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Opportunities and Challenges of Industry Revolution 4.0

Tangerang, 18th August 2018

Volume 5

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Preface

It is with a thankful heart to God that the proceedings of the ACMIT (Annual Conference on Management and Information Technology) 2018 is published. This is the publication of the papers which were presented during the conference ACMIT 2018 which was held at Swiss German University (SGU) on Saturday, 18th August 2018.
The theme of the conference was "Opportunities and Challenges of Industry Revolution 4.0". This theme is chosen since Industry Revolution 4.0 is coming, and we have to prepare for it. The theme was mainly reflected in the plenary sessions with the following speakers:

1. Ojahan Hutajulu, owner of PT Satunol Mikrosistem, who has given a presentation on "Reality of IoT Wireless Technology"
2. Sri Sardjananto, VP Business Process & System Integration at PT Aerofood ACS, who has given presentation on "Creating a Competitive Advantage in Digital Era (Case Study: Inflight Catering)"

In this conference a special session was also given for the presentation of the papers from the students of Master of Mechanical Engineering Swiss German University. This study program was also a co-organizer of the ACMIT 2018.
It is hoped that the published papers in this proceedings can be beneficial for the readers.

Tangerang, 26th September 2018

Dr. Eka Budiarto, S.T., M.Sc.
Head of Steering Committee

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Food & Beverage	: Catering

Rundown ACMIT 2018

08:30 – 09:00	: Registration
09:00 – 09:15	: Prayers and singing the National Anthem of Republic of Indonesia
09:15 – 09.45	: Welcoming speech by Head of MIT, Dr. Eka Budiarto, S.T., M.Sc as Chairman of Committee
09.45 – 10.00	: Welcoming Speech by SGU Foundation Chairman, Dr. med Frans Tsai by opening the ceremony
10:00 – 10:45	: First plenary session by Bpak. Ojahan Hutajulu (Owner PT. Satunol Mikrosistem)
10:45 – 11:30	: Second Plenary Session by Bpak. Sri Sardjananto (VP Business Process & System Integration)
11:30 – 12.00	: Q&A
12:00 – 12:15	: Photo session
12:15 – 13:30	: Lunch break
13:30 – 15:30	: Parallel sessions There will be 3 sessions. In each session there will be 7 presentations. For each presenter, 10 minutes time is allocated for presentation, added with 5 minutes for question-and-answer session

Schedule of Parallel Sessions
ACMIT 2018 – Saturday, 18 August 2018

No.	Time	Presenter	Moderator
1.	13:30 – 13:50	Paulus Agung Krismantara	Dena Hendriana, BSc., S.M., Sc.D
2.	13:50 – 14:10	Bibit Hartono	
3.	14:10 – 14:30	Singgih Aji Wibowo	
4.	14:30 – 14:50	Jepi Yuli Hindarianto	
5.	15:10 – 15:30	Agus Triyanto	
6.	15:30 – 15:50	Edy Sujiwo	

No.	Time	Presenter	Moderator
1.	13:30 – 13:50	Rafie Djajasoepena	Dr. Eka Budiarto, S.T., M.Sc
2.	13:50 – 14:10	Q Fadlan	
3.	14:10 – 14:30	Ricky Setiadi	
4.	14:30 – 14:50	Ardian Thresnantia Atmaja	
5.	15:10 – 15:30	Boaz Krisaputra Handoyo	

Routine Monitoring DCC CMM using Laser Interferometer

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Abstract. Manufacturing deals with the high quality product due to the accuracy which produced by measuring machines. In other case, the performance of regular diagnostic of measuring machine should be maintained to aim confidence and reliability in the measurements result. One of the equipment that can reach high accuracy is Direct Computer Control Coordinate Measuring Machine (DCC CMM). The accuracy of DCC CMM is a critical factor that affects result of product measuring. Operator need the higher accuracy machine to maintain the DCC CMM Performance and the consequent of the machine should has better accuracy than the DCC CMM accuracy it self. One of that tool is laser interferometer which has better accuracy than DCC CMM specification and produce the data and can be analyzed for DCC CMM performance. The consistent performance of the DCC CMM is constrained by the errors that brought by the machine error that occurs on a periodic basis on the account of machine usage, machine age and operating temperature. DCC CMM accuracy was compensated and improved by identifying the machine condition. This condition also applicable for predict the machine errors.
Keywords: DCC CMM, Accuracy, Laser Interferometer, Confident

1. Introduction

Manufacture industries are growing and request high quality product. To maintain high quality product, it is necessary to have high quality measurement equipment. Coordinate Measuring Machine is invented to gain the requirement of high accuracy measurement tools with the flexibility as the benefit. Moving parts as the Coordinate Measuring Machine should be calibrated and verified in order to ensure the machine's performance. This research has a purpose that Laser Interferometer's application can be applied as a Direct Computer Control (DCC) Coordinate Measuring Machine (CMM) routine monitoring and verification. In the last decade, DCC CMM has become main quality machine which inspect the final products that have a lot off accuracy and tolerance. Modern machining combined with CMM maker have developed the technology as higher measurement accuracy for a 3 + 2 axis DCC CMM. To gain the machine standard specification, calibration is a preventative action which conducted as basic machine specification by using a standard measuring artefact and compared to the machine scale. The test should be done several times to get the repeatability and the value of true scale reader. The value represented by scale and compare to the artefact / reference [1]. Routine monitoring for DCC CMM accuracy has a relation with the calibration of the DCC CMM. Calibration result will show the whole DCC CMM performance and capability. The capability is represented by the machine accuracy. Accuracy that showed in the parameter requirement affects to criterion of machine performance including quality assurance, quality inspection product, and traceability. Calibration results will maintain the machine performance for further processing of measuring requirement. DCC CMM performance should be maintained to ensure the measuring of the products can be accounted for. The monitoring results applied as one of the maintenance action for several DCC CMM to keep the performance after the machine calibrated. This action is important for maintaining confidence and reliability in the measurements [2].

2. Coordinate Measuring Machine

In the ISO 10360-2, a Coordinate Measuring Machine is a measuring system that has a moving probing system that has a function as a sensor. As the sensor, the probing will have a trigger and send to the machine controller to determine spatial coordinate as X, Y, Z position on the work piece surface. [2]. Coordinate Measuring Machine also gives a Cartesian coordinate that has a physical realization with whole system. CMM is used to measure the dimension of work piece by calculating Cartesian coordinate, and by the new technology, the machine has a capability measure the error of the work piece and compare to measurement request that provide by original drawing. The information of the workpiece will be shown as actual shape, size, form, location, and orientation and will be used for metrological evaluation. Workpiece will be evaluated using collecting data on its surface at certain points or an area generated by software calculation. The software will store different of sensors, both contact or laser/noncontact sensors, continuously/ scanning or discreetly. Each measuring point is determined in terms of its measured coordinates. The probing and sensors collect the direction of vector for each measuring point which usually provide better accuracies. [3]. Every Coordinate Measuring Machine have to mention the term of Maximum Permissible Error (MPE). The standard machine accuracy showed in the MPE value. Maximum Permissible Error contains Maximum Permissible Error (MPEE), Maximum Permissible Probing Tolerance (MPEP). Specifications are referred to as just E, P, THP etc. The most common accuracy terms of CMM mentioned in ISO 10360-2 : Volumetric Length Measuring Error E or MPEE.[4]

3. Laser Interferometer

Laser is a beam of concentrated light which possesses enormous amount of energy. The word LASER stands for: Laser Amplification by the Stimulated Emission of Radiation, which means that energy is coming from stimulated light produce by electromagnetic radiation[5].Using a laser for a measurement is a method that using phenomenon of interference of frequency that produce by waves (usually light, radio or sound waves). In the interferometry, a user will measure the wavelength difference that produced by a laser equipment. The difference of laser gap is happened when the additional equipment such like an optical device is moving. The moving devices will produce characteristics of the waves themselves and the materials that the waves interact with. Characteristic of the wave has a displacement result. The study of the techniques that use light waves for measure wave displacementIn addition, are described as interferometry. By measure the displacement, laser can be used for calibration and mechanical stage motion control in precision machine [6].

3.1. Principles of interferometry

Laser light

The output from a laser can be considered as a sinusoidal wave of light.

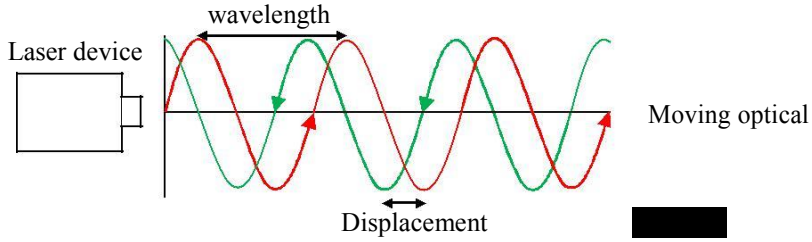

Figure 3.1. Picture of Laser Wavelength

Laser emerging light wave with the properties as:

- The wavelength of laser is precisely known, produce by laser equipment, determine accurate measurement. The accuracy is 0.5 ppm
- The wavelength is very short,that produce high resolution and precise measurement. The resolution is 0.1 nm
- All waves are in-phase, allowing interference to occur

Due to the modern technology, laser displacement interferometers utilise Helium Neon (HeNe) laser tubes. The HeNe tubes have a 633 nanometre (nm) wavelength output [7]. The homodyne interferometer using a HeNe laser as its source is a commonly used position sensor. By calculate using Michelson setup, there will be minimum two optical. One is fixed optical and the other one is moving optical. The moving optical can move and create relative displacement. The distance of the moving optical can be calculated with sinusoidal pulses. The speed information can thus be obtained by measuring its frequency. Other optical needed to determine the direction of the travelsuch like angular, rotary, linearity, etc. [8]

Figure 3.2. Laser Optics

4. CMM Verification : ISO 10360

ISO 10360 explains about standard CMM verification. The CMM verification are done periodically. Usually once a year and done by CMM maker. This standard currently has six parts consist of acceptance and reverification test for CMM that used for linear measuring dimension, CMM with the axis of rotary table and fourth axis, CMM with scanning application, CMM that using multiple-stylus probing system, and estimation of errors in Gaussian feature [2].

When verify CMMs, basically concentrates on two parameters which as probe error and length measuring error using a probe and stylus sensors that represented by ISO 10360-2. Verification of probe error has purpose to know character of probe, module and stylus that assembled as a machine sensor to get the value of repeatability in the measurement action. The sensors is calibrated using calibrated sphere with a specified value, the number of probing touch/points and determining a limiting value (probing error) from the range of the individual points around the sphere as an associated element. Length measurement causes error which takes several factors into error account include the probing behavior of the sensor, the length-dependent measuring error resulting from mechanical guideway errors, software geometry correction, and the length-dependent measuring error resulting from thermal behavior [3].

4.1. ISO 10360-2 (2009)

ISO CMM verification, especially 10360-2: Part 2 (ISO 2001a, 2009a) this standard is focused on the CMM structure accuracy including the scale reading and software. Standard tests of ISO 10360-2 is measuring the length of five calibrated block of artefact in each of seven different position, locations and orientations within cover minimum of 75% the CMM working volume. The position and orientation are recommended by parallel axis X, Y and Z of CMM and along the four diagonals volumes of the CMM (see Figure 4.1). The length of five block gauge

measured three times each. Total measurement is 105 value of length measurements. Measure Permissible Error of E (MPEE) is measured of 105 errors, is plotted in machine specification and machine figure issued by manufacturer's maximum permissible error specification (see Figure 4.2) [2]

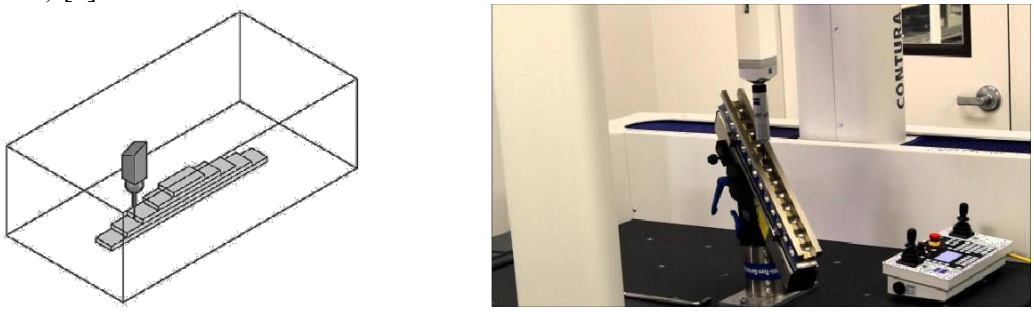

Figure 4.1. Measurement line in calibration procedure on five calibrated lengths reference block along a CMM axis.

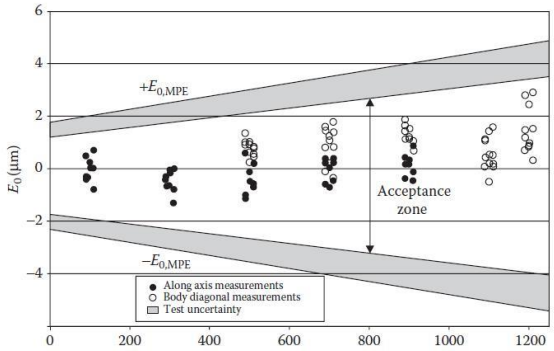

Figure 4.2. Machine verification result E values from the ISO 10360-2 testing procedure; the grey area shows the manufacturer specification an acceptance value.

In CMM Terminology, maximum permissible error is a indication of a CMM for size measurement error, EL, MPE, is stated in one of three forms:

a) E_L, MPE = ± minimum of (α + *L*/K) and B;
b) E_L, MPE = ± (α + β/K) ; or
c) E_L, MPE = ± B

where :
α is a value of positive constant, by unit in micrometers and stated by the manufacturer; K is a constant value/ dimension supplied by the manufacturer (ussually 1000 mm);
$_L$ is the measured size, in millimeters; and
B is the maximum permissible error EMPE, L, in micrometers, as stated by the manufacturer

Figure 4.3 DCC CMM Crysta Apex S by Mitutoyo and Prismo by Carl Zeiss

Measuring range	X axis	19.68"(500mm)	
	Y axis	15.74"(400mm)	27.55"(700mm)
	Z axis	15.75"(400mm)	
Resolution		0.000004" (0.0001mm)	
Guide method		Air bearings on each axis	
Drive speed		8-300mm/s (CNC mode), max. speed: 519mm/s	
		0 - 80mm/s (J/S Mode: High Speed)	
		0 - 3mm/s (J/S Mode: Low Speed)	
		0.05mm/s (J/S Mode: Fine Speed)	
Max. measuring speed		8mm/s	
Max. drive acceleration		2,309 mm/s2 (3D)	
Workpiece Maximum height		21.45"(545mm)	
Maximum mass		396.8lb(180kg)	
Mass (including the control device and installation platform)		1,135lbs.(515kg)	1,377lbs.(625kg)
Air supply Pressure		58 PSI (0.4MPa)	
Consumption		1.76CFM (50L/min) under normal conditions	
Air source		3.53CFM (100L/min)	
Probe used		Maximum permissible error (E0,MPE) ISO 10360-2:2009	Maximum permissible probing error (PFTU,MPE) ISO 10360-5:2010
SP25M (Stylus: ø4 X 50mm)		1.7+3 L/1000 (temperature environment 1)	1,7
		1.7+4 L/1000 (temperature environment 2)	1,9
TP200 (Stylus: ø4 X 10mm)		1.9+3 L/1000 (temperature environment 1)	1,9
		1.9+4 L/1000 (temperature environment 2)	1,9
TP20 (Stylus: ø4 X 10mm)		2.2+3 L/1000 (temperature environment 1)	2,2
		2.2+4 L/1000 (temperature environment 2)	2,2
		Temperature environment 1	Temperature environment 2
Limits within which accuracy is guaranteed	Temperature Range	20±2 °C (64.4-71.6 °F)	16 - 26 °C (60.8-78.8 °F)
	Rate of change	1 °C per hour or less 2 °C in 24 hours or less	1 °C per hour or less 5 °C in 24 hours or less
	Gradient	1 °C or less per meter	1 °C or less per meter

Table 4.1. The CMM sepecification due ISO 10360 (Crysta Apex S 500 Series, Mitutoyo Corp.)

5. System Qualification, Verification, Calibration and Machine Error

In field of manufacturing, Operator and Original Equipment Maker (OEM) CMM are using terms Calibration instead of Verification. CMM operators and OEM do the calibration by the probe the probe or getting the CMM calibrated to ISO 10360. Most of the calibration refers to ISO 10360-2 and ISO 10360-4 (Probing Error) since the Repeatability and Probing sensors has the main influence of the machine accuracy. To avoid confusion the correct terms are listed below:

There is one part of CMM that should be qualified by a task every day to determine the radius of stylus tip. Stylus or Probing system qualification will do before the CMM operator measure part to verify stylus tip diameter, stylus position compare to master ball.

CMM verification is a regular job that do by periodically by CMM engineer to check the machine accuracy still meet the specification. CMM calibration is a twenty one kinematic error checking to determine the errors. The calibration will put the machine as brand new due to mechanical and software system. On the performance checking, this activity applied as error mapping a CMM [2]

5.1. Twenty-one kinematic error

Error mapping activity is provide by maker to calculate the 21 geometric error and deviations that can occur in an articulating machine including CMM and machining centers.

The software will work for processing measurement result and all the data input. The software will compensate all the data to the controller of the machine. The deviations are majorly of these types (see Fig 5.1): (a) Linearity (3), (b)Straightness (6), (c)Rotation (9), (d)Squareness (3).

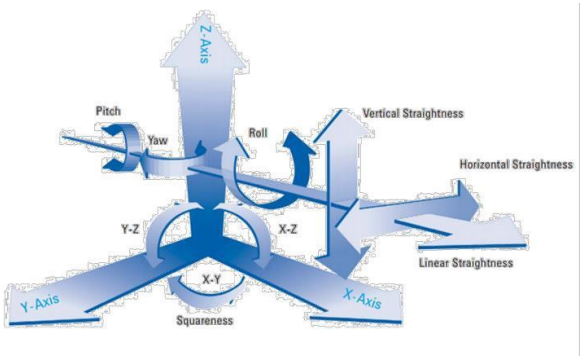

Figure 5.1. Twenty-one geometric deviation

5.2. Basic machine tool measurements using laser

Twenty-one geometric deviation that happen as a machine error can be captured by Laser Interferometer. Following measurements can be performed using lasers (Figure 5.2): (a) linear pitching and positioning accuracy. This linear and positioning also provide repeatability of axis, (b) straightness of axis, (c) squareness between axis, (d) flatness of surface, (e) rotary axis angular positioning, (f) angular pitch of axis, and (g) dynamic characteristics of machine tool. these factors.

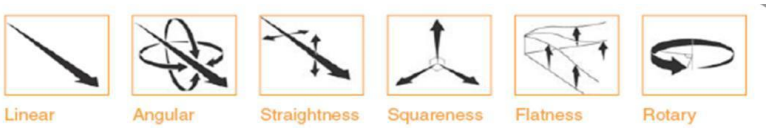

Figure 5.2. Basic Measurement using Laser

Laser interferometer provide the actual movement of the machine. The actual movement will be compared to the software result and for mapping of the machine error. The benefit for using laser interferometer is the uncertainty of measurement caused by external factor such like Environmental compensation (see figure 5.3), and material thermal compensation (see Table1). All the measurements provided by laser interferometer has been calculated in 20º C as the International temperature reference.

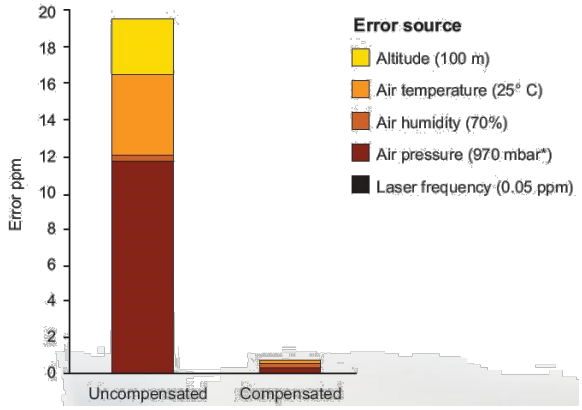

Figure 5.3. Comparison of environmental compensation refer to error source

Table 1. Coefficient of thermal expansion

Application		Expansion coefficient Ppm/ºC
Iron/steel	Machine structural elements, rack and pinion drives, ballscrews	11,7
Aluminium alloy	Lightweight CMM machine structures	22
Glass	Glass scale linear encoders	8
Granite	Machine structures and tables	8
Concrete	Machine foundations	11
Invar	Low expansion encoders/structures	<2
Zerodur glass	"Zero" expansion encoders/structures	<0.2

6. Routine Monitoring DCC CMM

The matter of this paper is using laser interferometer to do routine monitoring for DCC CMM. Due to terms of verification of CMM, which mentioned that verification is a task carried out at periodic intervals (often annually) to determine if the CMM still meets the manufacturer‘s specification, ISO 10360-2 is a acceptance and re-verification tests for coordinate measuring machines (CMM) for measuring linear. While the machine will operate for whole day, error will occur during the operation. CMM has characteristic that the component will wear due to the usage. The error will be check periodically in linear movement. A linear error means that the component error increases linearly with a proceeded length. A harmonic error has the form of the corresponding term of the Fourier series. [9]. Laser interferometer measurement can represent the performance of DCC CMM report in order to accuracy information. CMM and Machine tools have the location and position error. Since the accuracy is determine by 105 error as mentioned before, and will takes a time, the machine performance can be monitored by linearity checking using Laser Interferometer. Laser will provider error position and location direct in true condition. Pitching error or location error can be collect thru the axis movement..

6.1. Why choosing Laser Interferometer

When the operator facing multi-brand machine, the operator has to verify the machine regularly. The DCC CMM machine has several checking parameter that could be maintain fast. The linearity, positioning and repeatability each axis are enough parameter to check the machine performance fast. Measurements on different CMMs can be related to the international standard of length in a variety of ways depending on the design of the CMM and the transfer standards used. Figure 6.1 shows how the

laser interferometer accuracy can be adapted to CMM accuracy. With the 0,5 ppm (part per million accuracy) laser interferometer achieve the golden rule of calibration which has 1:10 better accuracy. Also at the top there is the wavelength of the iodine-stabilized HeNe laser, which is measured relative to the frequency of the atomic clock. Second level of pyramid shows laser Interferometer has better accuracy and traceability. With 0,5-1 part per millionth, laser interferometer can measure CMM movement and give the feedback for maintanance.[3]

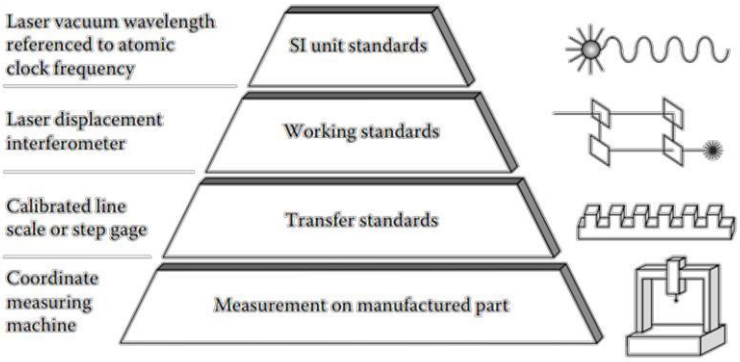

Figure 6.1. Pyramid of measurement with the best accuracy.

With the higher accuracy (0.5ppm) and higher resolution (1nm) compare to DCC CMM accuracy (1.7 μm + 3L/1000 mm), laser interferometer is applicable for doing CMM verification and calibration. Environmental and Thermal compensation make laser interferometer is traceable. All the task of calibration and verification already compensate to 20ºC as ISO 10360-2 standard. Flexibility and ease to use application are become added value.

7. References

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The Potential Of Blockchain Technology To Change International Mobile Roaming Business Model

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Abstract. The key objectives of this paper is to propose a design implementation of blockchain based on smart contract which have potential to change international mobile roaming business model by eliminating third-party data clearing house (DCH). The analysis method used comparative analysis between current situation and target architecture of international mobile roaming business that commonly used by TOGAF Architecture Development Method. The purposed design of implementation has validated the business value by using Total Cost of Ownership (TCO) calculation. This paper applies the TOGAF approach in order to address architecture gap to evaluate by the enhancement capability that required from these three fundamental aspect which are Business, Technology and Information. With the blockchain smart contract solution able to eliminate the intermediaries Data Clearing House system, which impacted to the business model of international mobile roaming with no more intermediaries fee for call data record (CDR) processing and open up for online billing and settlement among parties. In conclusion the business value of blockchain implementation in the international mobile roaming has been measured using TCO comparison between current situation and target architecture that impacted cost reduction of operational platform is 19%. With this information and understanding the blockchain technology has significant benefit in the international mobile roaming business.

Keywords: Data Clearing House; International Mobile Roaming; Blockchain, TOGAF

2. Introduction

Nowadays, Mobile Network Operators (MNOs) are facing trends that are rapidly transforming their networks and even their business models. As well as international mobile roaming (IMR) services that MNOs need to reshaping strategy with the pricing and bill shock swiftly to ensure subscribers utilize roaming services in increasing usage of traffic. In the context of mobile telecommunication network, the word of international mobile roaming (IMR) is used when a mobile phone is used outside of the range of its home network and connects to another available cell visited network (GSMA, 2012a). For example: a subscriber used the mobile telecommunications services in one country is able to use his or her mobile device in other countries. As the following describes in Figure 1. When a customer starting call during roaming, the retail price will have consumed for some cost elements: the wholesale charge for using the visited network, costs of interconnection link network, data clearing house platform for CDR processing fees, signalling fees between the networks, home operator's retail costs and taxes. Data clearing house is a intermediary system that acts as central authority to exchanges and processing of call data records (CDRs) and settlement between home operators and visited operator (GSMA, 2012b). The research problem on this paper is that the existing architecture of international mobile roaming has been used intermediary Data clearing house (DCH) as central authority for call data record processing between Mobile Network Operators. In term of business model each of operator will be charged platform fee and data processing fee with an expensive cost component

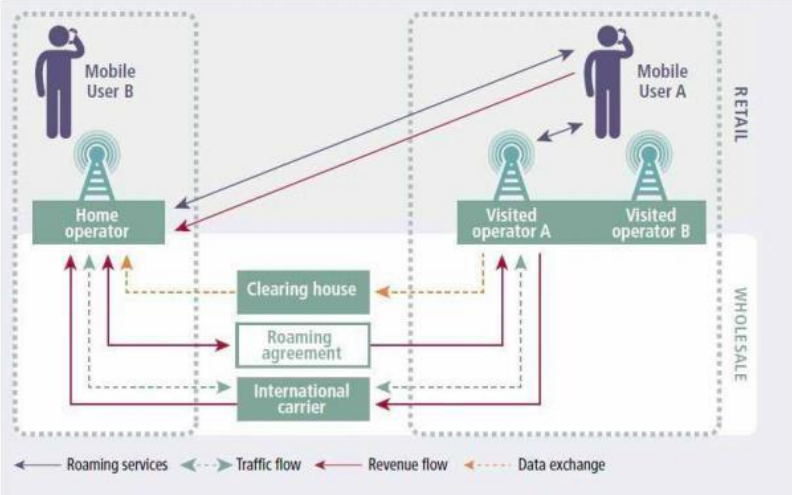

Figure 1.Commercial required for international roaming (GSMA, 2012b)

By developing a smart blockchain contract it has the potential to be implemented to cellular network operators that have roaming agreements. The real-time settlement using blockchain based smart contract as games changer to replace the method of offline billing information exchange between roaming partners used DCH. Automatic triggering of roaming contract based on call/event data which enables online charging and avoid in roaming fraud cases. Applications of blockchain technology have capabilities beyond the cryptocurrency. Blockchain could be eliminates the intermediaries player who have not any impact in the business architecture. Each transaction in the private chain ledger is verified by consensus of a majority of the participants in the system in simply means, blockchain is "a distributed database comprising records of transactions that are shared among participating parties"(Leon Zhao et al., 2017). Blockchain technology substitutes for the trust which under the central authority exchange data transaction. As a database which offers "data security, transparency and integrity, anti-tampering and anti-forgery, high efficiency, low cost"(Zhu and Zhou, 2016). The objectives of this paper is to propose a design implementation of blockchain based on smart contract which have potential to change international mobile roaming business model by eliminates third-party data clearing house.

2. Literature review

2.1 International Mobile Roaming

The review of the literature with international mobile roaming should be start with defining the concept of international mobile roaming. As this definition the possibility of roaming by telecommunications subscribers travelling between two countries requires a roaming 'route', which depends on the existence of commercial arrangements between mobile network operators ('MNOs') . (Kotlowitz and Tania, 2016). The terms and conditions of international roaming agreements are largely generic, with net settlement payments managed through a third-party clearing house between the MNOs. The roaming agreements and the required rating and billing facts are managed through the relevant billing system's roaming observe- up functions. The exchange of roaming events is managed by an outside broker, which is a data clearing house (DCH) .

2.2 Blockchain Based Smart Contracts

The literature of blockchain concerning in the capabilities of blockchain technology to enhanced business value of international mobile roaming services. The Blockchain implements a method to reach an understanding between two entities that exist in the blockchain. Called a "smart contract", is that of blockchain application make it viable to exchange an asset without third parties being aware of the transfer. This opens up the possibility of disintermediating the entire legal system and creating a new form of virtual agreements (Deloitte, 2017). One of the ideas behind smart contracts is to remove the middleman player in value chain of business to function as an intermediary, ensuring that the contract is executed (Alvseike et al., 2017). Moreover, smart contracts are not written in legal languages but are

written as computer programs and these computer programs have the ability to define strict rules (Tuesta et al., 2015). In addition, smart contracts can be programming in order to support a business logic driven by data. The conclusion of this literature is that the application of blockchain technology goes far beyond cryptocurrency. The ability of Blockchain can eliminate the presence of traditional business agreements with intermediaries involved through smart contract solutions.

