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Dynamic Manufacturing Environments and IoT Using Multiple Linear Regression Analysis

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Abstract

During the advent of Industrial revolution enhanced efficiency in dynamic manufacturing had been a perpetual task. Mechanization was completely curtailed and electricity power substituted has furthermore achieved the power of digitalization which includes the power electronics. It has been observed that the data collected were utilized for the purpose of direct feedback control, in real forensic purposes. In recent years the dynamic manufacturing environments has engaged upon a novel transformation, triggered by integration and cutting-edge analytics. The contemporary methods follows the novel technology named Internet of Things (IoT) for extraction of data, recognizing the patterns, descriptive and predictive models are obtained to provide dynamic manufacturing environments especially for decision making purposes. In order to accomplish this consolidation methods right from the product line data has to be analyzed using advanced machine learning tools for Big Data analytics which can be applied in dynamic manufacturing environments. With the evolution of the Internet of things (IoT), several IoT applications advances and emanates. The main impediment is to evaluate the dynamic manufacturing environments of users on IoT applications is a significant issue in IoT research. To address this issue, this article presents an IoT evaluation method based on multiple linear regression analysis.

Keywords: Dynamic manufacturing, Internet of Things, Big Data Analytics, Multiple linear regression analysis

Introduction

In the era of dynamic Manufacturing Environment and manufacturing has been transformed digitally, the dynamic manufacturing industry is the digital market where most of the Industrial IoT projects are perceived and by large the market where most IoT investment are done. IoT is the most essential component of industrial transformation endeavors across the world, including Industry 4.0 and the Industrial Internet. Manufacturing itself is not the just the lucid leader in the Industrial Internet on the other hand it excels all industries in wider IoT reality.

As per the IDC data, published in the year 2017, the dynamic manufacturing industry was better for a total IoT spend which is more than two times as much than the second highest vertical market. The Dynamic manufacturing is the leading in the IoT for various reasons where some are historical and others are related with the next industrial revolution 4.0 and then there are multifarious cases and actual IoT deployments that offer fast return and enable the manufactures to perceive digital transformations from other perspectives: competitive benefits, customer centricity, automation and efficiency.

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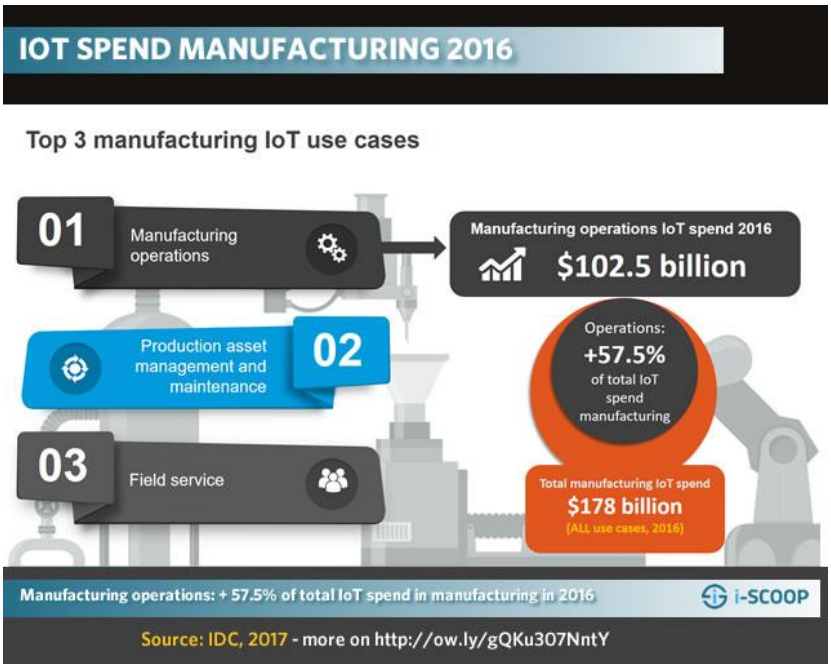

Manufacturing operations – the main IoT manufacturing use case in 2016 accounted for over 57 percent of total IoT spend in manufacturing

The manufacturing industry is outstanding in the Internet of Things for diverse things some are archival others are related with the upcoming industrial revolution 4.0. We are motivated to investigate the impact of IoT on system paradigms, when IoT can be applied in modern manufacturing enterprises. To accomplish this purpose, both the evolutions of manufacturing paradigms and IT are discussed.

