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DOCUMENT DESIGN OF QUALITY MANAGEMENT SYSTEM USING CLOUD COMPUTING AT PT XYZ

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ABSTRACT

In the era of Industry 4.0, the integration of advanced technologies in quality management has become a necessity to enhance operational efficiency and data security. This study aims to design a Quality Management System (QMS) document based on ISO 9001:2015 for PT. XYZ by leveraging cloud computing as a Quality 4.0 technology. The research addresses the company's need for secure, centralized document storage and timely information dissemination to external stakeholders. A digital application, in the form of a website, was developed using the waterfall model, which allows for a systematic and structured software development process. This website is integrated with Google Cloud Storage to facilitate secure and scalable document management. The findings indicate that the QMS documentation system designed using cloud computing effectively aligns with the operational requirements of PT. XYZ and provides practical benefits in terms of accessibility, efficiency, and risk mitigation related to document loss. The implementation of this system demonstrates the feasibility and advantage of adopting digital solutions for quality management documentation. This research contributes to the digital transformation of quality systems in manufacturing and service industries, offering a reference model for organizations seeking to modernize their quality documentation processes.

KEYWORDS *quality 4.0, quality management system (QMS), cloud computing, ISO 9001: 2015*

INTRODUCTION

The development of internet-based industries, which is then called *Industry 4.0*, has also impacted other fields, one of which is the field of quality, referred to as *Quality 4.0*. *Quality 4.0* continues to apply the principles of the quality management system (QMS) that exist today, but it is packaged in the form of digital technology. One of the most popular QMS frameworks today is ISO 9001:2015.

Various tools are used in the implementation of *Quality 4.0*, one of which is cloud computing. Cloud technology allows for the digital management of documents through a server system connected to the internet. Documents can be accessed or downloaded at any time by users who have access rights, either through a PC or smartphone. This system increases flexibility and security because it does not require a physical network, thus avoiding issues such as cable damage. Cloud technology also has a capacity that can be tailored to needs and supports integration with other technologies such as big data and the *Internet of Things* (IoT), making it an efficient and modern solution for data management. Currently, cloud computing service providers are growing both globally and locally, one of which is the Google Cloud Platform with the *Google Cloud Storage* feature.

PT. XYZ, a company engaged in packaged beverages, has implemented QMS, ISO 9001:2015, in its operations. The implementation of ISO 9001:2015 has gone well with the

acquisition of an ISO 9001:2015 system certificate from the Center for Standardization and Services of the Agro Industry (BBSPJIA)/BBIA Bogor. Although the quality management system has been running well, there are still several improvements that need to be developed in managing the company's ISO 9001:2015 documents due to several obstacles, including: (1) The problem of additional storage when there is a need to add new products; (2) Problems with digital documents for faster external purposes; (3) The problem of data storage security from the risk of loss.

This research discusses the design of a Quality Management System document, ISO 9001:2015, using cloud computing, specifically the *Google Cloud Platform* (GCP) with its *Google Cloud Storage* feature at PT. XYZ, as an application of *Quality 4.0* in the company. The purpose of this research is to create a draft QMS document (ISO 9001:2015) applied at PT. XYZ using cloud computing as a *Quality 4.0* technology tool for solutions in meeting document storage needs, providing data to external parties in accordance with the set time frame, and providing security from the risk of data loss.

A document is information along with its storage media, which includes records, specifications, procedures, drawings, reports, and standards used by an organization to ensure that its products or services consistently meet the set quality standards and customer needs (National Standardization Agency, 2015a). A quality management system (QMS) is defined as a formal system that documents processes, procedures, and responsibilities for achieving quality policies and objectives (American Society for Quality, 2020). Meanwhile, according to the ISO organization, QMS is a set of clearly defined processes and responsibilities that make the business run as it should (International Organization for Standardization, n.d.).

