficient systems where individual products will be produced with a batch size of one maintaining the economic conditions of mass production¹.

Internet, by virtue of its ubiquitous presence and impact on all business and technology aspects, has commanded an irrefutable presence in our lives. Internet has grown substantially in the last 5 decades starting from a micro network and to a macro global network serving billions of users. This tremendous evolution in the past few years connected billions of things globally². Among other influences, the most recent one is of Internet of Things (IoT). In³, define IoT as “a network of dedicated physical objects (things) that contain embedded technology to sense or interact with their internal state or the external environment”. In⁴ define “IoT as connecting intelligent physical entities (sensors, devices, machines, assets, and products) to each other, to internet services, and to applications”. With the advent of IoT, the physical world can now be connected to the all the systems with Internet. Things/devices, which were supposed to serve certain utilitarian purposes, can now actively participate in an ecosystem comprised of other things/devices. While doing so, things/devices can deliver even higher values to their intended recipients by virtue of their participation as active components/constituents of IoT. In⁵ states that, the “Internet of Things” allows people and things to be connected Anytime, Anywhere, with anything and anyone, ideally using any path/network and any service.

In⁶ argue that the “IoT is a development of the previous notions of ubiquitous computing, pervasive computing and ambient intelligence”. In⁷ define “IoT as a system of interrelated computing devices, mechanical and digital machines, objects, animals or people that are provided with identifiers and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction”. IoT is fundamentally the critical evaluation of the internet where machine – to – machine learning can be achieved⁸.

Forces from both sides of the Technology landscape such as pull and push acted and drove the IoT and its next steps. The push force was treating IoT as a new platform where the present and future Information and passing

of this information were applied. In contrast to technology pull forces where the existing areas of our economy, society and life are analyzed for the benefits by the wide spread deployment of IoT.

IoT, fundamentally, has grabbed the attention from both the providers as well as the users because of its ability to connect devices, people and goods over a global network. Each entity in the IoT landscape is allotted a unique identifier and the idea is to gather live data from each of them through the network. Live data can help organizations in deriving useful and interesting trends based on advanced analytics models. This process of churning and messaging massive data applying advanced analytics techniques to unearth unseen patterns and possible correlations are named as Big Data Analytics⁹.

Big Data is characterized by three main components, Variety, Velocity and Volume. It is now rapidly expanding in all sciences and engineering domains, including physical, biological and biomedical sciences. Until now big data was largely made of transactional data generated manually, which used to be stored in relational databases. With more number of IoT networks deployed in the world, the balance will shift fundamentally towards large volumes of sensor data, which is generated by these uniquely codified connected devices¹⁰. IoT makes a shift in the domain of Big Data management. It brings in a significant revolution in the conventional solutions by intelligently connected devices, people, processes and things via sensors¹¹. The most fundamental issue faced by the Big Data applications is churning of voluminous data, adding relevant information to convert the same into knowledge for decision-making¹². The churning of data applying advance analytics techniques done for the Business key performance indicator variables to derive and predict Business Decisions is termed as Business Analytics.

A very interesting scenario has been brought to light where a combination of electrical and mechanical parts behaves intelligently combining hardware, software, control sensors, data storage and connectivity over the global network. Opportunities of increasing productivity and reducing marginal costs at the same time turns into reality for organization as IoT allows sharing big data flows among modern companies¹³.

2. Current State of Knowledge

Advanced analytics is a general term, which simply means applying various advanced analytic techniques

to data adding relevant information and converting the same to knowledge which can either be used to find out answers of current questions or solve them assisting decision making. It is not a technology in and of itself, but rather, groups of tools that combine with one another to gain information, analyze that information, and predict outcomes of the problem solutions resulting into accurate and quick decision making¹⁴. “Data integration and data mining are the basis for advanced analytics”¹⁵. Advanced analytics driven data analyses allow enterprises to have a complete or “360 degrees” view of their operations and customers. Data analytics is an essential research topic in the IoT domain that has attracted many different research areas such as statistics, machine learning and data mining. The insight that they gain from such analyses is used to direct, optimize, and automate their decision-making and build a knowledge base for future¹⁶. It results in successful achievement of a variety of specific organizational goals with the help of the models built in the system. Advanced Analytics when applied in the context of Business Key Performance Indicators and the decision-making depends on the data collected is called as Business Analytics. Business analytics systems create value and provide competitive advantage for organizations. In¹⁷ states that the BA systems involve the use of advanced statistical analysis techniques in modeling, simulation, forecasting and data mining. BA systems need embedded within the business processes and routines of organizations.

