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WEB BASED CLOUD SOLUTION FOR SUPPORT OF QUALITY MANAGEMENT 4.0 IN THE CONCEPT OF INDUSTRY 4.0

Abstract: *New technological advances in complex production systems, accompanied with digitalization and implementation of different forms of information technology supported the paradigm Industry 4.0. This concept on the other side have making strong influence in all accompanied paradigms so right now we can talk about things such as Quality 4.0. In this paper we will research how implementation of ICT systems, especially web based applications, clouds and open source tools could contribute in development of the solution for improvement of the quality management. The specific system for management of quality documentation will be presented.*
Keywords: I*ndustry 4.0, Quality 4.0, QMS, DQMS, web applications, Node.js, Angular, MongoDB, Cloud*

1. Introduction

Advances in technology that form the foundation for Industry 4.0 will transform production: isolated, optimized cells will come together as a fully integrated, automated, and optimized production flow, leading to greater efficiencies and changing traditional production relationships among suppliers, producers, customers and between human and machine (Rüßmann et al 2015).

These new technologies that form main pilars of industry 4.0 are (Rüßmann et al 2015, Lee et al. 2015, Brettel et al. 2014): Big Data and Analytics, Autonomous Robots, Simulation, Horizontal and Vertical System Integration, The Industrial Internet of Things, Cybersecurity, The Cloud, Additive Manufacturing, Augmented Reality.

Industry 4.0 have large imapct on differnt areas so we have concepts such as: Quality 4.0 (Gunasekaran et al., 2019), Maintenance 4.0 (Franciosi et al., 2018; Scurati et al., 2018), Safety 4.0 (Badri et al., 2018), Cybersecurity 4.0 (Lezziet al., 2018), Operator 4.0 (Peruzziniet al., 2018), Logistics 4.0 (Barreto, et al., 2017), or influences and connections with SCM, Lean (Sanders et al 2014).

In this manusctipt the scope will be on Qualiy Management in the concept of Industry 4.0. Some authors stated that Quality Management and ISO 9001 standard have the great impact in three key aspects of Industry 4.0 (vertical, horizontal and end-to-end engineering integration) (Foidl & Felderer, 2015). Also it is clear that number of suggested pillars of Industry 4.0 could be employed and used for improvement of practice and concept of Quality Management. Having clear and precise documentation that supports Quality Management System DQMS is important part of all Quality Management System, also the concept of DQMS has been changing and eveolving by usage of new solutions ans new environemnts such as Indistry 4.0 pilars: big

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data and analytics and usage of cloud systems. In this manuscipt the possibility of implementation of web based cluode systems for documentation of qualtiy maagement system will be explored, specific arhitecture suggsted and as well as initail solutions described.

2. Basic principles of ISO 9001:2018 and connection to Industry 4.0

In analysis of quality management system and documentation for quality management system it is alwaus usefull to start with general principles and basic elements of ISO 9001:2015 standard. The seven quality management principles according to ISO 9001:2015 are:

1. Customer focus,
2. Leadership,
3. Engagement of people,
4. Process approach,
5. Improvement,
6. Evidence-based decision making,
7. Relationship management.

These seven basic principles are the main principles in ISO 9001: 2015 standard meaning that all companies: need to meet customers requirements and expectation; leadeers to develop right conditions in which all employees are included and engaged in achieving stated quality objectives; that employees at all level are essential to enhance its capability to create and deliver value; that evrything is based on porcess approach; where successful organizations have an ongoing focus on improvement; all decisions are based on the analysis and evaluation of data and information adn where for sustained success, an organization manages its relationships with interested parties, such as suppliers. These are seven quality management principles and on the other hand we can

Although “Industry 4.0” is the common term referring to the fourth industrial revolution, academics still struggle to properly define the approach, but mostly they are agree that this concept covers Cyber-Physical Systems, Big Data and Analytics, Autonomous Robots, Simulation, Horizontal and Vertical System Integration, The Industrial Internet of Things, Cybersecurity, The Cloud, Additive Manufacturing, Augmented Reality.

It is clear that some of the basic principles of quality management could be dramaticly improved using new trends suc as big data and analytics could improve evidance based decission making or using the cloud technologies for storing data could improve quality control and management as well as the quality management could improve horisontal and vertical system integration.

Quality documentation is important in the modern companies. Good documentation is the foundation of a QMS. Quality docyumentation covers processes or actvities and enables company to perform their processes and activities in accordance to specific standard. Generaly it covers: quality policy, quality manual, procedures, work instructions, quality plans and records.

So it is important to examine new technologoies that could provide new qulity in development, implementation and manintenence of documentation of quality management system.

3. Technologies and arhitectures for development of web based cloud solutions for support of QM 4.0

On the first place elected technologies should enable some important principeles for development of software support for DQMS such as: interoperability, deceentralization, real time capability, modularity and service oriented approach. In order to enable

selected task and to enable realization of concept of Industry 4.0 through improved vertical and horizontal integration the following componets are selected:

1. **Node.js**® as Java Acript rutime based on Chrome V8 Java Script engine as wolution based on open source. Node.js is a working environemnt for JavaScript which could be used on the frontside of web application. It is very usefull and high quality environemnt for application that work in real time and wher we have large data exchange.
2. **Node Package Manager** (NPM) is repositorium that could be used for exchange and usage of open srouce code that makes application high quality and represents de facto universally software repository for *font-end* and *back-end* development. There are number of available libraries and modules for JQuery, Bootstrap, React and Angular and compoents for frameworks such as i Ember and pacages for mobile platforms, IoT, front end, back end.
3. **MongoDB** is popular NoSQL data base. It is possible to downald MongoDB (https://www.mongodb.com) or use the data base on comercally availabe clouds. MongoDB keeps data as JSON documents with dynamic schems, it is non relational DB and it does not use SQL for connection, it is distrubuted and with open code.
4. **Angular** is JavaScript framework which is used for development of dynamic web aopplication and mobile applications. It is developed by Google and enables development of structured application whicha re easy for testing and amintenance. Angular uses Type Script. Angular introduced web componets as a key development component, so it demands differnt arhitecture. Righ nowthe NAgular 7.0 version is in use.
5. **Laravel** is a free, open-source PHP web framework that could be used for development of back end of application and connection with SQL data bases and legacy systems on one side as well as with single page applications developed in Angular or Reject (based on java Script).
6. **MySQL** as free source SQL data base or MySQL Enterprise Edition provides a simple, automated, and integrated and enterprise ready MySQL cloud service, enabling organizations to increase business agility and reduce costs.

This listed compnets could be used for development of solution for development and mainenence of documentation of quality system that could be used in concept Industry 4.0 providing better opportunities for vertical and horisotnal integration using new technologies, and new devices providing the best possible software support.

4. Cloud based, software solution DQMS 4.0

The general arhitecture of cloud based software solution for DQMS 4.0 is presented on the figure 1 employeing the software, data bases and technologies that are listed in the previous sections.

On the first place the front end for application DQMS 4.0 is developed using Angular as Java Script framework, also it could be used Reject but the general idea is to habe single page application n th front end with responsive design (using Bootstrap) in order to adjust for usage at differnt hardvare (using mobile platforms, notepads, lap tops or desk top computers). The complete application is web based enabling users to use, browse, controle or even to develop the DQMS using differnt devices. Also iptions as scaning QR is used to provide the additional information at different secors or places int he company.

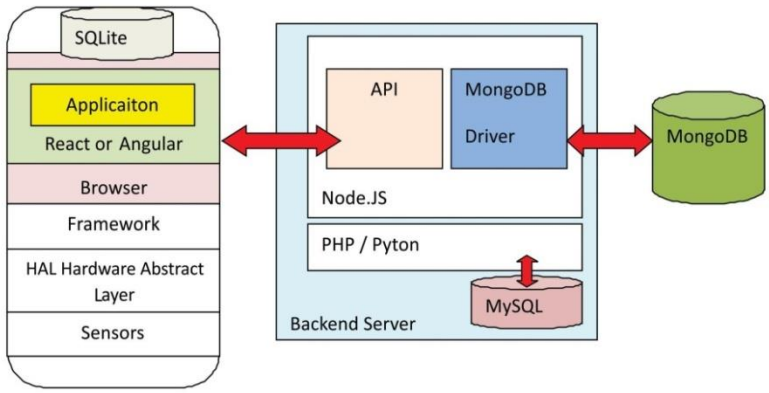

Figure 1 - Software architecture of the system

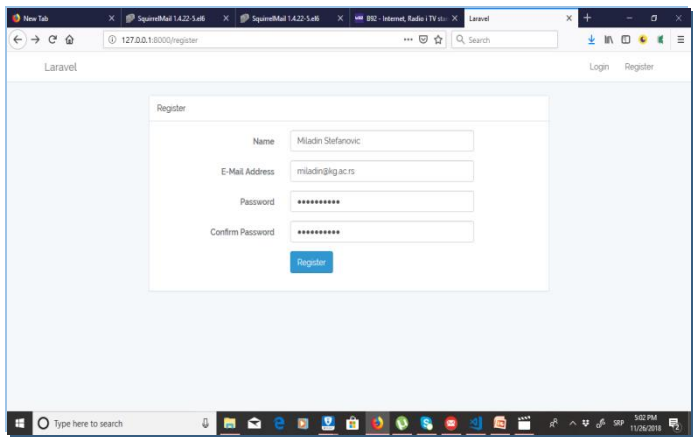

Figure 2 - Login for DQMS 4.0 system

The SQLite database was used on the client side for storing basic data about users (identification parameters, parameters for system access). The front end plart of applciation could acces this data base and store some data and to provide sinchronization when it is needed. The next compponent is Node.js with the aim to enable execution of JS code outside the browser and provides back end of application accompanied with connections with NoSQL Mongo.DB as well as PHP/MySQL or other legacy system. The Laravel and PHP are used for development of back end part of the applciation as well as providing the connections with legacy MySQL or other legacy SQL data bases in the company. All documents are structured using JSON formats and stored in MongoDB pn the cloud which enables flexibility of the system, keeping differnt versions of documentations and accesability to the system.

5. Conlusion

The quality management is important part of the new concept Industry 4.0 and development, implementation and maintenance of documentation of quality management system is also importnat task.

Quality management system could contribute in better horisontal and vertical integration in the concept of Industry 4.0 on one side and coul benefit fromusing the targeted technolgies such as Data Mining and Analytics, cloud systems and proide th feed back in decision making based on the evidence (as a basic principle of qualty management accodring to ISO 9001:2015).

In this paper the new technologies usefull for develoment of ne cloud based system for development, usage and maintenance of quality manangement documentation is presented. The solution is based on web technologies, cloud system, and noSQL data bases. The suggested arhitecture and developed system enables: reposnsive design, interoperability, deceentralization, real time capability, modularity and service oriented approach. On the other hand it could be important part in the concpet of Industry 4.0.

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