The QMS document is used as a guide and control for the implementation of the QMS to meet relevant customer and regulatory requirements, as well as to continuously improve the performance and effectiveness of business processes. A good QMS implementation guarantees that the required level of quality is essential for companies to have a competitive opportunity in the market (Castillo-Martinez et al., 2021). In its application, the preparation of QMS documents refers to the principles of *Plan, Do, Check, Action* (PDCA). The PDCA cycle is illustrated in Figure 1.

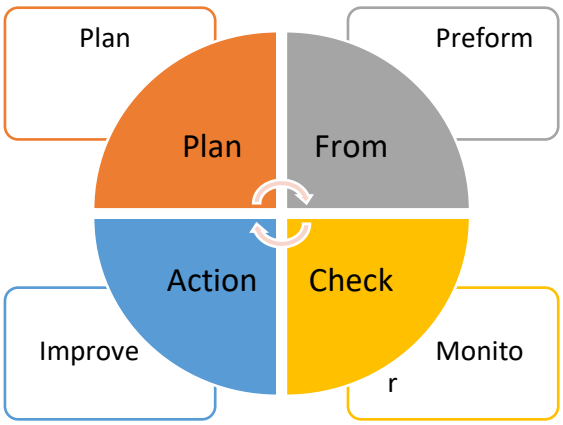


Figure 1. PDCA Cycle
Source: American Society for Quality (2020)

(Dentch (2017) explains the cycle according to its stages. *Plan*: top management determines the context, scope, limitations, and quality policies of the QMS. Quality targets are selected, and programs are designed to achieve those goals. The QMS document includes the identification of the core QMS process and its interactions. Performance indicators for core processes are also set out in the document. *Do*: the production and service processes are implemented with maintained controls to ensure customer requirements are met. Processes that support core processes are also implemented. *Check*: QMS is monitored and audited to measure performance against organizational goals and customer needs. The performance and results of the QMS are reported to top management. *Action* is initiated to correct deficiencies and improve quality performance, as demonstrated by the monitoring and measurement of QMS results. Employee resources and training are provided as appropriate to ensure QMS improvement.

One of the most popular QMS documentations in the world today is from the International Organization for Standardization (ISO) 9001 series. The ISO 9001 standard is the most widely applied by organizations and is widespread worldwide (Susanto et al., 2024).

Cloud Computing

Cloud computing is one of the technology tools in *Industry 4.0* that is used in *Quality 4.0*. Cloud computing is a service that allows users to flexibly meet computing needs, including database processing, application development, storage media management, and other IT services (Wiranda, 2023). Users only need to pay according to the amount of use of the service, thus providing high cost efficiency and scalability. Cloud computing, according to (Herwanto et al. (2020)), is a technology that makes the internet the center of data and application management, with computer users being given access rights (login). Users of cloud computing systems can freely meet the needs for such service infrastructure. Infrastructure can be physically reduced in the system. The internet system, which is central to this service, is the most important need.

Cloud infrastructure is known as an efficient model in terms of cost to provide information services. This model also reduces complexity in information technology (IT) management by creating an environment that can be accessed from anywhere, enabling the sharing and access of various computing resources such as remote servers, storage, and network applications with high reliability, flexibility, and scalability, driving innovation, and improving response capabilities in real-time (Khayer et al., 2020). Cloud infrastructure has become a platform to develop innovation and increase the capacity of quality human resources (Sahid et al., 2020). Today, the cloud is often used to distribute data and information from a central server to various locations. The cloud is a metaphor for the internet. Like the cloud that is often seen in computer network diagrams, the cloud in cloud computing is also an abstraction of a complex hidden infrastructure. It is a computational method in which information technology capabilities are presented as a service, allowing users to access them over the internet without needing to know the technical details behind them (Herwanto et al., 2020). Cloud computing is one of the major technologies that has transformed the computing field. Cloud computing represents a significant transformation in providing IT services by leveraging the concept of distributed and parallel computing. This creates an environment that can be accessed from

anywhere, allowing for sharing and accessing various computing resources such as remote servers, storage, and network applications with high reliability, flexibility, and scalability (Khayer et al., 2020).