“A close partnership between the Business Analytics (BA) group and the Business is vital”¹⁸. Insights provided by the BA group must align to the business strategies and focus areas that contribute to the business value. Business values offers to one or more segments of the customers and its network of partners who contribute to the profits and the revenue streams¹⁹. An overview of how a business operates is termed as Business Model. The need of the hour is to figure out mechanisms that can tightly couple and embed BA systems within the business. If the role of BA is perceived as a technical aspect, it can hamper the understanding of the rich role a BA may play within a company. It is a very specific Business role of assisting Business understanding and helping Decision-making through predictive models²⁰.

The fundamental understanding of Internet of Things and its role in changing the approach of understanding

the Business Process Management fundamentally from outside and within the firm is becoming Vital in the leading Managerial Literature and a lot is spoken about the same²¹. The need to scrutinize the emerging ideas on IoT is largely felt⁰⁷. IoT and its application in the real world are a very niche and emerging field of research. Figure 1 depicts the envisaged growth of IoT until the year 2020²².

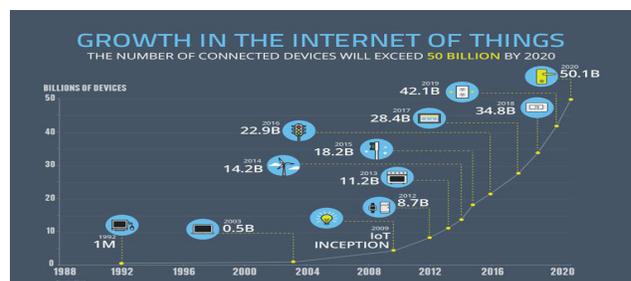


Figure 1. Growth in IoT.

It is envisaged and proven in some cases that IoT can actually reduce complexities and help create Smart Environments. In²³ stated that a preliminary research in applying/using IoT to ensure its inclusion in specific environments is missing and it has yet to make big inroads.

The investigation and a thorough examination of the role of IoT in Business Process Management is yet to be explored. The conversion of information into knowledge is the next leap, where the definition of knowledge is “information combined with experience, context, interpretation and reflection”. The Insights gained and the interpretation from the knowledge for taking sensible business decisions hugely depend upon the quality of knowledge possessed by an individual. For the Insights to be relevant to the existing Business strategies and goals of a focused organization, it is equally important to look at the existing live data along with the past data for comparison. While largely the past data would be used to generate useful and meaningful trends, the current month data would give an immediate insight to the relevancy of the correlations and help quick decision-making²⁴. Gathering of real time data through the smart sensing devices that is unpredictable and taking Business Strategy and goal-aligned decisions is a promising field of IoT Analytic application²⁵. There is no black box or straight-forward answer to the question of which the data to be evaluated to arrive at a correct Business decision-making model. The study undertakes

the task to build the Decision Making Model using Business Analytics on the data gathered from IoT devices (Big Data) to help achieve the business objectives and in turn the organizational goals.

3. Possible Losses/Damages to Organizations Due to the Limitations

An Enterprise is designed to handle enormous data types used for Decision Making at different point in time. Real time data collected at source aids quick decision making at source. This objective can be achieved only when the requirements of the decision pointers is spelt out and parameters are frozen on the basis of which decision can be taken in a dynamic and distributed environment. Closed loop decision making requires gathering the values of the variables. Data acquisition indicates the collection of data, which is transmitted by the smart sensors and other measuring equipment's. Data acquisition includes different ways such as Manual capture and recording. Electronic gathering of data with the help of sensors etc. is defined as Data acquisition²⁶. These sensors and data collection equipment become an integral part of the IoT eco-system transmitting data to the variables over net.

Some very important quoted statements that emphasize the benefits of consuming big data and Business Analytics for an organization²⁷. In²⁸ stated that if organizations have to leverage on the opportunities created by the data gathered, Business Analytics is the way forward. Another interesting reporting made by²⁹ stated that the high performing organizations were taking informed decisions based on data analysis at double the pace of a low performing organization. Big Data Analytics is playing an important role in transforming the landscape into a competitive one resulting in improvement of the organizational performance, which cannot be undermined. In³⁰ had sighted many successful examples of exploring and building Managerial strategies dependent on the extensive use of data and analytics and their potential to exploit.

Without the complete eco-system being built, Business Analytics alone will be insufficient to create the Business Value. The eco-system includes the resource allocation and orchestration along with the necessary investments to build the same with the IoT framework and usage of the same.

