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PREGLEDNI NAUČNI RAD / OVERVIEW SCIENTIFIC PAPER

THE FINANCIAL ASPECT OF IOT PROCESS AUTOMATION IN CREATING NEW VALUE FOR THE ECONOMY

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Abstract: *In today's world, devices with possibility to communicate, are emerging and growing daily. This advanced technology is bringing ideas of how to use these devices, in order to gain financial benefits for enterprises, business and economy in general. Purpose of research in this scientific paper is to discover, what are the trends in connecting these devices, called internet of things (IoT), what are financial aspects of implementing IoT solutions and how leaders in area of cloud computing and IoT, are implementing additional advanced technologies such as machine learning and artificial intelligence, to improve processes and gain increase in revenue, while bringing automation in place for the end users. Development of informational society is not only bringing innovation to everyday life, but is also providing effect on the economy. This effect reflects on various business platforms, companies and organizations while increasing the quality of the end product or service that is being provided.*

Keywords*: internet of things, machine learning, predictive maintenance*

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INTRODUCTION

IoT – Internet of things is the new technology that has one main role, to connect various things together. This connection is being done by usage of internet, which means that all these devices are visible in some sort of network. When it comes to the devices and their definition, there is wide range of home appliances such as kitchen devices (fridge, stove, microwave, etc.), smartphones, sensors for various use, like in agriculture, car industries and so on. What is important by IoT that it has wide broad of usage and it can be applied in any industry and in everyday life.

To know what is the financial aspect of the IoT and connectivity of different systems in general, there should be more explanation of the term called digital economy. Digital economy sometimes is mistaken only for transactions in the internet and it is being foreseen the complexity of the connectivity of the society in general. For example, today if someone wants to make additional financial income next to their every day job, they can scale from standard sources of income such as renting a house or an apartment to providing their skills and knowledge in digital form or even provide an applications to perform various tasks. These applications could be intended from streaming of content, everyday task planner to social platforms applications. This can create a source of bigger income that could transfer this initial side job into the company, which has possibility to grow and develop. Just by this example, it is quite easy to see how this process can transfer an initial idea to a financial value for the society in general. IoT implementation can be reflected in the similar process, as this is also considered to be part of digital economy.

In this paper, focus will be on how the connecting of various items or systems, could create a heterogeneous environment, that will create various benefits, from saving time resources to increase of financial revenue for the organizations or the institutions.

FINANCIAL ASPECT OF IOT

They are approximately around more than 8 billion (Knud Lasse Lueth, 2018) connected devices and company Ericsson has predicted that it will grow 29 billion of devices, that 80% from it, will be related to the IoT area. One of prediction regarding car industry alone, is that approximately 60 million cars (Sanel Jakupović and Vesna Novaković, 2017) will be able to communicate with each other or with other devices within the commination infrastructure. Benefit of having so wide range of implementation cases, is also making harder on forecasting the revenue that IoT will bring. Depending on industry IoT will be implemented, the revenue and market share will differ.

Table 1. Number of connected devices in millions from 2014 to 2020 depending on categories

Year	TV	Tablets	Smartphones	PCs	IoT devices
2014	-	-	4100	3200	5400
2020	3300	5500	6000	5000	30000

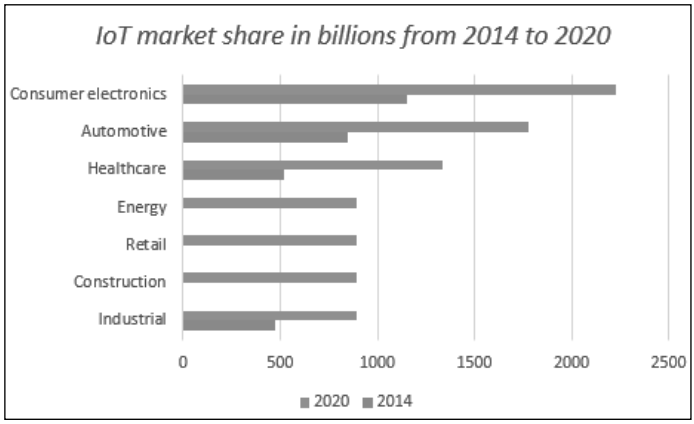
Source: Research results

Table 2. Prediction (in billion) of devices production 2016 to 2022 depending on categories

Year	Wide-area IoT	Short-range IoT	PC/Laptop	Mobile	Fixed phones	Total (billion)
2016	0,4	5,2	1,6	7,3	1,4	16
2022	2,1	16	1,7	8,6	1,3	29

