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A STUDY ON DIGITAL TWINS IN AUTOMOTIVE MANUFACTURING USING INTERNET OF THINGS (IOT) IN AS INDIAN AUTOMOTIVE INDUSTRY

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ABSTRACT

The integration of Digital Twin (DT) technology and the Internet of Things (IoT) has revolutionized predictive maintenance strategies in manufacturing. By creating a virtual representation of physical assets and utilizing real-time data from IoT devices, businesses can enhance operational efficiency, reduce downtime, and optimize resource utilization. This paper explores the synergy between DTs and IoT in predictive maintenance, discusses technological advancements, challenges, and provides case studies to illustrate practical applications. A review of existing literature from 2003 to 2023 highlights the evolution of these technologies and their transformative impact on manufacturing. The research also delves into how the combination of DTs and IoT enables advanced analytics, fosters proactive decision-making, and reduces operational risks. Furthermore, the study examines the challenges of integration, such as data security and interoperability, while outlining future trends like AI-driven automation and blockchain-enabled security, underscoring their potential to reshape manufacturing industries globally. By leveraging these innovations, organizations can not only predict failures but also dynamically adapt to changes in operational demands, leading to unprecedented reliability and cost-effectiveness. The integration of these technologies underscores the move towards smart factories and Industry 4.0, setting the stage for a more resilient and efficient manufacturing sector.

Keywords: Digital Twin; Smart Manufacturing; Real-Time Data; Predictive Maintenance; Process Optimization; Manufacturing Efficiency...Etc

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1.0 INTRODUCTION:

This Study is a summary on what the Internet of Things and more specifically the new paradigm of Industrial Internet of Things is all about, the current state of Indian Manufacturing, why this research was undertaken and the rationale behind it, what is the background and existing literature in this area of study, what is the scope of study and the framework being followed. a. Overview The world is witness to evolving manufacturing capabilities in nations globally which while further stimulating economic prosperity on one hand, is also resulting in an increased focus on developing advanced manufacturing capabilities on the other hand, using technology infrastructure. With the fast merging digital and physical worlds, referred to as the world of cyber physical manufacturing, advanced technologies are driving company- and country-level-competitiveness. The trend is aided by ubiquitous and pervasive computing technology and availability of data connection at high bandwidth speeds. Further there has been profound growth and proliferation of end point IoT sensors which have improved in terms of economy, miniaturization, power consumption, accuracy and digital integration capabilities. The Manufacturing sector in India is still not globally competitive (Deloitte, 2018) due to over emphasis on labor based production, lesser automation, legacy manufacturing assets and production plants, energy inefficient systems and because usage of Information Technology to integrate the physical and cyber world for potential benefits

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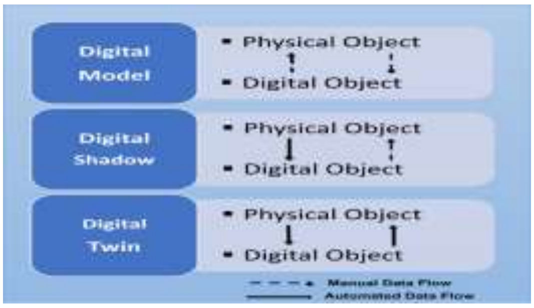
which other countries have adopted (Rockstorm, 2018) is almost non-existent.

Manufacturing Sector dynamics In this section we will explain the dynamics faced by a process and discrete manufacturing organization using a case study method. The operations of a global manufacturing unit of flexible packaging films was undertaken for this study (Ramakrishnan, 2016). The manufacturing process can be either made to stock or made to order. Made to stock orders are fulfilled based on set of predefined constraints or requirements predicted through usage or order historical trends or sales forecast. The major difference being that in case of made to order, each confirmed order is assigned to a production batch run (Zuyderduyn, 2011). Made to orders are custom made as per order specifications. Generally manufacturing companies adopt a mix of both strategies, however it becomes difficult to match outstanding inventory with new orders due to inventory traceability issues which is one areas addressable by IoT (Ramakrishnan., 2017). For each product to be manufactured, in process manufacturing batches and recipes with formulations have to be defined. Each batch run picks up defined formulation, draws input either manually or throw automated systems like flow meters or dispensers and processes them using manufacturing assets powered by electrical and mechanical energy generating a set of main products, bye products, invisible losses and waste products. The net sum on inputs of material remains same as the output of materials by weight. In this case study we observed that material moved from stores to the plant for processing in batches, automated silo dispenses kept track of the quantity and material type being fed into the process plant. Here again there are significant issues of inventory plus risks of production outages due to inventory shortfall or wastage of inventory, IoT again can play an important role by using sensor equipped IoT controlled flow meters and dispensers so that each unit of raw material can be tracked and accounted for. Also energy tracking and utilization can be accounted for using IoT based Smart Metering infrastructure. Further with connected process plants, data on plant performance can be directly 13 sourced to IT systems for further analysis.