This study offers a practical integration of ISO 9001:2015 QMS documentation with *Google Cloud Platform*, specifically tailored for a mid-sized Indonesian company. Using a structured *waterfall* development model, the research uniquely delivers a functional web-based application, validated through technical and user-level testing. Unlike prior studies, this work emphasizes real-world implementation, cost efficiency, and user adoption in a developing country context, contributing fresh insight to the digitalization of quality systems under *Quality 4.0*.

RESEARCH METHODS

This study applies the *waterfall model* Permana, (2023) in the design stage of its research. The stages start from data collection, which includes the selection of cloud computing service providers, the plan for the documents to be uploaded, the calculation of the estimated capacity, the internet network, and the browser to be used. The next stage is the creation of a cloud computing design model that will be used. In this study, a digital application will be created in accordance with the desired document management needs and integration with cloud computing application providers. The next stage is the application trial stage resulting from the ISO 9001:2015 document management design using a cloud computing application provider. At this stage, an experiment will be conducted to run the application, namely an experiment to open the view of the saved document and input the ISO 9001:2015 document using the application into the cloud computing system. From the results of the experiment, the process continues at the stage of the design test, which is carried out starting from the application running stage, the input of ISO 9001:2015 documents, and the display test, all carried out simultaneously. The system is tested to evaluate how smoothly it operates. Any obstacles that occur are identified and recorded to make an improvement plan for the system. After the design result test process, the next stage is the verification of the design results. The final stage is the operational implementation of the design results and the *disaster recovery plan* (DRP). At this stage, the application will be run as in daily operations, equipped with emergency response procedures in the form of the DRP.

RESULTS AND DISCUSSION

Data Collection

The data needed to make this design includes cloud computing application providers, the ISO 9001:2015 document to be uploaded, the required cloud storage capacity, the necessary internet network, and the type of browser to be used.

The application provider used in this study is *Google Cloud Platform* (GCP). The selection of GCP is not only because it is widely used globally, but also because it has representatives in Indonesia, making it easier to operate. The GCP facilities used are cloud storage. The package options selected are standard storage at $0.023 per GB per month. This price is the official price from GCP for the Indonesian region. The fee table for cloud storage can be seen in Figure 2.

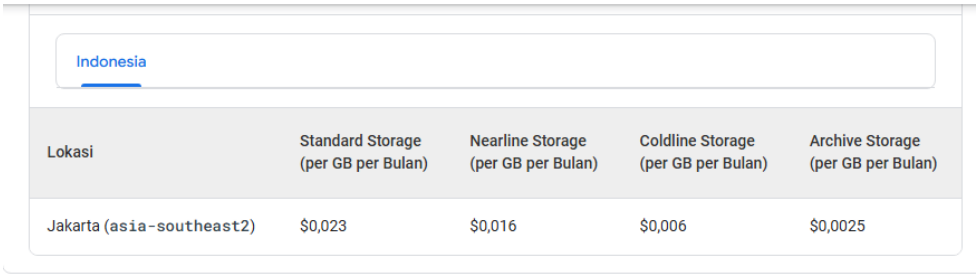


Figure 2. Cloud storage service fees
Source: *Google cloud* (2020)

The ISO 9001:2015 document that will be uploaded has several categories, including the quality manual (QM), quality procedure (QP), standard operating procedure (SOP), quality plan (QPL), quality objectives, operational forms, *HACCP Plan*, and proper documents. The documents will be uploaded to deep cloud storage.

The estimated cloud storage capacity required per month is currently 200 GB. However, due to the cost of the cloud storage service being charged per GB, this provides an advantage for users at the beginning of the application's operation. The internet network to run the application can use a cable (coaxial, fiber optic), Wi-Fi, wireless broadband, as well as satellites. The internet network is adjusted based on the location's access willingness. There are two browser options that can be used: Chrome and Firefox. These browsers were chosen because they are already widely available for general use.