Source: Research results

Figure 1. Chart comparing increase in IoT market share from 2014 to 2020



Source: Research results

For example, industry that is focused on semiconductors, has alone in year 2014 sales with 336 billion US dollars. By 2019 it will reach the 432 billion US dollars. Fastest growing component in semiconductors are sensors, achieving around 10% of share along with memory components with share of 18%, which are crucial for implementation of IoT solutions. Also, semiconductors revenue in wearable category, is from 2013 year where revenue was 15 million US dollars, elevated to 7 billion US dollars, as stated in PricewaterhouseCoopers report for 2015. This has led the semiconductors in also increasing development of other components such as batteries, to support durability and increasing computation components, to support processing of security requirements, which is beneficial for IoT solutions.

Internet of Things is capturing two major trends from product and service-oriented economy to an outcome economy (Bruce Sinclair, 2017). IoT monetizes combining various technologies by selling outcomes.

TOP SOLUTION PROVIDERS OF IOT SOLUTIONS

Market share of IoT as shown above, is getting bigger and bigger. That is the reason why top companies in cloud services are also looking for the way, on how implement solutions for IoT, to be applicable in various industries. Here will be described three companies such as Amazon, Microsoft and Google, in the financial term, how they impact IoT applications market including cloud data storage and data visualization.

Amazon AWS

Amazon AWS is cloud platform, developed by Amazon, which has made in 2018 year a 25,7 billion US dollars. Comparing with 2017 year, this was increase of 47%. It has a market share of 32% worldwide.

Microsoft Azure

Azure is Microsoft cloud platform that are fastest growing cloud services platform. It had revenue in 2018 7.4 billion US dollars, as stated Microsoft in their annual report for 2018. This is compared to 2017 fiscal year an increase of 12%. However according to Microsoft cloud report for 2019, Azure alone, has an increase of 73% in 2019 fiscal year for the Q3 quartal.

Google Cloud

Google Cloud platform is estimated to have revenue of 6.8 billion of US dollars, which puts the Google in third place on the market share, as Canalys has published in their cloud report for 2018.

Benchmark of revenue of the solution providers

To better understand what the market share is, here is the table provided that analyzes the market share and revenue of the top solution providers.

Table 3. Annual cloud revenue and growth comparing quartal Q4 for 2017 and 2018

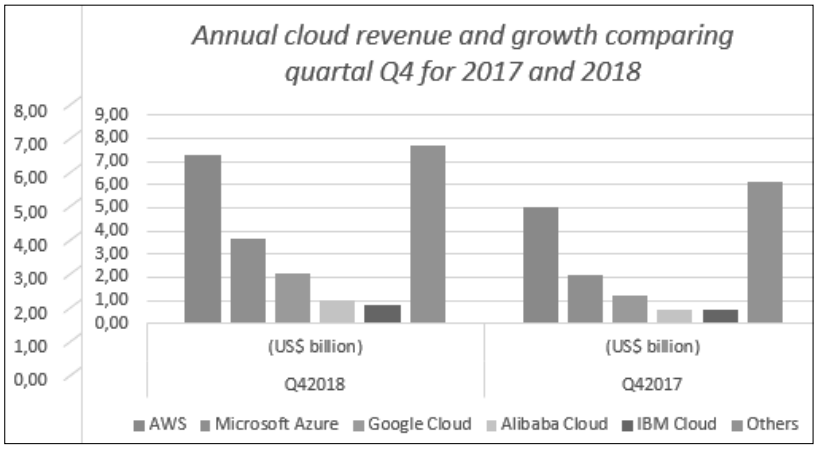
Vendor	Q42018	Q4018	Q42017	Q42017	Annual growth
	(US$ billion)	Market share	(US$ billion)	Market share	
AWS	7.3	32.3%	5.0	32.2%	+43.6%
Microsoft Azure	3.7	16.5%	2.1	13.7%	+75.9%
Google Cloud	2.2	9.5%	1.2	7.6%	+81.7%
Alibaba Cloud	1.0	4.2%	0.6	3.5%	+73.8%
IBM Cloud	0.8	3.6%	0.6	4.2%	+27.6%
Others	7.7	33.8%	6.1	38.9%	+26.7%
Total	22.7	100.0%	15.6	100.0%	+45.6%

Source: https://www.canalys.com/newsroom/cloud-market-share-q4-2018-and-full-year-2018

All solution providers are not so eager on representing their financial data into detailed categories, but they rather group other sections that are not specifically related to IoT and cloud, but they include other products, such as their commercial online products and social jobs platforms. This makes it bit difficult to have specific data, but what is clear, that growth of IoT and cloud platform will continue to spread in fast paced tempo.