2.3 TOGAF (The Open Group Architecture Framework)

The Open Group Architecture Framework (TOGAF) is a framework for enterprise architecture, which provides an approach for designing, planning, implementing, and governing an enterprise information technology architecture. According to the previous paper from (Sökmen, 2016) that TOGAF can helps organizations to design and implement a technology management architecture that meets the needs of the business. It is a comprehensive framework for developing a broad range of different IT architectures. This paper applies the TOGAF approach in order to addressing architecture gap to evaluate by the enhancement capability that required from these three fundamental aspect which are Business, Technology, Information. Most importantly, it enables to design, evaluate, and build the right architecture to enterprise. Figure 4 shows the diagram of TOGAF ADM lifecycle

3. Method (Material and Methods)

The analysis method of this paper using comparative analysis with the current situation of international mobile roaming business that commonly used framework from TOGAF Architecture Development Method (ADM) and will be validate using business value analysis by calculation of Total Cost Ownership comparison. This paper applies the TOGAF approach in order to addressing architecture gap to evaluate by the enhancement capability that required from these three fundamental aspect which are Business, Technology, Information. The TOGAF is used as a framework to develop and maintain enterprise architecture which have the requirement management process at the center of Architecture Development Method (ADM) in order to maintain traceability between requirements and the architectural structures (Sökmen, 2016). Based on the architecture gap evolution used TOGAF ADM there will be propose new design architecture of international mobile roaming business by involving of blockchain capability using smart contract solution and then there will be validate the business value. The validation of business value is used Total Cost of Ownership calculation. In general, the IT industry uses Total Cost of Ownership (TCO) to define acquisition cost, usage cost, O&M, of a feature to determine the feasibility of a purchase. (Barreneche, 2015). Figure 5 shows the method of analysis framework for this research.

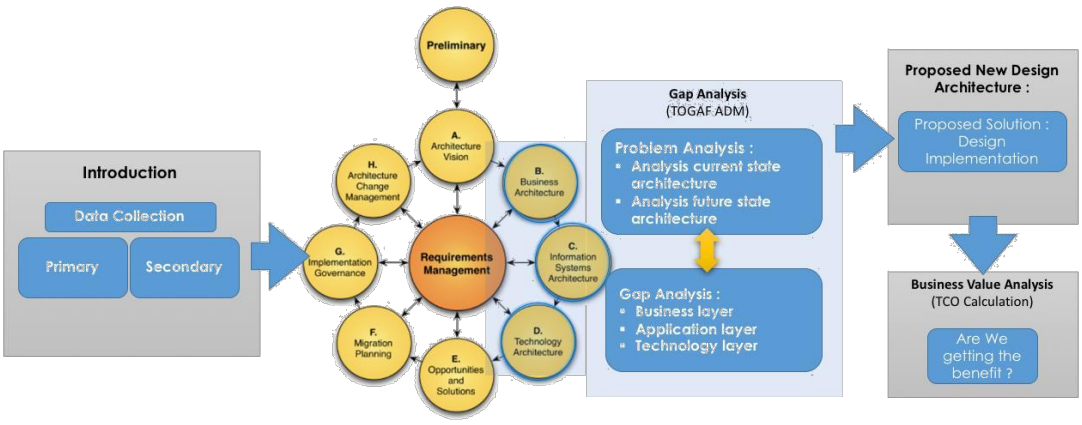

Figure 5. Method of analysis framework using TOGAF (adapted from The Open group, 2011)

The primary data are collecting from 3 main areas which are: (1) existing architecture and component cost for DCH system from company which running on International mobile roaming business, (2) contract roaming agreement from Mobile network operator company, (3) The data of high level architecture and business proposal for smart contract deployment from blockchain solution provider

company. While for the secondary data there are used desk research of previously papers, company white paper concerning blockchain technology and international mobile roaming service.

4. Result and Discussion

4.1 Gap Analysis with TOGAF framework

As describes in the Table 2. The architecture gap analysis based on TOGAF for phase B, C and D which are (B) Develop Business Architecture: Develop baseline and target architectures and analyze the gaps, (C) Develop Information Systems Architectures: Develop baseline and target architectures and analyze the gaps, (D) Develop Technology Architecture: Develop baseline and target architectures and analyze the gaps.

Table 1. Comparison of current and target architecture of International Mobile Roaming Business

Gap Analysis	Current Architecture	Target Architecture
Business Layer	There is high chances of disputes being raised between Operators since the exchange of billing records are offline	Lower operational overheads and cost leading to financial product
Application Layer	The offline billing information exchange between roaming partner through DCH system	Automatic triggering of roaming contract based on event data which enable online charging
	Dispute resolution process is also offline executed by DCH by validating the CDRs and contracts of all partners	Repository of verifiable transactions between operators allowing for quick dispute resolution
Technology Layer	The roaming agreement and the required rating and billing information are managed through the central billing system by using DCH system	Blockchain based smart contract is a software program on the the distributed ledger, allowing an immutable, verifiable and secure record of all contract

4.2 Target Architecture

The current and target solution using blockchain technology to provide as describe in the figure 6.

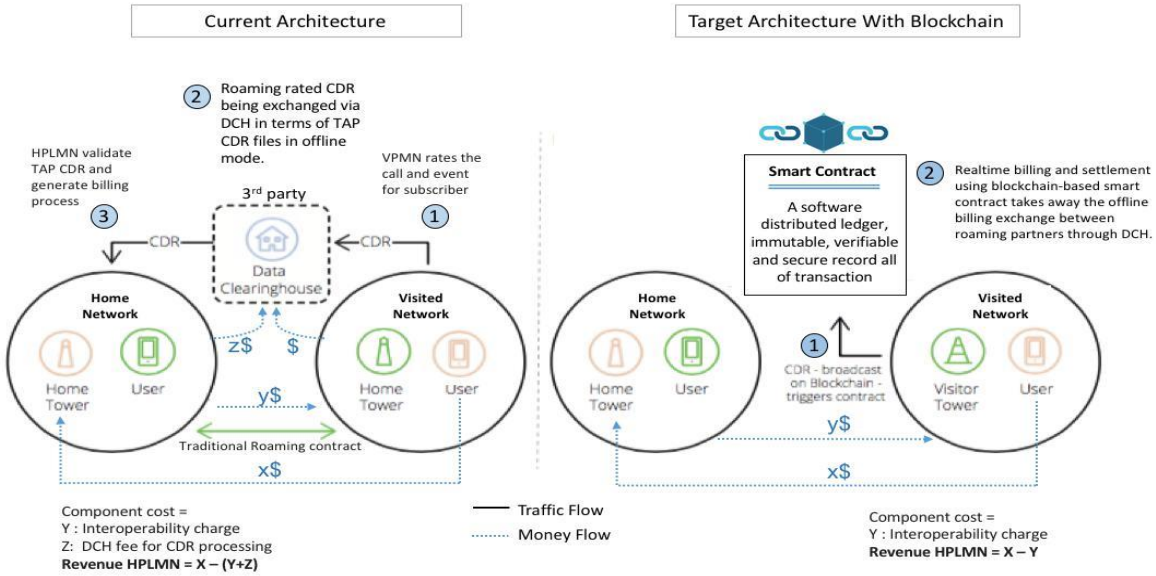

Figure 6. High level architecture IMR with blockchain smart contract

A capability of blockchain can be applied between mobile network operators that have a roaming agreement. The roaming agreement is carried out among the home network and the visited network as a smart contract this is prompted whilst a transaction containing the CDR information is broadcasted on the blockchain network. Every time a subscriber triggers an event in a visiting network, the visited network broadcasts the CDR information as a transaction to the Home network. This information triggers the smart contract and the terms of the agreement are done. The home network can thus automatically calculate the billing amount based on the services rendered and send this information back to the visited network. This helps instantaneous and varied authorization as well as settlement to occur in line with blockchain based smart contract terms. MNOs can also do eliminates with the DCH as intermediary, resulting in reducing operational cost.

4.3 Business Value Analysis

Based on the primary data from internal company that running for international mobile roaming business with existing DCH system have the two main component cost, which are platform fee and CDR processing fee. In this case we get the data from MNO that has 29 roaming partner for platform fee per month is around IDR 151,000,000 and IDR 4,700,000 per month for CDR processing fee. as describes in Table3 The TCO calculation using 5 years business case with the NPV result is IDR 6,817,559,123

Table 2. TCO calculation for existing DCH solution

TCO Current System	Year-1	Year-2	Year-3	Year-4	Year-5
Platform fee	1,812,000,000	1,812,000,000	1,812,000,000	1,812,000,000	1,812,000,000
TAP-CDR Processing fee	56,400,000	62,040,000	74,448,000	96,782,400	125,817,120
TOTAL	1,868,400,000	1,874,040,000	1,886,448,000	1,908,782,400	1,937,817,120
NPV	6,817,559,123				

Comparing the TCO calculation where used blockchain smart contract solution there are have 3 component cost which are initial setup fee, manage service and cloud infrastructure. Based on the primary data from Blockchain solution provider that initial setup fee is IDR 1,800,050 for one-time charge, which are cover whole project activities including resources for project manager, blockchain developer, UI/UX developer and system engineer for project time delivery is 3 months. While for the manage service cost is IDR 270,000,000 yearly based. Could infrastructure is required for this deployment, referring cloud subscription fee from Amazon web services that dimensioning based on requirement for 20 nodes is IDR 630,000,000 yearly based. The TCO calculation using 5 years business case with the NPV result is IDR 4,610,441,689

Table 3. TCO calculation for Blockchain solution

TCO of Blockchain	Year-1	Year-2	Year-3	Year-4	Year-5
Platform fee	1,800,050,000				
Manage Service	270,007,500	270,007,500	270,007,500	270,007,500	270,007,500
Cloud Infra (20 nodes)	360,000,000	360,000,000	360,000,000	360,000,000	360,000,000
TOTAL	1,868,400,000	1,874,040,000	1,886,448,000	1,908,782,400	1,937,817,120
NPV	4,610,441,689				

The comparison of Total cost ownership between existing DCH solution and using blockchain solution in the first year the blockchain solution cost higher than DCH solution, however in the second year until five years cost of blockchain solution lower than existing DCH solution. In summary that used blockchain smart contract solution generate the cost reduction around 19% as describes in figure 7.

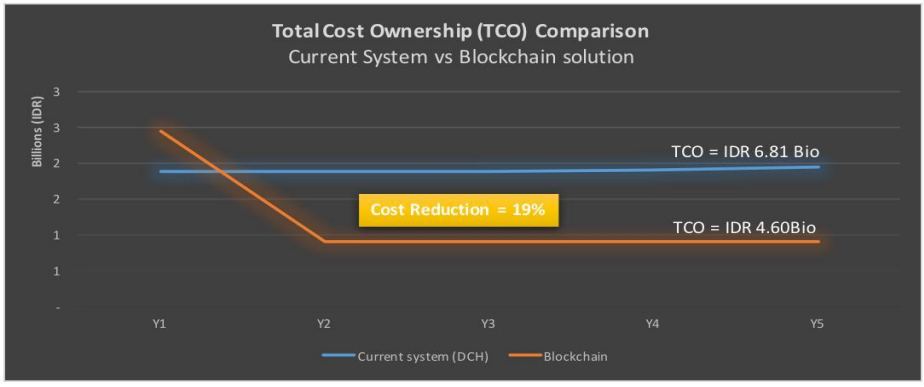

Figure 7. TCO Comparison

4.4 Validation Approach

In order to validate the reference architecture expert interviews have been conducted. The qualitative method is used to validate the propose target architecture and objectives of this research. There are several direct interviews were conducted with five experts from the telecommunication industry background and blockchain solution provider. The main section interview consisted of the background of the current international mobile roaming business, overview of capability blockchain smart contract based, the propose design architecture and business model canvas. In the last session of interview, we ask the interviewees to provide the explanation about alignment of this research objectives. All interviewee agreed with this architecture can be running well the blockchain as solution to roaming business, however some additional architecture integration needs to be improved to make smart contract deployment more suitable solution for data clearing house implementation. Basically blockchain smart contract architecture have the static data base method which the roaming contract agreement should be well converted into smart contract logic in the beginning of logic deployment. Due to blockchain have ability is immutable data, once changes of the contract agreement there are more complicated things to do which required effort to upgrade and migration to the latest version. To accommodate this condition, the deployment smart contract in International Mobile Roaming case is strongly recommended that to separate data base into two type which are static database and dynamic database. Where the static data which containing permanent information in the contract agreement (e.g: money flow) will be store to internal blockchain network protocol. While the dynamic data which containing periodically change information (e.g: rate, charging) there will be store to the dynamic database which excluded in the blockchain network. So that once any change of contract that impacted to code deployment is not disturbing to the central blockchain network. The following below in figure 8 the enhanced target architecture with blockchain.

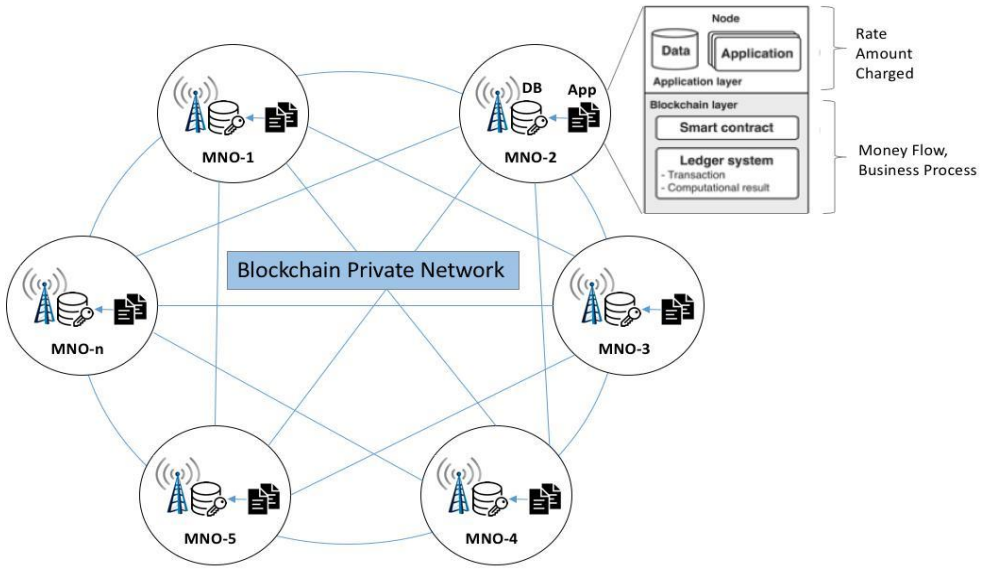

Figure 8. Enhanced Target Architecture with Blockchain

4.5 Conclusions

From the data above we can analyse that architecture blockchain smart contract solution able to eliminate the intermediaries DCH system in the international mobile roaming business. With the

blockchain the business model of international mobile roaming could be change with no more intermediaries fee for CDR processing. The online billing and settlement for Peer to peer connectivity among the mobile network operator become a value proposition to avoid dispute because of the offline CDR processing in the legacy DCH solution. In conclusion The business value of blockchain solution has been measured that cost reduction of 19% can be generated. With this valuable information and understanding the blockchain technology has significant benefit in the international mobile roaming business.

4.6 Recommendations

There challenging for the blockchain deployment in the international mobile roaming that should be consider which is the international mobile roaming services is a standardized by GSMA. Therefore, to make blockchain acceptable by MNOs globally, it should be standardized business process which is facilitated by GSMA as a worldwide community of MNO. The other thing is the paper is limited by the analysis for business value of blockchain technology in the international mobile roaming business, to make more comprehensive analysis the future research is needed on the risk analysis of deployment the blockchain smart contract in international mobile roaming service.

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Health 4.0: body management for autoimmune using instant messaging technology. Case Study: Autoimmune

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Abstract. Autoimmune disease is caused by our immune systems that attack our body. The autoimmune patients are treated by doctor that is specialized in neurology. The doctor will only give them some treatment to maintain the condition of the patient. Every patient has different body condition therefore the doctor treatment is different to manage each patient condition. It is important for the doctor to pay attention give different treatment to each patient depend on the autoimmune they have, and the patient condition. One of the method in monitoring patient condition is by doing frequent communication with the patient, so the body condition of patient can be controlled. In recent years, there are many kinds of technologies that the doctor can use to communicating with patients. One of the technology is instant messaging. The authors will conduct a descriptive research on how instant messaging can help the doctor and autoimmune patients managing the quality of life by using questionnaire and analyzing the result.

Keywords: instant messaging, autoimmune, quality of life

1. Background

In recent year, the technology has been developed very rapidly. The impact of the new technology has revolutionized many industries. The Internet of things, or cyber-physical systems, is one of the new technology that gave big impact to the industry. The healthcare industry beginning to utilize internet of things by using bio sensor to connect to the virtual world. It could be use in the management of autoimmune because it could optimize the accuracy and allow for the precise mapping of symptoms. Furthermore, the autoimmune patients can be encouraged by internet guided interventions to implement more physical activity in their lives. This cyber-physical system could flag up sudden changes in their daily activities, which well be associated with a flare up (Kumar & Sharma, 2017). Technology can help monitoring patient's vital signs by remote monitoring (Thimbleby, 2013). According to the International Telecommunication Union, the number of mobile phone users are more than 5 billion in the world and more than 85% of the world population is covered by commercial wireless signals (Ebrahimi, Mehdipour, Karimi, Khammarnia, & Alipour, 2018). Mobile phone apps have been used in healthcare recently. According to journal, mobile phone increase attention of patients as one of potential tools for supporting cancer patient. Authors found the presence of instant messaging technology have brings benefits in the field of healthcare. This journal discussed about the use of Instant Messaging lectures for autoimmune patients (Rincon, et al., 2017).

This apps can also empower patient to do their activities more effectively, support their behavior changes in daily life, help their self-monitoring to take care of their symptoms, increase their education of symptoms, and improve the patient's self-confidence by the feeling of being in contact and monitored with their healthcare team (Rincon, et al., 2017).

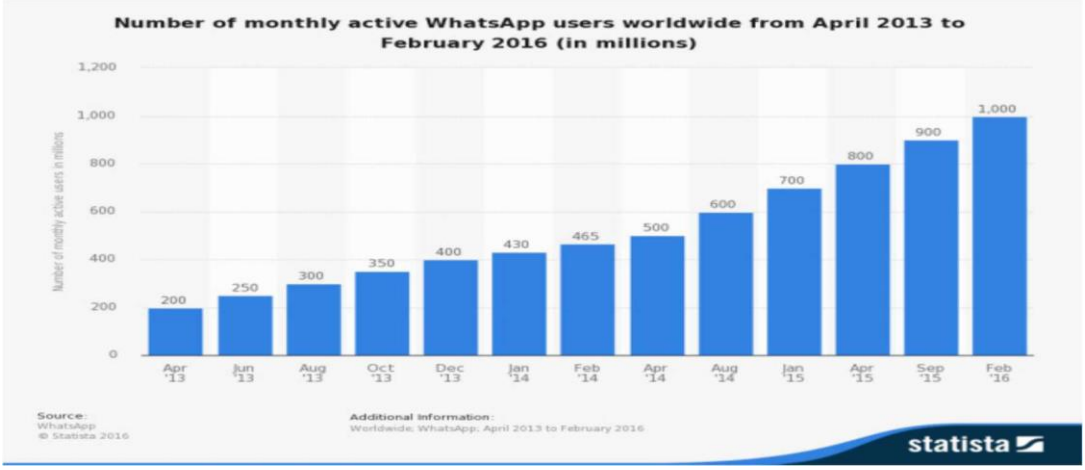

Figure 1. Survey Analysis on the usage of Instant Messaging Messenger (Kumar & Sharma, 2017)

First, Authors learn about technological strengths and weaknesses in Instant Messaging. However, there are some patients that have concerns of their healthcare environments. The authors try to review how using instant messaging apps can improve patient's health. Some journals explain that instant messaging beside for communication, instant messaging can be used for other things, such as to spread information to communities group. Thus, instant messaging can be useful for education, health, etc. (Head, Noar, Iannarino, & Harrington, 2013). Since there are only a few mobile apps that focused for improving patient's quality of lives, we learn about the impact of instant messaging for improving patient's quality of life.

2. Literature Review

2.1 Autoimmune

Autoimmune can be defined that the functional immune system of the body of Autoimmune patient have "horror autotoxicus" as defined by Paul Erhlics's (Cho & Gregersen, 2011). Taking care and managing the body are needed for people with autoimmune disease Stable condition of each individual with autoimmune is the key that every patient can achieve their quality of life (Plante, 2018)

Each individual has different perspective of quality of life. It depends on some factors, such as environment. Environment become one of the key to make body can heal itself. The environment can help autoimmune patients manage their body by knowing and learning to the signal of their body themselves.

2.2. Technology

In recent years the mobile phone technology has been developed very rapidly. It has revolutionized the way people communicate using their cell phone. According to World Health Organization reports, the application of mobile health and wireless technologies for supporting and achieving the objectives of the health industry has changed the image of health care service delivery (Ebrahimi, Mehdipour, Karimi, Khammarnia, & Alipour, 2018). Mobile health can provide many things, for example, the specialist can get the patient-related information, support the disease diagnosis, remind the time of medications, and measure physical activities. Thus, mobile health monitoring service are extremely effective for patients with chronic disease (Ebrahimi, Mehdipour, Karimi, Khammarnia, & Alipour, 2018). One of the most popular technology in smartphone is instant messaging because it has the ability to enhance communication within a group (Bouhnik & Deshen, 2014). Healthcare communication between physician and practitioners using instant messaging has not yet, to our knowledge, been researched

thoroughly. Structured interviews were carried out with autoimmune people who use the application in order to communicate with their doctors. There are four main purposes of instant messaging group:

1. Communicating with doctor and practitioner
2. Nurturing the social atmosphere
3. Creating dialogue and encouraging sharing among patient
4. As a learning platform (Bouhnik & Deshen, 2014)

3. Research Method

Lately, many people using instant messaging. They use instant messaging to communicate with their friends within a group. Healthcare communication between doctor, practitioner and patients are important for autoimmune people but has not yet been researched. Therefore, authors want to conduct qualitative explanatory research using questionnaires and interview to the person who has experienced with this method.

Authors developed some questionnaires for patients to detect their acceptance in using mobile phone health learning. Authors found two autoimmune patient communities which are involving the use of instant messaging as their learning tools to increase their health and quality of life. There are two medical groups of instant messaging which are learning about the health of autoimmune.

1. Odamun (Orang dengan autoimmune)/ Imunesia (Consist of people with autoimmune)
2. MS and NMO warrior (Consist of people with MS and NMO disease)

Both group using an online learning method by instant messaging. One of important environment for them are online environment, they don't need to travel to meet their doctor. The online environment helps them to ask about their condition and get answer from the group to make a better condition for each of them. The groups consist of doctors, as practitioners and patients. The groups are used to interact between practitioners and patient. Authors want to learn how effective the online learning using instant messaging group to make a better quality of life for auto immune patient. Each member of the group is unique since the body condition of each other is different depending to their immune. They make an online environment to ask about their condition and get answer from the group to make a better condition of their health. They have different health conditions to live their life. Therefore, authors chose to conduct a qualitative explanatory research to study about the impact of instant messaging learning system for them.

In this questioner there are six variables that will be used to explore perceptions, attitudes, and intentions before and after the use of technologies.

1. The perceived usefulness: shows how users believes that using whatsapp lecture would enhance his/her performance (Razmak & Belanger, 2018).
2. The Perceived of use or user friendliness: shows how the user believes that using whatsapp lecture is free of effort (Razmak & Belanger, 2018).
3. The compatibility: shows that the whatsapp lecture is perceived as consistent with the past experiences, existing values, and needs of potential adopters (Razmak & Belanger, 2018).
4. Communications: the extent to which people are able and willing to communicate thorough instant messaging (Razmak & Belanger, 2018).
5. Users Attitude: shows how each user evaluates and associates the target system with his or her job. (Razmak & Belanger, 2018)
6. Behavior intention: "an indication of individual's readiness to perform a given behavior, and it is considered to be the immediate antecedent of behavior " (Razmak & Belanger, 2018)
7. Patients health progression after joining the whatsapp lecture: Shows the impact of whatsapp lecture to their health

3.1. Data

Table 1. Questionnaire

Question No	Questions	Strongly Agree	Agree	Neutral	Dis-agree	Strongly Disagree	Total
1	Overall, I believe that finding and managing my health solution through information about health from whatsapp lecture is easy for me	18	36	10	0	1	65
2	I believe that learning to manage my health through whatsapp lecture is easy for me	11	46	7	1	0	65
3	It is easy for me to become skillful at using whatsapp	15	40	9	1	0	65
4	Using a lecture in Whatsapp will be useful to manage my health	19	35	6	3	2	65
5	Using a lecture in whatsapp, I will get my remission more quickly	8	35	17	3	2	65
6	Using a lecture in Whatsapp group to manage my health is compatible with my personal lifestyle	8	36	16	3	2	65
7	Using a lecture in Whatsapp group to manage my health is compatible with my learning preference	12	30	20	1	2	65
8	I feel comfortable communicating online with my doctor in the whatsapp group lecture	10	36	17	2	0	65
9	I believe that using whatsapp group lecture will promote my communication with my doctor in that group	13	37	12	3	0	65
10	Using whatsapp group to lecture to manage my health condition is a wise idea	16	41	7	1	0	65
11	I think it would be vey good to use electronic record better than printed record for my health lecture	12	42	9	2	0	65
12	Assuming that I have access to whatsapp group, I will frequently use it	14	40	10	1	0	65
13	Assuming that I have access to whatsapp group lecture, I will recommend it to others.	14	45	6	0	0	65
14	I get better after joining whatsapp group lecture	13	39	13	0	0	65

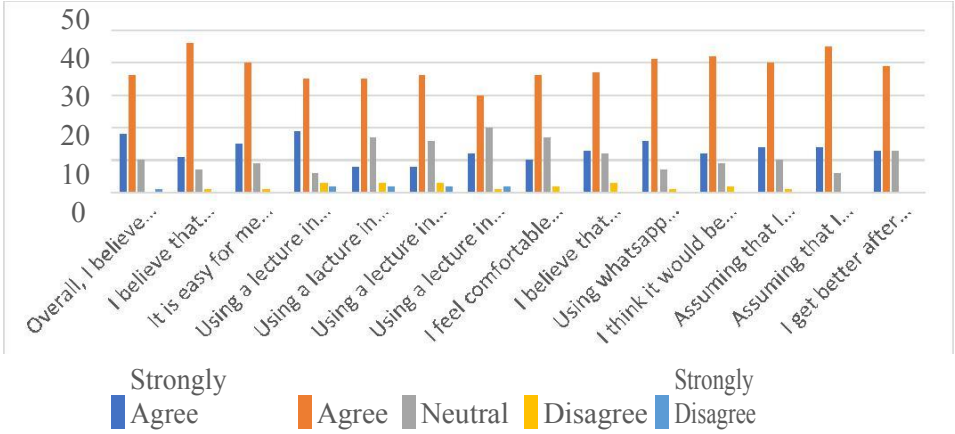

Figure 2. Acceptance of autoimmune patients using Instant Messaging lecture for body management

4. Analysis

Perceived ease of use (Question 1, Question 2, and Question 3):

the number of Instant Messaging increase every year because it is easy to use. Even for people that are in difficult situations and conditions find that Instant Messaging is easy to use.

Perceived usefulness (Question 4 and Question 5):

Most of the patient have mobility problems, therefore Instant Messaging lecture is very useful because Instant Messaging lecture can save their time and energy. It really helps them because by using Instant Messaging lecture they don't need to make appointment with the doctor and go to the hospital whenever they have some health issues. The Instant Messaging group member consists of doctor that share some useful information for the patient to get remission or stable condition.

Compatibility (Question 6 and Question 7):

Each patient in the group has different health conditions, thus each of them has different problem and lifestyle. Instant Messaging lecture can accommodate this issue because the doctor can help the patient just by sharing some useful information's.

Communication (Question 8 and Question 9):

The patient feels comfortable communicate with the doctor means that they feel that there have no barriers between them and the doctor in the group. Instant Messaging lecture has eliminated the barrier between patient and doctor. All the patients feel comfortable to talk with their doctor in Instant messaging group, because they get empathy from the group, the environment that they need.

Attitude toward usage (Question 10 and Question 11):

The Patient feel that the decisions to use Instant Messaging lecture is a wise idea means that the Instant Messaging lecture has help them in many ways. Such as, improve their quality of life, save their time and energy, boost their confidents. It can be seen that instant messaging can be useful for body management

Behavior Intention (Question 12 and question 13):

Electronic record for lectures is owned by both doctor and patients, on the other hand, printed record is owned by the doctor only.

Health progressions (Question 14):

Since using instant messaging lecture helps patients very much then they like to use instant messaging lecture more often. Instant messaging is also effective to minimize the flare-up condition, which are usually attackted to autoimmune patient in their daily life since they can learn to manage their body.

Summary

We learn that community make them encouraged to take care of their own disease. Each of them can collaborate with the doctor and community to make it more effective. The mobile technology effectively support each patient to take care of themselves. The snapshot of daily activity of the overall patient's can be seen more effectively by the doctor than during a regular follow-up visit. Patient's anxiety can be reduced in this online community.

Physical examination is more accurate and more focus because they have the right tools for examination, such as MRI machine, laboratorium, ERG machine, and physiotherapi room. Also the

result is recorded by the doctor therefore they can have medical record of the patients. On the other hand, there is no record of the impact of instant messaging lecture. Unlike using instant messaging lecture, the doctor can give prescription based on the result of physical examination.

Health 4.0 is needed and very useful for autoimmune patients. Frequent interaction between doctor and patients is needed to manage the patient condition

5. Future studies

There are some autoimmune patients that have difficulty in typing text message using instant messaging, thus by using video call the number of patient using instant messaging may increase because using video call is easier than texting. The instant messaging lecture impact on quality of life may improve if they use video call for communication, the doctor can check the condition of the patient more accurately because it can reduce miscommunication or miss understood.

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The Applicability Blockchain in Indonesia Based on Indonesian Data Privacy Regulation

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Abstract. Blockchain is a distributed ledger technology that has reliability in terms of maintaining data integrity and availability but not data privacy. Therefore, implementation of this particular unregulated technology must be reviewed to ensure compliance with relevant regulations, especially data privacy regulations which is this research main topic. For this reason, implementation of blockchain was observed in comparison with existing data privacy regulations in Indonesia. As initiation steps of research, data privacy regulations from Indonesia, Japan and Europe was used to be the input for the analysis of blockchain implementation. Two additional instruments, questionnaire and interview was used to produce an enhanced design for implementation of blockchain scheme in Indonesia. After the research was done, it was concluded that there is a possibility of blockchain implementation in Indonesia as long as the design was used with some notes as consideration.