Table 1. Data needs of digital *quality management system*

No	Required data types	Information
1	Cloud computing service providers	GCP, *google cloud storage*
2	Uploaded documents	QM, QP, SOP, QPL, Quality Targets, form, HACCP *Plan*, proper documents
3.	Estimated storage capacity	200 GB
4.	Internet network	Cable, Wifi, Wireless broadband, satellite.
5.	Browser used	Chrome, Fire Fox

Source : by Researcher

Creation of *Cloud Computing Model Design*

A digital application that will be created using the PHP programming language. As for the provider *Hosting* using niagahoster.co.id. Architecturally, the digital document will be stored through stages according to figure 3. In the picture, there are 3 stages of the document process, namely *Upload* document *Edit* documents, and *delete* document.

The system in the application will contain 3 process areas, namely the first *user* (page *sign in*) used for *sign in*comprise *Email* and *password*. The second is *frontend* (page *dashboard*) that contains *dashboard* where to process documents (*Upload, Edit, and Delete*). The third is *storage*, where in *storage* Ini *file-file* which is in *Upload* Stored. Area *user* and *frontend* is the work area that uses the app *website*. While the area *storage* is an area *cloud computing* that is *google cloud storage*.

Yard *sign in* consists of *email, password*knob *sign in* and *forgot password.* Page view *sign in* can be seen in figure 4.

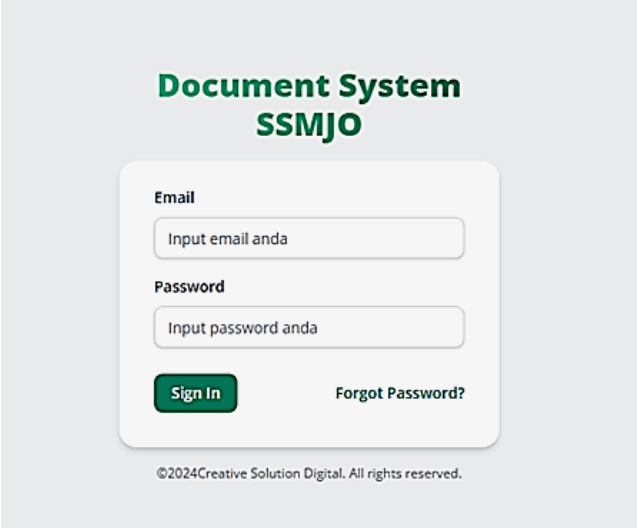


Figure 4. Sign *in Page*
Source: by Researcher

Yard *dashboard* Load *File* and data, product quarantine and *user.* The page view can be seen in figure 5.