Their relations are examined to perceive the needs of the subjects of innovative work by using multiple regression analysis. The Internet of Things (IoT) has been a present pattern in data security, and the advancement of the IoT and its presentation in all circles of human action caused countless security dangers. The dynamic manufacturing business is the premise of a country's economy and capably impacts individuals' job. Rising advancements can have diversion changing effects on dynamic manufacturing models, methodologies, ideas, and even organizations.

Review of Literature & Related Work

In this paper, it has been proposed an occasion based idea for a self-sufficient versatile hazard administration answer for the Internet of Things. The fundamental contrast and the oddity of the approach lies in usage additionally a strategy for finding understood and shrouded connections between Dynamic Manufacturing conditions occasions utilizing regression analysis.

This permits recognizing new practical connections between gadgets in the Internet of Things, which may show connections which ought not to be. Such "terrible" connections portray these incidents in the Internet of Things. The proposed complex of techniques contains straight relapse strategy that is a typical approach utilized as a part of a ton of research. It is additionally utilize measurable based relationship for observing irregularities in the Internet of Things occasions and their parameters.
The following figure shows the technology roadmap: The Internet of Things

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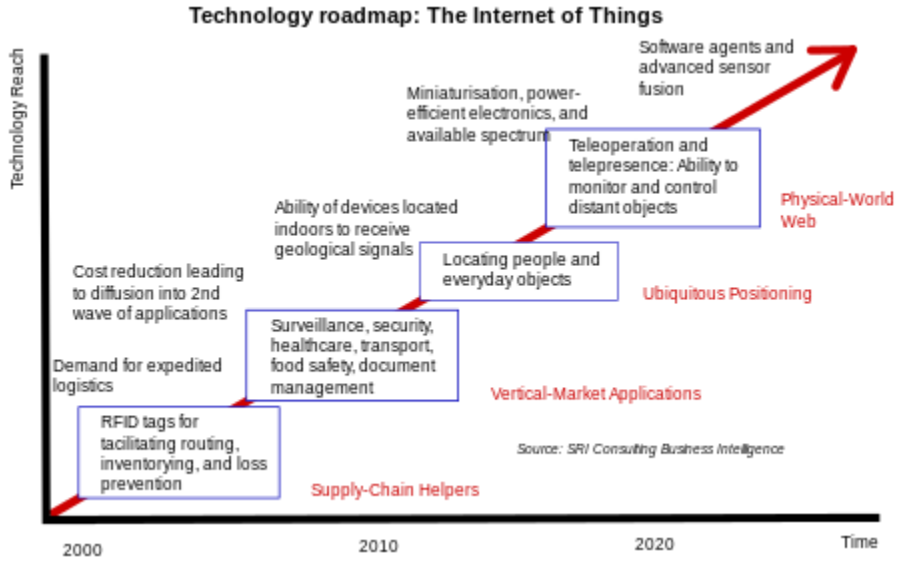

Source: https://en.wikipedia.org/wiki/Internet_of_things

Ongoing dynamic manufacturing events are then rated by a built-in algorithm and may be compared to the accumulated activity patterns, to distinguish normal from abnormal. In [29] it has been proposed an approach which is based on a historical analysis of manufacturing events with their probabilistic correlations. Applying linear regression analysis for providing cybersecurity in the Internet of Things is not widely covered. Applying regression analysis methods for the IoT analytics is represented in works [30-32].

In [33] a multiple linear regression is proposed to test whether the assessments of the brilliant cooler after the situation are identified with their partners after the connection. In [34] relapse investigation is connected to evaluate the connections amongst trust and an arrangement of factors portraying the conduct of a hub. The curiosity of our strategy for finding verifiable connections direct relapse examination lies in applying an uncommon coefficient that mirrors the closeness in flow of two informational indexes. Informational indexes are represented to as occasion parameters, gathered for a specific period. The proposed technique depends on a presumption that the arrangement of interconnected information are evolving comparatively.

