Business Intelligence in the World of IoT

Hanaa Mohammad said, Abdel-Badeeh M. Salem

***Abstract*—** A rapidly developing area in industry is the Internet of Things (IoT). In recent years numerous IoT research and application projects have been done in a joint industry university consortium or by universities. However, an important question to be further addressed is on the value creation by IoT industry applications where these applications in the sense of this paper are solutions using IoT technologies to: improve industrial manufacturing processes, create new service or supervision means for industrial installations, enable new and efficient ways to offer an optimized infrastructure, operate production plants, reduce operational cost or improve human safety in industrial areas. The present paper brings together experts from industry, academia and research offering: a view on the IoT application in industrial environments, expected evolution of IoT technology, the challenges, and the use in future factories, on connected and holistic processes. This paper is intended to contribute to an IoT supported paradigm change in industrial service, manufacturing, and over life sustainable industrial activities, how data mining methods, tools for data warehouse, and learning algorithms can be used in the context of the Internet of the Things(IoT), the decision-making process Business intelligence, Data warehousing & Data Mining, Exploration of data (laboratory), Preparation of data, Series, Regression, Clustering, Classification, Clustering and other Examples: Marketing models, logistics and production models, data envelopment analysis and the study of methods, algorithms and tools and their implementation in real systems.

***Keywords* —** Internet of Things (IoT), Business Intelligence (BI), data mining, Cyberspace and Big Data.

I. INTRODUCTION

The Internet of Things (IoT) is a system of interrelated computing devices, objects, mechanical and digital machines, people or animals that are provided with unique identifiers and with the ability to transfer data over a network without requiring human-to-human or human-to-computer interactions.

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Internet of Things (IoT) which has become part of our daily life where the idea of “things connected to the internet” has been continuously evolving in: contents, visions and technology and areas of applications. New real life and industrial projects, and joint future oriented industry and government initiatives such as Industry 4.0 in Germany, have been started [1]. Since Industrial production is one of the world's biggest economic factors, one of the major objectives of these initiatives is to bring the paradigms of the IoT to the factories to enable them to cope with the challenges raised by popular megatrends.

The decision-making process involves how tools for data mining methods and for data warehouse and how algorithms can be used in the context of the Internet of the Things (IoT). Corporate information systems and the components of the decision-making process Business intelligence, Data warehousing & Data Mining, Preparation of data, Exploration of data (laboratory), Regression, Series, Classification, Clustering and Examples: Marketing models, logistics and production models, data envelopment analysis

The industrial application of IoT is multi-facetted where each of the sub-sections in this paper will highlight an aspect related to the industrial application discusses or shows a case or the evolution and potential of a specific technology from an industry application point of view. The paper is having a holistic manner to industrial challenges and requirements. Also, it will refer to the factory concepts and applications supported by IoT, including processes and flows taking a view on related technologies and their evolution. In an industrial workshop at a recent conference [2], the authors addressed these types of topics.

At the beginning, the paper presents a view form industry regarding IoT applications, the requirements and challenges which have to be overcome or capabilities expected form industrial IoT applications. Subsequent sections discuss items like: future factory concepts and experience in the area, evolution and future of IoT technologies, use of smart objects for creating smart IoTbased applications, technologies inspiring connected life related to industry. The Paper then presents: the whole chain, flows and information services based on smart objects followed by a shopping basket approach from the industry point of view. Then, the paper presents aspects from a real industrial application in the hard environment of oil and gas industry. This Paper also presented some collected opinions on IoT and value aspects, obtained at an industry workshop during the 3rd IoT conference [2]. New types of applications can involve the smart house and the

electric vehicle, in which appliances and services that provide notifications, energy-saving, security; telecommunication, automation, computers and entertainment are integrated into a single ecosystem with a shared user interface. Obviously, not everything will be in place straight away. Developing the technology in Europe right now—demonstrating, testing and deploying products—it will be much nearer to implementing smart environments by year 2020. In the future computation, storage and communication services will be highly pervasive and distributed: people, machines, smart objects, platforms and the surrounding space (e.g., with wireless/wired sensors, M2M devices, RFID tags, etc.) will create a highly decentralized common pool of resources (up to the very edge of the "network") interconnected by a dynamic network of networks.

Internet of Things (IoT) is a network of dedicated physical objects (things) that contain embedded technology to communicate and sense or interact either with their internal states or with the external environment. The connecting of assets, processes and personnel enables the capture of data and events from which a company can learn behavior and usage, react with a preventive action, or augment or transform business processes. The IoT is a foundational capability for the creation of a digital business.

Of course, the idea is not new as such but becomes now evident as those related concepts have started to reveal synergies by combining them. However, the Internet of Things is still under development, in particular due to a number of factors, which limit the full exploitation of the IoT. Among those factors are:

Fig. 1 IoT Eosystem.