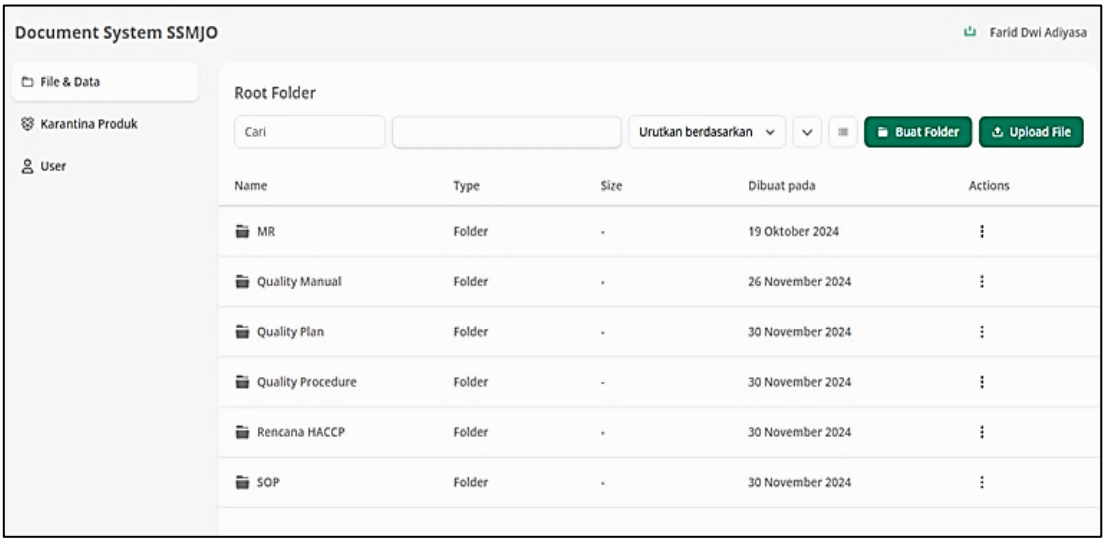


Figure 5. Dashboard page
Source: by Researcher

Google cloud storage used as a provider *cloud computing* which serves to store all the data in the *Upload* in the application website. The display can be seen in figure 6.

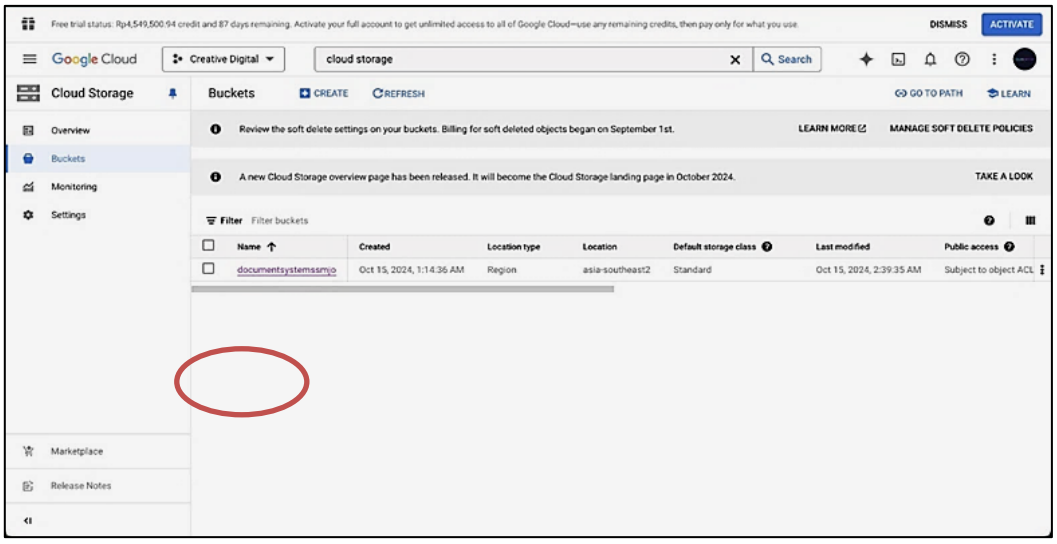


Figure 6. *Google cloud storage page view*
Source: *Google cloud* (2020).

Experiment on the Implementation of Design Results

This stage of the application website and the result of integration with *google cloud storage* try to run and compare the results with the specifications and criteria set. This experiment was carried out by the document controller and adm QC who acted as the administrator of the application website. The parameters evaluated are the main functionality, design suitability, smoothness *Input* data, and displays run well and can be used. From table 2, it is concluded that the design results meet the set criteria.

Table 2. Recap of the Implementation Experiment of Design Results

It	Criteria/Specifications	Information	Document Handler	Adm QC
1	Key Functionality	Does the plan fulfill all the main functions?	Yes	Yes
2	Design Suitability	Does the design match the initial specifications?	Yes	Yes
3	Smooth Data Input	Does the data input / upload document run smoothly?	Yes	Yes
4	Display	Does the display look as desired and smooth when opened?	Yes	Yes
Conclusion			The design meets the specified specifications and criteria	The design meets the specified specifications and criteria

Source. by Researcher

Design Result Testing

Testing the design results is carried out by trying the application simultaneously. All aspects tested starting from key functionality, *browser* compatibility, device compatibility, data

security, user and access management, performance, *load testing*, integration with other systems, data backup and recovery, resource usage efficiency, maintenance and updates were declared passed by the tester team with the conclusion that the application met the criteria. The team that tests the design results is the direct user of the application. A recap of the test results is shown in table 3.