In this way, interconnected dynamic manufacturing events and interconnected gadgets could be acquired. When it turns out to be clear how gadgets are interconnected will be substantially simpler to identify security occurrences by customary checking of protecting or infringement of connections. Proposed strategy for finding verifiable connections of gadgets utilizing straight relapse examination is propelled by work [35]. This strategy is received to occasion qualities of a proposed formal model of the Internet of Things occasion. For building occasion chains, we incompletely utilize an approach, proposed in [36].

IoT- Enabled Dynamic Manufacturing

IoT-empowered dynamic manufacturing alludes to a propelled guideline in which run of the productioin creation assets are changed over into keen assembling objects (SMOs) that can detect, interconnect, and cooperate with each other to naturally and adaptively complete assembling rationales [1]. Inside IoT-empowered manufacturing environments, human-to-human, human-to-machine, and machine-to-machine associations are acknowledged for astute

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observation [2]. In this way, on-request utilize and productive sharing of assets can be empowered by the utilization of IoT innovations in assembling. The IoT is thought to be a cutting edge fabricating idea under Industry 4.0 and has embraced late advances, for example, front line data innovation (IT) foundation for information procurement and sharing, which incredibly impact the execution of an assembling framework.

IoT-empowered manufacturing highlights continuous information gathering and sharing among different assembling assets, for example, machines, laborers, materials, and occupations [3]. The continuous information accumulation and sharing depend on key advances, which may be a radio recurrence recognizable proof (RFID) and remote correspondence norms. By utilizing RFID innovation, physical manufacturing streams, the developments of materials and related data streams, the perceivability and traceability of different manufacturing tasks can be flawlessly incorporated [4,5]. RFID labels and peruses are conveyed to regular manufacturing destinations, for instance, shop floors, sequential construction systems, and stockrooms, where shrewd articles are made by furnishing producing objects with RFID gadgets. This permits shop-floor unsettling influences to be identified and bolstered back to the dynamic manufacturing framework consistently [6], consequently enhancing the viability and proficiency of assembling and generation basic leadership.

A few genuine instances of IoT-empowered assembling have been accounted for. To enhance dynamic manufacturing adaptability, a RFID-empowered constant creation administration framework for a bike mechanical production system was presented [7]. This dynamic manufacturing framework is utilized as a part of Loncin Motor Co., Ltd. to gather ongoing generation information from crude materials, work-in-advance (WIP) things, and staff so things of intrigue are improved as far as perceivability, traceability, and trackability. A contextual investigation from a car part producer, Huaiji Dengyun Auto-Parts (Holding) Co., Ltd., gives another case [8]. This SME motor valve producer utilizes a RFID-empowered shop-floor fabricating arrangement crosswise over entire activities. In light of RFID-empowered constant information, an expansion was made to coordinate the assembling execution framework and the undertaking asset arranging framework. An instance of actualizing RFID-based continuous shop-floor material administration for Guangdong Chigo Air Conditioning Co., Ltd. was accounted for in Ref. [9]. For this situation, RFID innovation gave programmed and exact question information to empower continuous protest perceivability and traceability. More cases are accessible from the shape and bite the dust business, car part and frill fabricating organizations together, item life-cycle administration, and aviation upkeep activities [10– 13].

The Internet of Things (IoT)

The IoT alludes to a between systems administration world in which different articles are implanted with electronic sensors, actuators, or other advanced gadgets so they can be arranged and associated to collect and trading information [14]. In general, IoT can offer propelled availability of physical articles, frameworks, and administrations, empowering object-to-question correspondence and information sharing. In different enterprises, control and computerization for lighting, warming, machining, mechanical vacuums, and remote checking can be accomplished by IoT. One key innovation in IoT is programmed ID (auto-ID) innovation, which can be utilized to make smart objects. For instance, as right on time as 1982, specialists at Carnegie Mellon University connected an Internet-associated apparatus to an altered Coke machine [15]. The IoT is currently imagined as a bigger meeting of bleeding edge innovations, for example, universal remote measures, information examination, and machine learning [16]. This suggests a

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substantial number of customary zones will be influenced by IoT innovation, as it is being implanted into each part of our everyday lives.