Research Gap A thorough review of literature shows a gap in the understanding of the preparedness of Indian manufacturing industries from IoT (Consumer products), IIoT (manufacturing operations) and Industry 4.0 (overall strategy) adoption, a gap between recent industry and achievement of Industry 4.0 (Quin, 2016). None of the current existing models or Literature have covered all the dimensions of IoT adoption. Some have focused on technology – Core Systems while others have generalized of management aspects – Strategy , Lean Operations The Indian Manufacturing structure is different – Lower Collaboration , Less Data Transparency , Limited Data Driven decisions , more spending on OT than IT, Infrastructure issues even at connectivity levels , manual driven operations.

***DIGITAL TWIN IN MANUFACTURING SECTOR:**



1.1Need of the Study:

Literature has shown in similar context that that evaluation of programs and progress in possible using capability maturity models (Kenneth, 2017). The capability maturity model originated as a framework developed by Carnegie Mellon University to improve its process for developing computer software (Paulk, 2009). The model includes a selfassessment that presents the organizations best practices in a key progress area and then shows how it can redefine its capabilities as it involves to more mature state. (Paulk., 1993).

1.2 Objectives of Study:

1. Identifying the determinants of manufacturing competitiveness and the factors affecting IoT adoption in an enterprise using existing models.
2. Identifying impact and benefits of IoT adoption in the top 5 construct areas using a pre and post analysis.
3. Is there enough awareness about IoT in companies?
4. Using survey method analyze the factors determining a successful adoption of IoT projects as evidenced by successful adopting organizations.

A few limitations of the study are highlighted below. 1. The primary data gathered depends upon the sole understanding and perspective of the respondents. Hence, the contextual relationship amongst the variables is dependent on the knowledge and experience of respondents taking part in the survey and domain experts who participated. This dependency leaves a probability of the final results being influenced. 2. The recommended model for the impact of IoT origin real-time data on the Supply Chain Management of the automotive industry from the vendor perspective is based on the data 169 Conclusion gathered from the vendors of the automotive industry. The results and model may vary if the data is collected from vendors of other industries. 3. The recommended model for the impact of IoT origin real-time data on the Supply Chain Management of the automotive industry from the customer perspective is based on the data collected from the customers of the automotive industry. The results and model may vary if the data is gathered from customers of other industries. 4. There is a fundamental concern raised by the organization with IoT implementations. The potential risk is identified by the organization Information Security experts for the data transmitted over the Internet. In the absence of an adequate and security framework, the data can be intercepted and used against the organization. This has proved to be one of the significant hurdles in the IoT implementation journey for the industry. Organizations are sensitive, particularly towards the customer data transmitting over the Internet. Thus the spread of IoT is observed to be inadequate in the customer processes. The current study does not cover the aspect of Information Security. The reason being, it's a specialized and elaborate analysis that requires in-depth knowledge of Information Security tools. 5. The study has considered major externally aligned parameters. The researcher has not taken into account the influence of Government policies since they are changing over a period of time and cannot be considered for any reference.

1.3 Review of Literature:

Comprehensive literature review is the starting point of any research to understand what work has already been done and what are the gaps which need to be fulfilled in upcoming research relating to the subject area. This chapter covers a comprehensive identification, evaluation and summarizing of relevant literature from authentic sources and reputed research journals or conference proceedings, having undergone a rigorous filtration for adequacy and relevance to the current area of research and its topic.

The expression “Internet of Things” (IoT), coined back in 1999 by Kevin Ashton and has been widely discussed in forums worldwide as having graduated from a future technology to something which has now become current technology (IoT Week, 2019). Over the last decade the term Internet of Things (IoT) has attracted attention by projecting the vision of a global infrastructure of networked physical objects, enabling anytime, anyplace connectivity for anything (Kosmatos, 2011). Gartner identifies IoT as one of the top ten strategic technology trends, Cisco forecasts 50 billion devices connected by 2020 and a potential market in excess of $14 trillion.