Table 3. Recap of the test results of the design

It	Tested Aspects	Testing Criteria	Document Handler	Adm QC 1	Adm QC 2	Production Adm 1	Production Adm 2
1	Key Functionality	Do all the key features and functions work according to specifications?	Pass	Pass	Pass	Pass	Pass
2	Browser *Compatibility*	Does the app run well on different *browsers* (Chrome and Firefox)?	Pass	Pass	Pass	Pass	Pass
3	Device Compatibility	Does the app work well on different devices (*desktop*, *tablet, smartphone*)?	Pass	Pass	Pass	Pass	Pass
4	Data Security	Do data encryption and other security protocols work properly?	Pass	Pass	Pass	Pass	Pass
5	User and Access Management	Is user management and access control working correctly?	Pass	Pass	Pass	Pass	Pass
6	Performance	Does the app meet established performance standards, such as response time and processing speed?	Pass	Pass	Pass	Pass	Pass
7	*Load Testing*	Does the app stay stable under high load (e.g., multiple users are active at the same time)?	Pass	Pass	Pass	Pass	Pass
8	Integration with Other Systems	Does the app integrate well with other related software or services?	Pass	Pass	Pass	Pass	Pass
9	Data Backup and Recovery	Is the *backup* and recovery process running correctly and quickly?	Pass	Pass	Pass	Pass	Pass
10	Resource Usage Efficiency	Is the app using resources (CPU, memory, *bandwidth*) efficiently?	Pass	Pass	Pass	Pass	Pass
11	Maintenance and Updates	Is the app easy to update and maintain, including security updates?	Pass	Pass	Pass	Pass	Pass
		Conclusion	The app meets all the testing criteria	The app meets all the testing criteria	The app meets all the testing criteria	The app meets all the testing criteria	The app meets all the testing criteria

Source: by Researcher

Verification of Design Results

The verification process aims to ensure that the design that has been made meets the criteria and requirements that have been determined. This includes the functional, technical,

and performance aspects of the product or system for which it is designed. This process is the basis for ensuring the quality and readiness of the design before the implementation or production stage.

Verification of design results is carried out by users and related superiors. The verification was conducted by 11 people with positions including production *adm*, *adm* DC, *adm* QC, logistics *adm*, purchasing, production *spv*, *spv* QC, *spv* PPIC, *spv* Warehouse PIPB & DC, and *spv* logistics & spare parts. There are 15 criteria in verification, namely accessibility, user-friendliness, access speed, key functionality, account and user management, data security, data backup and recovery, compatibility with business processes, integration with other applications, user experience, customization and setup, availability of technical support, documentation and user assistance, and under-load performance. Verification carried out by 11 people stated that they passed for 15 verified parameters. A recap of the verification results can be seen in Table 4. From the table, all users conclude that the application is ready to run. The user in Table 4 with the position of *adm* has the authority to fill out and control the forms used, while the position of *spv* has the authority to create and manage, namely issuing and revising *SOPs* in their parts. With the suitability of this verification, it is hoped that the application can support and provide convenience for users in carrying out their daily tasks. The application is expected to help users, especially in controlling documents in their respective sections. Coordination between superiors, namely *spv* and subordinate *adm*, in terms of document control will be easier and faster. In addition, it can also help with coordination, especially for the necessary documents between sections, thereby speeding up coordination between related sections that need it.

Implementation of Operational Design Results and Disaster Recovery Plan (DRP)

These stages include the implementation of operational applications, monitoring the performance of cloud computing systems, updating security systems, optimizing costs used, implementing a backup system, and implementing disaster recovery planning (*DRP*) for emergency response. A list of ISO 9001:2015 documents that are uploaded can be seen in Table 5.