RFID innovation gives one such case. It has been accounted for that almost 20.8 billion gadgets will be associated and make full utilization of RFID by 2020 [17]. Such a move will impact a large portion of the business, and particularly fabricating segments. RFID innovation has been utilized for distinguishing different protests in stockrooms, creation shop floors, coordinations organizations, dispersion focuses, retailers, and transfer/reuse stages [18]. After recognizable proof, such questions have keen detecting capacities so they can associate and connect with each other through particular types of interconnectivity, which may make an enormous measure of information from their developments or sense practices. The interconnectivity between shrewd items is predefined; such questions are given particular applications or rationale, for example, fabricating techniques that they trail being furnished with RFID perusers and labels [19]. RFID offices not just help end-clients to satisfy their everyday tasks yet in addition catch information identified with these activities so creation administration is accomplished consistently. IoT advances have been broadly utilized as a part of industry.

Big data analytics

With a forceful push toward the Internet and IoT advancements, information is ending up increasingly available and universal in numerous ventures, bringing about the issue of huge information [20]. Enormous information commonly originates from different channels, including sensors, gadgets, video/sound, systems, log documents, value-based applications, the web, and online networking encourages [21]. Under these conditions, a "major information condition" has step by step come to fruition in the assembling segment. Despite the fact that the progression of the IoT (e.g., keen sensors) has streamlined the gathering of information, the inquiry stays of whether this information can be handled legitimately so as to give the correct data to the correct reason at the opportune time [22]. In a major information condition, the datasets are substantially bigger and might be excessively intricate for ordinary information investigative programming [23]. In this way, for associations and makers with a wealth of operational and shop-floor information, progressed investigation systems are basic for revealing shrouded designs, obscure connections, advertise patterns, client inclinations, and other valuable business data.

Research in the scholarly world and industry demonstrates that retailers can accomplish up to a 15%– 20% expansion consequently on venture by presenting BDA innovations [24]. In many ventures, putting client relationship administration (CRM) information into examination is thought to be a viable method to improve client engagement and fulfillment [25]. For instance, a car organization can dispatch a "cosmetic touch up auto" that will fulfill clients more than previously, by mining history requests and client criticism [26]. In addition, a more profound examination of different information from machines and procedures can understand the profitability and aggressiveness of organizations [27]. For instance, in the creation stream of biopharmaceutical generation, several factors must be checked to ensure the exactness, quality, and yield. By preparing enormous information, a producer can determine serious parameters that have the maximum impact on excellence or yield disparity [28].

Features and Formal Models of IoT

At the present time evolution of the IoT follows the inclination of mounting intelligence of devices that are element of the IoT. This way that there is an rising number of projects in which

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devices commune with each other devoid of human participation. So the extent of human influence on the device functioning is minimized and eventually could be reduced to zero [37]. Thus, the data for analysis is fully represents the data from the devices, each of which functions in agreement with a certain algorithm. For this basis, device's data analytics will provide enhanced results than data analysis from users whose behavior is complicated to forecast.

A proposed complex method consists of 4 methods:

- Rule-based association method of detection priori timid events
- Both statistical and rule-based association method of finding potential safety events
- Linear regression method of detection potential security events
- Event association method for investigation security incidents Rule-based correlation method of detection in the IoT.

Statistical and rule-based association method aims to detect irregular event uniqueness by estimate of statistical parameters, such as maximum, minimum, standard deviation etc. This technique also uses rule-based association for detecting safety events, but it is able to detect anomalies in data that could be an unknown attack's manifestation. Linear regression method of detection prospective safety events aims to find implicit interconnections in data from IoT devices and to disclose an analytical form of interconnections.

Infringement of these interconnections may show potential security occurrences. The last occasion connection technique for security occurrences examination intends to investigate interconnections between both security and standard occasions. Based on occasion relationship comes about occasion binding building winds up conceivable, subsequently permits identify security occurrences in the IoT at a beginning time. For portrayal information from the IoT gadgets as an occasion, there is one have to execute a formal model of an occasion, as indicated by which a lot of heterogeneous information from the gadget will be collected and prompt a typical sight because of the standardization [37]. A formal model of an occasion is additionally required for building up the complex of security episodes identification techniques. Applied to the IoT an event represents in a form of tuple called event, describes the following information fields:

- Source
- Destination
- Action
- Date
- Time
- Functions

Event's parameter Source is a set of characteristics to exclusively recognize the device that generates the event. It is explained by an IP address and ports of a device, and also by device ID. So, = {Source_IP,Source_id,Source_Ports_}. Destination is a set of distinctiveness to uniquely spot the device that receives the event.