1.Barricelli et al., 2021 Hu et al., 2021). In the Apollo program of NASA, two identical spacecraft were built to reflect the conditions of the spacecraft during the mission, and the spacecraft left on the earth was defined as a ―twin‖ (Boschert and Rosen, 2016; He et al., 2021).

2.Marina (2017) has summarized different papers contrasting the approach for Industry 4.0 adoption in terms of Horizontal Integration, Vertical Integration, IoT IoS computing, Cyber Physical Systems, New Business Models, Flexible Production and Cluster Concept.

3.Pessl (2017) has advocated a 6 step roadmap for enterprises starting with Analysis of requirements, analysis of maturity state, defining target state, defining 43 measures, realization and decisions to finally defining projects. This however does not factor the complexity of I4 which may be more iterative model.

4.Merz (2016) has divided the approach for Industry 4 introduction – Actual Analysis, Target Determination, Implementation. First deals with the companies experience, second is to define objectives of technology usage, and then plan and execute projects accordingly.

5.(Chryssolouris et al., 2019). The advancement in information and communication technologies (IOT) has substantially supported production development. The fast development of technologies such as big data, Internet of things (IoT), artificial intelligence, cloud computing, wireless sensor networks, etc. and presenting great potential in the industry offers opportunities for the integration of physical space with digital space, which is an inevitable tendency to address increased complications and high demand coming from the market.

6.Michael Grieves titled ―Conceptual Ideal for PLM.‖ Although it referred to Product Lifecycle Management, the concept presented included the basic features of a digital twin that have not changed considerably since that time: the ―real space‖ and ―virtual space‖ that connect through data and information exchange (Grieves and Vickers, 2017; Tao et al.,

7.(Tao et al., 2022) Internet of Things (IoT) The Internet of Things (IoT) involves the interconnection of physical devices through the internet, allowing them to collect and exchange data. In the context of manufacturing, IoT facilitates real-time monitoring and control of equipment and processes by embedding sensors, actuators, and network connectivity into physical devices. IoT devices generate vast amounts of data that can be used to gain insights into the performance and condition of manufacturing systems. This data is critical for making informed decisions regarding production schedules, maintenance activities, and quality control.

8. David Gelernter in 1991 and named ―Mirror Worlds.‖ In addition, as a solution to the unproductivity of data transfer through paper for PLM, Kary Främling et al. proposed a mediator-based architecture in which ―each product component‖ had a corresponding ―virtual match‖ or a mediator related to it (Singh et al., 2021). In 2006, ―product avatar,‖ which was a similar concept to the model proposed by Grieves, was introduced by Hribernik et al. The product avatar concept aimed to create an information management architecture that supported a two-way information flow from a product-based Manufaturing.

1.4 Research Methodology:

The inclusive approach deployed during the research, assumptions employed, and the methods used are covered in this chapter. Methodically solving the research problem is included in the Research methodology (Kothari, 2004). The chapter further covers the background in a contextual way on how the

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investigation is steered. Research Methodology (RM) mentions the framework used to map research along with the required tools and techniques for conducting research. Along with this, it also encompasses the systematic procedures for the identification of a research problem and how the conclusions have been reached (Singh, 2006). RM includes problem identification, literature review, gap analysis, hypotheses formation, testing procedures, data gathering, scales used for measurement, analysis, and interpretation along with conclusions (Singh, 2006; Kumar, 2019).

1.5 Research Design:

The theoretical structure encompassing a research study that is conducted, an investigation plan, and a strategy to find the solutions to the research gaps are termed as a Research design (Kerlinger, 1966). Profoundly some researchers also the term is as the blueprint of the study where the investigations are carried out by collecting, collating, and analyzing the data (Phillips, 1966). Interviews that the researcher conducts and survey tool used along with the observations, experiments, sampling, and sampling frame, analysis of data, and inferences drawn are elaborated in the research design. The chapter in-depth encompasses the following 1) The Type of research 2) Plan for data collection 3) Data Analysis Tools, 4) Research design, 3) Time dimension, 4) Research instrument (Outline and format, Questions, Rating scales, Pre-testing of questionnaire and Pilot-study), 5) Sample Design 6) Reliability and Validity analysis, 7) Normality of data analysis, and 8) identification of Outliers 9) Triangulation. Finally, it provides 10) Summary of research methodology followed.

1.6 Sample Size:

A survey of over 100 respondents across manufacturing organizations in India of different scale and scope and the challenges faced during successful adoption of IoT projects in any of these construct areas. The respondents were filtered using filter questions on their status of adoption.