Keyword: regulation, blockchain, data privacy, Indonesia, implementation

1. Introduction

Bitcoin as one of the cryptocurrency products is the result of the development of the public blockchain created by Satoshi Nakamoto (Nakamoto, 2008). The main purpose of this development is to reduce and eliminate third parties in the payment system. This deduction uses the context of decentralization and consensus. Where decentralization is a concept used to verify a transaction (Wright and Filippi, 2015). While consensus is the method used to validate transactions (Seibold and Samman, 2016). With these two things, bitcoin is a product that has high integrity and availability.

Seeing the advantages of the blockchain, blockchain is still in the development phase in addition to the financial industry (cryptocurrency). Industries such as logistics, healthcare and banks have the potential to utilize blockchain (Lewis, 2015). However, there are some things that are still an obstacle in blockchain implementation, especially in the data processing process (Halpin and Piekarska, 2017). Permissionless blockchain as a public network allows various types of entities both personal and institutional to join the blockchain network. Considering this is a public network, every data transaction can be seen by all entities in the network. While in some industries, transaction data is data privacy that is very confidential. This makes one of the other concerns of the slow adoption of blockchain by businesses today (Lukacs, 2017).

Given the importance of data privacy, some regions have issued strict rules for the use of data privacy. GDPR is a regulation that regulates European privacy data. While APPI is a regulation established by the Japanese government in conducting privacy data safeguards. Referring to the problems above, Japan is currently developing blockchain based on these regulations (Ministry of Economy, 2017).

The development of blockchain was also felt in Indonesia. Currently the adoption of blockchain in Indonesia has experienced a significant development. However, currently blockchain development is still in the phase of measuring benefits and risks that will occur in blockchain adoption (Probank, 2017). In maintaining the security of data privacy of Indonesian society, the Indonesian government also has regulations governing the data privacy (DLA, 2018).

The regulation is also have specifically regulated the protection of data privacy on electronic systems. However, there are no studies related to blockchain in Indonesia according to data privacy regulation. Based on the literature that was found during research, one of examples that can be used as a reference is the use of cloud computing technology (Nugraha, 2012) because this technology has the potential to manage data privacy so that it is part of data privacy regulation subject. In another study, there is already a blockchain design that has an architecture such as Figure 1 (Latifa *et al.*, 2017). It can be seen that blockchain has the potential to manage data privacy. But, there are several security holes issues that needs more attention as it may have an impact on someone's privacy on the blockchain (Conti *et al.*, 2017). Therefore, there needs to be a study on blockchain implementation where it must comply with data privacy regulations.

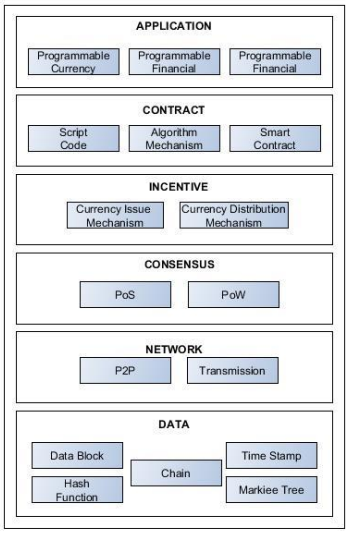

Figure 1.Blockchain Architecture (Latifa *et al.*, 2017)

Referring to the above problems, this paper is intended to assess the potential applicability of blockchain implementation in Indonesia. The main reference is based on the applicable regulations in Indonesia. To support research, GDPR and APPI regulations will be used as additional references. So that hopefully the author can provide recommendations for blockchain architecture design in accordance with data privacy regulation.

2. Methodology

As the objective of this research is to find out about response of Indonesian data privacy regulation for blockchain implementation in order to propose a design that complies with applicable law and regulations, qualitative research was used. These are the procedure that was done during research:

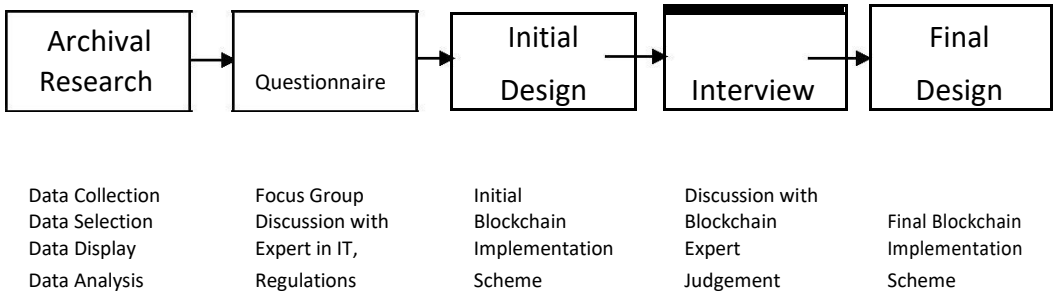

Figure 2. Research Flow

First, archival research that was consist of data collection, data selection, data display and data analysis was done. For data collection, regulation related to data privacy was collected, especially the one in Indonesia. However, regulation of data privacy in Indonesia has not been specifically created but spread over several existing regulations (DLA, 2018). Besides data privacy regulations in Indonesia, there are two more regulations that was collected as part of research. Those are Act of Protection Personal Information (APPI) from Japan which has started to implement blockchain and General Data Protection Regulation (GDPR) from Europe (DLA, 2017) that have broad impact related to personal data processing for Europeans. After the data was collected, it was selected to which relevant with the objective of this research. As a result, relevant Indonesian regulation has been grouped on Table 1, which is also part of data display.

Table 1. Data Privacy Regulation in Indonesia

No	Law	Number of articles	Note
1	Regulation of the Minister of Communication and Information No. 20 of 2016 on Protection of Personal Data in Electronic Systems.	38	Articles 1 through 38
2	Law Number 19 of 2016 About Amendment To Law Number 11 of 2008 About Information and Electronic Transaction	6	Article 26, Article 30, Article 31 Article 32, Article 33, Article 35
3	Government Regulation No. 82 of 2012 on the Implementation of Electronic Transactions and Systems	2	Article 1 no 27 Article 15
4	Law Number 24 of 2013 regarding Amendment to Law Number 23 of 2006 regarding Population Administration	1	Article 84

After that, the collected data was analyzed to draw initial conclusion as the input for the questionnaire. The data privacy regulation was compared to blockchain mechanism, which leads to criteria that may fulfill the compliance criteria.

Second, questionnaire was used as part of instrument to evaluate the archival research analysis result. In this part, convenience sampling was used and the criteria for the participant of questionnaire is Expert in Security, Privacy and also understand about blockchain. For the questionnaire itself, open ended questionnaire was presented to the participants, so any additional recommendation can be added as part initial design. Third, initial design of framework was composed based on the result of the questionnaire. Forth, interview was done to evaluate the initial design. Different with the first questionnaire, the interview's participant is the expert of the subject itself which in this research is blockchain. By doing this, it was expected that validity can be constructed through triangulation of multiple sources (Yin, 2002). Fifth and the last, final design was composed based on analysis on the interview result. Analysis was done by combining the first and second instrument result.

However, there is a limitation in this research which is the scope. In this research, the main data that was being used is regulation in Indonesia. For the subject itself, the blockchain that is referred is the blockchain on bitcoin.

3. Result and Discussion

3.1. Data Privacy Regulation Comparison

As the first step of the research, the author comparing the data privacy regulation among APPI, GDPR and Indonesia. Gap analysis is the main objective of the comparison process as described on table 2.

Table 2. Data Privacy Regulation Comparison

No	Parameter	Indonesia	Japan	Europe
1	Objective	Protect data privacy on Information and electronic transaction	- Protect personal data - Support business to growth	Protect personal data
2	Definition Personal Data	data that can identify individuals, directly and indirectly	data that can identify individuals, directly and indirectly	data that can identify individuals, directly and indirectly
3	Collecting and Processing	inform the purpose of data collection and processing	inform the purpose of data collection and processing	inform the purpose of data collection and processing
4	Data Controller	Electronic system organizer	Business operator	Data Controller
5	Data Correction	Not yet clearly regulated the procedure for deleting personal data	provide an optional mechanism to delete privacy data	Owner of data must remove directly the data

Defining the data privacy terminology, author used five parameters to analyze the regulations. According to the data, three regulation described the same definition and characteristic of data privacy. However, there is a very significant difference in the context of data correction. GDPR will regulate data privacy is tighter than the other two regulations. While the rules in Indonesia there is no regulation that states explicitly how to treat the data correction.

3.2. Implementation blockchain in Japan

Japan is success story of blockchain Proof of Concept. The story can be summarized on table 4. It has been tested for vary industries especially for Banking industry. For other industry, BitFlyer workin closely with the other companies such as Hitachi, Fujitsu and NTT Data to develop Miyabi Blockchain.

Table 3. Result of Blockchain's PoC

No	Proof of Concept	Result
1	Establishment of future backbone operation systems that utilize blockchain technology	Successfully conduct transaction for 2,5 million account with capacity 90.000 per hour (Daisuke Yamazaki, 2016)
2	Streamlining cross-border settlement processes in securities transactions	Reduce time for cross-border transaction from 3 days to 1 days and information can't be tampered (Mizuho Bank, Ltd.,Fujitsu Limited, 2016)

3	Japanese Domestic Interbank Payment Operation	Reduce cost for interbank transaction (Deloit, 2016)
4	Applicability of Distributed Ledger Technology to Capital Market Infrastructure	Identify potential and limitation of the DLT application to capital market infrastructure (Santo *et al.*, 2016)
5	Biometrics Verification System for Retail	Implement Coupon system based on Biometric data. Biometric data of customer stored on Blockchai. The result are reduce of verification time and easu registration and authentication. (Hitachi, 2018)
6	Blockchain Supply Chain	Improve efficiency of procurement and inventory management (Hitachi, 2017)

The proof of concept has involved three major blockchain. Miyabi is the biggest while Iroha Hyperledger and Hyperledger Fabric are the other blockchain technology is involved for the PoC. Table 5 show the blockchain comparison used for Proof of Concept.

Table 4. Blockchain PoC comparison

	Miyabi	**Hyperledger Iroha**	**Hyperledger Fabric**
Consensus	BFK2	YAC	Plugable
Type of Blockchain	Permissioned	Permissioned	Permissioned
Company	BitFlayer	Soramitsu	IBM
License	Enterprise	Open Source	Open Source
Objective Blockchain	Fast Transaction	Development Application	Complexity and Confidentiality

Referring to the table 3, all the blockchain type is the permissioned blockchain. The character of this type can be summarized as follow:

1. There is a selection and verification process to join the blockchain network
2. Not everyone can join and get existing data on the blockchain
3. There must be one party in charge of regulating and monitoring the blockchain network

3.3. Blockchain and Indonesian Data Privacy Regulation

As the developed country, Indonesia's government has several regulations to control the data privacy. The data privacy is considered as part of the customer data. The protection will refer to separate regulation, as follows:

1. Law number 11 of 2008 on Electronic Information and Transactions (EIT Law). It has been amended in 2016 for regulation number 19 and it is implicitly discussed of a data or electronic information, both general and personal (Governament, 2008).
2. Government Regulation No. 82 of 2012. on the implementation of electronic systems and transactions for personal electronic data (Governament, 2012).
3. Regulation of the Minister of Communication and Information No. 20 of 2016 concerning the protection of personal data in electronic systems (Information, 2016).
4. Law Number 24 of 2013 Article 84. It describes the protection of Indonesian citizens personal data (Governament, 2013).

Table 5. Blockchain and Indonesia Data Privacy Regulation

No	Regulation	Data Privacy Parameter	Blockchain
1	Minister of Communication and Information No. 20 of 2016 article 1	Data personal confidentiality	Decentralized network addresses the data among the node. It is potentially every connected node can easily read the transaction data.
2	Law No. 11 of 2008 Article 16		
3	Minister of communication and information number 20 of 2016 article 1 point 2	Personal data is the data attached to the person whether it is directly recognizable or indirectly	Blockchain address pseudonym which allows to reveal the identity of the individual, then this will also violate the provisions of the privacy data protection regulations
4	Law Number 24 of 2013 Article 84	Personal data that must be protected	Since the data stored on the blockchain can be accessed by all members of the blockchain then when blockchain is implemented in other sectors, these data must be protected

3.4 Blockchain Design for Data Privacy Regulation

According to the data privacy regulation and compared to the blockchain capabilities, the table 6 shows the blockchain comparison among regulation.

Table 6.Regulation response for blockchain's recommendation to protect data privacy

No	Recommendation for Blockchain	Indonesia	Japan	Europe
1	There is one organization that complies with the laws that are responsible for the blockchain network	OK	OK	OK
2	Filter and Selection member of blockchain	OK	OK	OK
3	Private network for blockchain	OK	OK	OK
4	Encrypt data on blockchain	OK	OK	OK
5	Using another option for remove data on blockchain	OK	OK	NO

From the regulation perspective, GDPR article number 17 stated that the privacy data must able to be removed on any application, including the blockchain. Meanwhile the Indonesia and APPI is less restrict, data privacy disposal can be treated as the optional part. Regulation will accept if the developer has the mitigation process to control or remove it.

Based on the data privacy regulation, the successfully blockchain implementation must to be follow the recommendation as follow:

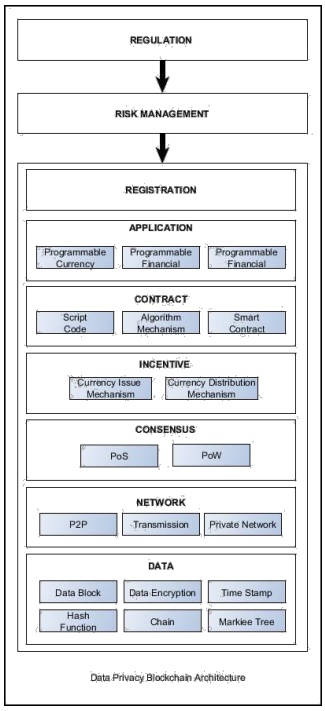

Figure 3. Blockchain design for data privacy regulation

1. Governance process. This will regulate and monitor any rules that applicable to the blockchain network. It will be including of data privacy determination must be maintained.
2. Registration. The registration will control the parties who are trying to join the blockchain network known as the permissioned blockchain. This will address the responsible control to the parties.
3. Private Network. This part will prevent the blockchain from the cyber-security attack due to only certain parties who has key will be involved in transaction.
4. Encryption Data. Securing process has to be covered into data level. Thus, the encryption must be applied for every single data. Only authorized party will able to read the data *(Deloit, 2016)*.

4. Conclusion

Referring to the results of the research above, blockchain implementation can be done in Indonesia. However, there are several things that must be adapted to the applicable regulations in Indonesia. One of them is the aspect of data security privacy that is protected by law. For that we need an architecture customization that refers to the applicable regulations, in the form of:

1. Governance process
2. Registration process (permissioned)
3. Private network
4. Data encryption

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Blockchain in Supply Chain: Case Study of Lottemart Ciputat

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Abstract. Current supply chain methods are having difficulties in resolving problems arising from the lack of trust in supply chains. The root reason lies in two challenges brought to the traditional mechanism: self-interests of supply chain members and information asymmetry in production processes. Blockchain is a promising technology to address these problems. The key objective of this paper is to present qualitative analysis for blockchain in supply chain as the decision-making framework to implement this new technology. The analysis method used Val IT business case framework, validated by the expert judgements. The further study needs to be elaborated by either the existing organization that use blockchain or assessment by the organization that will use blockchain to improve their supply chain management.

Introduction

The movement of goods (supply chain) for people around the world is massive. For example, in 2015 the market's global value was $8.1, and is expected to grow to $15.5 trillion by 2023, making it one of the largest industries on the planet. In the United States, freight and logistics spend in 2015 totaled $1.48 trillion, nearly 10% of the country's GDP (Transparency Market Research, 2016).

According to KPMG, many parts of the logistic value chain don't have a full visibility and trusted system to communicate between various members. They use manual processes to keep track of the movement of their goods. For example, some members rely on manual data entry and paper-based proof of delivery (POD) to record the orders. Some PODs are send back through couriers, that will create issue on bad data handling practices. Lack of transparency and bad tracking is both the cause-of and caused-by this manual/paper based data.

In summary, the challenges of current traditional mechanism are:

1. The self-interests of the supply chain members
2. The information asymmetry in the process

Rise in adoption of technologies has reached supply chains industry, summing up substantial research and innovation interest towards developing reliable, auditable and transparent traceability systems. Recently, there are a lot of supply chain enterprises start develop and implement a full integrated system based on transparent blockchain contracts to track the whole flow of supply chain, from the moment from the moment a shipment leaves the factory, to the final delivery on the customer's doorstep. This blockchain technology will help to create a full transparency communication system between parties.

In the consumer goods and retail industry, companies like Unilever and Wal-Mart are exploring the use of blockchain technology to improve their tracking and visibility. With blockchain they are able to enhance the transparency of data because the used of a single source of truth.

Material and Methods

2.1 Supply Chain Traceability

A supply chain is a group of manufacturers or producers and service providers that are working together, creating end to end distribution chain to deliver products and services that are needed by end users (Bozarth & Handfield, 2006). The actors in a retail supply chain are linked collectively through the physical flow of products from manufacturers to end consumers.

Shifting forward, many supply chain manufacturers develop track and trace application to help them on delivery process. It means that tracking each physical product will be done digitally so that it will be more secure and traceable. For example, physical product will be embedded with Internet of Things (IoT) sensor and it will transmit the data about product integrity, temperature, and other evidences.

2.2 Blockchain Technology

Blockchain is declared as a distributed database, where information/data will be stored on the blockchain arrangement and can only be accessed by computers that are affiliated to. One individual file of data is divided into parts, termed blocks. All blocks accept to be accurate by the absolute network, which happens algorithmically. For the action to proceed, the actors/ parties needs to show their 'digital signature', which will be accurate through the blockchain network. Encryption is activated to protect the data.

Blockchain receives a lot of attention due to their characteristics, which the main characteristic is; it reduces the charge for trusted third parties and intermediaries. These characteristics cover the:

1. Creation of data records that are permanent, i.e. cannot be afflicted or deleted
2. Decentralized
3. Peer to Peer (public and private)
4. Ability to analyze the time and origin of every access in the Blockchain
5. Access by all participants to all data in the Blockchain
6. Guaranteed accomplishing of smart contracts (programs) that automatically execute already a set of agreed conditions are met

In this work, we explore the potential of smart contract; an emerging blockchain based decentralized technology that provides a new paradigm for trusted and transparent computing. By replacing the central server with a carefully designed smart contract, we construct a decentralized privacy preserving search scheme where the data owner can receive correct search results with assurance and without worrying about potential wrong doings of a malicious server.

Smart Contracts are applications with a state stored in the blockchain. They can facilitate, verify, and enforce the process of a contract. Each smart contract, identified by a special address, consists of script code, a currency balance, and storage space in the form of a key/value store. Once created and deployed, the contract's code cannot be modified forever even by its creator.

Therefore, we use smart contract to create a fair reciprocal mechanism, where the data owner receives correct search results as long as he honestly pays the money, and the worker earns the money as long as he faithfully follows the protocol.

2.3 *Case Studies of Previous Blockchain Implementation in Supply Chain*

By the end 2016, Walmart was doing two blockchain trial projects, supported by IBM. The first project is to track products from Latin America to US, and the second one is moving meat from Chinese farms to stores (Popper & Lohr, 2017). Currently, Walmart spends several days to track the movement of pork products. However with the help of Blockchain, it only requires a few minutes. In Blockcain, Walmart can track details about the farm, factory, batch number, storage temperature and shipping. In addition, Walmart filed a patent application for this blockchain technology in May 2017.

In April 2017, the world's largest defense contracting firm, Lockheed Martin teamed up with Virginia-based GuardTime Federal announced plans to integrate blockchain into its supply chain risk management (Higgins, 2017b).

Maersk is the world's largest and busiest carrier company. It was reported that Maersk main problem is the tons of paperworks that they need to manage. For every container, it has its own paperwork (Popper & Lohr, 2017). Maersk creates a blockchain software with the help of IBM to help replacing the current paperwork. The goal is when customs authorities signed off on a document, they could immediately upload a copy of it with a digital signature. All the parties involved, such as government authorities will be notified whether that order has been completed. With blockchain, all the parties are confident that no one can alter the data.

In 2017, Intel built a blockchain system to track the movement of seafood supply chain, from a fisherman to a fishmonger, to a seafood restaurant. By combining blockchain and IoT, they were also able to record the temperature data and fishmonger's record.

2.4 *Val IT*

The IT Governance Institue (ITGI) released Val IT in March 2006. Second version of it Val IT 2.0 was released in 2008 (P Voon, 2009). Val IT is recognized as the first comprehensive framework to support enterprise from the point of view of IT governance, with a focus on value. Val IT's overall goal is to enable enterprises manage their investment in IT changes environment in a right way to get optimal result, by having a highest value benefit, in the most affordable cost, and in an acceptable level of risk (ITGI, 2008).

Method

The authors formed a research framework as follows:

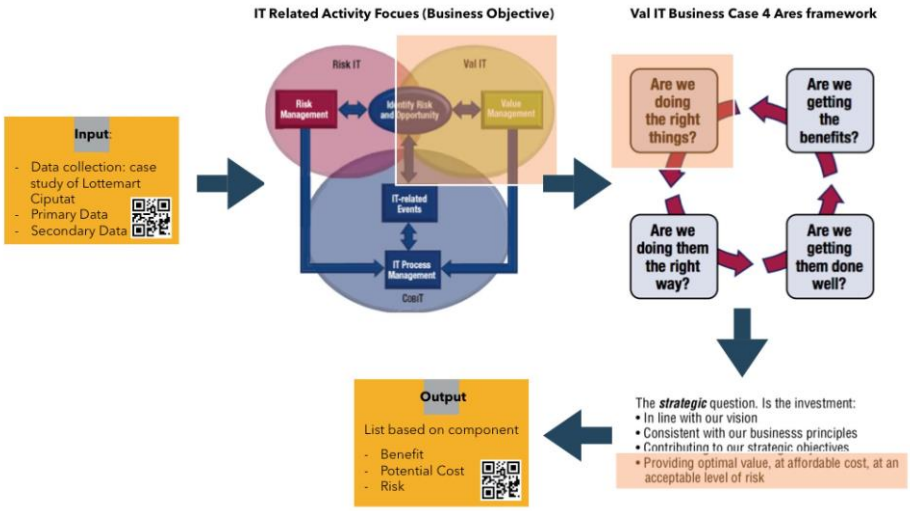

Figure 1. Method of analysis framework using Val IT (adapted from the ITGI, 2006).

In this paper, we will use Val IT framework as the analysis method. By doing analysis using Val IT, we hope that this paper may help stakeholders to make business decision easier after they understand the value and how it is created.

In addition, in order to answer the research question and to design an effective design that solves the problem at hand within the corporate and regulatory context, we follow Val IT framework, using one of four fundamental IT governance related question: Are we doing the right things? This identifies the risk of error or lack of clarity in the desired business outcomes in a changing environment, as follows:

Below are the outputs of the paper:

1. How business outcome will be measured? And all initiatives required achieving expected outcome? We will show the business canvas for the new technology
2. List of cost component
3. Key risks: identify risk

Table 1. List of expert and topic discussion

Interviewee	Company	Profession	Topic
Irwan Hariawan	Lottemart Wholesale Indonesia	Customer Excellence Manager	1. Current and propose changes of flow processing 2. Current issues on fields
Siti Hardianti	Lottemart Wholesale Indonesia	Supply Chain Associate	1. Provide data regarding calculation of delivery order 2. Propose changes of flow processing
Ginanjar Fahrul	Ritase.com	Head of Backend Dev	Propose system architecture
Indri Suprapti	Ritase.com	Finance Manager	Current reconciliation and charging mechanism
Andik Susilo	Microsoft Indonesia	Microsoft MVP on infrastructure	Migration planning and risk
Pandu Sastrowardoyo	Blockchain Zoo	Co-Founder	Blockchain implementation, architecture, and cost component

Results and Discussion

Current process of Ritase x Lottemart Wholesale supply chain will be used as a case study. Based on blockchain and IoT, a system for traceability is proposed, in which the logistics data is shared among Lotte, Ritase, transporter, driver, and customer.

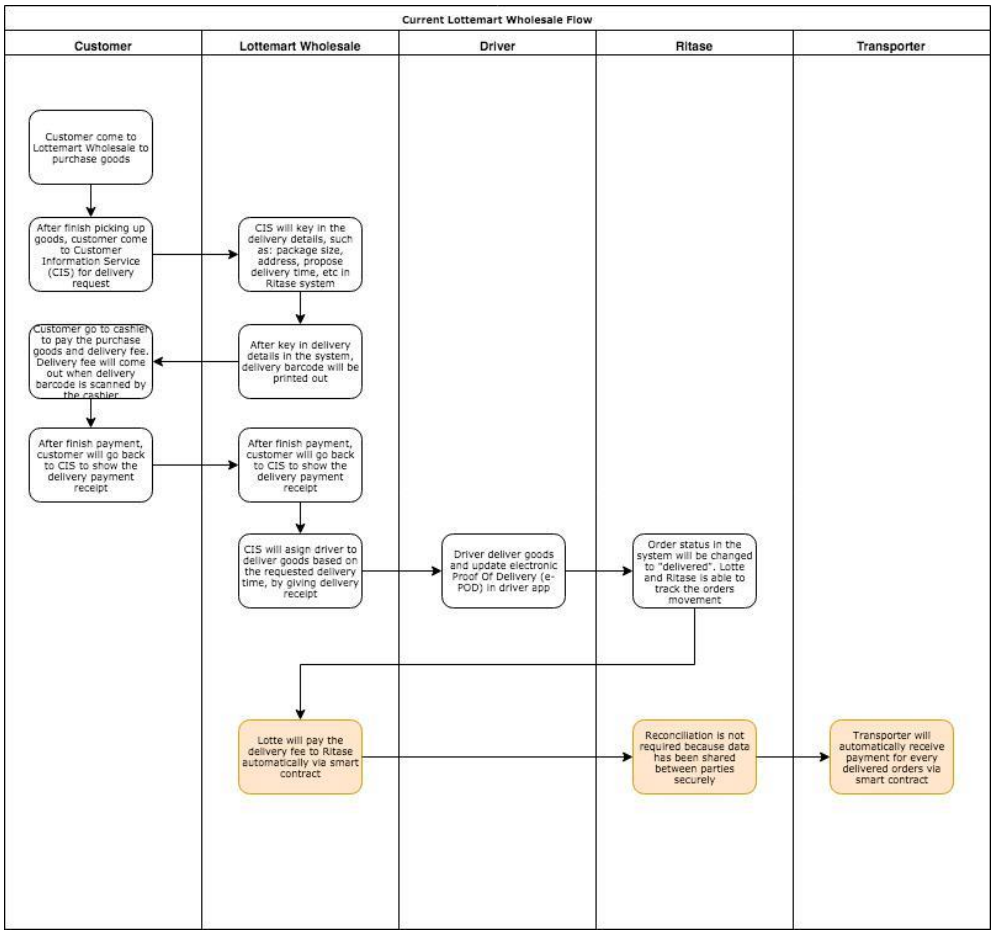

Figure 2. Target Lottemart Wholesale x Ritase logistic flow

The current and target system architecture of supply chain management system using blockchain technology (Chen, 2017), validated by expert judgement, will be described in figure 3.

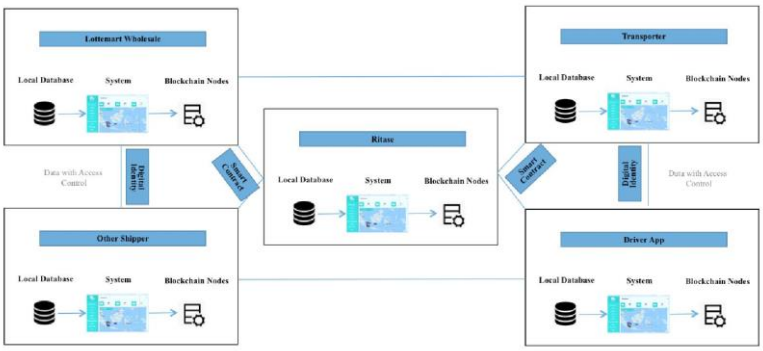

Figure 3. Proposed blockchain system architecture

Blockchain technology offers the possibility to make complete remittance information available to all the parties involved in transactions, reducing the time and manual effort involved in payment reconciliation to minutes instead of days. A corporate supplier could create its own Permissioned Blockchain where it and its buyers can store and retrieve relevant remittance information. The blockchain nodes can be authorized to allow companies within a supply chain to download relevant information to seamlessly match with the payment statement information received from the Bank.

By speeding up the reconciliation process, corporates will gain better visibility and control over their cash positions within their supply chain. They will avoid lengthy invoice disputes, reduce collection queues and be able to review credit lines more efficiently and those are benefits, which are difficult to ignore.

4.1 Key Benefit

In addition, the urgency to implement a new system in current business process is due to the different delivery fee for every supply chain parties in every month.

Month	Lottemart Ciputat	Ritase	Transporter
January Batch 1	IDR 13,057,000	IDR 10,281,600	IDR 11,125,000
January Batch 2	IDR 16,778,000	IDR 12,170,700	IDR 14,990,400
February Batch 1	IDR 14,088,000	IDR 10,926,900	IDR 12,850,200
February Batch 2	IDR 10,079,000	IDR 7,742,700	IDR 8,069,400
March Batch 1	IDR 13,624,000	IDR 9,909,000	IDR 12,370,500
March Batch 2	IDR 12,246,722	IDR 8,790,300	IDR 11,924,100
Summary For 3 months	IDR 79,872,722	IDR 59,821,200	IDR 71,330,400
Average Summary per month	IDR 26,624,241	IDR 19,940,400	IDR 23,776,800

Figure 4. Reconciliation result between supply chain parties

The business model canvas is required to determine value proposition of blockchain based smart contract in supply chain logistic. The following as below for the business model canvas of blockchain based smart contract.