However, as it can be seen from the table above, as market is getting bigger there is a linear growth of the revenue from the top solution providers. If this continues for the 2019 fiscal year, this projects a growth for all of the providers, with a minimum increase of quarter of the value of their current growth. Of course, it all depends on how innovative, scalable and beneficial their solutions for the end clients and customers will be.

Figure 2. Charts comparing Q4 for 2017 and 2018



Source: Research results

IMPLEMENTATION OF IOT ARCHITECTURE WITH MACHINE LEARNING – RECOMMENDED SOLUTION

Having announced Microsoft to spend 5 billion US dollars on IoT by 2022 year, it makes pretty much clear of where the future of IoT relays (Julia White, 2018). Here is shown a case study of recommended implementation of an IoT in company and what are the benefits and disadvantages. This case study recommendation will be based on Azure IoT platform as one of the strongest growing IoT platforms in the world.

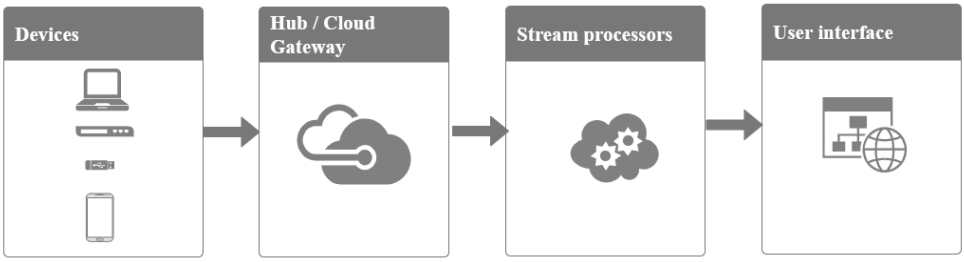
The company called Rockwell wants to have their devices connected from all over the world, they need to have two-way communication, easily to add new devices to IoT network, to have real time analytics and ability to have data visualization. Focus is on this case study not only to get devices to be connected and have overall preview, but also to implement predictive maintenance, that has huge impact on finance and people's safety.

Structure of IoT solution follows, according the reference IoT architecture from the Microsoft:
- Devices
- Hub / Cloud gateway
- Stream processors
- User interface

Devices to be considered an IoT device must be able to send or receive data from the cloud. Hub oversees sending and receiving data to devices and controlling access to them. Stream processors are responsible for processing of data and storing the data. User interface is the end system for users being able to explore and visualize the data.

For all these elements in IoT architecture, Microsoft has implemented a set of communications rules and algorithms. Each device has an API (Application Programming Interface) supported for various programming languages to communicate with. For Hub it has implemented secured communication with several various protocols and implementation of device connections to the cloud. For stream processing there is stream analytics service, for quickly processing data and providing data to pass on to the end users. This end user service is called time series insights and it is responsible for representing data to the user in meaningful manner.

Figure 3. Architecture of IoT solution



Source: Research results

To implement predictive maintenance solution, it must be clear that this belongs to the term of predicting future events. To predict a future event, it should be looked at the past data. It is important to find patterns in huge amount of data, that could help us in determine the outcome based on the new data that is coming in to our system. This is where machine learning comes in place.

Here are the six process that help us in building a machine learning model:
- Determine the outcome we want to achieve
- Identify potential sources of data
- Centralize, normalize and process data
- Model, test and iterate
- Validate model against the live data
- Integrate the model into daily operations

Our first step is to know what the end result that is being looked for is and what is the achievable outcome. In our case, goal is to prevent failures of specific sensors or machines, that could cause money and time costs.

Second process is to know what data sources are available for disposal. This phase is crucial because it is necessary to build predictive maintenance model based of data that is required to be processed. These data can be log data, sensors data, environment data etc. This is where is needed to identify all relevant data from with our enterprise or our business domain.

Third phase is the phase where our data will be connected into one data set, so it will be able to process it. All different data source can have various data type formats such as JSON from IoT device, text data format from log files, etc. Here the processing must be implementing like cleanse, normalize and combine our data, or in short, data preparation. This can be the lengthiest process, based on types of data that must be transformed into single data type format.