1.6.1 Plan for data collection:

In the study, multiple objectives had to be met. One was to study the impact of real-time data emerging from the IoT implementation on an automotive supply chain. The second was to recommend the supply chain model with IoT constructs and internal & externally aligned parameters. Therefore multiple plans had to be included, which are mentioned below:

1.6.2 Primary Data Sources :

When the researcher is involved in the collection of data with the help of surveys for investigation as a part of the study, the data collected is termed as “Primary data.” The primary data was gathered via means of the survey from customers and vendors of the automotive industry. While the data was gathered over the online survey the limitations of the same were studied and mitigated. The limitations include: a. Low response rates to the online survey b. Biased data collection if the distribution channel and list is incorrect c. Participants feel disengaged since the context needs to be first understood. d. Without an identifier, it's impossible to gauge whether the right respondent has given the response.

1.6.3 Secondary Data Sources :

When the data is already collected by some other researchers and used for studies about similar areas, the data is termed as “Secondary data.” For the current study, the secondary data is sought from research papers mostly from the supply chain and digital domains, articles reports, books, IoT growth, and supply chain trends from Gartner reports, Forrester Waves, and facts related to the Automotive sector from the SIAM database. A detail list of secondary sources is given in the references section of this report.

1.7 Data Analysis:

Reliability Testing There is a mandatory requirement of 0.60 or above for Cronbach’s α coefficient to demonstrate the internal consistency of the established scales

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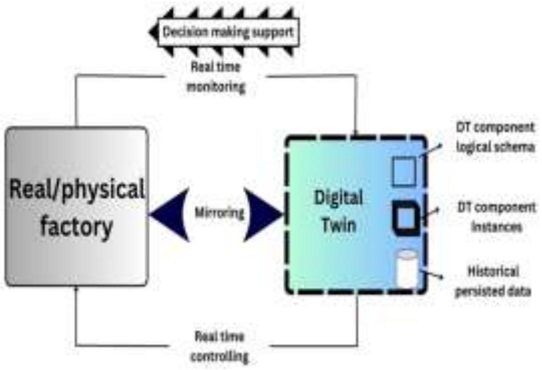
(Nunnally, 1978). The calculated internal consistency (Cronbach's α) is ranging from 0.85 to 0.9 for a sample size of 541. The Kaiser- Meyer- Olkin's (KMO) value calculated was 0.70, and even Barlett's test was observed significant at 0.000 levels ($p < 0.000$) during the data adequacy test, as against a minimum value of 0.5 (Prakash et al.,2011). Composite Reliability is observed > 0.7, while the average variance extracted (AVE) is greater than 0.5. (As reported in the table below). Discriminant validity calculation reveals that all the values of squared correlations are less than the average variance (AVE). It implies that the model has a good fit.



*** Digital twin-IOT In Real Time Monitoring**

*** Composite Reliability and Average Variance Extracted:**

Latent Variable	Observed Variable	Standard Loadings (>0.7)	CR (>0.7)	AVE (>0.5)
Interconnectivity	IC1	0.909	0.894	0.809
	IC2	0.890		
Things related Services	TS1	0.757	0.737	0.585
	ED1	0.772		
Dynamic Change	DS2	0.820	0.813	0.685
	DS3	0.836		
Product Life cycle	PLM2	0.825	0.862	0.676
	PLM3	0.838		
	RR1	0.803		
Prod_cyl	CS2	0.942	0.900	0.800
	CM2	0.942		
Chan_Mgt	CS3	0.972	0.970	0.900
	CM3	0.972		

Composite Reliability and Average Variance Extracted (Source: SPSS)

2. Is there enough awareness about IoT in companies?

Hypothesis 3: Null Hypothesis -H0: There is no enough awareness about IoT in companies

Alternate Hypothesis -H1: There is enough awareness about IoT in companies

Statistical Test: Friedman Chi-square Test

Level of Significance (α) =0.05

Test Statistics Table:

Test Statistics	
N	51
Chi-Square	117.035
df	4
Asymp. Sig.	.000

Observation: X2 (4) =117.035, P=0.000, N=51

Conclusion: Since the p value is less than the level of significance (0.05) the null hypothesis is rejected. Hence it is concluded that there is enough awareness about IoT in companies.