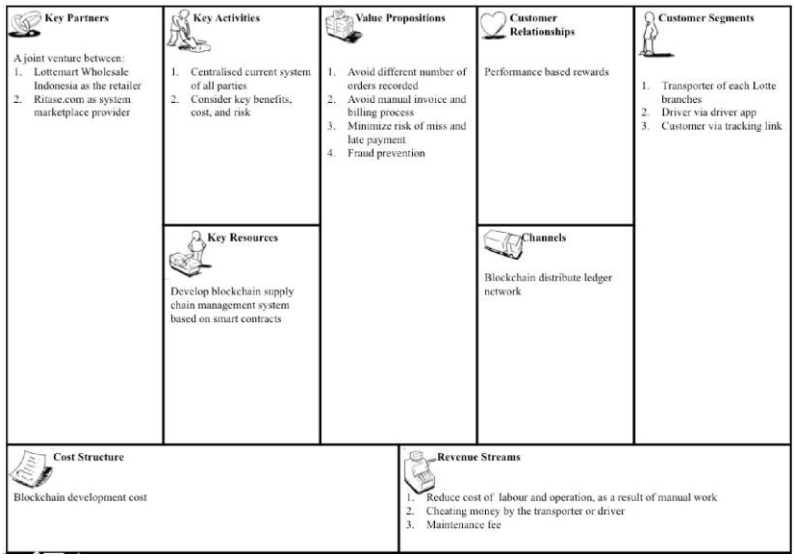

Figure 5. Business model canvas on blockchain for supply chain

Table 2. Proposed key benefit of blockchain in supply chain

Key Benefit	Description	References
Decentralized Management	Improved care data sharing and analysis without ceding control: Blockchain is by design a decentralized (ie, a peer-to-peer, non-intermediated) architecture. Each institution can keep full control of their own computational resources (while collaborating with other institutions for data sharing and analysis).	Decovny, S. (2017)
Immutable Audit Trail	Unchangeable log of clinical research protocols: "Use of blockchain technology has recently been shown to provide an immutable ledger of every step in a clinical research protocol, and this could easily be adapted to basic and experimental model science. All participants in the peer-to-peer research network have access to all of the time stamped, continuously updated data. It is essentially tamper proof since any change, such as to the prespecified data analysis, would have to be made in every computer within the distributed network."	Ahram, T. *et al.* (2017)
Data Provenance	Ensure original manufacturer and ownership transferring in supply chain: "Using Blockchain, the origin of the product and its components are detected, and any transfer of ownership in each case is made clear and available to everyone. Forged, poor quality or stolen goods can be tracked and identified."	Caro, M. P., Ali, M. S., Vecchio, M., & Giaffreda, R. (2018)
Robustness/Availability	- Improved robustness for supply chain: "In the existing solutions, there is still a central authority that can be compromised and documents that can be faked. - Superior data availability: "Blockchain would ensure continuous availability and access to real-time data. Real-time access to data would improve coordination in emergency situations. "	Francisco, K., & Swanson, D. (2018)
Security/Privacy	Secured and privacy data sharing: "confident that the blockchain will hold them securely."	Disterer, G. (2013). Sattarova Feruza, Y., & Kim, T. H. (2007)

4.2 Cost Component

When companies make decisions about the IT investment, one of the most common questions they ask is "how much does it cost?" This paper explains about the cost component of implementing this technology, instead of giving the exact price because the specification of each company might be different depends on the services they use.

Table 3. Proposed cost component of blockchain in supply chain

Cost Component	Description	References
Blockchain Platform	Depending upon the consensus mechanism, select the most suitable platform. Free and Open Source platform is available, eg: 1. Big Chain DB 2. Hyperledger 3. Openchain 4. etc Or use blockchain solution provider	Luxembourg, D. (2017).
Nodes	- Permissioned or permission-less - Number of nodes -Nodes will run on the cloud, on premise, or both -Hardware configuration issues like processors, memory, and disk size -Base operating systems (usually Ubuntu, Red Hat, or Windows)	Luxembourg, D. (2017).
APIs	Some blockchain platform come with pre-made API or not. Major of APIs categories: - Audit functions -Data authentication through digital signatures or hashes - Smart contracts -Smart asset lifecycle management: payment, exchange	Deloitte. (2016)
Admin and User Interface	- Front end and programming languages (Javascript, Python, Nodejs, etc) - External database (MySQL, MongoDB, etc) - Servers (web servers, FTP servers, mail servers)	Deloitte. (2016)
Integration	AI, Machine Learning, IOT, etc.	Fintech, P., & Conference, Q. (2018)

4.3 Risk

Table 4. Proposed risk of blockchain in supply chain

Risk	Description	References
DowntimeRelatedwith Business Continuity	When doing migration from old to new technology or one database to another database, one of the risk that is hard to avoid is there will always be a downtime, while we want to keep the credibility of our data.	Zwißler, F., & Hermann, M. (2007)
Data Migration	When there is miss procedure on data transfer, it will cause longer downtime or the data will not be credible anymore.	Zwißler, F., & Hermann, M. (2007)
Performance Degradation	New environment will be different with the previous technology, and will affect the performance of the system. We need to do the tuning again.	Fintech, P., & Conference, Q. (2018)
Scalability Inflexible	In blockchain, to scale up or scale down, we need to tweak the hardware.	Fintech, P., & Conference, Q. (2018)

Conclusion and Future Work

We introduced blockchain technology in supply chain, which provides decentralized management, an immutable audit trail, data provenance, robustness/availability, and security/privacy. We identified benefits compared to traditional distributed databases for supply chain management system, and provided qualitative analysis, such as cost component and risk factors of the blockchain supply chain management system.

However, cautionary tales exist. There are still challenges with the scalability and performance of the technology, with complexity, with governance, etc. Now, it's up to each enterprise whether it is worth to implement this technology and whether this is the right time with the valuable information and understanding given. These challenges can be addressed through careful application design and implementation. We expect many new applications to emerge soon.

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Application End of Line Resistor (EOLR) and Voltage Divider for Passive Infrared Motion Sensor

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Abstract. End of Line Resistor (EOLR) is a resistor that has a certain value to protect the circuit at the end of a loop or zone. The End of Line Resistors is used in security systems to enable the control panel to monitor wiring of open and closed. In this research using an Arduino microcontroller and Passive Infrared (PIR) Motion Sensor that connected with the systematic circuit to supervisory a loop or zone. Systematic circuit use combination of the resistor as the end of line resistor and voltage divider method. Analog input on Arduino uses to detect different states of sensors. The 1K resistor in series with the sensor line provides some protection for the input pin against the unexpected current flow. The 4K7 pull-up resistor, when combined with the resistance provided by the sensor, acts as a voltage divider, exposing the analog input to a different voltage depending on the state of the sensor. The result of measurement viewed by serial monitor function on the personal computer. PIR Sensor connected with an analog pin on microcontroller running well and there is no significant voltage value changing.

Keyword: Microcontroller, Motion Sensor, Resistor, Voltage Divider, Analog

1. Introduction

Resistors are basic electronic components used to limit the amount of current flowing in a circuit. Another function of the resistor is as a limiting electric current can be used as a divider of electrical voltage and as a decrease in the voltage of the electric current. In the digital circuit, the "high" signal is 5 volts and the "low" signal is 0 volts, whereas in the digital circuit 3.3 volts the "high" signal is 3.3 volts and the "low" signal is 0 volts. Of course, the "high" signal does not have to be exactly 5 volts or 3.3 volts, depending on the tolerance of the circuit and Integrated Circuit used. In a digital circuit, when using the sensor as the input data to the microcontroller sometimes occurs the problem of unreadable value. The input value floats between high and low. To solve this problem you can use a pull-up or pull-down resistors that use the voltage divider principle.

In this paper, it is observed that a systematic design approach for interfacing the Passive Infrared Motion Sensor to a single port of a microcontroller is possible to improve the security system.

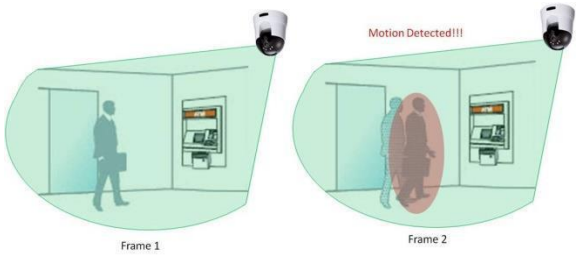

Figure 1. Motion Sensors

2. Scope

The scope of this study is limited at the Passive Infrared (PIR) motion sensor and Arduino microcontroller for the security home security system. In this research use Arduino's analog inputs to build sensor circuits that are as fully featured and advanced. The System allows detecting any of possible failure, tamper, or trigger conditions automatically with 4 channel sensors.

3. Methodology

Research use hardware and software design method the following below:

3.1. Hardware Design

Research use a notebook and components according to the following table:

Table 1. Component required

No	Components	Qty	No	Components	Qty
1	Arduino	1	6	Diode 1N4001	4
2	PIR Sensor	4	7	Relay 12Volt	8
3	Resistor 4K7Ω	17	8	Buzzer	1
4	Resistor 1KΩ	4	9	LED	8
5	Resistor 680Ω	8	10	Power Supply 12Volt	1

3.2. Software Design

Source code for main program to show the result via serial monitor function can be seen below:

```
// Show the result via serial monitor function
Serial. print(sensorInput, DEC );
Serial. print( ": " );
Serial. print(voltageReading, 2);
Serial. print( " (" );
Serial. print(valueReading, DEC);
Serial. print( " (" );
Serial. print(state, DEC );
Serial. print( ") | " );
```

3.3. Design Justification

Design according to the schematic circuit as shown by following schematic diagram:

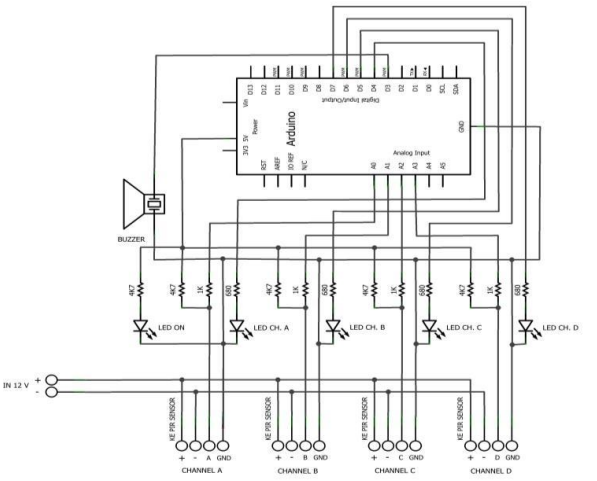

Figure 2. Control panel schematic diagram

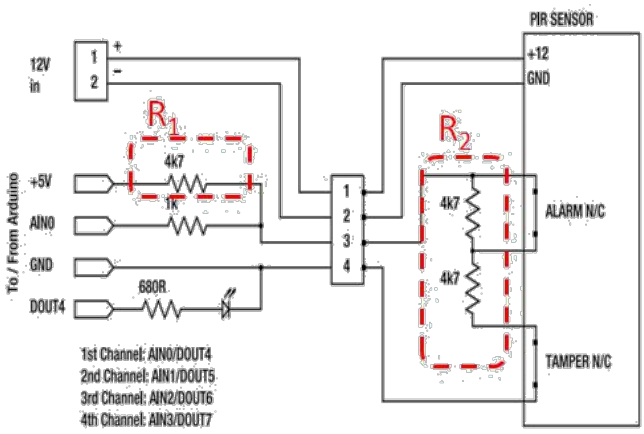

Figure 3. Sensor schematic diagram

3.4. Design of Experiment

Wiring all of component is shown by the following figure:

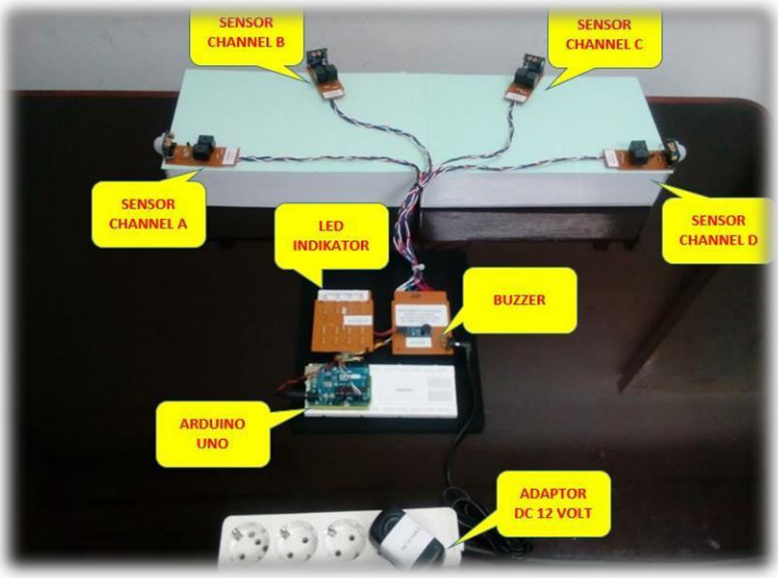

Figure 4. Wiring component

4. Test Result

4.1. Test Result on State 0 - wire shorted

According to the circuit on figure 3, the calculations using voltage divider formula:

$$= \frac{^{2}}{(_{1} + _{2})} 5$$

$$= \frac{\sim 1}{(4\,7 + \sim 1)} 5$$

$$= \sim 1 \qquad h \quad h\,1 : 0.00488 = \sim 200$$

Test result on state 0 or when wire shorted is shown by the following figure below:

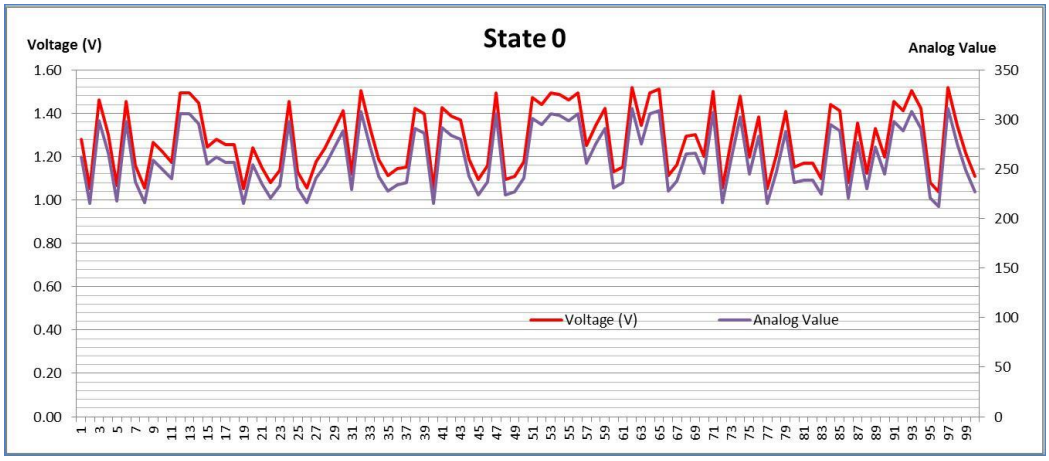

Figure 5. Test result on state 0

According to figure 5, from measure until 100 times, it can be seen that the maximum voltage is 1.52 volt with analog value is 310 and the minimum value is 1.04 volt with analog value is 213. There is no significant voltage value changing in the experiment.

4.2. Test Result on State 1 – normal condition or no trigger

According to the circuit on figure 3, the calculations using voltage divider formula:

$$= \frac{^{2}}{(\ _{1} + \ _{2})} \ 5$$

$$= \frac{4\ 7}{(4\ 7 + \qquad 4\ 7)} \ 5$$

$$= 2.5 \qquad h \quad h\ 2.5 : 0.00488 = 512$$

Test result on state 1 or when a normal condition is shown by the following figure below:

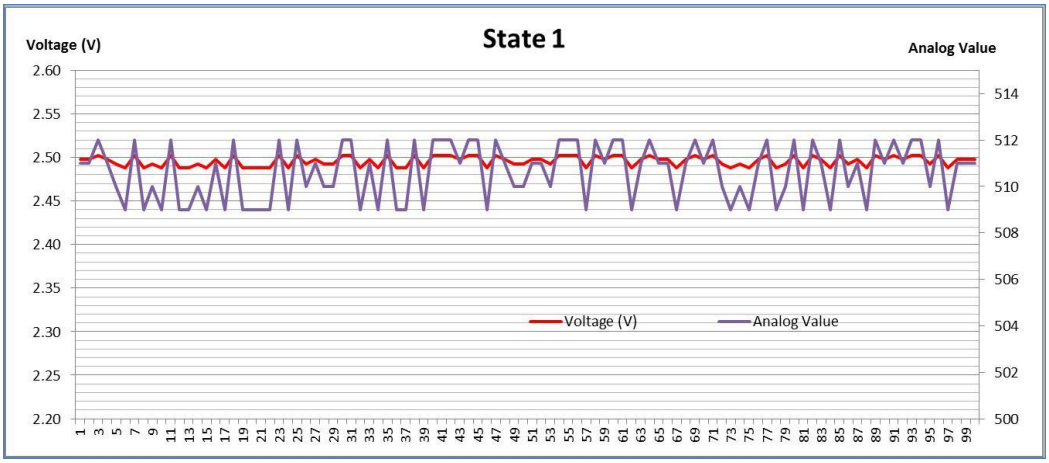

Figure 6. Test result on state 1

According to figure 6, from measure until 100 times, it can be seen that the maximum voltage is 2.50 volt with analog value is 512 and the minimum value is 2.49 volt with analog value is 509. There is no significant voltage value changing in the experiment.

4.3. Test Result on State 2

According to the circuit on figure 3, the calculations using voltage divider formula:

$$= \frac{^{2}}{(_{1} + _{2})} \; 5$$

$$= \frac{4\,7 + 4\,7}{(4\,7 + (4\,7 + 4\,7))} \; 5$$

$$= 3.33 \qquad h \quad h\,3.33 : 0.00488 = 680$$

Test result on state 2 or when the sensor tripped is shown by the following figure below:

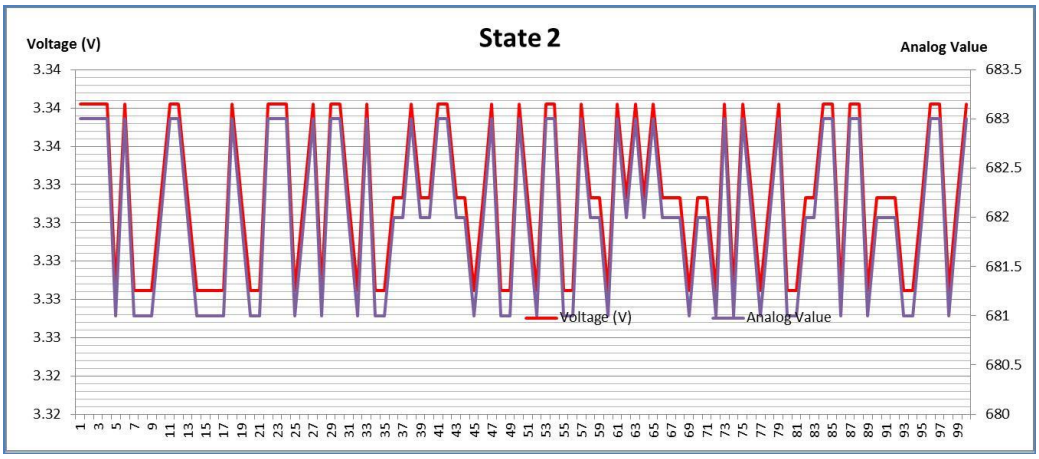

Figure 7. Test result on state 2

According to figure 7, from measure until 100 times, it can be seen that the maximum voltage is 3.34 volt with analog value is 683 and the minimum value is 3.33 volt with analog value is 681. There is no significant voltage value changing in the experiment.

4.4. Test Result on State 3

According to the circuit on figure 3, the calculations using voltage divider formula:

$$= \frac{^{2}}{(_{1} + _{2})} \; 5$$

$$= \frac{}{(4\,7 + \quad)} \; 5$$

$$= 5 \qquad h \quad h\,5 : 0.00488 = 1023$$

Test result on state 3 or when wire cut or tamper detected is shown by the following table below:

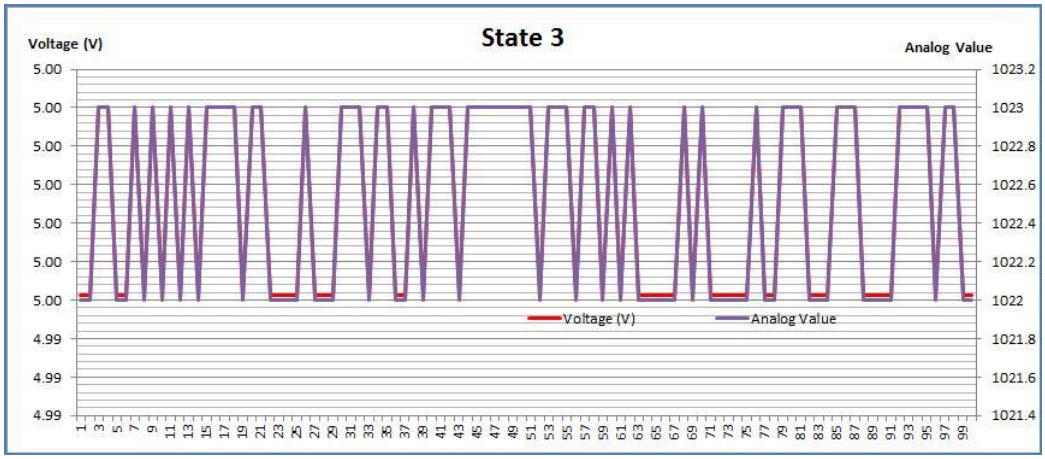

Figure 8. Test result on state 3

According to figure 8, from measure until 100 times, it can be seen that the maximum voltage is 5 volt with analog value is 1023 and the minimum value is 5 volt with analog value is 1022. There is no significant voltage value changing in the experiment.

From above test results can be summarized states or sensor conditions a voltage value and analog value according to the following table 2:

Status - Condition	***Resistance (Ohm)***	***Voltage (Volt)***			***Analog Value***		
		Calculation	*Actual Minimum*	*Actual Maximum*	*Calculation*	*Actual Minimum*	*Actual Maximum*
0	*0*	*~1*	*1.04*	*1.52*	*0*	*213*	*310*
1	*4K7*	*2.5*	*2.49*	*2.5*	*512*	*509*	*512*
2	*9K4*	*3.3*	*3.33*	*3.34*	*675*	*681*	*683*
3	*Infinite*	*5*	*5*	*5*	*1023*	*1022*	*1023*

Table 2. State, voltage and analog value of system

5. Conclusion

1. Analog input on Arduino uses to detect different states of sensors and there is no significant voltage value changing in the experiment.
2. The End of Line Resistor works to supervise the field wiring for open or short circuit conditions and report to the control panel.
3. This design gives four possible voltage levels applied to the Arduino analog input depending on the state of the sensor.

4. The system can detect 4 states of the sensor as the following:
   - the wire has been short-circuited then resistance value is 0 and the voltage is ~1 Volt
   - normal conditions or no trigger then resistance value 4K7 and the voltage 2.5 Volt.
   - the sensor has been trigger then resistance value 9K4 and the voltage value is 3.3 Volt.
   - the wire of the system has been cut then resistance became infinite and voltage is 5 Volt.
5. The difference between calculation and the result caused by ideally the switch has zero series resistance and the microcontroller input pin has an infinite input impedance. But in fact, the switch circuit has a non-zero series resistance and the microcontroller input pin has an infinite input impedance.

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Analysis Of Power Quality Effect On The Life Time Transformer

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Abstract. In the industry that runs today, of course, electricity cannot be separated from the electricity used for all production processes. In Indonesia, currently PT. PLN (Persero) (PLN) is the only one of electrical energy provider for the medium and larger scale of industry. The electricity power for industry is usually supplied by 20 kV distribution grid. Meanwhile, industrial utilities, equipment and machinery mostly require lower voltage. Therefore, it is necessary to step down the voltage of the PLN distribution grid from 20 kV to 2 kV, 1 kV, 400 Volt or lower by using step down transformer. Step down transformer has very important role in any industrial facility. Failure and under performance in the maintenance and operation of step down transformer will cause significant effect to the continuation of industrial facility. There are several things that can affect the lifetime of the transformer, one of them is the power quality of the supplied electricity from the grid. The power quality in the form of Total Harmonic Distortion Voltage (THDV), Total Harmonic Distortion Current (THDI), voltage sag, flicker, current, and power must be maintained in required limit or standard range so that it keeps the step down transformer in the best performance and also longer lifetime. In order to know the performance and lifetime of the transformer, there are two important tests that need to carry out periodically which are Dissolved Gas Analysis (DGA) and Break Down Voltage (BDV) test. These tests examine the dissolved gas content and dielectric strength in the transformer oil. The work in this thesis is to carry out a study of power quality effect on a transformer lifetime. The supplied power quality of the PLN grid in the outgoing of step down transformer was measured by using HIOKI PW319 power analyser. Experiment and analysis in this thesis concluded that there is a strong correlation between the supplied power quality of PLN grid and the performance and lifetime of the examined transformers. Poor power quality causes the running lifetime and the performance of the examined transformers decreases.
Keywords: Transformer, Power Quality, THDV, THDI, Power Analyzer

1. Introduction

In an industrial process, Electricity is one of the important factors used to support the Production process. Equipment and machinery used in industries require enormous electrical energy. Similarly, PT. GeTe uses large electricity to run its production machinery. The use of this large electricity must be supported by the quality of electricity supply. Power quality not only affects the customer side but can also affect PLN which acts as the main resource. PLN as the main electricity source flows a voltage of 20KV, so that for the production process a tool is needed to reduce the voltage, namely the step down transformer.

The use of the voltage-dropping transformer is not only used by PLN but also the middle and upper scale customers also use voltage-lowering transformer. PT. GeTe is a medium-scale electricity utility PLN that gets 20 kV power supply input. So to run the industrial process working voltage needs to be lowered first with a voltage-lowering transformer. There are over 100 voltage reducing transformers

available in this company, so that proper maintenance is required for the transformer to work with the maximum and also the transformer has a longer working life.
In this case, transformer owned by PT. GeTe needs to be tested to determine the performance of the transformer installed. By using transformer oil test (Dissolved Gas Analysis and Break Down Voltage) it will be known transformer performance or can be called with the transformer lifetime. Lifetime transformer is closely related to the quality of electrical power included in the transformer.
Transformer contained in PT. GeTe is known to experience some performance degradation after testing of transformer oil. This is what underlies the author to do research related to the existing transformer performance so that it can be done to prevent damage to the transformer. By doing this research will know the relationship of transformer performance or lifetime with the quality of electric power. Then from these results can be recommended how to make the transformer performance is maintained and can even work longer.
The author considers this very important given the role of the transformer is so vital in the production process and minimize the losses experienced if the transformer suffered sudden damage.

2. Scope

The limitations of the problem in this research are as follows:

1. The analysis used is statistical analysis or comparison data.
2. Taking the transformer test data in the Mixing plant
3. Measuring tool using Hioki Power analyser PW3198
4. Analysis focused on power quality research on transformer.
5. Temperature of the transformer not measure.

3. Methodology

Methodology used by writer to know the degradation of transformer performance by collecting data result of Dissolved Gas Analysis (DGA) test, Break Down Voltage (BDV) on mixer transformer 1 and transformer 2.Then measured at each transformer output by using measuring instrument HIOKI PW3198. After the data collected then performed the comparison of oil test results and power quality of each transformer

3.1. Dissolved Gas Analysis (DGA)

DGA (Dissolved Gas Analysis) can literally be interpreted as an analysis of transformer conditions based on the amount of solute gas in transformer oil. DGA in the industrial world is also known as a blood test or blood test on the transformer. Human blood is a compound that is easy to dissolve other substances that are in the vicinity. Through testing the substances dissolved in the blood, it will obtain related information about human health. Similarly, the transformer, the test of solutes (usually gas) on transformer oil (transformer oil is analogous to human blood) will provide information related to the overall health and quality of the transformer.
Certain gases generated in an oil-immersed transformer should be addressed as the first indication of a malfunction that may eventually lead to failure if not connected.
Some indications of the source of the gases and the kind of insulation involved may be gained by determining the composition of the generated gases and interpreted according to IEEE standard C57.104-2008. (IEEE Standard C57.104-2008)

Table 1. Dissolved Gas Concentration Standard

STATUS	Disolved Key Gas Concentration Limits [(µL/L (ppm)2]							
	Hydrogen (H2)	Methane (CH4)	Acetylene (C2H2)	Ethylene (C2H4)	Ethane (C2H6)	Corbon Monoxide (CO)	Carbon dioxide (CO2)	TDCG
Condition 1	100	120	1	50	65	350	2500	720
Condition 2	101 - 700	121 - 400	2 - 9	51 - 100	66 - 100	351 - 570	2500 - 4000	721 - 1920
Condition 3	701 - 1800	401 - 1000	10 - 35	101 - 200	101 - 150	571 - 1400	4001 - 10000	1921 - 4630
Condition 4	> 1800	> 1000	> 35	> 200	> 150	> 1400	> 10000	> 4630

Whereas
Condition 1 (Very Good):
Total Dissolved Combustible Gas (TDCG) below this level indicates the transformer is operating satisfactorily
Condition 2 (Good):
Total Dissolved Combustible Gas (TDCG) within this range indicates greater than normal combustible gas level.
Condition 3 (Bad):
Total Dissolved Combustible Gas (TDCG) within this range indicates a high level of decomposition
Condition 4 (Very Bad):
Total Dissolved Combustible Gas (TDCG) within this range indicates excessive decomposition

3.2. Break Down Voltage (BDV)

Test Break Down Voltage (BDV) is a Breakdown Voltage Test. It is necessary to check the dielectric strength of the Transformer oil. The dielectric strength is the maximum capacity of the transformer oil to withstand the insulating oil voltage. This test shows the strength of the Transformer oil dielectric.
The oil contained in the transformer has two functions, the first as isolation, and the second as cooling the transformer core and windings. So the use of transformer oil in the transformer depends on the voltage rating. Therefore, the oil test is performed according to the voltage rating.
The Electrical strength of the oil given the breakdown voltage, measured using an electrode system in accordance with IEC 60156 and IEC 60422. The electrode are spherical with 12.5 mm 13 mm radius and electrode gap are 2.5mm. The measurement is carried out at rated frequency 40-60 HZ. The rate of increase of the voltage being 2 kV/s. Start from zero up to the value producing break down.
The electric strength of the oil shall be carried out six times on the same cell filling. The Electrical strength is the arithmetic mean of the six results which have been obtained.
The dielectric strength of old oil in service oil should be at least like table below.