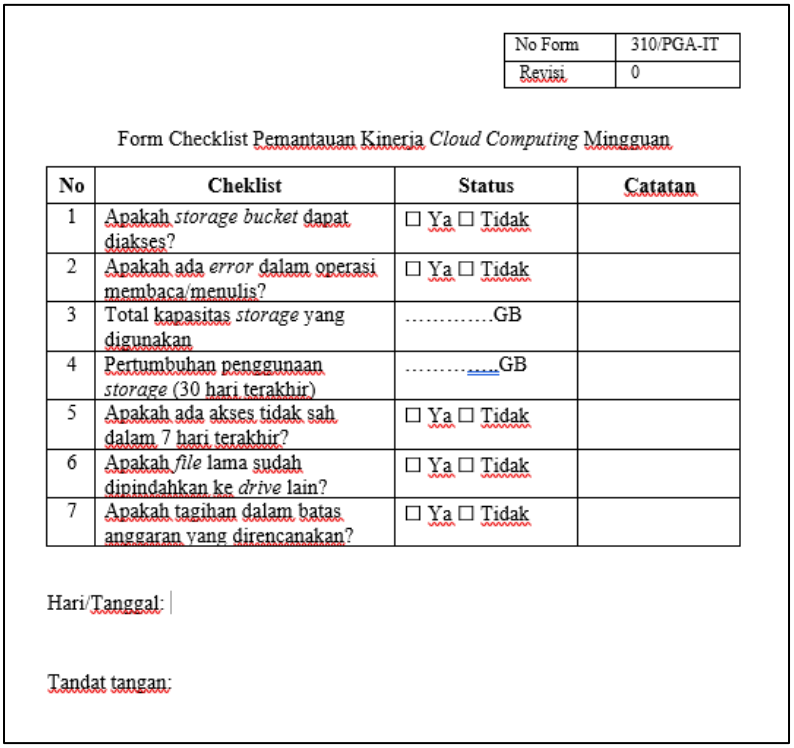
Table 5. List of ISO 9001: 2015 documents of PT. XYZ

No.	Document Type	Sum	Information
1.	Quality Manual (QM)	1	
2.	Quality Procedure (QP)	1	
3.	Standard Operating Procedure (SOP)	250	Each part
4.	Quality Plan	1	
5.	Quality Objectives	6	Each part
6.	Quality Policy	1	
7.	Form	250	Each part
8.	Management Review Meeting	1	
9.	Audit Mutu Internal	1	
10.	Product Recall Simulation	1	
11.	Customer Satisfaction Survey	1	
12.	Acceptable Quality Level (AQL)	10	
13.	Government Regulations	30	
14.	Manual DRP	1	
Source : by Researcher			