II. IoT Ecosystem

The idea is of course not new as such but it becomes now evident as those related concepts have started to reveal synergies by combining them. But, the Internet of Things concept is still maturing, in particular due to a number of factors, which limit the full exploitation of the IoT. Among these factors:

A. Business Intelligence (BI) & IoT

For Business Intelligence (BI), we intend to use the set of models and methods that explore the data in order to obtain first the information and then the knowledge. More alternatives are analyzed where more precise and effective conclusions and timely decisions on things are reached: a global network of the interconnected

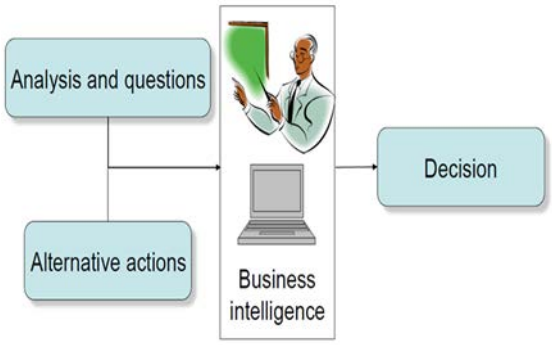

Fig. 2 Benefits of BI

In Year 2008, for the first time ever more objects than people were connected to the Internet! New ideas and methods to solve problems are provided by merging the concepts from those two fields. The following factors appear to be the most relevant:

• There is no clear approach for the utilization of unique identifiers and numbering spaces for various kinds of persistent and volatile objects at a global scale.

• There is no accelerated use and further development of IoT reference architectures like for example the Architecture Reference Model (ARM) of the project IoT-A.

• Less rapid advances in semantic interoperability for exchanging sensor information in heterogeneous environments.

• There exist difficulties in developing a clear approach for the enabling innovation, ownership and trust of data in the IoT while at the same time respecting security and privacy in a complex environment.

• There are difficulties in developing business which embraces the full potential of the Internet of Things (IoT).

• Missing large-scale testing and learning environments, which both facilitate the experimentation with complex.

sensor networks and stimulate innovation through reflection and only partly-deployed rich interfaces in light of a growing amount of data and the need for context-integrated presentation.

• Currently, there are the following hurdles to the exploitation of the Internet of Things (IoT): Among these hurdles there are practical aspects which involve substantial roaming-charges for geographically large-range sensor applications and missing technical availability of instant and reliable network connectivity. A better exploitation of the Internet of Things (IoT) potential is done by: a stronger cross-domain interactivity, increased real-world awareness and utilization of an infinite problem-solving space. The subsequent chapters of this book will present further approaches and solutions to those questions. In addition, eight new projects from the recent call on SMARTCITIES in the

scope of the European Research Program FP7, including a support and coordination action on technology road-mapping, will reinforce this year the research and innovation on a safe/reliable and smart Internet of Things, and complete the direct IoT related funding of 70M in FP7. The potential of combining IoT and Cloud technologies will be explored through a project resulting from a joint venture with Japan.

B. Mathematical Modeling

The decision-maker is provided with information and knowledge from the Business Intelligence (BI) environment through the use of some appropriate mathematical models. This type of Business Intelligence (BI) analysis tends to promote a scientific and rational management of companies: Identifies the objectives of the analysis and performance indicators, Develop mathematical models that relate the control variables with the metrics and parameters, analyzes the performance effects of changes in control variables.

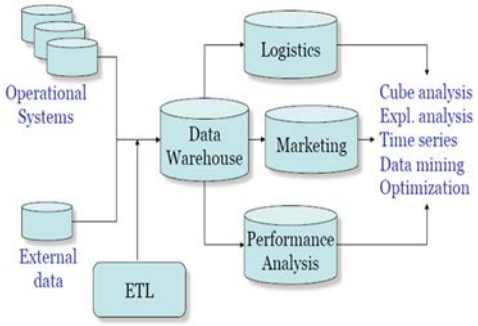

Fig. 3 Business Intelligence (BI) Architecture

III. Business Architecture (BI) Analysis

The analysis of Business Architecture (BI) is devoted to different types of Organizations with complex structures; but if we restrict our attention to enterprises, we can place the BI methodologies into the following three departments: Sales and Marketing, Logistics and Production, Management control and performance measurement.

Enterprise Functions & BI.