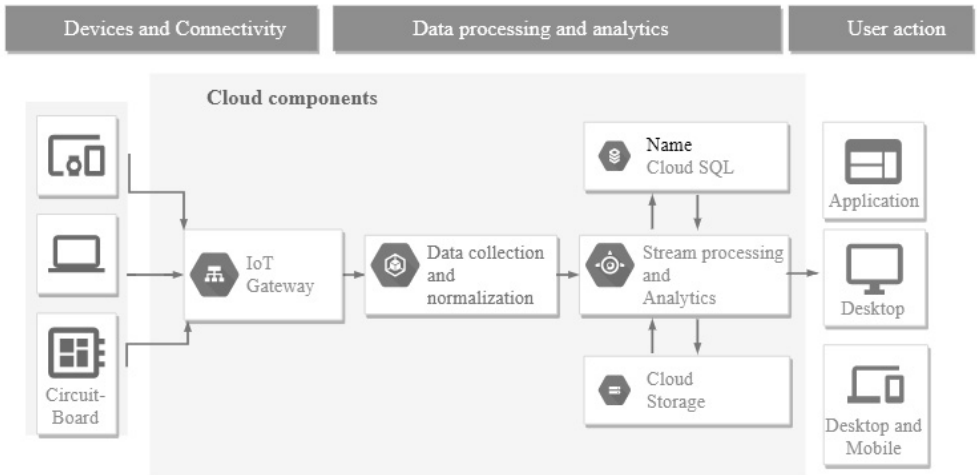
In the fourth phase, we are identifying patterns in data, by using statistical models to determine which analytics technique is best to implement. This is where model is being developed, by using test data and going through iteration until "fine tune" of the expected results is finished.

For the fifth phase, model for predictive maintenance is ready, and ready to test real data, data from production. Our model is still not released into the produc-

tion, as this is only meant for validation if our model is performing well, within controlled environment that has a production-like conditions.

The final phase, the sixth phase is for releasing predictive maintenance model into the production. This is the phase where model can also be in semi-phase released. When it is released, it will automatically create work logs in the customer relationship management tool, so technicians can inspect and repair the devices, and then later to create auto-scheduled maintenance, to replace the devices, etc. This helps in improving processes in general, with stocking the less parts, ordering on time right parts or devices, etc.

Figure 4. Diagram of implementation of machine learning in IoT, based on architecture



Source: Research results

What is also important in stream processing part, that Microsoft has his own data storage, based on SQL Server, which has huge power in processing data needed for building models for machine learning, including predictive maintenance model.

Benefit of using Azure platform (Sanel Jakupović and Hrnjica Bahrudin, 2016) is, that is so easily scalable, providing three category types:

- Infrastructure as A Service, IAAS
- Platform as A Service, PAAS
- Software as A Service, SAAS

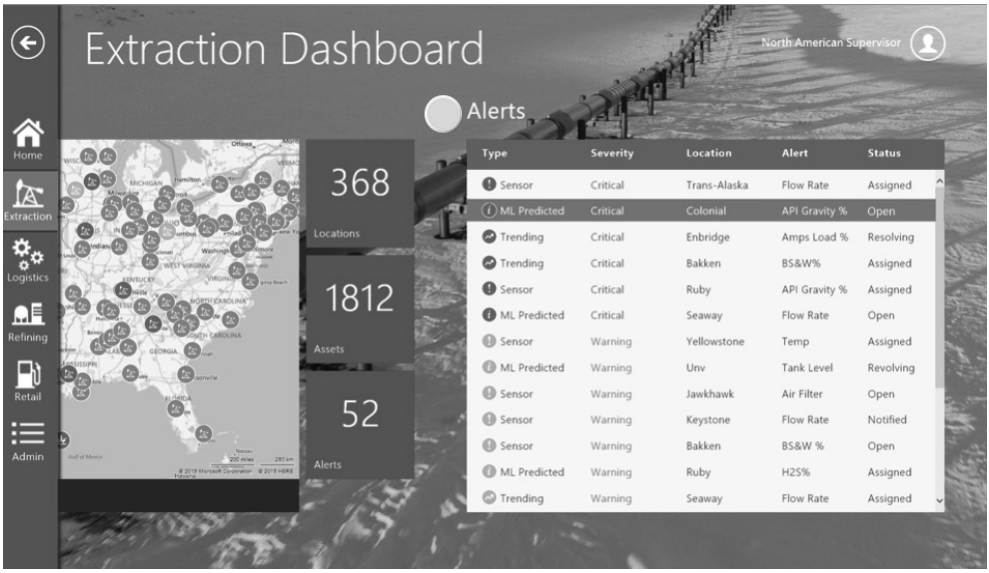
Infrastructure as A Service, IAAS, is mostly used for deployment of virtual machines, or using advantage of rented hardware infrastructure.

Platform as A Service, PAAS, is widely used platform as here is provided not only the virtual machine and infrastructure, but also preinstalled software or large range of software applications in general, required by the end user. This is including wide range of applications, also including database engines such as Microsoft SQL Server.