Table 2 Dielectric Strength Standard

Transformer Category		Condition		
		Good	Fair	Poor
170 - 400	KV	> 60	50 - 60	< 50
72.5 - 170	KV	> 50	40 - 50	< 40
< 72.5	KV	> 40	30 - 40	< 30

Oil which does not whit stand this voltage may contain bubble, dust or moisture.

3.3. Hioki PW3198

The Hioki 9624-50 PQA-HiView Pro is a software application for analysing binary format measurement data from the Hioki 3196, m197 and 3198 Power Analysers on a computer.
The PQA-HiView Pro can load and read only binary data recorded with the Hioki 3196, 3197 and 3198 Power Analysers.

Figure 1 HIOKI PW3198

Figure 2 *Schematic Measurement output transformer*.

3.4. Power Quality

Power Quality as a term often defined as the ability of the power grid to supply the flow of electricity acts as a provider of available power flow, has noise-free with pure wave sinusoidal form, and always in voltage and frequency tolerance. However, deviations from these ideal conditions often occur in most networks, usually the amount of burden imposing disturbances increases rapidly. Problems with Power Quality is a problem for a number of business sectors with high costs and increasing number of disruptions causing modern production equipment to become more sensitive to interference. Ironically, often the equipment itself is the cause of the coming disorder. Measures Causing Losses and Disturbances The acts that cause harm and disruption are simplified terms for related technical phenomena that are problems in the scope of the electrical world.

Power quality has several problems, such as :

3.4.1 Voltage Sag

Voltage Sag event is a voltage drop. This event could be caused by network error or entry of equipment requiring large initial flows to the network.

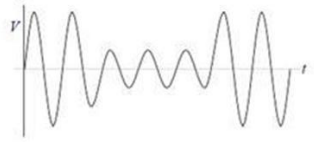

Figure 3 Voltage sag

Voltage sag can result in equipment failure, computer errors, computer memory loss. The phenomenon of Voltage Sag is known as a flicker phenomenon. Flicker is a distortion phenomenon in the amplitude of the voltage wave repeatedly.

3.4.2 Power Surge

Power Surge is an imposition of a sudden increase in power supply to a load. This event is perceived as an increase in stress at the load. This event can happen if the electric equipment that uses a large power suddenly loose/removed from the network. This incident is felt by the other load as an increase in voltage (at normal frequency) this voltage rise can reach 110% or more of the normal voltage.

Power Surge can cause flicker, equipment off, errors on computer, and memory loss in computer.

3.4.3 Transient

Transient is a variable change (voltage, current) that takes place during the transition from one stable condition to another. The causes of transient occurrence include:

a. Load switching (connection and disconnection)
b. Capacitance switching
c. Transformer inrush current
d. Recovery voltage

Transients are power quality disorders involving high currents and destructive tensions or even both. It can reach thousands of volts and amps even in low voltage systems. However, such phenomena exist only in a very short duration and less than 50 nanoseconds up to 50 milliseconds. Transients include abnormal frequencies, which can reach a value of 5 MHz.

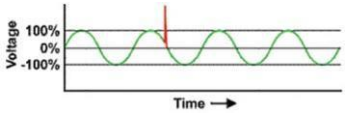

Figure 4 Transients

In addition, transients are also known as waves. The surge is a voltage wave, current or power while in an electrical circuit (IEEE 100). Another IEEE definition indicates that it is part of a variable change that is lost during the transition from one operating condition to another. Such descriptions are too vague, which can be used to describe almost all the unusual events occurring in the electrical system.

In addition, most electrical engineers will refer to the muffled oscillator transient phenomenon in the RLC circuit when hearing the term.

3.4.4 Transient

Voltage unbalance can be defined as the ratio of negative or zero order component to positive sequence component (IEEE). Or it can be said as a voltage variation in the power system where the magnitude of the voltage or phase difference between them is not the same. Therefore this power quality problem only affects the poly phase system.

The voltage between the phases is mostly unbalanced. However, when the voltage imbalance becomes excessive, it can cause problems for poly phase motors and other loads. In addition, adjustable speed drives (ASD) can be more sensitive than standard motors. Causes Voltage unbalance due to unequal load on distribution lines or in production machines. In other words, negative or zero sequence voltages in the power system are usually generated from unbalanced loads that cause negative sequence current or zero to flow.

Voltage Unbalance means that the voltage available in the three phases is not the same, this can happen in any distribution system.

Researcher will use ANSI / NEMA definition / calculation, because it is simpler and can be readily calculated from the measured data. In practical, there will be no difference if we use IEC definition by more than 0.05%. We calculate the voltage imbalance based on ANSI / NEMA definition, as follows:

An example, for each phase voltage V A = 230 Volt, V B = 232 Volt, V C = 225 Volt. V AVERAGE = (V A + V B + V C) / 3 = 229 Volt. Maximum deviation from V AVERAGE is due to V C; V C – V AVERAGE = 4 Volt. Therefore, the voltage imbalance = (4 / 229) × 100% = 1.75%. Desirable level of voltage imbalance is less than 1% at all voltage levels. The ANSI C84.1-1995 requires the voltage imbalance to be < 3%, while the more recent IEC 61000-3-13 requires the voltage imbalance to be < 2%. Based on the experiment on NEMA Std. Pub. MG 1-1998, motors will get additional heating which varies as cube of voltage imbalance (3% of unbalance equals to 25% additional heating of the motors).

3.4.5 Harmonic

Harmonics can be regarded as a sinusoidal voltage or current which has a frequency and is an integer multiple of the fundamental frequency at which the power system is designed to operate. This means that for a 60-Hz system, the harmonic frequency is 120 Hz (2nd harmonic), 180 Hz (3rd harmonic) and so on. Harmonics and the base or current voltage can produce non-sinusoidal forms, thus, distortion waves are a matter of power quality. The non-sinusoidal waveform corresponds to the number of different sine and phase-phase waves, and has a frequency that is a multiple of the system frequency.

The harmonic distortion values can be shown by the harmonic spectrum with the magnitude and phase angle of each harmonic component. In general use Total Harmonic Distortion (THD), as a measure of the effective value of harmonic distortion. Protection from high level harmonics including isolation or source modification, multiplication phase, pulse width modulation (PWM) and passive or active harmonic filter application.

Harmonics is a disturbance that occurs in the electric power distribution system due to the current and voltage wave distortion. The distortion of current and voltage waves is caused by the formation of waves with a frequency multiplied by a frequency of the fundamental frequency. In fact, the existence of this harmonic causes a loss in the distribution transformer, harmonics are a symptom of the formation of waves with different frequencies which are all integers with their basic frequencies. This is called the harmonic frequency that arises in the original waveform while the base frequency multiplier is called the harmonic sequence number. For example, the basic frequency of an electrical system is 50Hz, so the second harmonic is a wave with a frequency of 100Hz, the third harmonic is a wave with a frequency of 150Hz and so on. If the frequency at 50 Hz is said to be the fundamental frequency or basic frequency (f), then if the wave is distorted if it experiences multiple frequency from its basic frequency, for example the second harmonic (2f) at 100 Hz, third (3f) at 150 Hz and the

harmonics n has an nf frequency. These waves will ride on the fundamental frequency wave and a defective wave will form which is the sum of pure waves with the 3rd harmonic wave.
In Figure 2-4, the third harmonic distorted fundamental waveform is shown. As the standard harmonics reference used is the IEEE 519. 1992 standard, "IEEE Recommended Practices and Requirements for Harmonic Control in Electric in Electrical Power Systems". Based on the IEEE 519. 1992 standard there are criteria used to evaluate harmonic distortions, namely the limits for current harmonics and voltage harmonics limits as shown in table 3 and table 4.

Table 3 Standard Current harmonics (THDI)

System Voltage	*Isc/ILOAD*	*THDI (%)*
Vrms ≤ 69 kV	< 20	5.0
	20-50	8.0
	50-100	12.0
	100-1000	15.0
	> 1000	20.0
69 kV < Vrms ≤ 161 kV	< 20	2.5
	20-50	4.0
	50-100	6.0
	100-1000	7.5
	> 1000	10.0
Vrms > 161 kV	< 50	2.5
	≥ 50	4.0

Table 4 Standard Voltage harmonics (THDV)

System Voltage	*IHDv (%)*	*THDv (%)*
Vrms ≤ 69 kV	3.0	5.0
69 kV < Vrms ≤ 161 kV	1.5	2.5
Vrms > 161 kV	1.0	1.5

The transformer is designed to deliver the required power to the load with a minimum loss on its fundamental frequency. Harmonic currents and voltages will significantly cause more heat. There are two effects of more heat on the transformer when the load current contains the following harmonic components:
a) Current harmonics cause increased copper losses
b) Voltage harmonics cause increased iron losses, such as eddy currents and hysteresis losses. Eddy current occurs when the core of a ferromagnetic (iron) material is electrically conductive. The eddy current concentration is higher at the ends of the transformer winding because the effect of the magnetic field density leaks on the coil which causes the phenomenon of the eddy current to occur. Increasing eddy current losses because harmonics affect the working temperature of the transformer which is seen in large real power losses (watts) due to the eddy current.

4. Test result

In Table 3 there is a difference from the results of testing the quality of oil. In the transformer 1 results are very clear that there are some items on the transformer that the value of measurement outside the standard set. While in the transformer 2, all the measurements enter the standard set. This indicates that transformer 1 is in declining performance condition or the transformer is in poor condition.
In table 4 is the result of measurement Dissolved Gas Analysis test where transformer 1 in bad condition compared with measurement result in transformer 2. If this condition is not immediately handled will cause damage transformer. TDCG (Total Dissolved Combustible Gas) which is the amount of combustible gas dissolved in transformer1 represents a very large value of the set value limit.
While the measurement at the transformer output as shown in Table 5, clearly visible the quality of electric power that flows. In transformer 1 the quality of electric power flowing is worse than the one flowing in transformer 2.
By looking at the comparison of power quality measurements on the two transformers (see table 5) then compared with the results of the oil test as in the comparison table in the 3 and 4 table tables we can conclude that the quality of power affects the condition or performance of the transformer. Load characteristics also greatly affect the quality of electric power thus affecting the condition of the transformer.

Table 5 Comparing Result Oil Quality Transformer 1 and 2

Item	Standard	Unit	Limit	Result Transformer 1		Result Transformer 2	
				Value	Note	Value	Note
Water Contance	IEC 814	mg/kg	< 40	48.0	Outside Limits	9.0	Inside Limits
Breakdown Voltage	IEC 156	kV/2.5mm	> 40	31.0	Outside Limits	80.0	Inside Limits
Colour	ASTM D 1500	ASTM scale	-	Amber/L2.5	-+	Clear/0.0	-+
Interfacial Tension	ISO 6295	mN/m	> 28	24.3	Outside Limits	38.2	Inside Limits
Neutralisation Value	IEC 60296	mgKOH/g	< 0.1	0.080	Inside Limits	0.020	Inside Limits
Oil Quality index Number	OQIN/WP 222	.	> 160	304.0	Good	1910	Good

Table 6 Comparing Result DGA Test Transformer 1 and 2

Gas		Transformer 1		Transformer 2	
		Part per Million (ppm)	Condition	Part per Million (ppm)	Condition
Water	H20	48		9.06	
Hydrogen	H2	4615	Condition 4	<10	Condition 1
Methane	CH4	3285	Condition 4	4	Condition 1
Acetylene	C2H2	420	Condition 4	<1	Condition 1
Ethylene	C2H4	10783	Condition 4	40	Condition 1
Ethane	C2H6	3177	Condition 4	2	Condition 1
Carbon monoxide	Co	409	Condition 2	74	Condition 1
Carbon dioxide	CO2	3883	Condition 2	1993	Condition 1
Total Dissolved Combustible Gas (TDCG)		22699	Condition 4	120	Condition 1

Table 7 Comparing measurement output transformer 1 and 2

ITEM PQ	Transformer 1		Transformer 2	
	Result	Condition	Result	Condition
U unbalanced	1.97%	Fair	0.34%	Good
I unbalanced	9.84%	Fair	15.70%	Fair
Current	429.5 A	-	60.8 A	-
THDV	6.17%	Poor	2.75%	Good
THDI	80.88%	Poor	4.39%	Good
Frequency avg	49.994 Hz	Good	50.001 Hz	Good

5. Conclusion

Experiment and analysis in this thesis concluded that:

1. Poor supplied power quality from PLN grid as indicated in Table 5 is the main cause of the decreasing of the performance and lifetime of the examined transformers.
2. Lifetime transformers are influenced by the supplied power quality. So it is important to maintain the supplied power quality at the standard range and minimize its effect to the transformer.
3. Further analysis indicates that poor transformer insulation and higher load fluctuation load coil or stray capacitance may cause harmonic harvesting in the grid.
4. Load characteristics such as load fluctuation affects, indirectly the supplied power quality.
5. By comparing the results of the transformer 1 and transformer 2 measurements with the oil measurement results of each transformer can be seen that the power quality greatly affect the performance of the transformer.
6. From the measurement results, it can also be concluded that the transformer is also influenced by the production load.

6. Recommendations

After looking at the results of the study then the authors recommend several things as follows:

1. Taking into account the load characteristics before installing or selecting the transformer is required to maintain the long-lasting performance of the transformer.
2. Installation of filters can be done to reduce harmonic voltage
3. Use of transformer type for fluctuating load
4. Quickly Schedule Purification oil transformer to make new performance transformer.

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Assessing Privileged Access Management (PAM) using ISO 27001:2013 Control

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Abstract. ISO 27001 is one of the most widely adopted and respected information security standards in use today. It is promulgated by the International Standards Organization (ISO). Many organizations seek to be certified for the standard, which provides a framework for implementing an Information Security Management System (ISMS). The standard touches on virtually every aspect of information security. Access controls - including Privileged Access Management (PAM), thus figure prominently into the ISO 27001 certification and audit processes. In order to manage their privileged accounts, organization should be use PAM to protect critical IT assets, meet the compliance regulation and to prevent data breaches. But unfortunately many organizations do not have enough knowledge when they plan to build PAM solutions. Many organization do not have base-line when they acquire new PAM technology. This paper will help organization to acquire PAM solution that meet the ISO 27001 control. Our compliance matrix give organization a guideline to achieving the implementation of ISMS framework with PAM technology.

1. Introduction

The ISO 27001 standard sets out a specification for the development of an information security management system (ISMS) and guarantees that an organization is following international information security best practices (Itradat *et al.*, 2014). The goal of ISO 27001 is to help organizations set up and maintain effective information security using a process of continual improvement. ISO 27001 provides a control framework for virtually every aspect of information security. The standard has controls devoted to security policy, physical security, incident response and so forth.

Administrative account such as root, administrator, super user and domain admin are all privileged accounts that have unlimited access (Harley and Lee, 2006). User administrator that has access to the system can perform any task using privileged account, and multiple users will use the same account ID and password. Using privileged account roles give them elevated privileges that essentially give users full control over the systems they are managing.

Privileged access is one of the most sensitive aspects of IT. According to Verizon Data Breach 2018, the misuses of privileged account is the 3rd breaches incident on the Public Administration sector (*2018 Data Breach Investigations Report*, 2018). The privileged accounts have the ability to make sweeping

and fundamental changes to IT systems on which the business may depend. When used in unintended ways, their impact can cause a wide spectrum of damage from compliance violations resulting in fines, to security incidents causing reduced brand confidence and lost revenue ('Three Important Reasons for Privileged Identity Management', 2015).

Solution like Privileged Access Management (PAM) can manage privileged access, log all activity in the form of session recordings or keystroke logging, and monitor applications to ensure that a threat actor does not gain inappropriate access, and document all sessions just in case they do (insider threats) (Haber and Hibbert, 2018). PAM is about ensuring - and documenting - that only people with the proper authorization can administer critical systems.

A technology evaluation require a baseline to help organization choosing the right solution. This paper examines the role of Privileged Access Management (PAM) in executing the controls specified by the standard and highlights how the use of a seamless PAM solution meets some key ISO 27001 recommendations while decreasing the cost to meet others. Each section on ISO 27001 will analyze and map their respective controls with PAM solution, to meet and facilitate compliance with the standard. Our main contribution on this work is a matrix compliance of ISO 27001 Annex Control related to PAM solution, to enable end user reviewing PAM technology based on ISO 27001 control.

2. Information Security Management System (ISMS)

2.1. ISO 27001:2013

ISO 27001 is the latest incarnation of the original British Standard 7799, which was first published in 1995. It establishes a framework for an ISMS through policies and procedures spanning physical, technical, and legal controls. The controls framework is intended to help an organization accomplish the risk management goals through a meticulous and extensive compliance process. The ISO 27001 documentation describes the standard by saying it was created, "[to] provide a model for establishing, implementing, operating, monitoring, reviewing, maintaining and improving an information security management system (ISO/IEC 27001:2013, 2013). The standard is broadly embraced by IT professionals. The need for robust security is the most compelling driver of ISO 27001 adoption. According to a survey in the ISO 27001 Global Report 2015, almost 70% of respondents said that improving information security was the biggest driver for implementing ISO 27001 (*ISO 27001 Global Report 2015*, 2015). Technology neutral and top-down in approach, ISO 27001 suggests a six-stage planning process. The process includes defining a security policy, scoping the ISMS, doing a risk assessment, managing identified risks and selecting control objects and specific controls.

ISO 27001:2013 Annex Control contains 18 domains, of which the first 4 are introductions. The remaining 14 chapters cover the topics on Table 1. Table A.1 on Appendix A listed complete ISO 27001:2013 Annex Control.

Table 1 ISO 27001:2013 Annex Control Domain (ISO/IEC 27001:2013, 2013)

A.5. Information Security Policies	A.13. Communication security
A.6. Organization of Information Security	A.14. System acquisition, development and maintenance
A.7. Human Resource Security	A.15. Supplier relationships
A.8. Asset Management	A.16. Information security incident management
A.9. Access Control	A.17. Information security aspects of business continuity management
A.10. Cryptography	A.18. Compliance
A.11. Physical and environmental security	
A.12. Operation Security	

The standard, which consists of extensive documentation backed up by certification consultancies and audit processes, is intended to span multiple segments of an organization. While ISO 27001 does not

mandate any particular control, it does offer a controls checklist. These are listed in a related standard, ISO/IEC 27002:2013 (ISO/IEC 27001:2013, 2013). Other related standards offer implementation guidance (ISO 27003), metrics (ISO 27004) and auditing guidelines (ISO 27007) (*ISO 27000 Family of Standards*, 2018). For the purposes of simplicity, this paper considers this collection of related standards to effectively comprise ISO 27001.

2.2. Privileged Access Management (PAM)

PAM refers to the solutions and processes that enable IT departments to manage and audit the activities of all "privileged users" (Haber and Hibbert, 2018). A privileged user has administrative access to critical systems and data. For instance, a person who is authorized to set up and delete email accounts on Microsoft Exchange Server is a privileged user. Like any privilege, "root" privileges should only be extended to trusted people (Harley and Lee, 2006). Privileges should also be revoked when the need expires.

PAM keeps an organization safe from accidental or deliberate misuse of privileged access (Haber and Hibbert, 2018). For this reason, PAM should figure prominently into the implementation of ISO 27001. An ISMS needs to keep track of employees and contractors as well as remote or even automated users. Some privileged users can even override existing security protocols. If administrators can make unauthorized system changes, access forbidden data and then hide their actions that exposes the organization to serious risk. In ISO 27001 terms, a privileged user might be able to undermine much of the ISMS, either accidently or deliberately.

2.3. Privileged Access Management Component

Privileged Access Management (PAM) provides an automated password and session management solution that provides secure access control, auditing, alerting, and recording for any privileged account. The technology is designed to manage a local or domain shared administrator account; a user's personal admin account; service, operating system, network device, database (A2DB), and application (A2A) accounts; and even SSH keys, cloud, and social media (Haber and Hibbert, 2018). PAM enables the effective implementation of ISO 27001 by offering a secure, streamlined way to authorize and monitor all privileged users for all relevant systems. Particularly, it (Carson, 2017) :

- Grants privileges to users only for systems on which they are authorized.
- Grants access only when it's needed and revokes access when the need expires.
- Avoids the need for privileged users to have or need local/direct passwords.
- Centrally and quickly manages access over a disparate set of heterogeneous systems.
- Creates an unalterable audit trail for any privileged operation.

Gartner define two distinct tool categories have evolved as the predominant focus for security and risk management leaders considering investment in PAM tools (Felix Gaehtgens, Anmol Singh and Dale Gardner, 2017):

- **Privileged account and session management (PASM)**: Privileged accounts are protected by vaulting their credentials. Access to those accounts is then brokered for human users, services and applications. Sessions are established with possible credential injection, and full session recording. Passwords and other credentials for privileged accounts are actively managed (i.e., changed at definable intervals or upon occurrence of specific events).
- **Privilege elevation and delegation management (PEDM)**: Specific privileges are granted on the managed system by host-based agents to logged in users. This includes host-based command control (filtering), and also privilege elevation, the latter in the form of allowing particular commands to be run with a higher level of privileges.

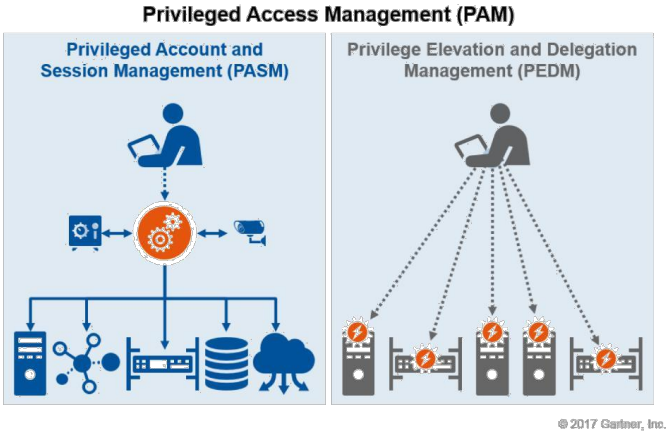

Figure 1 Privileged Access Management Tools (Felix Gaehtgens, Anmol Singh and Dale Gardner, 2017)

Privileged Access Management solutions vary architecturally. However, most offer the following components working together.

2.3.1. Access Management

Governs access to privileged accounts and creates a single-entry point, responding to ISO 27001 access control policy definition and policy enforcement. The privileged user requests access to a system through the Access Manager. The Access Manager is aware of which systems the user can access and his or her specified level of privilege. A super admin can add/modify/delete privileged user accounts on the Access Manager, thus reducing the risk that a former employee will retain access to a critical system. It also provides super admins with a centralized view of all session history held by privileged users, restoring complete visibility and control over strategic equipment (Haber and Hibbert, 2018).

2.3.2. Password Management

Password Management is a simple security function that helps a user store and organize passwords. Prevents privileged users from knowing the actual passwords/credentials to critical systems (Haber and Hibbert, 2018). A password vault can also preclude manual overrides on physical devices, a risk addressed by the physical controls described in ISO 27001 Section A.11. In this case, the PAM system stores passwords in a secure vault and opens access to a system for the privileged user once he or she has been approved for access. It can also extends administrator's password management policies by enforcing credential protection mechanisms such as A2A PM (Application-to-Application-Password-Management), automatic password rotation, and so on.

2.3.3. Session Management

Tracks privileged user connections and activities on target systems. A Session Management module provides real-time monitoring and record of all user activities to prevent incidents and conduct postmortem analyses and audits (Haber and Hibbert, 2018). PAM will help organization to adopt four eyes principle to have one of mutual accountability. Each individual is accountable to another, removing the risk of completely autonomous decisions, and increasing the likelihood that errors will be detected.

CA Technologies (*CA Inc. Common Stock (CA)*, 2018), leader in PAM market released PAM Buyer Guide to provide feature check list when planning to invest PAM Solution. Combining Gartner PAM Market Guide (Felix Gaehtgens, Anmol Singh and Dale Gardner, 2017) with CA PAM Buyer Guide ('Buyer's Guide: Privileged Access Management', 2016), PAM Domain solution matrix shown on Table B.1 on Appendix B.

3. Mapping ISO 27001:2013 Annex Controls to PAM Feature Domain

As discussed on Section 2, ISO 27001:2013 contains of 14 Annex Controls, PAM feature domain also defined by combining Gartner market Guide and CA PAM Buyers Guide. To map the ISO 27001:2013 standard into the PAM Feature Domain, it is necessary to define the method in order not to miss any security requirement. The steps to mapping the ISO 27001:2013 Annex to PAM will be following these below diagram.

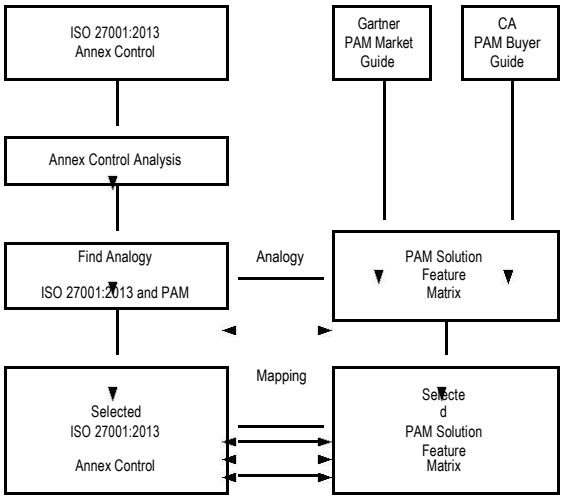

Figure 2 Mapping ISO 27001:2013 and PAM Solution

3.1. ISO27001:2013 Annex Control Analysis

The first steps, it is necessary to analyse and identify the structure of the ISO 27001:2013 Annex Control. The control contain of 14 domain (A.5-A.18). Mapping methods will be focusing on this domain and control.

3.2 Find analogy between both documents

The second steps, to find the analogy between Annex and PAM feature. Each control can be directly extracted from the PAM domain feature. Several of the controls contained in the ISO 27001:2013 standard discuss access control and PAM directly, even if the specification does not refer to PAM by name. In general, the principles of PAM underscore the entire spectrum of access controls in ISO 27001.

3.3 Mapping Annex Control to PAM Domain

The final steps, mapping the annex control to PAM domain feature. The structure of mapping table will contains the complying matrix of Annex and PAM feature related to the control.

4. Complying Matrix ISO 27001:2013 and PAM Feature Domain

4.1. Annex (A.6) Organization of Information Security

PAM helps companies respond to some of the controls highlighted in the section A.6 of ISO 27001:2013. Particularly, it answers the controls A.6.1.1 information security roles and responsibilities which lays ground for the definition and allocation of user or authority roles, as well as A.6.1.2 Segregation of duties. PAM provides administrators with the means to create, adjust, or delete fine-grained groups of users and sub-users [PAM.1.1]. It helps administrators have high visibility over the number of users within their system and allocate roles in a fluid manner [PAM.1.2]. At the same time, administrators can directly assign users the right level of privilege from a central point of command, thereby allowing them

respond to the principle of least privilege and segregate duties appropriately [PAM.1.2]. With each role and privilege clearly defined, PAM mitigates the risk of unauthorized or negligent activity within organizations' core network [PAM.1.6].

4.2. Annex (A.9) Access Controls

Annex A.9 in particular, which provides access controls, discusses PAM both directly and indirectly. The control specified in A.9.2.3 Management of Privileged Access Rights, reads, "The allocation and use of privileged access rights shall be restricted and controlled." A.9.4.4 Use of Privileged Utility Programs, has a control which specifies, "The use of utility programs that might be capable of overriding system and application controls shall be restricted and tightly controlled." PAM can play in the execution of ISO 27001 Access Controls. For example, A.9.2.2 User Access Provisioning, offers a control where access rights can be assigned or revoked [PAM.1.1 PAM.1.2]. A The PAM solution can also terminate privileged access rights upon employee termination, as specified in A.9.2.6 Removal or Adjustment of Access Rights [PAM1.6].

4.3. Annex (A.11) Physical and Environmental Security

Physical and environment security might seem far from system access management issues. However, the two topics are closely linked. Control A.11.1 Secure Areas, has the objective, "To prevent unauthorized physical access, damage and interference to the organization's information and information processing facilities." Physical access can easily translate into data and systemic access. Unauthorized physical access to a system exposes an organization to the risk of improper administrative actions, such as deleting accounts or reconfiguring security settings. A PAM solution with a password vault lets privileged users do whatever they need to do without requiring any physical access to the hardware itself [PAM1.4]. In many traditional IT environments, admins had to manually reset servers, so physical access was expected. The practice created risk, though, which PAM mitigates [PAM.1.4 PAM.1.7].

4.4. Annex (A.15) Supplier Relationships

In many modern enterprises, supplier personnel may need privileged system access. Outsourced IT vendors, some of whom might be on different continents, may need to have "root" access to critical systems. Control A.15.1 Information Security in Supplier Relationships, acknowledges this reality. The control objective for A.15.1 is, "To ensure protection of the organization's assets that is accessible by suppliers." To protect an organization's IT assets from unauthorized access by suppliers, the PAM solution can define and enforce agreed-upon access policies [PAM.1.4]. The PAM solution should also provide auditability that enables both supplier and client to verify that the policies are being followed [PAM.3.1, PAM.3.3]. Controls A.15.1.1. and A.15.1.2 both address the requirement for establishing security policies in supplier relationships and agreements. PAM makes it possible to be specific about policies and prove compliance. PAM solutions that provide session management enable administrators to be aware of what happens on their systems, including through remote access [PAM.3.7]. Session management creates and audit trail and a high level of traceability of activities done on privileged accounts [PAM.3.7]. By being able to monitor suppliers with privileged account access, the PAM solution bolsters compliance with ISO 27001 control A.15

4.5. Annex (A.5) Management direction for information security

Even when a security policy is not directly related to PAM, PAM may well be a part of the policy, because privileged access underpins many other security policies. If an organization unable control privileged access, then few of other policies will be effective. For example, a company may have an acceptable use policy for web browsers and email systems. However, if an admin can delete accounts and erase browsing histories without anyone knowing, that will make the control deficient [PAM.1.1].

4.6 Annex (A.12) Operations Security

PAM also plays a role in operations security. Enriched by a Session Manager component, a PAM solution should be able to record and track all privileged user session activities at all times, thereby contributing to a secured operations flow on critical resources [PAM.3.1 PAM.3.5].