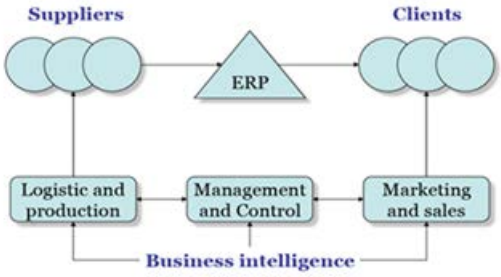

Fig. 4 Phases of (BI) Analysis

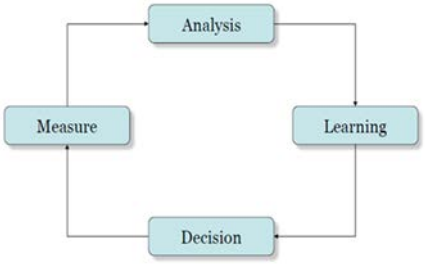

Fig. 5 Phases of (BI) Analysis

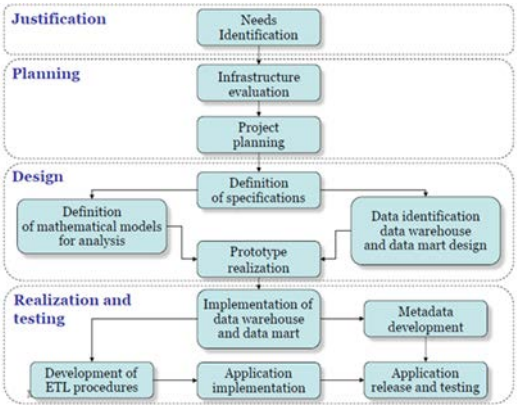

Fig. 6 BI Analysis Methodologies

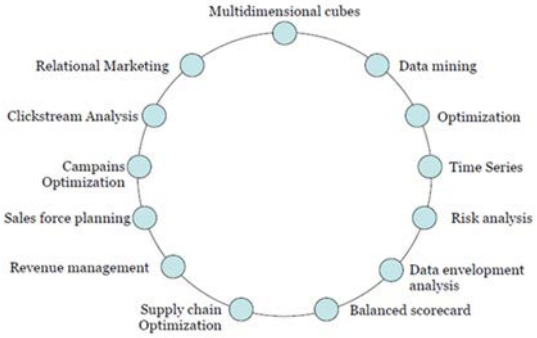

Fig. 7 BI Analysis Methodologies

Classification of data mining systems according to the kind of knowledge discovered and the methodology of the current study depends mainly on applying a combination of four stages: as the model will be built in steps represented in the states as the following:

A. Collecting audit data and network traffic events and transmitting these data by (BI) Analysis units **(Computer network sensors).**

B. Analysis of the traffic data by **(DM-ID unit)** which contains different modules that employ various DM algorithms and techniques (e.g., Frequencies, decision tree model, logistic regression algorithms). Each of these

modules works independently to deploy a penetration test to detect intrusions in the network audit data.

C. Monitoring and visualizing the results of the penetration test by a (Virtualization unit).

D. Analyzing intrusion results, evaluating system performance, taking decisions on detected intrusions, checking for positive and negative results, controlling system operation, generating a performance report and deciding if any changes/updates are needed by the **(Managerial decision-maker).**

The results of this method are very useful in building a strategy for measuring the extent of securing data in order to improve the management of servants which are effective for: business intelligence, any type of data to be used, any type of data was transferred in a proper way. This study could be remarkable because it is one of the first studies covering the use of data mining tools in Cyberspace.

The foremost megatrends relevant to factories are: Progressing technological evolution, globalization, the dynamism of product life cycles, and the shortage of resources and the aging work force. The Central effects are the acceleration of innovation cycles and the increasing customer demand for individualized mass production with the highest quality expectations. Within the context of the industrial production, the Internet of Things (IoT) projects and applications are developing in supply chain, manufacturing, servicing and supervision. A major question in all projects concerns: the value and the benefit which such an application can bring to the owner, to the user or to the society. The value question is extremely pertinent in the industry: in the manufacturing industry the entire factory related processes, but also in industrial applications where it comes to ensure the operation of industrial installations and providing supervision, and improved life service. It is the value that such applications bring which will determine their acceptance, adoption and wide use. However, this value is very difficult to quantify and prove, and it depends on multiple aspects which are strongly dependent on application area. The present paper is focusing on IoT applications from the point of view of value creation for industry and brings together expert opinions from academia, industry and research.

IV. Conclusions

The Internet of Things (IoT) continues to affirm its important position in the context of Information and Communication Technologies and in the development of society. Even though concepts and basic foundations have been elaborated and reached maturity, further efforts are necessary for unleashing the full potential and federating systems and actors. Internet of Things (IoT) is a concept and a paradigm that considers pervasive presence in the environment of a variety of objects/things that through Internet of Things (IoT): Converging Technologies for Smart Environments and Integrated Ecosystems, where in line with this development, the majority of the governments in Europe, in Asia, and in the Americas consider now the Internet of Things as an area of growth and innovation. Even though larger players in some application areas still do not recognize the potential of (IoT), many of them pay high attention or even accelerate the pace by coining new terms for the IoT and adding additional components to it. Moreover, end-users in the private and business domain have nowadays acquired a significant competence in dealing with networked applications and smart devices. As the Internet of Things (IoT) continues to develop, still further potential is estimated by a combination with related technology approaches and concepts such as Cloud computing, Future Internet, robotic, semantic and Big Data.

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