Destination = {Destination_IP, Destination_id,Destination_ports}. Characterizes an event type where Action = {Message, Command, Unknown}. Date consists of three characteristics = {Date_start, Date_stop, Date_abs}, wherever Date_start is a date from where event probing starts Date_stop is a date in anticipation of which event searching is executed, Date_abs is a date of cataloguing an event in a system. Analogically, time characterizes time of event generation,

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Time = {Time_start, Time_stop, Time_abs, Time_critical!}. Here Time_start is a time from which event searching starts, Time_stop is a time until which event searching is performed, Time_abs is a time at which the event was logged in a system, Time_critical ! Is a critical period. There is also a set of functions for event processing:

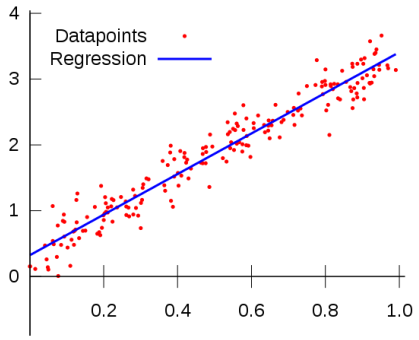
- Get_num
- Get _vlaue
- Find_Event

Functions Set: Functions = {Get_Num, Get_value, Find_Event}.
Get_Num functions concludes the number of events, Get_value decides the value of an event's characteristics, Find_Events functions finds in log file an event with inappropriate characteristics. Thus an event is signify as a tuple - Event = {Source, Destination, Action, Time, Functions}

Multiple Linear Regression analysis

The need to ascertain the connection coefficient notwithstanding the coefficient of comparability in progression depends on the way that the vicinity of coefficient of similitude in flow to 1 may show the presence of a solid nonlinear interconnection, while the estimation of relationship coefficient is near 1 just if there should arise an occurrence of a solid straight relationship. Accordingly, the estimation of the connection coefficient is an integral factor for the second step of t a foundation of types of scientific relationship [37]. Assurance of an analytical form for distinguished interconnections in view of the accompanying methodologies:

- Multiple Linear regression (Predominant approach)
- Nonlinear regression
- Extrapolation



Assuming a linear interconnection, w equation in normal form and find its coefficients using the method of least squares. In the absence of a pronounced linear interconnection, experimental data is represented a curve line in accordance with a set of nonlinear functions, which are standard when trying to identify an analytical form of interconnection [37]. If identifying an analytical form of interconnection using described regression approaches is impossible then we propose to use extrapolation for prediction of a set of future va List of standard using functions when trying to identify an analytical form of interconnection is as follows:

- A linear function *=D+
- An exponential function *
- A rational function of the form #1
- A logarithmic function *=

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- A power function *=Df
- A hyperbolic function *=

A rational function of the form #2 In accordance with instructions proposed in [regression form of the equation is:

*g=:(D)+h (3) Carrying out the calculations identify an analytical form of nonlinear interconnection between event's characteristics and, as a consequence, between devices. The scheme of a correlation and regression method of detection potential security events is represented by the figure 2.

Conclusions

As mounting awareness is given to Industry 4.0, dynamic manufacturing is becoming more and more significant in the development of contemporary industry and market. Dynamic manufacturing is measured to be a key prospect outlook in both research and application, as it offers additional significance to a mixture of products and systems by applying progressive technologies to conventional products in manufacturing and services. Product service systems determines to persist to reinstate conventional product types. Major concepts, key technologies, and universal applications are covered in this article. The outlook of research and applications are emphasized after a methodical review. This article can enlighten and motivate researchers and industrial practitioners to promote in pressing forward the manufacturing industry, ahead. The concepts discussed in this paper will throw more light on innovative ideas in the attempt to comprehend the much expected Fourth Industrial Revolution. In this article, we suggest multifaceted techniques in the IoT using multiple linear regression analysis. Providing dynamic manufacturing environments in the IoT is a task, which intricacy augments along with an evolution of the IoT. The major contributions of this article comprise a latest approach for IoT based on finding implied interconnections in the IoT. This method is based on a computation of the coefficient of connection in dynamics. This coefficient designates how related are changes in time and the values of the two datasets. A small experiment was also conducted using the machine data of the blast furnace, and established that even a minute volume of a dataset is capable to distinguish an interconnection. The direction for supplementary works is to expand methods to gather and process data from the IoT in real-time for fast response.