4.7 Annex (A.16) Information Security Incident Management

PAM figures into information security incident management, which is addressed by control A.16. For example, control A.16.1 Management of Information Security Incidents and Improvements, aims, "To ensure a consistent and effective approach to the management of information security incidents, including communication on security events and weaknesses." A PAM solution that can provide security managers with accurate information about privileged account sessions thanks to high traceability and monitoring capacities [PAM.3.1 PAM.3.3 PAM.3.5]. A PAM solution also able to provide instant reporting on any administrative sessions that took place on targeted systems can give security managers a working narrative of the incident [PAM.1.7].

4.8 Annex (A.18) Compliance with Internal Requirements

The controls specified in A.18 cover compliance with internal requirements. These requirements may be driven by internal policy as well as by legal and contractual requirements (A.18.1) or regulatory schemes (A.18.1.1). The objective of A.18.1 is "To avoid breaches of legal, statutory, regulatory or contractual obligations related to information security and of any security requirements." PAM can play an important role in ensuring this sort of compliance [PAM.2.5 PAM.3.7]. Privileged access management may be directly required by compliance programs. Compliance usually requires documentation. PAM enables the organization to document how it defines and enforces privileged access controls. PAM also provides logs of privileged sessions for use in compliance audits [PAM.3.3].

5. CONCLUSION

PAM solution facilitates ISO 27001 compliance by creating an access gateway for system admins that uses single sign-on (SSO). This capability enables the IT department to define and enforce access policies for admins and other employees who need privileged access. PAM lets admins manage access rights and passwords to servers and other devices through a single console. Equally, Session Manager module offers super administrators seamless visibility over their information system, from the identity of the privileged users operating on it or authorized to do so, to a full disclosure of their activity in real time or after their session has closed. This setup lets the IT department adapt access privileges quickly in response to organizational change. IT department turnover also becomes less of an issue with this level of control, ensuring that critical servers cannot be accessed by individuals no longer authorized to do so. With all the work involved in ISO 27001 compliance, the PAM solution should offers a streamlined, low-overhead solution to the privileged access controls of the standard.

6. APPENDICES

6.1. Appendix A

Table A. 1 ISO 27001:2013 Annex Control (ISO/IEC 27001:2013, 2013)

Domain	Control Objective	Controls	
A.5 Information Security Policies	A.5.1 Management direction for information security	A.5.1.1	Policies for information security
		A.5.1.2	Review of the policies for information security
A.6 Organization of information security	A.6.1 Internal organization	A.6.1.1	Information security roles and responsibilities
		A.6.1.2	Segregation of duties
		A.6.1.3	Contact with authorities
		A.6.1.4	Contact with special interest groups
		A.6.1.5	Information security in project management
	A.6.2 Mobile devices and teleworking	A.6.2.1	Mobile device policy
		A.6.2.2	Teleworking
A.7 Human resource security	A.7.1 Prior to employment	A.7.1.1	Screening
		A.7.1.2	Terms and conditions of employment
	A.7.2 During employment	A.7.2.1	Management responsibilities
		A.7.2.2	Information security awareness, education and training
		A.7.2.3	Disciplinary process
	A.7.3 Termination and change of employment	A.7.3.1	Termination or change employment responsibilities
A.8 Asset management	A.8.1 Responsibility for assets	A.8.1.1	Inventory of assets
		A.8.1.2	Ownership of assets
		A.8.1.3	Acceptable use of assets
		A.8.1.4	Return of assets
	A.8.2 Information classification	A.8.2.1	Classification of information
		A.8.2.2	Labelling of information
		A.8.2.3	Handling of assets
	A.8.3 Media handling	A.8.3.1	Management of removable media
		A.8.3.2	Disposal of media
		A.8.3.3	Physical media transfer
A.9 Access control	A.9.1 Business requirements of access control	A.9.1.1	Access control policy
		A.9.1.2	Access to networks and network services
	A.9.2 User access management	A.9.2.1	User registration and de-registration
		A.9.2.2	User access provisioning
		A.9.2.3	Management of privileged access rights
		A.9.2.4	Management of secret authentication information users
		A.9.2.5	Review of user access rights
		A.9.2.6	Removal or adjustment of access rights
	A.9.3 User responsibilities	A.9.3.1	Use of secret information
	A.9.4 System and application access control	A.9.4.1	Information access restriction
		A.9.4.2	Secure log-on procedures
		A.9.4.3	Password management systems
		A.9.4.4	Use of privileged utility programs
		A.9.4.5	Access control to program source code
		A.9.4.5	Access control to program source code
A.10 Cryptography	A.10.1 Cryptographic controls	A.10.1.1	Policy on the use of cryptographic controls
		A.10.1.2	Key management
	A.11.1 Secure areas	A.11.1.1	Physical security perimeter

		A.11.1.2	Physical entry controls
		A.11.1.3	Securing offices, rooms and facilities
		A.11.1.4	Protecting against external and environmental threats
		A.11.1.5	Working in secure areas
		A.11.1.6	Delivery and loading areas
A.11 Physical and environmental security	A.11.2 Equipment	A.11.2.1	Equipment siting and protection
		A.11.2.2	Supporting utilities
		A.11.2.3	Cabling security
		A.11.2.4	Equipment maintenance
		A.11.2.5	Removal of assets
		A.11.2.6	Security of equipment and assets offpremises
		A.11.2.7	Secure disposal or reuse of equipment
		A.11.2.8	Unattended user equipment
		A.11.2.9	Clear desk and clear screen policy
A.12 Operation Security	A.12.1 Operational procedures and responsibilities	A.12.1.1	Documented operating procedures
		A.12.1.2	Change management
		A.12.1.3	Capacity management
		A.12.1.4	Separation of development, testing and operational environments
	A.12.2 Protection from malware	A.12.2.1	Controls against malware
	A.12.3 Backup	A.12.3.1	Information backup
	A.12.4 Logging and monitoring	A.12.4.1	Event logging
		A.12.4.2	Protection of log information
		A.12.4.3	Administrator and operator logs
		A.12.4.4	Clock synchronization
	A.12.5 Control of operational software	A.12.5.1	Installation of software on operational systems
	A.12.6 Technical vulnerability management	A.12.6.1	Management of technical vulnerabilities
		A.12.6.2	Restrictions on software installation
	A.12.7 Information systems audit considerations	A.12.7.1	Information systems audit controls
A.13 Communications security	A.13.1 Network security management	A.13.1.1	Network controls
		A.13.1.2	Security of network services
		A.13.1.3	Segregation in networks
	A.13.2 Information transfer	A.13.2.1	Information transfer policies and procedures
		A.13.2.2	Agreements on information transfer
		A.13.2.3	Electronic messaging
		A.13.2.4	Confidentiality or non-disclosure agreements
A.14 System acquisition, development and maintenance	A.14.1 Security requirements of information systems	A.14.1.1	Information security requirements analysis and specification
		A.14.1.2	Securing application services on public networks
		A.14.1.3	Protecting application services transactions
	A.14.2 Security in development and support processes	A.14.2.1	Secure development policy
		A.14.2.2	System change control procedures
		A.14.2.3	Technical review of applications after operating platform changes
		A.14.2.4	Restrictions on changes to software packages
		A.14.2.5	Secure systems engineering principles
		A.14.2.6	Secure developments environments
		A.14.2.7	Outsourced developments
		A.14.2.8	System security testing
		A.14.2.9	System acceptance testing
	A.14.3 Test data	A.14.3.1	Protection of test data
		A.15.1.1	Information security policy for suppliers relationships

A.15 Supplier relationships	A.15.1 Information security in supplier relationships	A.15.1.2	Addressing security within supplier agreements
		A.15.1.3	Information and communication technology supply chain
	A.15.2 Supplier service delivery management	A.15.2.1	Monitoring and review of supplier services
		A.15.2.2	Managing changes to supplier
A.16 Information management security incident	A.16.1 Management of information security incidents and improvements	A.16.1.1	Responsibilities and procedures
		A.16.1.2	Reporting information security events
		A.16.1.3	Reporting information security weaknesses
		A.16.1.4	Assessment of and decisions on information security events
		A.16.1.5	Response to information security incidents
		A.16.1.6	Learning from information security incidents
		A.16.1.7	Collection of evidence
A.17 Information security aspects of business continuity management	A.17.1 Information security continuity	A.17.1.1	Planning information security continuity
		A.17.1.2	Implementing information security continuity
		A.17.1.3	Verify, review and evaluate information security continuity
A.18 Compliance	A.18.1 Compliance with legal and contractual requirements	A.18.1.1	Identification of applicable legislation and contractual requirements
		A.18.1.2	Intellectual property rights
		A.18.1.3	Protection of records
		A.18.1.4	Privacy and protection of personally identifiable information
		A.18.1.5	Regulation of cryptographic controls
	A.18.2 Information security reviews	A.18.2.1	Independent review of information security

6.2. Appendix B

Table B. 1PAM Domain feature mapping ('Buyer's Guide: Privileged Access Management', 2016; Felix Gaehtgens, Anmol Singh and Dale Gardner, 2017)

Domain	Control	
PAM.1 Access Management	PAM.1.1	PAM.1.1 Control access to privileged accounts, including shared and "firecall" (emergency access) accounts.
	PAM.1.2	Delegate, control and filter privileged operations that an administrator can execute.
	PAM.1.3	Require high-trust authentication for privileged access by either providing or integrating with other multifactor solutions to ensure required levels of trust and accountability.
	PAM.1.4	Implement workflow features for administrative users to request access, and for authorized approvers to grant this access.
	PAM.1.5	Access to shared accounts can be contingent on additional workflow approvals and/or high-trust MFA. An audit trail documents all privileged account use.
	PAM.1.6	Provides a zero-trust model where all access is denied, unless it is specifically permitted
	PAM.1.7	Providing full attribution for user activities using shared passwords
	PAM.1.8	Supports a broad set of end-point types like UNIX®/Linux® via SSH or Telnet, Microsoft, Windows® and published apps via RDP, databases, mainframe systems via TN3270 or TN5250, and network devices via SSH or Telnet
	PAM.1.9	Supports local application execution, invoking local/desktop application connections to managed devices
PAM.2 Password Management	PAM.2.1	Automatically randomize, manage and vault passwords and other credentials for administrative, service and application accounts.
	PAM.2.2	Eliminate hard-coded passwords by making them available on demand to applications.
	PAM.2.3	Provide single sign-on (SSO) for privileged commands and actions in a secure manner, such that credentials are not revealed.
	PAM.2.4	Support "break the glass" scenarios for emergency and disaster recovery purposes, including the support for firecall accounts.
	PAM.2.5	Users of privileged accounts should not be allowed to see or access the actual passwords for these accounts, passwords for shared accounts must not be shared, which can lead to uncontrolled access.
	PAM.2.6	Rotating credentials and changing them in situ — that is, in the place where they are held by the system, application or service. Examples are Windows services that run under local or domain service accounts, whenever the password is changed, the services require that their service configuration is updated on each local system where the services run.
	PAM.2.7	Automatic generation of credentials for continuous deployment/continuous integration and orchestration tools, as new instances are built, such as in elastic scalable environments.

	PAM.2.8	Managing cryptographic access keys and other credentials used within containers, such as Docker.
	PAM.2.9	Allowing an application to retrieve the password from the vault through a network-protocol-based API.
	PAM.2.10	By use of application-to-application password management (AAPM) agents that are installed on local systems and allow applications to access credentials using host-based access control mechanisms, described in the next section.
	PAM.2.11	Application fingerprinting or checksum verification of the application, its configuration and other dependent files to prevent tampering.
	PAM.2.12	Environment verification, such as the user ID or process under which the application is started, from which directory it is started, and so on.
	PAM.2.13	One-time password mechanisms, where after every invocation the next sequence password is generated from a seed, stored and verified upon subsequent invocation.
	PAM.2.14	Automates the creation, use and change of passwords, SSH session keys and other credentials
	PAM.2.15	Centralizes the administration, storage, release and audit of credentials
	PAM.2.16	Store credentials in an encrypted safe, protecting them using managed keys generated, stored, and used via software or FIPS-140-2 validated HSM
	PAM.2.17	Scales by managing high volume credentials (across multi-site, hybrid enterprise environments)
	PAM.2.18	Provides built-in replication of the credential safe/password vault, aiding disaster recovery
	PAM.2.19	Manages and modify credentials based on flexible password change policies including rotating passwords at scheduled intervals
	PAM.2.20	Provides automated login to managed endpoints using privileged credentials without revealing the credentials to users
	PAM.2.21	Provides transparent login for secondary credentials such as SUDO, databases, and other targets that require secondary authentications
	PAM.2.22	Provides learn mode for RDP applications and web applications, simplifying credentials acquisition when using RDP published applications and web-based applications
	PAM.2.23	Offers support for dual credential approval, requiring approvals by designated users prior to allowing access to credentials for managed accounts
	PAM.2.24	Provides detailed application-to-application password audits and activity reporting
	PAM.2.25	Allows specific security controls around requesting applications or scripts, including support for: Specific UIDs executing the script or application, The calling path, The file path, Checksum validation and denies the requesting application's access to the credential if any or all of the above return a false or untrue value
	PAM.2.26	Allows for the use of an encrypted cache to speed up transaction times and support outage situations
PAM.3 Session Management	PAM.3.1	Monitor, record and audit privileged access, commands and actions.
	PAM.3.2	Provides session recording and playback for privileged user sessions across RDP/VNC, SSH and cloud management consoles or web-based systems
	PAM.3.3	Generates comprehensive logs of all requests and responses by the system, including a complete, detailed account of what happened on sensitive systems and who performed a specific activity
	PAM.3.4	Provides full-resolution capture of privileged user sessions
	PAM.3.5	Provides DVR-like playback controls for session replay, allowing session review from beginning to end, back up and replay portions of a session, or fast-forwarding to specific points of interest, like jumping to specific points in the timeline to evaluate violations
	PAM.3.6	Provides comprehensive support for web application session recording, including high-fidelity session tracking for web-based applications and management interfaces (for example, AWS Management Console, VMware interfaces and the Microsoft Office 365 administrative portal)
	PAM.3.7	Supports always-on session recording and auto-start session recording when a policy violation is detected
	PAM.3.8	Provides extensive logging capabilities of the critical interactions that take place between hybrid clouds and individual users, supporting configuration management solutions like
	PAM.3.9	Puppet or Chef, and a broad range of application programs employing AWS software development kits
	PAM.3.10	Records and forwards session activity to SIEM tools for further examination and automation

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Blockchain Governance: An Evaluation from COBIT 5 Perspective

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Abstract. Currently blockchain has been recognized and implemented in cryptocurrency sector, but not for other industry, especially enterprise. Through this research it is expected to help the adoption process of blockchain. The evaluation was conducted on blockchain through testing using COBIT 5 cascaded from Stakeholder Question to IT Process. 35% of organization goal is applicable with selected stakeholder question, while 65% is applicable with IT related goal. The results of the analysis stated that finding of this study was more applicable for enterprise organizations such as fintech company with some parameters need to be added as the future work due to the enterprise organization had a lot of business and governance processes that were already running. Meanwhile the start-up organization can be audited as well based on this process.

Keyword: blockchain, COBIT 5, governance, Indonesia, enterprise governance, cryptocurrency, start-up.

1. Introduction

Since the inception of bitcoin in the past decade, Satoshi Nakamoto (Nakamoto, 2008) has provided an alternative solution to the method of digital payment system by prioritizing the trust principle in every transaction. The goal of the trust system is to be eliminating the third party as a mediator like the payment of conventional system through P2P (peer-to-peer) technology. In a conventional transaction, an intermediary medium will be maintained by a central institution as a place to register and confirm to determine the validation of the transaction. However, in practice, the trust of the centralized system provides a set of problems that become constraints in a transaction such as cost issues, the level of transaction efficiency and security issues (Denford, Dawson and Desouza, 2015).

To mitigate these problems, Nakomoto designed a digital currency system to cover the weaknesses of conventional methods with the main purpose of using other than to reduce third-party media, with the trust of the concept of payment model becoming more secure where the cryptography proof is used as the main platform so that the frequent fraud found in digital transactions can be reduced (Nakamoto, 2008) through decentralized mechanisms where each node – the entity connected to the blockchain environment - in a blockchain network can be used as a node in charge of validation (Mingxiao *et al.*, 2017).

The development of this technology provides a very significant benefit to the financial sector, as evidenced by the growing number of cryptocurrencies using blockchain as its main platform. By looking at a number of blockchain benefits such as eliminating the 3rd party involvement in the chain (Morabito, 2017), industry sector other than financial will potentially adopt blockchain (Bhowmik and Feng, 2017)

especially when IoT technology has been well implemented for public. (Singh and Chopra, 2018). But somehow, the non-financial industry sector has not yet adopted much of the blockchain. The main issue of implementing of the blockchain for private sector is governance process that need to be decided. The adopting of the governance process will impact to the existing business model (Hamida *et al.*, 2017).

Various studies have been conducted for a new blockchain technology, based on research conducted by (Yli-Huumo *et al.*, 2016), where the security and impact trends are the main focus in blockchain research, in addition to data integrity, authentication and problems surrounding cryptography. But a few researches that discusses the governance process that can be used as a standard. The unavailability of standard governance that can be adopted by the private sector corporate sector is one of the key concepts that must be considered to maintain the integrity, auditable, availability and security of any data and transactions conducted (Yuan, Lin and Mcdonnell, 2016).

According to (Piazza, 2017), the paper explains bitcoin as the success story of blockchain implementation a in cryptocurrency, there are many potentials that can be utilized by blockchain such as voting system, transparency ownership mechanism, security in accounting system and smart contract. Similar to the Piazza study, (Yermack, 2017) describes the advantages of the use of blockchain and its potential disruption, the cryptocurrency will shifting the value of money. In line with Piazza's idea, (Reijers, O'Brolcháin and Haynes, 2016) provides also some of the social problems that may arise from the impact of blockchain, especially cryptocurrency. In addition to social problems, both Piaza and Reijers show that the development of blockchain can have an impact on the development of governance processes of an institution. Especially with the various types of consensus generated by blockchain as described by (Zheng *et al.*, 2017).

However, the blockchain adoption process, some aspect must be put in the highest consideration. One o one of them is the evaluation governance process owned by both blockchain and enterprise. Currently, the enterprise adopt the governance process from the existing well known standard framework i.e COBIT - with the latest update is COBIT 5 - with some of the advantages that COBIT can provide support for business decision making, good risk management, able to generate value from IT-enabled processes, optimize cost, day-to-day operational management up to compliance with applicable regulations (Isaca, 2013). As written by (Laksito and Amikom, 2015) that COBIT is able to assess the maturity level of IT governance in an education world. Similar to Laksito, (Islamiah, 2014) conducts a maturity level study of one of the government institutions with research coverage on IT management with APO domains. To provide a more complete literacy, the authors use research on the aspects of IT management on BAI and MEA domains through research results (Fitrianingsih, 2016). While in the governance area, the authors complete the literacy component of the research results by (Gandhi and Kurniati, 2012)

Simultaneously, IT industry in Indonesia are preparing the adoption of the blockchain. The embryo adoption of blockchain is clearly visible, at least within the last two years there are many business people who focus on blockchain and created a blockchain association of Indonesia (ABI) (Blockchain and Indonesia, 2018). Therefore, through this paper, it is expected to contribute to the preparation of organization in adopting blockchain in the context governance evaluation.

2. Methodology

Seeing blockchain as one of the breakthrough phenomena in the digital world since a decade ago, this breakthrough innovation is considered a digital disruption (Marsal-Llacuna and Miquel Oliver-Riera, 2017) for some industries, at least today the financial industry has more or less been threatened by the presence of this blockchain. Referring to this issue that currently blockchain has not been widely adopted by other industries, the objective of this paper is to conduct blockchain evaluation by using COBIT 5 as one of the standard of IT Governance framework which is widely used by corporate, by proposing an

idea of a framework that can be used to adopt blockchain through governance and IT management processes derived from questions based on stakeholder needs. This framework can be used to determine the best strategic plan for corporate to design the preparation of the adoption of the blockchain.

Answering the research question, the author will use the qualitative research approach by defining the proposal formula (Saha and Ray, 2011) of adoption process. As the proposal/formula completed, it then will be validated by the expert (Utami, Istiyanto and Raharjo, 2007). The formula is cascaded from the business perspective to get the business sight, stakeholder question, organizational goal, IT related and into lower layer which is IT Processes. However, blockchain is the new technology concept in IT, the author started research by selecting the appropriate stakeholder question "*How can I best exploit new technology for new strategic opportunities?".*

3. Result and Discussion

3.1. Business framework adoption

As a new technology that is currently much loved by corporations, blockchain is still not widely used by organizations in Indonesia. Referring to this condition, this paper is done as a bridge to assist organizations in adopting blockchain. The first initial assessment has to be completed from the business perspective. To assess this, the business team can use the initial framework that has been published by Economic Forum, Dr. Catherine Mulligan (Rangaswami *et al.*, 2018).

3.2. Stakeholder Needs

Having finished with the assessment process using the Catherine Mulligan framework, the next step is to determine stakeholder needs. Referring to data from a number of stakeholder needs issued by COBIT 5 as listed in table 9 below, then selected some questions relevant to current conditions in the adoption of blockchain. As the new technology concept, the questions will be selected as the "*How can I best exploit new technology for new strategic opportunities?"*

3.3. Organizational Goals

The selection of stakeholder needs will have an impact on the selecting of the next step, in the form of organizational goals. Stakeholder Needs then to be mapped into organization goals. The result of the mapping shows that there are 35% (6 of the 17) organization goals corresponding to stakeholder needs. The mapping results can be seen as follows:

Table 1. Mapping Stakeholder need – Organizational Goals

Stakeholder Need	Organization Goals
How can I best exploit new technology for new strategic opportunities?	1. Stakeholder value of business investments
	2. Portfolio of competitive products and services
	8. Agile responses to a changing business environment
	13. Managed business change program
	16. Skilled and motivated people
	17. Product and business innovation culture

3.4. IT Related Goals

The organizational goal mapping results, then mapped back to the lower level of IT Related Goal. COBIT 5 provides a guideline for using IT related goals as much as 17, where the seventeen IT Related

goals are deployed based on a balanced scorecard with four parameters namely **Financial** (*Alignment of IT and business Strategy, IT Compliance and support for business compliance with external laws and regulations, Commitment of executive management for making IT-related decisions, Managed IT-Related business risk, Realized benefit from IT-enabled investments and service portfolio, Transparency of IT cost, benefits and risk*), **Internal Development** (*IT Agility, Security of Information, processing infrastructure and applications, Optimization IT Assets, resources and capabilities, Enablement and support of business processes by integrating applications and technology into business process, Delivery of programs delivering benefits, on time, on budget and meeting requirements and quality standards, Availability of reliable and useful information for decision making, IT Compliance with internal policies)*, **Customer** (*Delivery of IT Services in line with business requirement, Adequate use of applications, information and technology solutions)* and **Learn and Growth** (*Competent and motivated business and IT Personnel, Knowledge, expertise and initiatives for business innovation).*

3.5. IT Process

The IT Process to be then mapped into the IT related goals to be selected which the most importance process has to be completed and prepared before adopting the blockchain. The mapping process can be shown as the table 15 below. Within the top primary and secondary process will be put as the highest priority to be implemented.

How can I best exploit new technology for new strategic opportunities

APO01	Manage the IT Management Framework	45.45%	36.36%
APO07	Manage Human Resources	45.45%	27.27%
APO04	Manage Innovation	45.45%	18.18%
EDM 02	Ensure Benefits Delivery	36.36%	54.55%
APO08	Manage Relationships	36.36%	54.55%
APO02	Manage Strategy	27.27%	72.73%
EDM 01	Ensure Governance Framework Settings and Maintenance	27.27%	63.64%
EDM 04	Ensure Resource Optimization	27.27%	63.64%
BAI02	Manage Requirements Definition	27.27%	63.64%
BAI05	Manage Organizational Change Enablement	27.27%	63.64%
APO03	Manage Enterprise Architecture	27.27%	54.55%
APO05	Manage Portfolio	27.27%	54.55%
APO11	Manage Quality	27.27%	54.55%
BAI01	Manage Program and Projects	27.27%	54.55%
MEA01	Monitor, Evaluate and Assess Performance and Conformance	18.18%	72.73%
BAI08	Manage Knowledge	18.18%	54.55%
APO10	Manage Suppliers	18.18%	45.45%
BAI04	Manage Availability and Capacity	18.18%	45.45%
BAI07	Manage Change Acceptance and Transitioning	18.18%	45.45%
DSS01	Manage Operation	18.18%	45.45%
DSS03	Manage Problems	18.18%	45.45%
EDM 05	Ensure Stakeholder Transparency	18.18%	27.27%
BAI06	Manage Change	9.09%	72.73%
DSS04	Manage Continuity	9.09%	72.73%
BAI03	Manage Solutions Identification and Build	9.09%	63.64%
APO06	Manage Budget and Costs	9.09%	54.55%
APO09	Manage Service Agreement	9.09%	54.55%

APO12	Manage Risk	9.09%	45.45%
DSS06	Manage Business Process Controls	9.09%	45.45%
BAI10	Manage Configuration	9.09%	36.36%
BAI09	Manage Assets	9.09%	18.18%
DSS02	Manage Service Request and Incident	9.09%	18.18%
EDM 03	Ensure Risk Optimization	0.00%	63.64%
DSS05	Manage Security Service	0.00%	45.45%
MEA02	Monitor, Evaluate and Assess the System of Internal Control	0.00%	27.27%
MEA03	Monitor, Evaluate and Assess Compliance with External Requirements	0.00%	27.27%
APO13	Manage Security	0.00%	18.18%

As one of the new technological concepts, adoption of blockchain is referred to stakeholder questions of how large organizations can exploit blockchain as one of the new technologies that will be adopted that can increase income financially.

By using the COBIT 5 framework, where all processes are derived from stakeholder needs to the lower layer aspects of the IT process, it is generated that to adopt the blockchain of each organization it can be concluded that:

a. Organizational goals will focus on fulfillment as follows: Stakeholder value of business investment, Portfolio competitive product and services, Align response to changing business environment, Managed business change program, Skilled and motivated people, Product business innovation and culture.
b. As for IT related goals, IT organizations should focus on (top down priority): Alignment of business, Delivery of IT Services in line with business requirement, Focus on IT agility process, Knowledge, expertise and initiative for business innovation, Commitment of executive management for making IT-related decisions, Realized benefit from IT-enabled investments and service portfolio, Delivery of programs delivering benefits, on time, on budget and meeting requirements and quality standards, Optimization IT Assets, resources and capabilities, Enablement and support of business processes by integrating applications and technology into business process, Competent and motivated business and IT Personnel, Adequate use of applications, information and technology solutions.

To support the needs of the organization, IT should be able to deliver the process of IT adoption process is recommended to run the IT process as follows:

a. Governance: must be able to ensure that the process governance can provide tangible benefits to the organization (EDM02) by at least forming a major framework that can be used by the organization in running the process (EDM01) during the adoption of blockchain including optimization of resources owned by the organization (EMD04).
b. Management: in the process of daily activity work, the organization should focus on several key aspects including:
    1. Make IT management more appropriate (APO01).
    2. Effective and efficient use of human resources (APO07).
    3. Given that blockchain is a technology that categorizes new technology, it requires proper management of innovation to maximize the ability of blockchain (APO04).
    4. Blockchain will decide on a lot of intermediary or 3rd party, therefore it needs strong relationship management both existing supplier and supplier selection process in accordance with blockchain condition (APO08).
    5. In addition to maintaining the continuity of the organization, it takes a strong strategy in running the organization. For that IT process must always refer to organizational goals priority (APO02).
    6. Given that blockchain is a new technology, it is certain that the needs of organizations that will adopt blockchain meet the needs. Therefore, every need must be clearly defined (BAI02).

Changes will occur very often during adoption, for which the process of managing change takes place including changes in principles, framework & policies, process people, skills, competencies and cultures, ethic and behavior, services, infrastructures & application and information (BAI05).

4. Conclusion & Future Work

Based on the results of research within Indonesia as the target that uses a question stakeholder question, in general it can be used as a reference for the blockchain adoption process. However, the results are more suitable for enterprise organization with some parameter need to be added to meet stakeholder needs. The business core will fit for fintech, banking, logistic system, supply chain and healthcare. The further research is to be explored for organization that has been implemented blockchain either enterprise and startup organization within adding some parameters.

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Application of a Non-Contact Laser in Profile Measurement

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Abstract. In the tire manufacturing process especially for the tread production process, one of the important things in making tread is parameter like length, width, and height. The width of this tread is very influential on the quality of the tread made; the more accurate the dimensions of the tread made then the quality of the product will be better. The current measurement is done by the manual method that is by using a simple steel roll meter. The possibility of measuring the error in viewing the number on the tools, that the measurement results do not match the actual tread size. This research is the application of a non-contact laser in profile measurement on the extruder machine so it can facilitate the work of employees in controlling the width of the tread. This design uses a Linear Motion Lead Screw Slide Stage (Stroke Actuator, Stepper Motor, and Driver), laser distance sensor and Arduino Mega 2560. In this prototype, the signal from the distance sensor is processed in the microcontroller and sends to the computer to create a curve graph in the computer display. The actual final result of the object profile measurement was provided.

Keywords: tread; linear motion; laser distance sensor; profile measurement.

1. Introduction

In the tire manufacturing process, the dimensional accuracy of a product's output is important in order to continue in the next production process. But this cannot be separated from human error if the measurement is done manually.

Tire manufacturing process with accurate specifications will ensure the safety of consumers. Some components of tire manufacturing are of concern regarding the accuracy of the measurement. One of the material in the process is TREAD. Tread is the outer part of the tire in direct contact with the road media. The case of measurement error occurs on the measurement of the width of the tread. The current measurement is done by a manual method that is by using a simple steel roll meter. The possibility of measuring the error in viewing the number on the tools, that the measurement results do not match the actual tread size. In the manual measurement, employees are required to see accurately to avoid errors in the measurement of the resulting product. To reduce the occurrence of errors in making a product, the use of sensors is a way that is often used and done.

In the process of making the tread parameters (length, width, and height) is very important, the width of the tread very influential on the quality of treads made. The most common problem with tread production is held tread. Hold tread is the width of tread over and width of tread under.

Based on historical data of tread production in the tire manufacturing company, there is a variation of tread width causing hold in the process and return claim product. The current measurement process is shown in figure 1.

Figure 1 Current measurement process [Author: illustration of the current condition]

2. Objectives

The objectives of the study comprising of:

- Prototype and develops the real-time measurement of object distance.
- To analyze the correlation between distance and speed of a sensor movement to getting the object size.