Software as A Service, SAAS, as its names implies is offering software hosted in the cloud. Here end users have their credentials where they simply use software as it is, and all data is stored on the cloud. Best example for SAAS is Office365, Outlook, Skype, etc.

Within our case study recommendation, we can use all of three, depending on how custom or general solution is needed to be implemented. PAAS implementation is the most general one, as all software is already built in and provided for building predictive maintenance.

Figure 5. Interactive dashboard for end users, showing IoT device statuses



Source: https://demos.azureiotsolutions.com/demos/predictivemaintenance

BENEFITS OF IMPLEMENTATION OF PREDICTIVE MAINTENANCE

Based on improvements when implementing predictive maintenance, as Microsoft has published in their solution accelerators report, it has come to the following results:

- 5% improvements in machine life time, based on reducing and anticipating machine breakdowns, with emphasis on keeping optimum work performance
- 50% reduced downtime based on preventing possible failures. Hour of machine not working can be calculated on delay in production, not to mention other indirect processes being blocked by downtime
- 40% reduction in maintenance cost when performing schedule maintenance that is not needed. By receiving data coming from the devices, system will be able to calculate and predict the results, notify the supervisors based on data processed, what is needed to be inspected and eventually changed or repaired
- 25% reduction in employee's safety, by predicting breakdowns that could result in harming the employees working with this equipment and minimize the danger occurring as end effect from these malfunctions
- 20% saving in operations. This means that when machines are not performing well, there will be energy costs occurring, material if being used by machine that is not used optimally, etc.
- Improved data analytics, by collecting all data from devices and machines, there can be planned and implemented solutions that will improve processes in our organization
- Improved quality of product, which will lead to improve satisfaction by end users and clients.
- Increased performance in the future processes, as predictive maintenance will create knowledge base that can be used guidance for recognition of possible failure and how to resolve these issues in best possible manner

APPLICABLE INDUSTRIES FOR PREDICTIVE MAINTENANCE

Predictive maintenance can be used pretty much everywhere where we have IoT and machine learning together implemented. From food industry to automotive industry, including pharma industry and oil industry, it will be great help in improving production and safety. Some of the industry that is already implementing IoT with predictive maintenance:

- Gas and oil industry are one the richest industries with great risk of impacting quality of life and environment. NASA together with US Navy had made survey where they have found out that 82% are random machine failures,

which could be prevented with implementation of predictive maintenance.
- Automotive industry is the first industry that has developed just in time methodology for manufacturing, since late sixties and early seventies years. They have implemented robots and various sensors to increase production and supply chain. One of great examples in automotive industry is cooperation of IBM with their Watson IoT and Jaguar Land Rover auto brand.
- Airlines is one of the most sensitive industries that requires accurate data integration, in order to preserve safety and punctuality in their everyday business. This where predictive maintenance with IoT can contribute to provide higher level of security including economic growth in aviation industry in general. One of good example is Delta Air Lines, where they had almost 5200 flight cancelations due to maintenance. They successfully improved predictive maintenance including Big Data for gathering and analyzing data, which has helped them to bring flight cancelation to zero. This company had 14.8% increase in operating margin in 2017 as result of implementing all these changes and had made 3.6 billion US dollars of net profit (Kevin Michaels, 2018).

CONCLUSION

By analyzing the economic aspect of IoT systems, it is concluded that bright future is ahead of IoT. Also, in addition to the financial point of view, here is presented an architecture of IoT proposed by one of the key market players, and how it can be scalable and productive at the same time. What is important, that combination of new technologies such as Machine Learning and Artificial Intelligence, easily can be implemented in the overall solutions of IoT, making IoT even more efficient in automatization of processes, creating new value for the businesses and producing an increase in financial revenue.

The area of implementation of IoT is practically unlimited, starting from health care, agriculture, logistic, transportation to banking and homes. Another important factor of IoT is the safety where it resembles in saving of people lives and various assets. This benefit alone creates a huge value for the society.

What is important to know, that IoT opens up the whole new dimension in economy, where increase of business opportunities are helping companies and organizations generate new stream of income. Just by implementing new models and services in IoT, end users and customers are getting more efficient and automated processes, cost savings and above all, increased safety and security.

Future of IoT is bright and it will definitely continue to develop and grow. Network connectivity is improving fast i.e. 5G wireless network, artificial intelligence implementation is growing fast, different platforms are being developed for synchronization and orchestration of various systems, which all of these create factors that helps IoT to become a standard way of our society development. With this in mind, IoT is definitely creating a financial value in our economy, and this is just a part of its limitless functionality.

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