References

[1] Zhong R.Y., Dai Q.Y., Qu T., Hu G.J., Huang G.Q.RFID-enabled real-time manufacturing execution system for mass-customization production Robot Com-Int Manuf, 29 (2) (2013), pp. 283-292.

[2] Tao F., Cheng Y., Xu L.D., Zhang L., Li B.H.CCIoT-CMfg: Cloud computing and Internet of Things-based cloud manufacturing service system IEEE Trans Ind Inform, 10 (2) (2014), pp. 1435-1442.

[3] Bi Z., Xu L.D., Wang C.Internet of Things for enterprise systems of modern manufacturing IEEE Trans Ind Inform, 10 (2) (2014), pp. 1537-1546.

[4] Lu B.H., Bateman R.J., Cheng K. RFID enabled manufacturing: Fundamentals, methodology and applications, Int J Agile Syst Manage, 1 (1) (2006), pp. 73-92.

[5] Zhong R.Y., Li Z., Pang L.Y., Pan Y., Qu T., Huang G.Q. RFID-enabled real-time advanced planning and scheduling shell for production decision making Int J Comp Integ M, 26 (7) (2013), pp. 649-662.

[6] Huang G.Q., Zhang Y.F., Chen X., Newman S.T. RFID-enabled real-time wireless manufacturing for adaptive assembly planning and control, J Intell Manuf, 19 (6) (2008), pp. 701-713.
[7] Liu W.N., Zheng L.J., Sun D.H., Liao X.Y., Zhao M., Su J.M., et al.RFID-enabled real-time production management system for Loncin motorcycle assembly line Int J Comp Integ M, 25 (1) (2012), pp. 86-99
[8] Dai Q.Y., Zhong R.Y., Huang G.Q., Qu T., Zhang T., Luo T.Y. Radio frequency identification-enabled real-time manufacturing execution system: A case study in an automotive part manufacturer Int J Comp Integ M, 25 (1) (2012), pp. 51-65.
[9] Qu T., Yang H.D., Huang G.Q., Zhang Y.F., Luo H., Qin W.A case of implementing RFID-based real-time shop-floor material management for household electrical appliance manufacturers J Intell Manuf, 23 (6) (2012), pp. 2343-2356.
[10] Wang M.L., Qu T., Zhong R.Y., Dai Q.Y., Zhang X.W., He J.B.A radio frequency identification-enabled real-time manufacturing execution system for one-of-a-kind production manufacturing: A case study in mould industry Int J Comp Integ M, 25 (1) (2012), pp. 20-34
[11] Huang G.Q., Qu T., Zhang Y.F., Yang H.D.RFID-enabled product-service system for automotive part and accessory manufacturing alliances Int J Prod Res, 50 (14) (2012), pp. 3821-3840.
[12] Cao H., Folan P., Mascolo J., Browne J. RFID in product lifecycle management: A case in the automotive industry Int J Comp Integ M, 22 (7) (2009), pp. 616-637
[13] Saygin C., Tamma S. RFID-enabled shared resource management for aerospace maintenance operations: A dynamic resource allocation model Int J Comp Integ M, 25 (1) (2012), pp. 100-111.
[14] Xia F., Yang L.T., Wang L., Vinel A.Internet of Things Int J Commun Syst, 25 (9) (2012), pp. 1101-1102.
[15] Farooq M.U., Waseem M., Mazhar S., Khairi A., Kamal T. A review on Internet of Things (IoT) Int J Comput Appl, 113 (1) (2015), pp. 1-7.
[16] Xu L.D., He W., Li S. Internet of Things in industries: A survey IEEE Trans Ind Inform, 10 (4) (2014), pp. 2233-2243.
[17] Lund D., MacGillivray C., Turner V., Morales M. Worldwide and regional Internet of Things (IoT) 2014–2020 forecast: A virtuous circle of proven value and demand International Data Corporation, Framingham (2014 May)
[18] Wang Y.M., Wang Y.S., Yang Y.F. Understanding the determinants of RFID adoption in the manufacturing industry Technol Forecast Soc, 77 (5) (2010), pp. 803-815.
[19] Guo Z.X., Ngai E.W.T., Yang C., Liang X. An RFID-based intelligent decision support system architecture for production monitoring and scheduling in a distributed manufacturing environment Int J Prod Econ, 159 (2015), pp. 16-28.
[20] Manyika J., Chui M., Brown B., Bughin J., Dobbs R., Roxburgh C., et al.Big data: The next frontier for innovation, competition, and productivity McKinsey Global Institute, New York (2011).
[21] Rich S. Big data is a “new natural resource,” IBM says. 2012 Jun 27 [cited 2017 Mar 20]. Available from: http://www.govtech.com/policy-management/Big-Data-Is-a-New-Natural-Resource-IBM-Says.html
[22] Lee J., Lapira E., Bagheri B., Kao H. Recent advances and trends in predictive manufacturing systems in big data environment Manuf Lett, 1 (1) (2013), pp. 38-41.
[23] Barton D., Court D. Making advanced analytics work for you Harv Bus Rev, 90 (10) (2012), pp. 78-83,128.