Figure 3: A More Effective Decision Process

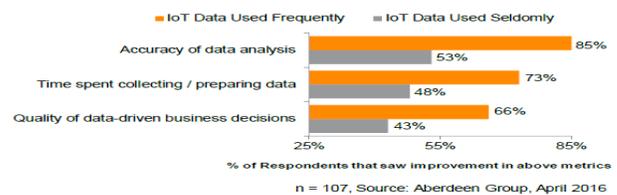


Figure 2. Usage of IoT Data.

Figure 2 depicts the difference between usage and non-usage of IOT Data³¹

As shown in Figure 3, Industries will not be able to reap the benefits of Advanced Analytics. It would cripple the organizations if the data required for the quick and accurate decision-making is not provisioned because of the absence of the IoT infrastructure. It will not only affect decision - making, but would also bring in opacity in the organization's vision towards the future and will lead to a Speculative Horizon influencing the Business Model³¹.

Figure 4: Top and Bottom Line Impact

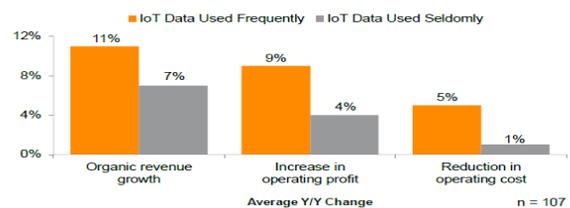


Figure 3. Impact of IoT Data on Top line and Bottom Line of Companies.

4. Conclusions

With the world moving towards Industry 4.0, IoT has gained a prominent position and has continued to expand its horizons in all domains. IoT fundamentally allows people and things to connect anytime, anywhere through devices which can transmit data with anything over any network. The Smart environment thus evolved which consists of Smart devices transmitting the data over Smart networks. As mentioned earlier the data transmitted coupled with the relevant information is converted to knowledge, which can be used in Business Decision Making. Currently while IoT is evolving, Business Analytics too has equally caught an eye from large organizations. Right decision making at the right time and at the right place is the key to successful businesses in

today's dynamic environment. With IoT data, the possibilities of online business analytics increase rapidly. Past data is fed in the Business Analytics models to identify the hidden trends and envisage the future, while the current data helps to validate the relevancy of the Model. This also helps business in taking some course corrections if required. Study of current state of knowledge reveals the insufficiency of information or evidence of the amalgamation of IoT data with Business Analytics. This can reveal many emerging research directions in some very specific and specialized domains such as manufacturing etc.

5. Limitations

Internet of Things and its contribution to Business Analytics are the major highlights of this paper. The attempt is also to understand Big data and how it is stitched in the Business Analytics Scheme of Things. While IoT conceptually is clarified the other important peripherals of IoT such as Architecture & Dependencies, Challenges in Implementation, Robustness, Openness, Privacy, Security etc. are not covered. Advanced Analytics and its linkage to Business Analytics are depicted without getting into the Business Intelligence domain i.e. the Visualization piece of the Analytics portfolio.