3. Theoretical Perspectives

3.1. Tire Tread Extrusion

The tread is the tire portion of the tire that serves to protect the tire from the impact, the puncture of an object from the outside that can damage the tire. Treads made many patterns called Patterns.

This process is an extrusion or forms a tread and sidewall of the compound resulting from the mixing process. Prior to the extrusion process, the compound is processed first on an open mill machine to increase the temperature and make the compound more homogeneous. Open mill process by entering the compound into 2 pieces that have gape roll (according to the desired tread type) for 5 minutes.

After a homogeneous compound, the compound is driven by a screw through a die that has a shape corresponding to the desired tread shape. Then the tread is marked (marking) which is then coated plastic to be cooled with water on cooling conveyor. The next process is cutting tread in accordance with the provisions that the tip of the tread is given cement and then placed on the pan truck for the next process (building). At the end of the line, the tread is cut according to a specific length and weight for the tire being built. [1]

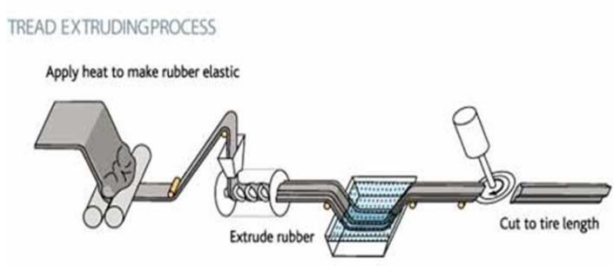

Figure 2 Tread extruding process [1]

The inspection process is to measure the points of the tread point (extrude rubber), the cross-section of the tread is shown in figure 3.

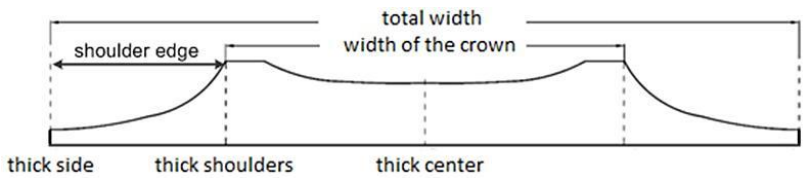

Figure 3 Measurement point of tread cross-section [Author: data observation]

The tread specimen measurement point description for inspection guide can be seen in table 1.

Table 1 Tread measurement point description for inspection guide

no.	point name	width	
		design(mm)	tolerance(mm)
-	shoulder edge	56.5	-
1	thick side	1.5	±0.5
2	thick center	10.0	±0.5
3	thick shoulders	9.0	±0.5
4	width of the crown	120.0	±2.0
5	total width	230.0	±1.5

3.2. Principles of Dimensional Measurement System

The method used to measure distance depends on the accuracy and distance capability required of the device. Measurement principles include triangulation, time-of-flight measurement, pulse-type time-of-flight systems, and modulated beam systems. For distances of a few inches with high accuracy requirements, "triangulation" sensors measure the location of the spot within the field of view of the detecting element. Time of flight (ToF) sensors derive range from the time it takes light to travel from the sensor to the target and return. For very long range distance measurements (up to many miles) "time-of-flight" laser rangefinders using pulsed laser beams are used. Modulated Beam Systems use the time light takes to travel to the target and back, but the time for a single round-trip is not measured directly. Instead, the strength of the laser is rapidly varied to produce a signal that changes over time. [2]

The dimensional measurement systems allow measuring depth by using one or more cameras or sensors. The vision system that operates in the visible spectrum and IR can be categorized into the four groups shown below:

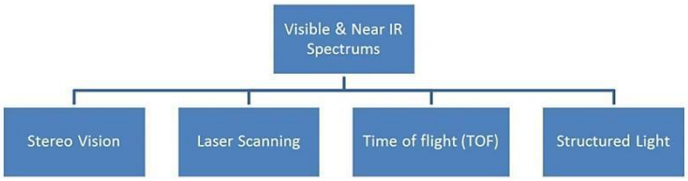

Figure 4 Dimensional Measurement Categories of Objects [3]

4. Design of Experiment

Material equipment and setting position of the design of the experiment can be seen in figure 5 and prototype realization can be seen figure 6.

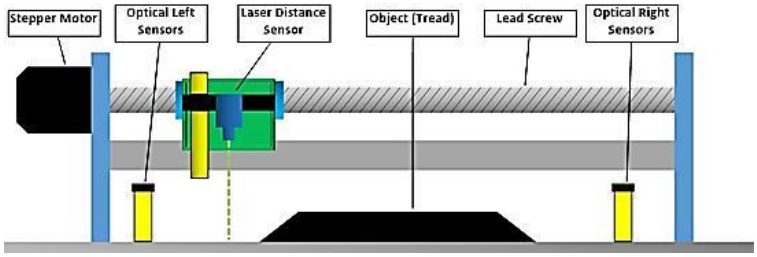

Figure 5 Material equipment and setting position.

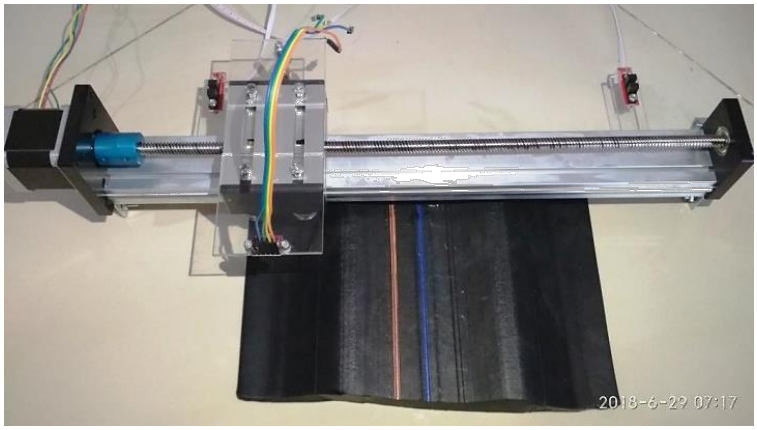

Figure 6 Prototype realizations.

The experiment uses hardware above that laser distance sensor will be moving by a linear guide with the constant speed. This experiment uses a ToF type and a CCD type Laser Displacement Sensor. From the datasheet, the controller produces an analog voltage as the output of the measurement result.
The voltage range is ± 5 Volts (3µm 0.000119 "/ mV). Those are having to measure range ±15 mm. Unlike the TOF range sensor; this sensor measures the thickness of an object that is represented by an analog voltage as its output. Measurements in this experiment are output voltages processed by Arduino on the Analog input pin. In this research, the authors present results on the use of Triangulation CCD type sensors. [4][5][6]

First, the object distance is captured every 100 milliseconds (can be set on software code). Microcontroller processes the sensor measurement results. The measurement data display to the Arduino serial monitor, it will be analyzed into the curve.

Second, data will be calculated and analyzed and summarize the dimensions in accordance with the measurement point above.

4.1. Initial Condition

The first step in this experiment is the initialization of the sensor height. According to the specifications of the data sheet that the reference distance sensor is 80 mm.

The second step is to measure the distance between the left end-stop sensors with the end-stop right sensor. The distance is 285 mm. Graph of data of initialization of the sensor height can be seen in Figure 7.

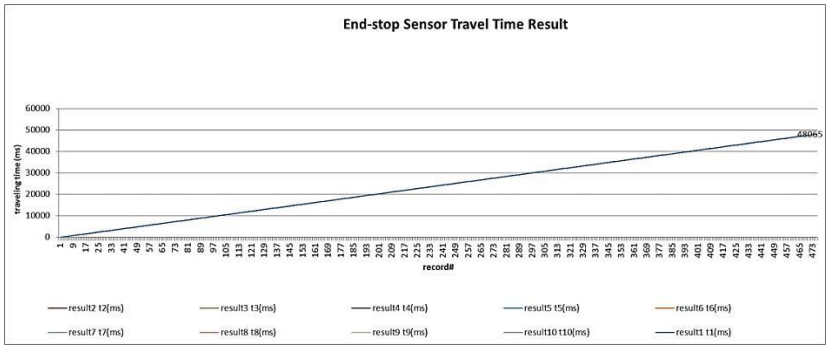

Figure 7 Graphs for Initialization of Sensor

The third step is to determine the speed of the sensor moving from left to right. From the above data obtained the sensor travel time when leave left end-stop the sensor left to the right end-stop sensor. The average travel time is 48064 milliseconds. We get the speed of the sensor is 5.93 mm/s.

4.2. Calibration System

The definition of calibration according to ISO/IEC Guide 17025:2005 and Vocabulary of the International Metrology (VIM) is a series of activities that establish a link between the values indicated by the measuring instrument or measuring system, or values represented by a material measure, with values already known relating the magnitude measured under certain conditions. The purpose of calibration is to achieve measurement traceability. Calibration should be carried out periodically. The time interval is influenced by the type of calibration of measuring instruments, the frequency of use, and maintenance.

This activity tries to measures block-gauge with different thickness (1mm; 2mm; 4mm; 10mm). This is to determine the measurement deviation on each millimeter. Measurement in block gauge with the arrangement can be seen in figure 8. Figure 9 shows the graph of the sensor stability for this block gauge measurement. This is done with 4 times the measurement.

According to table 2, the maximum average deviation is +0.64 on the measurement in an object with a thickness of 4.00 mm.

Figure 8 Block gauge on an initial condition

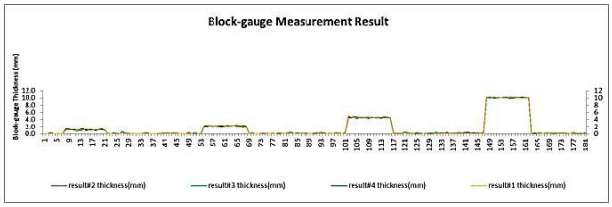

Figure 9 Graph of block-gauge measurement

Table 2 Block-gauge measurement results

no.	block gauge thickness(mm)	result#1 (mm)	deviation	result#2 (mm)	deviation	result#3 (mm)	deviation	result#4 (mm)	deviation	average deviation
1	1.00	1.07	+0.07	1.11	+0.11	1.06	+0.06	1.13	+0.13	+0.09
2	2.00	2.33	+0.33	2.26	+0.26	2.23	+0.23	2.27	+0.27	+0.27
3	4.00	4.64	+0.64	4.65	+0.65	4.65	+0.65	4.60	+0.60	+0.64
4	10.00	10.18	+0.18	10.18	+0.18	10.15	+0.15	10.13	+0.13	+0.16

5. Experiment Result

This experiment has been done 10 times sampling using CCD Laser Displacement Sensor on the tread object. It is each measurement with 475 data records. In order to know repeatability of distance measurement, we try to check the result of measurement parameter by using thickness and time travel of data record.

The overall graph and data of the experimental results are shown in figure 10 and table 3. The deviation value in the block gauge measurement and tread object because the ADC resolution of Arduino is 10bit. While the head sensor requires ADC resolution of more than 12bit.

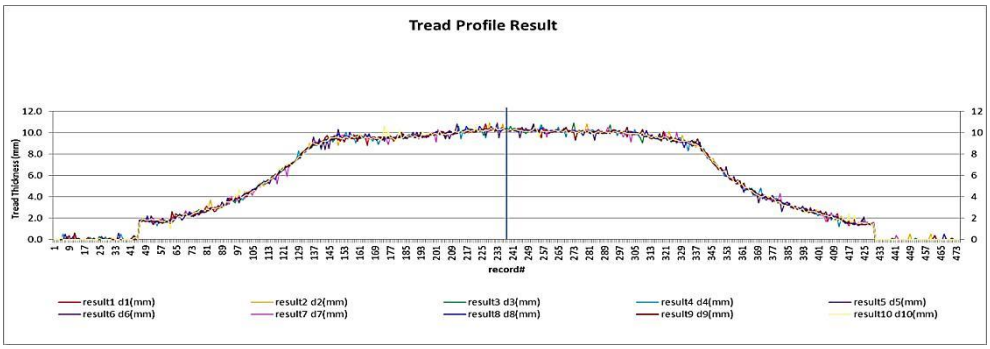

Figure 10 Graph of Tread Measurement

Table 3 Record data of tread measurement for thick-side and total-width value (a); thick-center value (b); thick-shoulders and "wide of the crown" value (c)

rec#	result1		result2		result3		result4		result5		result6		result7		result8		result9		result10	
	t1(ms)	d1(mm)	t2(ms)	d2(mm)	t3(ms)	d3(mm)	t4(ms)	d4(mm)	t5(ms)	d5(mm)	t6(ms)	d6(mm)	t7(ms)	d7(mm)	t8(ms)	d8(mm)	t9(ms)	d9(mm)	t10(ms)	d10(mm)
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
44	4360	0.0	4360	0.0	4360	0.3	4360	0.0	4360	0.0	4360	0.0	4359	0.0	4361	0.0	4361	0.0	4360	0.2
45	4461	0.0	4461	0.0	4461	0.0	4462	0.0	4462	0.0	4462	0.0	4461	0.0	4462	0.0	4462	0.0	4462	0.0
46	4563	1.7	4563	1.7	4563	1.7	4563	1.7	4563	1.7	4563	1.8	4562	1.7	4564	1.8	4563	1.7	4563	1.6
47	4664	1.8	4664	1.8	4664	1.9	4664	1.7	4664	1.8	4664	1.8	4664	1.8	4665	1.7	4665	1.7	4664	1.8
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
429	43401	1.4	43404	1.5	43398	1.5	43395	1.4	43401	1.5	43399	1.4	43397	1.5	43403	1.5	43398	1.4	43398	1.4
430	43502	1.6	43505	1.4	43499	1.4	43496	1.5	43503	1.5	43501	1.5	43499	1.6	43504	1.4	43499	1.5	43500	1.5
431	43604	0.0	43607	0.0	43601	0.0	43598	0.0	43605	0.0	43602	0.0	43600	0.0	43606	0.0	43600	0.0	43601	0.0
432	43705	0.0	43708	0.0	43702	0.0	43699	0.0	43706	0.0	43703	0.0	43701	0.0	43707	0.0	43702	0.0	43702	0.0
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
thick side [X]		1.7		1.6		1.6		1.6		1.6		1.7		1.7		1.6		1.6		1.6
travel time(ms)	38939		38942		38936		38933		38940		38938		38937		38940		38936		38937	
the speed used in this experiment = 5.94 mm/s																				
total width	231.30		231.32		231.28		231.26		231.30		231.29		231.29		231.30		231.28		231.29	

(a)

rec#	result1		result2		result3		result4		result5		result6		result7		result8		result9		result10	
	t1(ms)	d1(mm)	t2(ms)	d2(mm)	t3(ms)	d3(mm)	t4(ms)	d4(mm)	t5(ms)	d5(mm)	t6(ms)	d6(mm)	t7(ms)	d7(mm)	t8(ms)	d8(mm)	t9(ms)	d9(mm)	t10(ms)	d10(mm)
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
233	23525	10.3	23527	10.2	23523	10.1	23522	10.3	23525	10.3	23525	10.9	23523	10.3	23526	10.4	23523	10.3	23524	10.3
234	23627	10.2	23629	10.1	23624	10.2	23624	10.4	23627	10.2	23626	9.5	23624	10.1	23628	10.2	23624	10.3	23626	10.3
235	23728	10.2	23730	10.3	23727	10.2	23725	10.2	23728	10.2	23727	10.4	23725	10.2	23729	10.1	23725	10.3	23727	10.3
236	23829	10.5	23831	10.8	23828	10.4	23826	10.3	23829	10.4	23829	10.4	23827	10.4	23830	10.3	23827	10.4	23829	10.4
237	23931	10.2	23933	10	23929	10.2	23928	10.2	23931	10.3	23930	10.2	23928	10.3	23932	10.3	23929	10.3	23930	10.2
238	24032	10.3	24034	10.2	24031	10.3	24029	10.6	24032	10.3	24031	10.2	24029	10.1	24033	10.2	24031	10.3	24031	10.3
239	24134	10.2	24136	10.3	24132	10.2	24131	10.2	24134	10.1	24133	10.3	24131	10.2	24135	10.2	24132	10.2	24133	10.2
240	24235	10.3	24237	10.2	24234	10.6	24232	10.1	24235	10.1	24234	10.3	24232	10.2	24236	10.2	24233	10.2	24234	10.3
241	24336	10.2	24338	10.2	24335	10.3	24333	10.3	24336	10.2	24336	10.2	24334	10.3	24337	10.2	24335	10.3	24335	10.2
242	24438	10.3	24440	10.2	24436	10.4	24435	10.1	24438	10.2	24438	10.3	24435	10.1	24439	10.2	24436	10.2	24437	10.3
243	24539	10.1	24541	10.4	24538	10.3	24536	10.2	24539	10.1	24539	10.1	24536	10.2	24540	10.2	24538	10.3	24538	10.3
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
thick center		10.2		10.3		10.3		10.3		10.2		10.3		10.3		10.2		10.3		10.3

(b)

rec#	result1		result2		result3		result4		result5		result6		result7		result8		result9		result10	
	t1(ms)	d1(mm)	t2(ms)	d2(mm)	t3(ms)	d3(mm)	t4(ms)	d4(mm)	t5(ms)	d5(mm)	t6(ms)	d6(mm)	t7(ms)	d7(mm)	t8(ms)	d8(mm)	t9(ms)	d9(mm)	t10(ms)	d10(mm)
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
138	13891	8.9	13892	8.8	13890	8.8	13891	8.8	13892	8.9	13892	8.9	13891	9.2	13892	8.9	13891	9.0	13892	8.9
139	13993	9.0	13994	9.0	13992	9.0	13992	8.8	13993	8.9	13993	9.0	13992	9.0	13994	8.9	13992	9.0	13993	8.9
140	14094	9.1	14095	9.1	14093	9.0	14093	9.1	14094	9.4	14094	9.2	14094	9.0	14095	9.1	14094	8.8	14094	8.8
141	14196	9.1	14197	9.1	14194	9.1	14195	8.4	14196	8.5	14196	9.2	14195	9.2	14197	9.1	14195	9.2	14196	9.1
142	14298	9.3	14298	9	14296	9.2	14296	9.2	14297	9.2	14297	9.2	14296	9.2	14298	9.2	14296	9	14297	9.2
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
334	33767	8.9	33769	9	33765	9.1	33762	9	33767	9.1	33767	9	33765	9	33769	9	33765	9.1	33765	9
335	33869	9.0	33871	8.8	33866	8.9	33864	8.9	33869	9.3	33868	8.7	33866	8.9	33871	9.0	33866	9.0	33867	9.0
336	33970	9.1	33972	8.9	33968	9.2	33965	9.1	33970	8.9	33969	8.8	33967	8.9	33972	8.9	33968	9.0	33968	8.9
337	34071	8.8	34073	8.6	34069	9.1	34066	8.9	34072	9.0	34071	9.0	34069	8.9	34073	8.9	34069	9.1	34070	8.9
338	34173	8.9	34176	8.9	34170	8.9	34168	8.8	34173	8.9	34172	8.9	34170	8.8	34175	8.8	34170	9.4	34171	8.8
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
thick shoulders [X]		9.1		9.0		9.1		9.1		9.2		9.0		9.0		9.0		8.9		8.9
travel time(ms)	19876		19877		19875		19872		19876		19875		19873		19877		19874		19874	
the speed used in this experiment = 5.94 mm/s																				
width of the crown	118.06344		118.06938		118.0575		118.03968		118.06344		118.0575		118.04562		118.06938		118.05156		118.05156	

(c)

5.1. The "thick-side" value

Data measurement results have been obtained when the thickness values on record the value and the end value is reached. Data result for thick-side can be seen in table 3(a). According to table 3(a), the left of thick-side value is on record to 46th and the right of thick-side is in the record range to 430th. The average of the overall thick-side measurement data is 1.6 mm. The mean deviation of this measurement value is +0.1 mm from the actual value of spec is 1.5 mm.

5.2. The "thick-center" value

To determine the value of the thick-center is by capturing the measurement value in the middle of the record. The cycle of the measurement round produces 475 records. So to determine the value of the thick center is the position of data on record to 238th. It is as shown in table 3(b). According to table 3(b), the average of the overall thick-side measurement data is 10.3 mm. The mean deviation of this measurement value is +0.3 mm from the actual value of spec is 10.0 mm.

5.3. The "thick-shoulders" value

The thick-shoulder measurement depends on the distance of the tread edge to the thick-shoulder section with the spec (shoulder edge) is 56.5 mm. As described in the initial conditions that the reference distance between the right-to-left boundary sensors is 285 mm. The number of record data per batch of the measurement object is 475. Thus, the distance between the measurement data record is 285 mm divided by 475 equal 0.6 mm. So, the data record length is 56.5 divided by 0.6 equals 94.

With the left and right positions of the thick-side are respectively on the 46th and 430th records. Then, the position of the record data for the left thick-shoulder point is 46 plus 94 equals 140. Similarly, the data record position for the right thick-shoulder point is 430 minus 94 equals 336. It is as shown in table 3(c). The mean deviation of this measurement value is 0.0 mm from the actual value of spec is 9.0 mm.

The accuracy of the width parameter measurement: the relationship of the total sample data and the speed of the sensor head.

By knowing the distance between points of measurement is 0.6 mm, then the value is as accuracy for measuring the width of the tread. Those are "width of the crown" and "total width".

5.4. The "wide of the crown" value

The measurement of "wide of the crown" depends on the travel time of the each of "thick-shoulders" value on the left to the right. To measure "wide of the crown" is travel-time of "thick-shoulders" from each left-right section multiplied by reference speed, it can be seen in table 3(c).

5.5. The "total-width" value

The total-width calculation in this experiment is shown in table 3(a). To measure total-width is travel-time of thick-side from each left-right section multiplied by reference speed. According to table 3(a), the total-width average is 231.3. It is having a deviation of +1.3 of the spec size.

The overall measurement results of all parameters are shown in the table below.

Table 4 Measurement result for all parameters

point name	measured				
	thick side	thick center	thick shoulders	width of the crown	total width
design(mm)	1.5	10.0	9.0	120.0	230.0
tolerance(mm)	± 0.5	± 0.5	± 0.5	± 2	± 1.5
result#1	1.7	10.3	9.1	118.1	231.32
result#2	1.6	10.2	9.0	118.1	231.28
result#3	1.6	10.3	9.1	118.1	231.26
result#4	1.6	10.6	9.1	118.0	231.30
result#5	1.6	10.3	9.2	118.1	231.29
result#6	1.7	10.2	9.0	118.1	231.29
result#7	1.7	10.1	9.0	118.0	231.30
result#8	1.6	10.2	9.0	118.1	231.28
result#9	1.6	10.3	8.9	118.1	231.29
result#10	1.6	10.3	8.9	118.1	231.29
average [Ẋ]	1.6	10.3	9.0	118.1	231.3
range [R]	0.1	0.5	0.3	0.1	0.1
Ẋ-deviation	+ 0.1	+ 0.3	+ 0.0	- 1.9	+ 1.3

6. Conclusion

Linear Motion Lead Screw Slide Stage (stroke actuator, stepper motor, and driver), laser distance sensor and Arduino Mega 2560 are used to build the profile measurement system. From the thesis about prototype tread width measurement and the experiment result which have been done then can be taken the following conclusions:

- The uses of distance sensor VL53L0X in distance measurement have some deviations. These are because of the VL53L0X distance sensor characteristic, the further distance of the object with the distance sensor hence the slightest deviation.
- The use of sensor CCD Laser Displacement Sensor (Keyence LK Series) in the distance measurement in accordance with the specifications expected in this study. The differences between the two sensors are the type and diameter of the laser beam.
- In this experiment, measurements with high accuracy sensor will be easy in determining the dimensions of the object.
- To get the object profile and size, it can be done by measuring the distance of the object by scanning the laser distance sensor which is moved linearly.

7. Recommendation

After prototype testing of the tread profile measurement then the authors can provide suggestions for this tool for further developing to be better, as following recommendations:

- To get more accurate results the sensor readings are upgraded the microprocessor such as Teensy 3.2 that is also compatible with Arduino IDE which is better for measuring tread dimensions. Use the voltage level shifter from (-5V to +5V) to 0-10V and then use a voltage divider to 0-5V so it.
- Added a program to store into database and process the results from the measurement of the tread dimension so that it can be analyzed easily according to the spec parameters.
- The use of sensors must be of high specification and can measure on the condition of moving objects, that the research is the same as the actual conditions.

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Energy Consumption Analysis to Detect Process Failure in Rubber Compound Mixing Process

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Abstract. There are many ways to detect the abnormality of rubber mixing process regardless of the availability of indicator system of the abnormality. One way is to detect the problem after the result of rubber production tested by laboratory teams. Abnormality will be late to be anticipated because the result of the test will appear after 8 to 10 batch afterward. The abnormality in the mixing process will be detected if the results of the testing compound are out of the specification. The energy consumption will be measured for every batch by using the internal current sensor in the AC motor main drive. By reading the figure of measurement, energy consumption character will be identified and the specification standard of energy consumption can be defined. The process will follow the specification standard of energy consumption and abnormality condition will be corrected immediately.

1. Introduction

Mixing is the most important sequence in the rubber process and very decisive for the next step. The purpose of the mixing process is to produce products that have well distribution and dispersion materials to fulfill the expectation of the final product [1]. The mixing process needs to decide the ingredients, equipment, and also time, speed, pressure, and temperature setting. It means to minimize the labor, energy and equipment cost per unit volume of product. Due to the highest viscosity and elastic properties of the rubber, it needs a lot of power which requires a powerful engine such as an internal Banbury mixer [3].

The tangential type of internal Banbury mixer has a cylindrical short chamber that is united on one side which is contiguous with two slightly spiral rotors where each of those rotates separately. The chamber has a hopper door to insert the material and has a drop door to drop out the compound after the mixing process is complete[2].

The power consumption on the mixer chamber can be one of the urgent matter in the mixing process which indicates the process is running and influences the quality of the compound product [4]. In the normal conditions, the power consumption should be either the same or not with the big difference in value while mixing the same SKU.

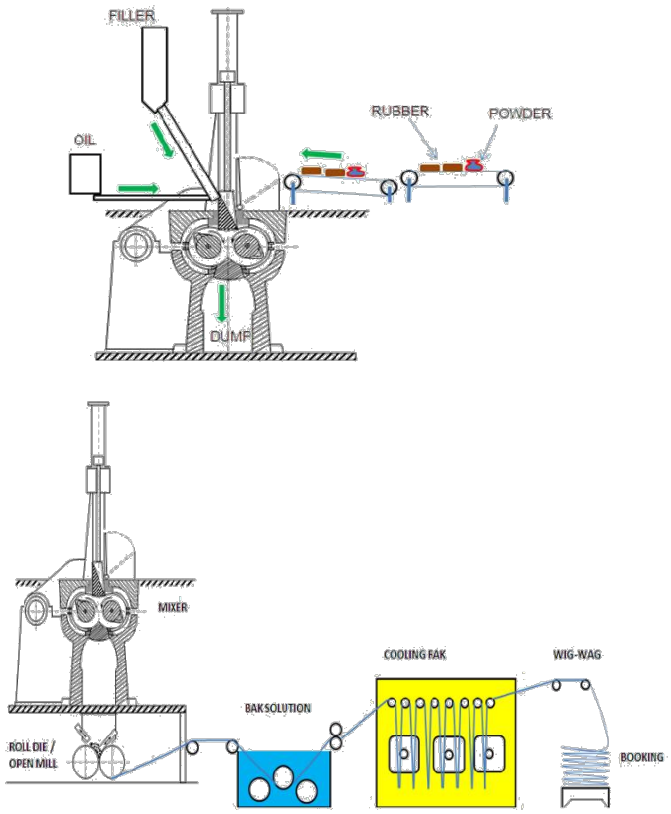

Figure 1 Banbury mixing process

2. Research Problem

Since there is no initial indication system to detect an abnormality in the mixing process, the problem will be detected after the result of production-tested by the laboratory team. Abnormality in the mixing process will be detected if the result of a testing compound such as Mooney viscosity, Mooney scorch time, tensile strength is out of the specification. The abnormality will be detected after 30 to 45 minutes delay, or equivalent 2.000 kgs compound, for waiting the aging time and decreasing temperature of the compound from 120° Celsius to 40° Celsius.

3. Scope

The scope of this study is limited at the internal Banbury mixer with the capacity of 270 Litre, for the final batch compound mixing process.

The limitations of the problem in this research are as follows:

1. The research using statistical and process capability analysis.
2. Collecting energy consumption data in the motor mixer by measuring electric current motor mixer and then processed as energy consumption data in MES (manufacture execution system).

3 Collecting data MH Rheo test from the laboratory department.

4. The analysis focused on the correlation of energy consumption in a motor mixer and the viscosity of the compound.

4. Methodology

The method used in this research is data evaluation research. This research begins by collecting current motor data, which is taken from the internal sensor of the main motor drive mixer, then processed as energy consumption data using MES (Manufacture Execution System) on the mixing machine, then analyzed the pattern to make a warning system and decision making.

This research will start from a literature study to find and collect all related document from various books, journals and other related articles to support the research. Then, the researcher makes the conceptual design to determine the hardware to measure and collect all related data needed. Then, the researcher also makes a data simulation and testing. The result of simulation and testing will be analyzed and evaluated. The writing process will start after the testing step is finished

4.1. Materials and Equipment

In designing this system, we use the following components :

1. ABB AC Motor 1.500 kW
2. ABB Single drive modules ACS800-04/-04M/-14
3. Personal Computer - PC Industry
4. Profibus Communication System
5. Communication Protocol Simatic CP5612
6. HMI Touch Screen Siemens 15".

4.2. Block diagram

In general, this research consists of ABB AC Motor 1.500 kW, ABB Single Drive Module ACS800 as a current sensor, PC, Profibus Cable, Simatic CP5612 as Communication Protocol and HMI.