In order to find out where the differences lies we refer to the rank table, which is mentioned below:

Ranks	
	Mean Rank
Awareness about IoT of the respondents	3.23
Conference or seminar attended by the respondent	1.33
Training or workshop attended by key people of the organization	3.01
There is enough awareness about the current state of technology in IoT in My Company	2.95

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When it comes to Technology, what best describes you?	4.48

Regarding various training/conference/workshop/training also the variation is less. From the rank table it has been seen that there is a high variation about the respondents describing themselves when it comes to Technology.

1.8 Discussion:

In contemporary businesses, there is a significant paradigm shift observed. Organizations realized the fact that they cannot compete individually in this ferocious market, which is influenced by globalization. Customers are increasingly demanding connectedness from the organization. The market situation is exploited by global players to attract and retain customers. Organizations thus started competing as supply chains. Businesses are operating with a complex network of business partnerships. Management of such a complicated network of relationships is termed as Supply Chain Management. It ascertains the requisite synergies to the organization for accomplishing the inter-company integrations. Organizations are striving to achieve business process excellence, and Supply Chain Management offers this opportunity with the help of a strategic framework. The framework profoundly consists of three interconnected components, network structure, business process, and management components. The linkages among the supply chain members are documented in the Network Structure. The output of the supply chain is agreed between the member of the supply chain, and the process/activities to achieve this output is covered in the Business Process. These business processes need to be amalgamated and managed. Management components across the supply chain accomplish this.

The conceptual model tested with the Customer inputs revealed the following insights

: • The organization can leverage IoT origin real-time data to effectively manage internally aligned parameters such as inventory management, product life cycle management and reduced returns and build a competitive Supply Chain 158 Conclusion

• Outside-In view from the customers states the dominance of a Supply chain collaboration that is aligned to internal parameters for the longevity of an organization and omits the external alignment

• IoT origin real-time data can be consumed to enhance the Supply Chain efficiency with internal parameters aligned.

• The factor loadings showcase the importance of the Internal parameters on the Supply Chain Management aiding the organization gain strategic advantage

The Automotive industry customer fundamentally buys a product that serves the purpose of driving him from one location to another. Beyond this need, the customer expects the manufacturer to remain connected, offer a superior experience, and consider customer inputs during the development of the new product. For managing such expectations, the organizations adopt digital technologies such as the Internet of Things to gather customer data automatically. The organizational boundaries restrict the flow of such information to the customers while the benefits are offered seamlessly. Customers, therefore, are more inclined to know the benefits provided by the organization than how the organization can deliver the same.

1.9 Recommendations and Suggestions:

The research showcases the impact of IoT origin real-time data on the Supply Chain Management of the automotive industry. In the current era, organizations must remain connected with the customers. Markets are dynamic, and customer demands are volatile. Thus there is an inherent need for real-time data to be transmitted in the fastest possible way. The supply chain needs to mitigate the above challenges. The current research study encompasses all such cases and presents the impact of real-time data on all the supply chain constructs individually and in a collaborated eco-system. Some recommendations and implications of the study are given below.

1. Traditionally the Indian industries were focused on producing and selling the products in the market. The paradigm shift was observed when transactional marketing was replaced by relationship marketing. This brought the concept of being a customer centric organization. Previous studies have proven that about 60% of the revenues are achieved from existing customers. Therefore it is recommended that organizations need to be customer-centric.
2. Digital footprint in India is spreading, with the Internet becoming an integral part of the business process. Yet industries in India have not fully embraced the usage of digital technologies such as the Internet of Things, especially in the supply chain domain. Experts have identified new business and expansion opportunities with the help of digital technologies implemented in the supply chain domain. Thus it is recommended that businesses invest and deploy digital technologies such as IoT in the supply chain domain.
3. The implementation of digital technologies such as IoT allows the organization to capture real-time customer information. Especially in the B2C transactions, this can be of great benefit, wherein the customer buy can be tracked to create a value proposition to the customer. Such value propositions offered to customer's results in customer satisfaction as well as revenue for the organization.
4. Post the demand is inputted in the system, the researcher suggests automation in the planning area basis, in which the demand can be acknowledged and confirmed with a date of delivery. This aids agility in the complete chain and simultaneously improves the planning at the customer end too. Therefore it is recommended to implement systems based on real-time data such as IoT in the warehouse.
5. Organizations involved in the manufacturing of products with a wide range preferably deploy Flexible Manufacturing Systems (FMS). In the case of FMS, information plays a vital role. Information on production schedules, batch sizes, etc. is the critical input to FMS. The effectivity of FMS can be further augmented with the help of the real-time data emerging from the IoT implementation. Real-time data enables quicker changeovers of the manufacturing setups basis the information received from the market. The benefits can be viewed in terms of reduction in the work in progress inventories along with the production aligned to the market demands.
6. The Indian Automotive Industry is greatly influenced by the globalization and the Government taxation policies. The study from the customer perspective reveals customer expectations. The recommended model ignores the externally aligned parameters. The reason being customers consider the external parameters to be aligned as a pre-requisite. For the customers, the organization should be focusing more on the internally aligned parameters to manage the supply chain effectively.
7. The critical vendors profoundly partner with the manufacturers. They solely depend on them for their growth and longevity. When the supply chain model