6. References

1. Lasi H. Berkeley: Industry 4.0, Business and Information System Engineering. 2014; 6(4):239-42. <https://doi.org/10.1007/s12599-014-0334-4>
2. Kopetz H. Internet of Things, Real-Time Systems: Design Principles for Distributed Embedded Applications. 2011; 13:307-23.
3. Steenstrup K, Kutnick D. Gartner, Inc.: The Internet of Things Revolution: Impact on Operational Technology Ecosystems. Gartner Research Note 3. 2015.
4. Rio R, Banker S. IoT Changes Logistics for the OEM Spare Parts Supply Chain. ARC Insights 2014.
5. Sundmaeker H, Guillemin P. Vision and Challenges for Realizing the Internet of Things. Cluster of European Research Projects on the Internet of Things. Brussels: European Commission - Information Society and Media DG. 2010.
6. Dohr A, Osprian R, Drobits M, Hayn D, Schreier G. The Internet of Things for Ambient Assisted Living. Proceedings of Seventh International Conference on Information Technology. 2010. <https://doi.org/10.1109/itng.2010.104>
7. Nolin J, Olson N. The Internet of Things and convenience. Internet Research. 2016; 26(2):360-76. <https://doi.org/10.1108/IntR-03-2014-0082>
8. Khan R, Khan S, Zaheer R, Khan S. Future Internet: The Internet of Things Architecture, Possible Applications and Key Challenges. Proceedings of 10th International Conference on Frontiers of Information Technology. 2012 Dec 17-19. <https://doi.org/10.1109/fit.2012.53>
9. Sagiroglu S, Gazi D. Big Data: A Review. Proceedings of International Conference on Collaboration Technologies and Systems (CTS). 2013 May 20-24. <https://doi.org/10.1109/cts.2013.6567202>
10. Barnett G. Harnessing Data in the Internet of Things: Strategies for managing data in a connected world. 2015.
11. Shanker U. How the Internet of Things Impacts Supply Chains. Date Accessed: 06/01/2017: Available from: <http://www.inboundlogistics.com/cms/article/how-the-internet-of-things-impacts-supply-chains/>.
12. Rajaraman A, Lescovec J, Ullman J. Cambridge: Cambridge University Press: Mining of Massive Data Sets. 2011.
13. Giudice M. Discovering the Internet of Things (IoT): Technology and business process management, inside and outside the innovative firms. Business Process Management Journal. 2016; 22(2):263-70. <https://doi.org/10.1108/BPMJ-12-2015-0173>
14. Stankovic J. Research Directions for the Internet of Things: IEEE Internet of Things Journal. 2014; 1(1):3-9. <https://doi.org/10.1109/JIOT.2014.2312291>
15. Bose R. Advanced analytics: Opportunities and challenges, Industrial Management and Data Systems. 2009; 109(2):155-72. <https://doi.org/10.1108/02635570910930073>
16. Wu S, Zhu S, Wu G, Ding W. Data Mining with Big Data. IEEE Transactions on Knowledge and Data Engineering. 2013; 26(1):97-107.
17. Davenport T, Harris J. Harvard Business School Press: Competing on Analytics: The new Science of Winning. 2007.
18. Shanks G, Bekmamedova N. Achieving benefits with Business Analytics systems: an evolutionary process perspective. Journal of Decision Systems. 2012; 21(3):231-44. <https://doi.org/10.1080/12460125.2012.729182>
19. Janssen A, Dijkman M, Sprenkels B, Peeters T. Business models for the Internet of Things. International Journal of Information Management. 2015; 35:672-78. <https://doi.org/10.1016/j.ijinfomgt.2015.07.008>
20. Emblemvag J. Business analytics: getting behind the numbers. International Journal of Productivity and Performance Management. 2005; 54.
21. Mashari M, Zairi M. Revisiting BPR: a holistic review of practice and development. Business Process Management Journal. 2000; 6(1):10-42. <https://doi.org/10.1108/14637150010283045>
22. Wellers D. Is this the future of the Internet of Things? Date Accessed: 27/11/2015: Available from: <https://www.>

- weforum.org/agenda/2015/11/is-this-future-of-the-internet-of-things.
23. Coetzee L, Olivrin, G. Inclusion through Internet of Things. Date Accessed: 16/03/2012; Available from: <http://www.intechopen.com/books/assistive-technologies/inclusion-through-the-internet-of-things>.
 24. Gnawali O, Moss D, Clark R, Jones B, Eason W, Shirkalin D. Scaling IoT Device APIs and Analytics: Information Processing in Sensor Networks (IPSN). Proceeding of the 15th ACM/IEEE International Conference. 2016 Apr 11 -14.
 25. Chui M, Loffler M, Roberts R. The Internet of Things. Mckinsey Quarterly. 2010; 2:8-9.
 26. Bi Z. Internet of Things for Enterprise Systems of Modern Manufacturing. IEEE Transactions on Industrial Informatics . 2014; 10(2):1537-46. <https://doi.org/10.1109/TII.2014.2300338>
 27. Sharma R, Mithas S, Kankanhalli A. Transforming decision-making processes: a research agenda for understanding the impact of business analytics on organizations. European Journal of Information Systems. 2014 July; 23(4):433-41. <https://doi.org/10.1057/ejis.2014.17>
 28. Chen H, Chiang R, Storey V. Business Intelligence and Analytics: From Big Data to Big Impact. Business Intelligence Research, MIS Quarterly. 2012; 36(4):1165-88.
 29. LaValle S, Lesser E, Shockley R, Hopkins M, Kruschwitz N. Big Data, Analytics and the Path from Insights to Value. 2011.
 30. Davenport T, Harris J, Morrison R. Harward Business Press: Analytics at Work: Smarter Decisions, Better Result. 2010
 31. Lock M. IoT Analytics and the Value of Data Versatility. Date Accessed : 16/05/2016; Available from: http://v1.aberdeen.com/launch/report/research_report/12252-RR-iot-analytics.asp.