The design of this research is shown as in the following figure :

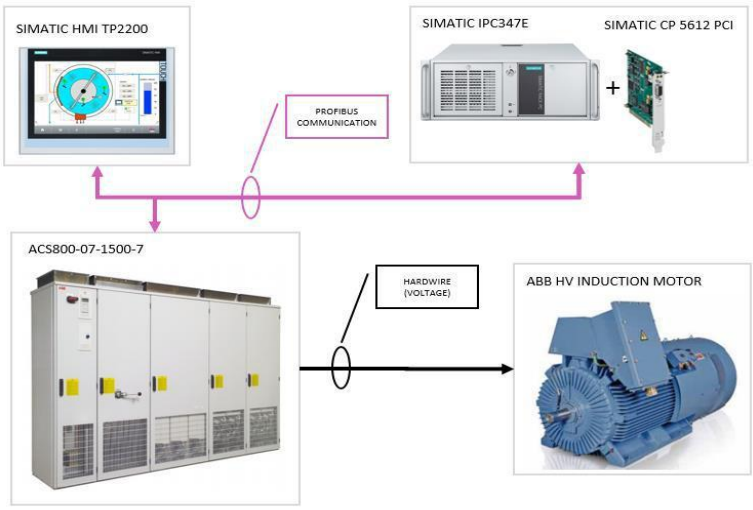

Figure 2 Block Diagram

4.3. MH Rheo Test

Based on ASTM International Standards Organization (ASTM D 2084), MH Rheo Test (maximum torque) is standard test characteristics in rubber mixing vulcanization process, that more deeply on ultimate crosslink density of all ingredients.

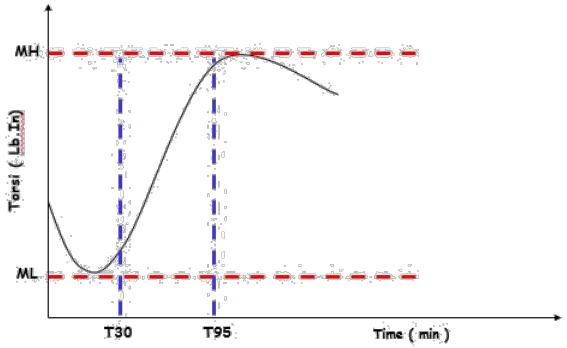

Figure 3 MH Rheo Test

5. Data Analysis

5.1 Measurement current

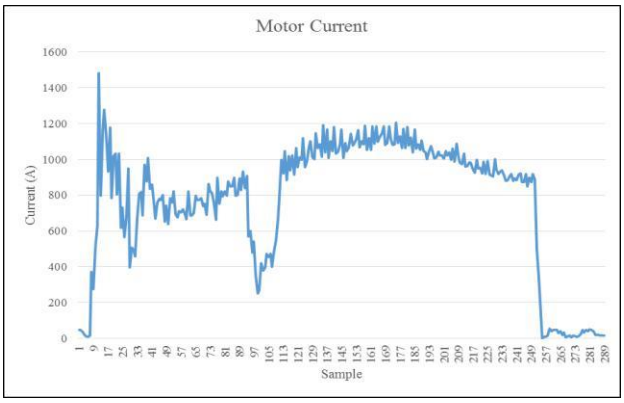

Figure 4 Motor Current Compound H1193 in machine BM2

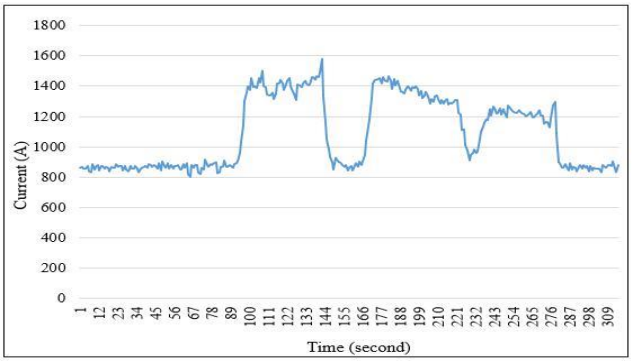

Figure 5 Motor Current Compound H1234 in machine BM2

5.2 Energy Consumption & Compound Quality Correlation Analysis

By using the Microsoft Excel program to analyze the data, we find out that the energy consumption in the mixing process has a strong relationship to MH Rheo test results. From the figure, it can be seen that if the energy consumption rises to the top level, then the value of the MH Rheo test will be on the top level. On the other hand, if the energy consumption in the production process falls to the bottom level, then the value of the MH Rheo test of the product will be on the bottom level.

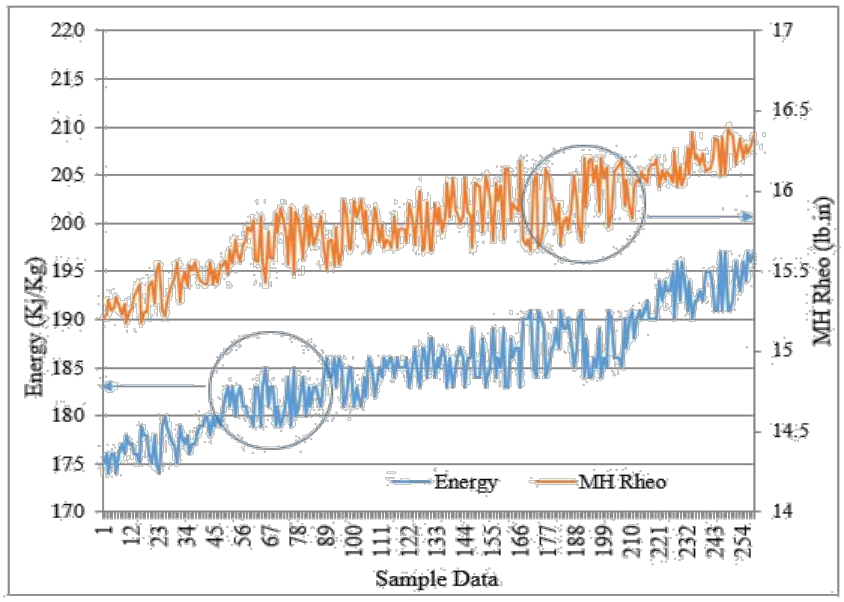

Figure 6 Data Graphic of energy consumption and MH Laboratorium test

By using Minitab, the correlation coefficient value of abnormality condition between energy consumption and MH Rheometer test is 0.700 with the level of significance P-Value is 0.000. It means that the parameters have a strong relationship. The positive value of the coefficient correlation means that the relationship is proportional.

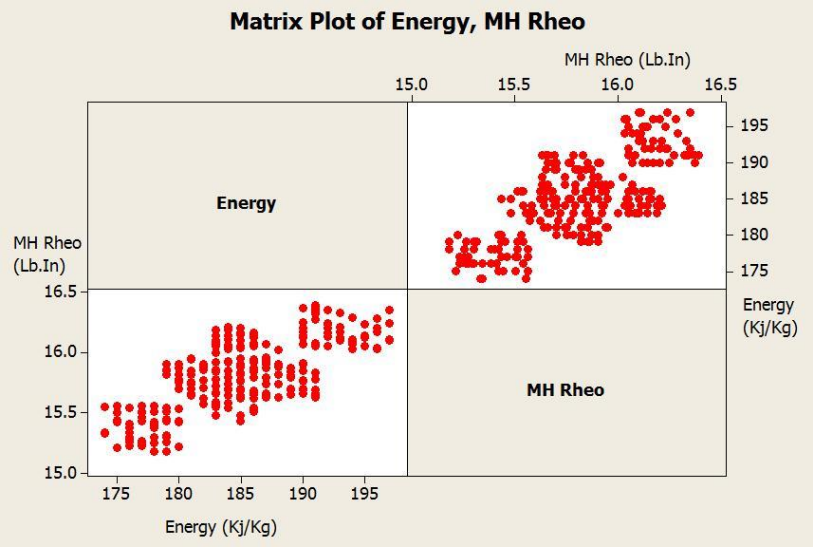

Figure 7 Matrix Plot of Energy Consumption and MH Rheometer Test

5.3 Define Specification Standard

Index capability process method is used to define the specification standard of energy to determine the center line, the upper limit and lower limit of energy consumption. The following is the detail of energy consumption inner liner compound data :

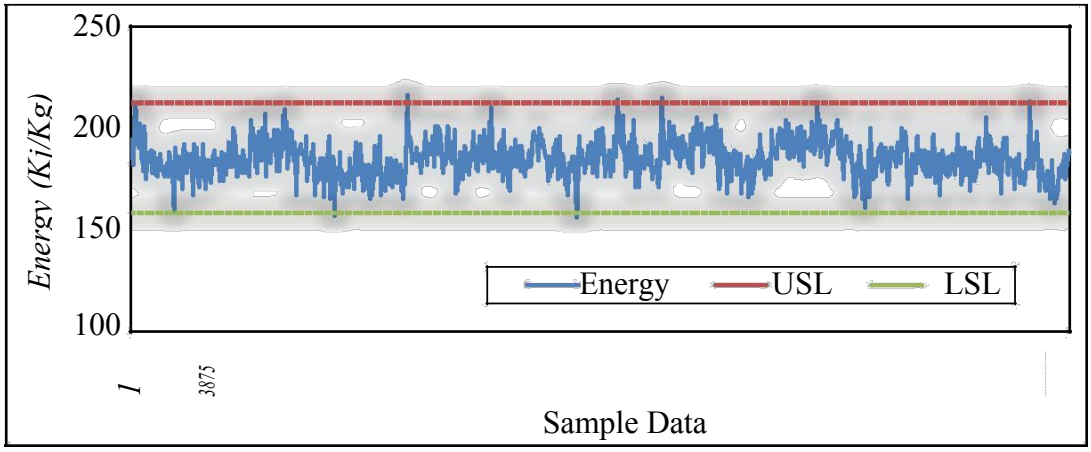

Figure 8 Upper limit and lower limit energy

The maximum standard of energy consumption in inner liner compound (USL) is 212.14 KJ/Kg, the minimum standard (LSL) is 157.84 KJ/Kg and the target center line is 184.99 KJ/Kg, with the detail as follows:

Item	
Average	184.99
Stdev	9.05
USL	212.14
LSL	157.84
Target	184.99
% Tolerance	15%

R-bar	7.54
s (Rbar/d2)	6.69
Cp	1.35
CpK	1.35

Where :

- *Average (Mean) is the sum of all the data entries divided by the number of entries*
- *Stdev measure variability and consistency of the sample or population*
- *USL is the upper specification limit (USL = Average + (3 x Stdev) [5]*
- *LSL is the lower specification limit (LSL = Average - (3 x Stdev) [5]*
- *Target is middle value about USL and LSL*

5.4 Implementation specification energy

The standard of energy consumption has been embedded in the machine control system as a complement to the other parameter controls. The setting of upper limit, lower limit and target center line standards becomes the responsibilities of a technical engineer, who will control them by using IPC dashboard or using HMI touch screen in the engine control room.

Thus, the energy consumption of each production process is maintained to be in the range that has been set. If there is an abnormality, the alarm will sound and the production process will stop automatically. Then, the operator will check all the supporting parameters to make sure everything still in the right rules.

6. Conclusion

In the mixing process, the abnormality will be detected after the test result of product quality conducted by the laboratory team. The result of the test will appear after 8 to 10 batch afterward. It is about 30 to 45 minutes delay waiting for the aging time and decreasing the temperature of the compound from 120°C to 40°C.

By monitoring the energy consumption, which is closely related to the viscosity of the material, we can prevent and decrease the losses caused by the out of spec production. The energy consumption will be measured for every batch with certain cycle time, using an internal current sensor in AC motor main drive. From the measurement, energy consumption characters will be identified and specification standard of energy consumption can be defined. The process will follow the specification standard of energy consumption and abnormality condition will be corrected immediately.

By using Minitab, the correlation coefficient value of abnormality condition between energy consumption and MH Rheometer test is 0.700 with the level of significance P-Value is 0.000. It means that the parameters have a strong relationship. The positive value of the coefficient correlation means that the relationship is proportional.

7. References

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Implementation device for measuring water depth at proving ground test track

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Abstract. Tires adhesion on the wet surface between the road surface and vehicle tires is one of the requirement from ECE Regulation No.117 for tires sold in European countries. When tested on a specified test track, tires will be tested and compared the test results with standard reference test tires (SRTT). As a result, the performance index from measured tires is given and indicated by a wet grip index (G). ECE Regulation R117 specifies the wet grip index at a level of water depth between 0.5 and 1.5 mm on the test track surface [1]. The measurements can be done using a simple 150 mm steel ruler with the graduation of 0.5 mm. Before measuring, the tip of steel ruler is polished with Kolor Kut to show the different color when ruler tip is dipped into the water perpendicularly. Then record the data for monitoring the water depth of the test track. Since ECE Regulation R117 specifies the water depth at 1.0 mm +/- 0.5 mm, then it will need a measuring device which has a graduation of less than 0.5 mm. For this reason, we develop a tool for measurements water depth which able to show measurements of one-tenth of a millimeter.

Keyword: water, depth, measuring, device, track.

1. Introduction

With referring to ECE R117 for approval tire adhesion on the wet surface. There is a requirement at General Test Conditions for wet conditions. For the surface that wetted from the track-side. The test surface shall be wetted for minimum half an hour before testing to equalize the surface temperature and water temperature [1]. It is a recommendation that track-side wetting is continuously applying throughout testing. The water depth shall be between 0.5 and 1.5 mm.

Since there is no commercial device for measuring water depth on the road surface, then there is a need to develop a Device for Measuring Water Depth [2] for use in Proving Ground Test Track.

The objective of this paper is to develop measuring device able to measure water depth on the test track at 0.5 – 1.5 mm with graduation less than 0.5mm. Then make sure the method can work appropriately by conducting water depth measurements on the test track using this device.

2. Scope

The scope of this study is limited to the development of measuring device and implementation the measurement of water depth at Proving Ground Test Track at Karawang.

3. Methodology

3.1. Measure the water depth.

To do the measurement is simple and the device easy to handle. The result can be read easily with digital display monitoring provided on the micrometer measurement tool. Connect the tool to the measurement device by using screws. By turning clockwise direction at the micrometer screw, the sensing probe will move down. If sensing probe of measurement device has touched the water film above the test track, it creates some resistance at sensing probe which then activated IC N555, and the buzzer will make sound with a LED sign shining. Once buzzer sound is heard we stop turning down the sensing probe, then the value of water depth can be read from the digital display. The contact patch of the device set at the zero level of the road surface and the measurement device also calibrated at this level of test track surface using a flat plate. Before doing the measurements, the volume of water must be positive covered or above the track surface.

The following figure illustrates road surface condition with the micro & macro textures.

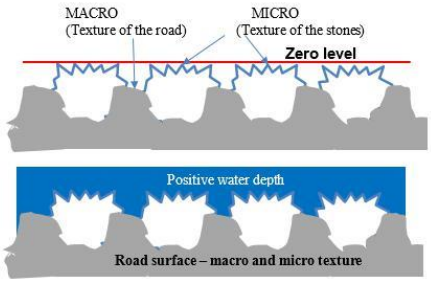


Figure 1. Zero level and Positive water depth. To do the measurements the macrotexture to make sure already covered with water. The device will measure the positive part of water depth at each measurements points, and record the result data. Water depth value is determined by averaging the test data result.

3.2. Water parameter for electrical conductivity.

Parameter electrical conductivity the water [3] used for watering the track as shown below:

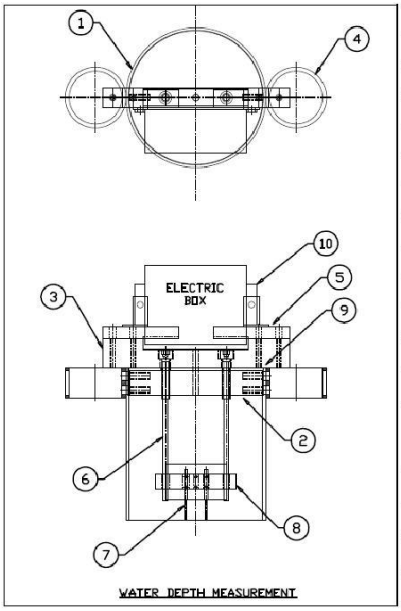
Table 1. Water parameter.

No. Sampel : 01/Lab-Eks/V/2017

Parameter	Satuan	Hasil	Standar	Metode Uji
A. FISIKA				
Rasa	-	tidak berasa	tidak berasa	IK No. 21 (Organoleptik)
Bau	-	tidak berbau	tidak berbau	IK No. 21 (Organoleptik)
Suhu *	° C	24,8***	****	SNI 06-6989.23-2005
Warna	skala PtCo	10	50	SNI 06-6989.3.80-2011
Kekeruhan *	skala NTU	3,5	25	SNI 06-6989.25-2005
Zat Padat Terlarut	mg/L	394	1500	IK No 12
Daya Hantar Listrik *	µS/cm	806	-	SNI 06-6989.1-2004
B KIMIA				
pH *	-	7,58***	****	SNI 06-6989.11-2004

For 20 mm distance of sensing probe, the conductivity < 1 second is acceptable.

3.3. Develop a measurement device.
3.3.1. Mechanical drawing



11	Bolt & nut	sus304	12 pcs	
10	Box holder	ss-41	1 pc	
9	Cover	Acrylic	1 pc	
8	Sensor holder	teflon	1 pc	
7	Contact pin	sus304	2 pcs	
6	Sliding L bolt	sus304	2 pcs	
5	Clamp holder	sus304	2 pcs	
4	Casing holder	sus304	2 pcs	
3	Holder	sus304	1 pc	
2	Base	sus304	1 pc	
1	Casing	sus304	1 pc	
ITEM	DESCRIPTION	MATERIAL	QUANTITY	REMARKS
MESSENGERS			FILENAME	
DRAWING NAME	WATER DEPTH MEASUREMENT			
DESIGNED BY		DRAWING NO.		
DRAWN BY		DATE		
CHECKED BY		SCALE	1 : 2, 1 : 3	
APPROVED BY		SHEET NO.	1 OF 1	

Figure 2. Design drawing for a measuring device.

The body of device and parts mainly using stainless steel as the environment of measurement are at water area. Stainless steel has properties to resist against rust.

3.3.2. Measuring Head

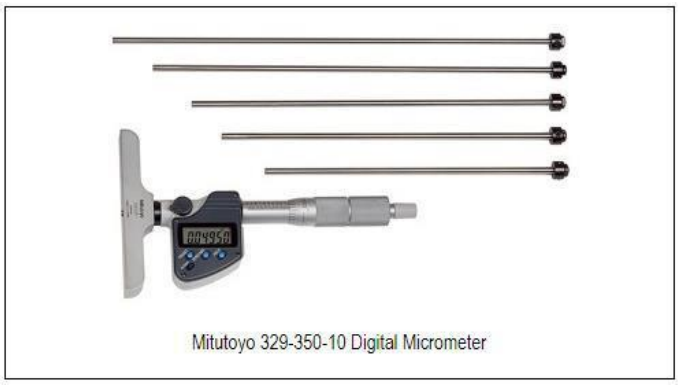


Figure 3. Mitutoyo 329-350-30 Digital Depth Micrometre [4].

For the head of measurement device use Mitutoyo 329-350-30 Digital Depth Micrometre 0-6"/ 0-150mm, 6 Rods & SPC.
Graduation: 0.01mm For this development method of measuring water depth is targeted to allow an accuracy of measurement at one-tenth of a millimeter.

3.3.3. LED Indicator.

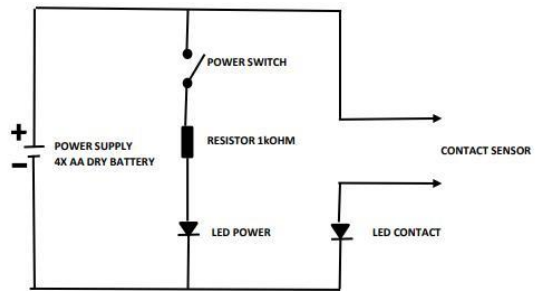


Figure 4. Electrical Circuit for LED.

To identify once both sensing probes touched the water then LED will light ON.

3.3.4. Buzzer alarm using IC NE555 [6]

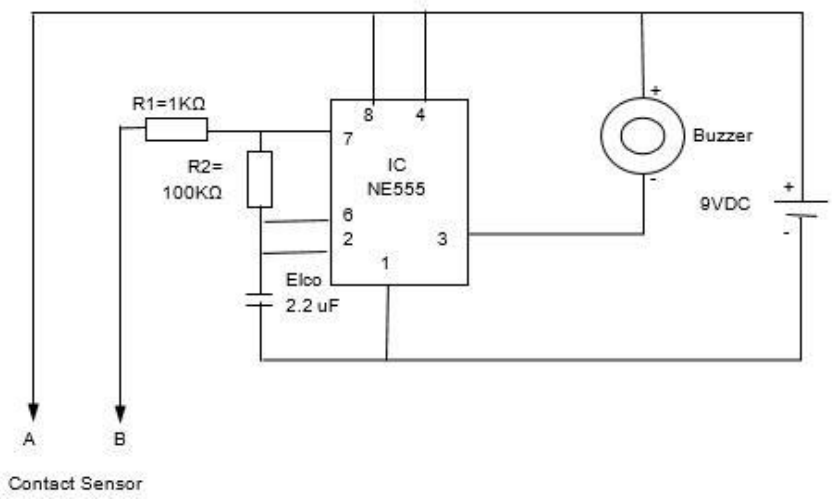
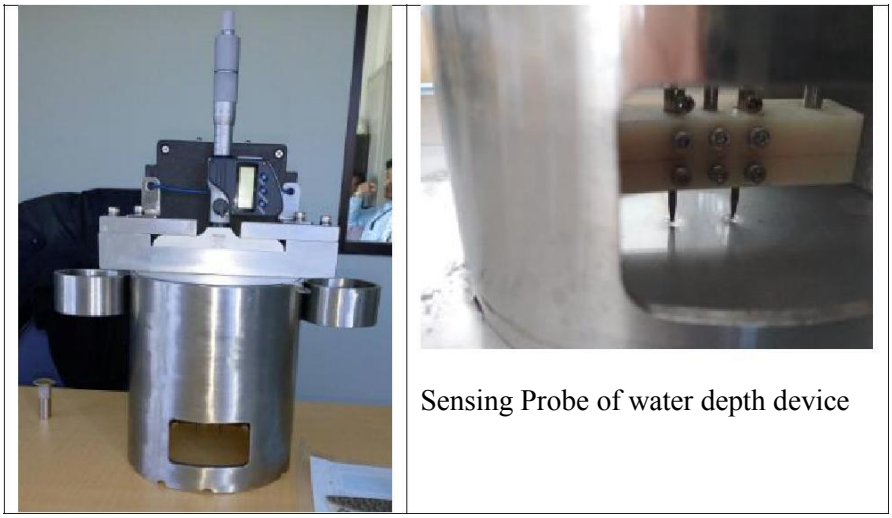


Figure 5. Electrical Circuit for buzzer.

On test track under the sun shining the LED shine may not visibly be seen. So application buzzer alarm will help the operator identify once sensing probe touched the water.

3.3.5. Picture of the measurement device after assembled



Sensing Probe of water depth device

Figure 6. Measuring device after assembled

4. Test Result

4.1. Verification on the different method of reading the measurement of water depth:
There are three methods to read the water depth:

4.1.1 Method1: Measurement Turn Down using water depth device.
Read condition at “ON” is when sensing probe touch water. The probe connected by water.

4.1.2 Method2: Measurement Turn Up using water depth device.
Read condition at "OFF" is when sensing probe leaves the water. In this case, it does not connect with the water.

4.1.3 Method3: Using a steel ruler covered with Kolor Kut water finding paste.
Kolor Kut also has known as Water Gauging Paste is used to test the water depth from the water surface to above the macrotexture. The yellow color paste is applied to the tip of steel ruler and dipped to water at test track to zero level of the macrotexture of the road. The tip of steel ruler with

the paste that touches water will immediately change color to a brilliant red when contacted. After that, we can determine the depth of the water by the Kolor Kut paste that has turned its color [5].

Steel Ruler 150 mm with the graduation of 0.5 mm, covered with Kolor Kut.	Kolor Kut water finding paste.
  Before dipped After dipped	

Figure 7. Steel ruler with Kolor Kut to measure the water depth.

The comparison result from the above three methods of measurement shown below table 2:

Table 2. Verification table for three ways of measuring the water depth.

Date of measurement:			7/31/2018
No	Method1	Method2	Method3
1	0.949	1.419	1.000
2	0.940	1.423	1.000
3	0.950	1.424	1.000
4	0.952	1.414	1.000
5	0.956	1.412	1.000
Minimal	0.94	1.412	1.000
Maximal	0.956	1.424	1.000
Averages	0.949	1.418	1.000
St. Dev	0.006	0.005	0.000

There is a different result for measurement result using method1 and method2 at 0.469mm (from 1.418mm - 0.949mm). Standard deviation is also small enough at 0.006 mm.
The difference caused by water capillarity when sensing probe lifting up the water still stick at the tip of sensing probe.

While from measurement result using method3 with a steel rule, by rough reading we can only read as 1 mm without any digit after the comma.

Based on the above water depth measurement result, then method1 is selected as it is the best way of measuring the water depth.

4.2 Implementation of water depth measurements at Proving Ground Test Track at Karawang.

Figure 8. The water depth measurements at Proving Ground Test Track Karawang.

Then we do a real measurement at the watering track. We compared the previous method of measuring water depth usingmethod3 above with steel rule comparing to using the measuring device withmethod1 for measurements. There are 2 tracks, track number B5 and track number B9 with 202 points measurement for each record.

See the graph comparing measurements result from different measurement methods, i.e., by using a steel ruler and measuring device using micrometer at below:

4.3. Measurement water depth at Test Track B5

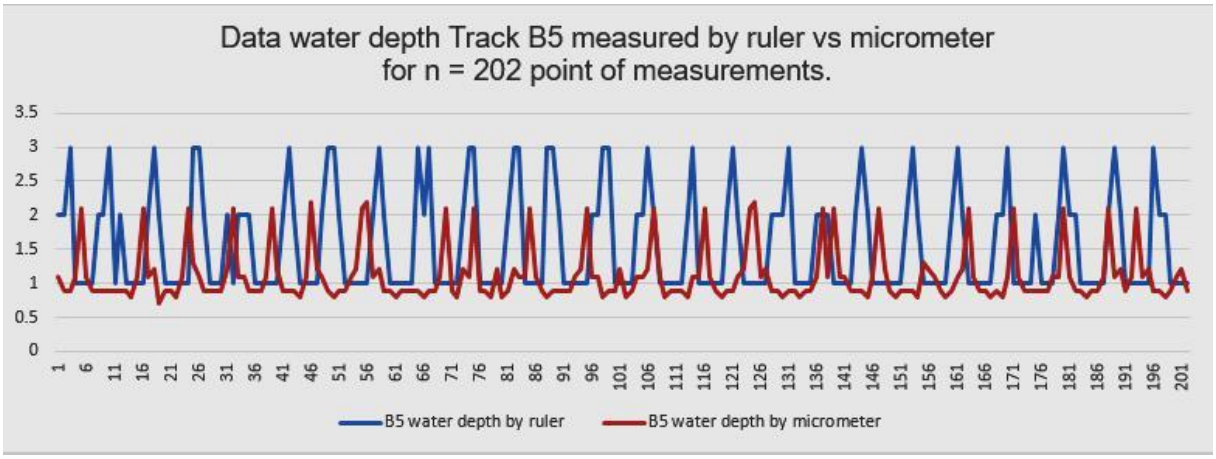


Figure 7. Graph of measurement water depth at Track B5 by using micrometer versus ruler.

4.4. Measurement water depth at Test Track B9

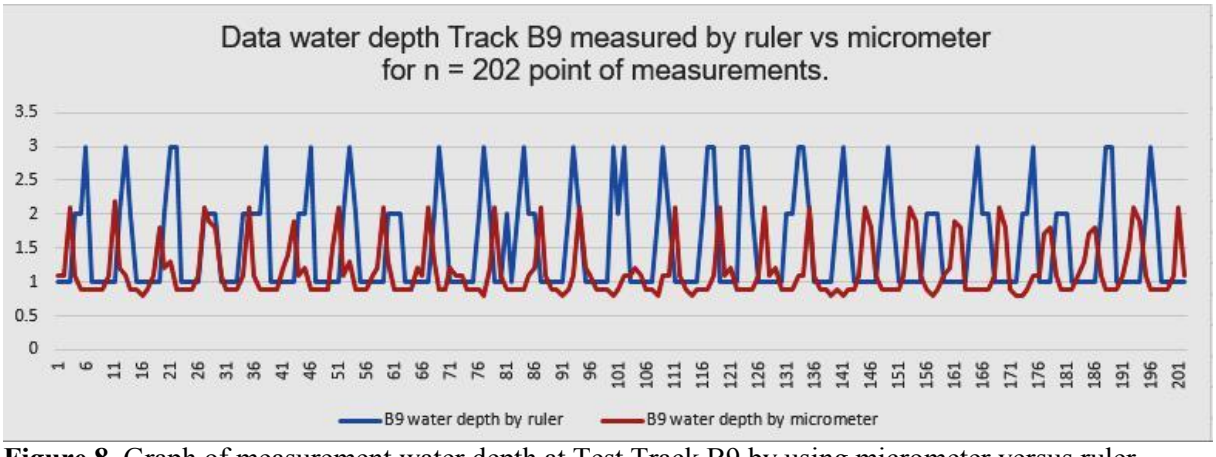


Figure 8. Graph of measurement water depth at Test Track B9 by using micrometer versus ruler.

The result data's from measurements are recorded and calculated as shown in Table 3 below:

Table 3. Water depth measurement results

Track number	B5 Track			B9 Track		
Condition	Ruler	Micrometer	Gap	Ruler	Micrometer	Gap
Date of measurement	Feb 2018	May 2018		Feb 2018	May 2018	
Minimum	1	0.7		1	0.8	
Maximum	3	2.2		3	2.2	
Averages n=202 points	1.5545	1.1119	0.4426	1.5396	1.1594	0.3802
St. dev	0.7394	0.3900	0.3494	0.7199	0.3931	0.3268

5. Conclusion

- To read water depth data with a graduation of 0.5 mm is difficult when using a steel ruler with Kolor Kut.
- While using water depth measuring device can read measurements with the graduation of one-tenth of a millimeter.
- Variation of measurements by using a measuring device can reduce the Standard Deviation of the measurements from 0.7199; 0.7394 to 0.3900; 0.3931 mm. The varieties come from measuring tool accuracy, and area coverage from measuring tools size.

6. Recommendation

- Since reading and recording the data from the track is done manually write the result on the recording sheet. It is advised to improve further in the device:
- To include wired cable data into the laptop in the field track. In order, data can read and type automatically into the computer.
- Data transfer using wireless communication which is more convenient for use.

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Atos