was tested with the vendor inputs, the recommended model showcases a strong need of the organization to have supply chain collaboration with real-time data emerging from the IoT implementation and external as well as internally aligned parameters. This model is crucial for the automotive industry and can be referred for an effective supply chain collaboration.

1.0 Suggestions:

1. Market are subjected to ferocious competition with volatile demands from the customers. The recommended model is derived by examining the alternatives from the customer perspective for the automotive industry. It is advisable to conduct further studies (basis this model) in other major industries to generalize the impact of real-time data emerging from the Internet of Things on the Supply Chain Management
2. In the current era, suppliers form the primary part of an organization's supply chain. Suppliers are treated as partners by the manufacturers. The recommended model is derived by examining the alternatives from the vendor perspective for the automotive industry. It is advisable to conduct further studies (basis this model) in other major industries to generalize the impact of real-time data emerging from the Internet of Things on the Supply Chain Management
3. The model can be further tested with a larger sample to validate the results.
4. While in the current study covers the Automotive industry, i.e., the manufacturing industry the research instrument can also be tested for other service industries to validate the recommended model
5. While validating the impact of IoT origin real-time data, it was revealed that there are very few companies that have implemented IoT in the complete supply chain. A further in-depth study can be conducted to understand the challenges of the organizations to go ahead with full implementation
6. The present study conducted a comprehensive review of the impact of real-time data emerging from the IoT landscape in the automotive industry. While the research was done, the aspects of Information Security were not considered sufficiently as Information Security is a vast topic in itself. Further studies can be conducted on the Information security aspects of IoT implementation and the recommended architecture.

1.11 References:

1.Abernethy, M. A., & Lillis, A. M. (1995). The impact of manufacturing flexibility on management control system design. Accounting, Organizations and Society, 20(4), 241 258. 2.Acharya, V. V., Pedersen, L. H., Philippon, T., & Richardson, M. (2017). Measuring systemic risk. The Review of Financial Studies, 30(1), 2-47.

3.Afshar, V. (2015). 2016 - The Year of Connected Customer. Retrieved from https://www.huffingtonpost.com/vala-afshar/2016-the-year-of-connecte_b_8833496.html 4.Ageron, B., Gunasekaran, A., & Spalanzani, A. (2012). Sustainable supply management: An empirical study. International journal of production economics, 140(1), 168-182. 5.Aggarwal, C. C., Procopiuc, C., & Yu, P. S. (2002). Finding localized associations in market basket data. IEEE Transactions on Knowledge and Data Engineering, 14(1), 51 62. 6.Ahmed, S., Coenen, F., & Leng, P. (2006). Tree-based partitioning of date for association rule mining. Knowledge And Information Systems, 10(3), 315-331. doi: 10.1007/s10115 006-0010-1

7.Alcott, M. J. (1991). Grocers move to ease life in not-so-fast lane. Sacramento Bee, (April 22), cl. Al-Mashari, M., & Zairi, M. (2000).

8.Revisiting BPR: a holistic review of practice and development. Business process management journal, 6(1), 10-42. Altizon. (2019).

9.Use Cases for IoT | Case Study | Success Story - Altizon Systems. Retrieved 27 December 2019, from https://altizon.com/case-studies/ Ameri, F., & Dutta, D. (2005). Product lifecycle management: closing the knowledge loops.

10.Computer-Aided Design and Applications, 2(5), 577-590. Anderson, A. K., Yamaguchi, Y., Grabski, W., & Lacka, D. (2006). Emotional memories are not all created equal: evidence for selective memory enhancement. Learning & Memory, 13(6), 711-718.

11.Anderson, C. K., & Carroll, B. (2007). Demand management: Beyond revenue management. Journal of Revenue and Pricing Management, 6(4), 260-263. Anderson, E. W., & Sullivan, M. W. (1993). The antecedents and consequences of customer satisfaction for firms. Marketing Science, 12(2), 125-143