VOL 2 ISSUE 4 (2018) PAGES 110 - 119

Received: 25/03/2018. Published: 15/04/2018

[24] Perrey J., Spillecke D., Umblijs A.Smart analytics: How marketing drives short-term and long-term growth Court D., Perrey J., McGuire T., Gordon J., Spillecke D. (Eds.), Big data, analytics, and the future of marketing & sales, McKinsey & Company, New York (2013).

[25] Fosso Wamba S., Akter S., Edwards A., Chopin G., Gnanzou D.How "big data" can make big impact: Findings from a systematic review and a longitudinal case study Int J Prod Econ, 165 (2015), pp. 234-246.

[26] Agarwal R., Weill P.The benefits of combining data with empathy MIT Sloan Manag Rev [Internet], 54 (1) (2012 Sep [cited 2017 Mar 20]) Available from: http://sloanreview.mit.edu/article/the-benefits-of-combining-data-with-empathy/

[27] Lee J., Wu F., Zhao W., Ghaffari M., Liao L., Siegel D.Prognostics and health management design for rotary machinery systems—Reviews, methodology and applications Mech Syst Signal Process, 42 (1–2) (2014), pp. 314-334.

[28] Brown B., Chui M., Manyika J. Are you ready for the era of "big data"? McKinsey Quarterly (4) (2011), pp. 24-35.

[29] M. Marvasti, A. Poghsoyan, A. Harutyunyan, N. Grigoryan, "An Anomaly Event Correlation Engine: Identifying Root Causes, Bottlenecks, and Black Swans in IT Environments," VMware Technical Journal, Vol. 2, No. 1, pp.35-46, 2013.

[30] C. Floerkemeier, "The Internet of Things," IOT 2008, Zurich, Switzerland, pp.68-86, 2008.

[31] Y. Wang, Y.C. Lu, I.R. Chen, J.H. Cho, A. Swami, "A Logit Regression-based Trust Model for Mobile Ad Hoc Networks," 6th ASE International Conference on Privacy, Security, Risk and Trust, Boston, pp. 1-10, 2014.

[32] J. Guo, I. Chen, "A Classification of Trust Computation Models for Service-Oriented Internet of Things Systems,".

[33] C. Floerkemeier, "The Internet of Things," IOT 2008, Zurich, Switzerland, pp.68-86, 2008.

[34] J. Guo, I. Chen, "A Classification of Trust Computation Models for Service-Oriented Internet of Things Systems,"

[35] G. Zhaojun, Y. LI, "Research of Security Event Correlation based on Attribute Similarity," Research of Security Event Correlation based on Attribute Similarity, Korea, pp. 110113, 2012.

[36] J.-H. Bellec, M-T. Kechadi, "Fuzzy Event Correlation Algorithm in Wide Telecommunication Networks International Journal of Multimedia and Ubiquitous Engineering, Vol.3, No. 2, pp.103-116, 2008.

[37] Daria Lavrova1 and Alexander Pechenkin, "Applying Correlation and Regression Analysis to Detect Security Incidents in the Internet of Things", International Journal of Communication Networks and Information Security (IJCNIS)Vol. 7, No. 3, 131-137, 2015.