Table 4. Recap of verification results

	Position		Adm DC	Spv Warehouse PIPB-DC	Spv Logistik-Sparpart	Adm Logistics	Adm Purcahasing	Spv PPIC	Production Adm	Production Spv	Adm QC	Spv QC	Document Handler
	Verified Aspects	Verification Criteria	Valuation										
1	Accessibility	Is the app easily accessible from different devices and locations?	Satisfying	Satisfying	Satisfying	Satisfying	Satisfying	Satisfying	Satisfying	Satisfying	Satisfying	Satisfying	Satisfying
2	User-Friendliness	Is the app easy to use and understand?	Satisfying	Satisfying	Satisfying	Satisfying	Satisfying	Satisfying	Satisfying	Satisfying	Satisfying	Satisfying	Satisfying
3	Access Speed	Is the application response time fast and in line with expectations?	Satisfying	Satisfying	Satisfying	Satisfying	Satisfying	Satisfying	Satisfying	Satisfying	Satisfying	Satisfying	Satisfying
4	Key Functionality	Do all the promised features and functions work properly?	Satisfying	Satisfying	Satisfying	Satisfying	Satisfying	Satisfying	Satisfying	Satisfying	Satisfying	Satisfying	Satisfying
5	Account and User Management	Does the account creation, profile management, and access control process work well?	Satisfying	Satisfying	Satisfying	Satisfying	Satisfying	Satisfying	Satisfying	Satisfying	Satisfying	Satisfying	Satisfying
6	Data Security	Do you feel your data is safe in this app?	Satisfying	Satisfying	Satisfying	Satisfying	Satisfying	Satisfying	Satisfying	Satisfying	Satisfying	Satisfying	Satisfying
7	*Data Backup* and Recovery	Can you backup and restore data easily?	Satisfying	Satisfying	Satisfying	Satisfying	Satisfying	Satisfying	Satisfying	Satisfying	Satisfying	Satisfying	Satisfying
9	Conformity with Business Process	Does it support your workflows and business processes effectively?	Satisfying	Satisfying	Satisfying	Satisfying	Satisfying	Satisfying	Satisfying	Satisfying	Satisfying	Satisfying	Satisfying
10	Integration with Other Applications	Does the app integrate well with other systems or applications you use?	Satisfying	Satisfying	Satisfying	Satisfying	Satisfying	Satisfying	Satisfying	Satisfying	Satisfying	Satisfying	Satisfying
11	User Experience	Was the overall experience of using this app satisfactory?	Satisfying	Satisfying	Satisfying	Satisfying	Satisfying	Satisfying	Satisfying	Satisfying	Satisfying	Satisfying	Satisfying
12	Customization and Setup	Does the app provide customization options that suit your needs?	Satisfying	Satisfying	Satisfying	Satisfying	Satisfying	Satisfying	Satisfying	Satisfying	Satisfying	Satisfying	Satisfying
13	Availability of Technical Support	Do you get adequate technical support if you run into problems?	Satisfying	Satisfying	Satisfying	Satisfying	Satisfying	Satisfying	Satisfying	Satisfying	Satisfying	Satisfying	Satisfying
14	User Documentation and Assistance	Is the documentation and user manual helpful and informative?	Satisfying	Satisfying	Satisfying	Satisfying	Satisfying	Satisfying	Satisfying	Satisfying	Satisfying	Satisfying	Satisfying
15	Under-Load Performance	Does the app still function properly when used simultaneously by multiple users?	Satisfying	Satisfying	Satisfying	Satisfying	Satisfying	Satisfying	Satisfying	Satisfying	Satisfying	Satisfying	Satisfying
	Conclusion		The app is ready to run	The app is ready to run	The app is ready to run	The app is ready to run	The app is ready to run	The app is ready to run	The app is ready to run	The app is ready to run	The app is ready to run	The app is ready to run	The app is ready to run

System performance monitoring *cloud computing, up date* Security System, Cost optimization used, and System Implementation *back up* carried out on a weekly basis. The monitored parameters are in accordance with the *Checklist* Performance Monitoring *cloud computing* Downloads which can be seen in figure 7. Monitoring is carried out by document controllers or QC admins.



No Form	310/PGA-IT
Revisi	0

Form Checklist Pemantauan Kinerja *Cloud Computing* Mingguan

No	Cheklist	Status	Catatan
1	Apakah *storage bucket* dapat diakses?	☐ Ya ☐ Tidak	
2	Apakah ada *error* dalam operasi membaca/menulis?	☐ Ya ☐ Tidak	
3	Total kapasitas *storage* yang digunakan	……GB	
4	Pertumbuhan penggunaan *storage* (30 hari terakhir)	……GB	
5	Apakah ada akses tidak sah dalam 7 hari terakhir?	☐ Ya ☐ Tidak	
6	Apakah *file* lama sudah dipindahkan ke *drive* lain?	☐ Ya ☐ Tidak	
7	Apakah tagihan dalam batas anggaran yang direncanakan?	☐ Ya ☐ Tidak	

Hari/Tanggal:

Tandat tangan:

Figure 7. *Weekly* Cloud Computing *Performance Monitoring* Checklist
Source: By Researcher

DRP program documents of PT. XYZ includes DRP manuals and SOPs for implementation guidance in the field. The following is a list of DRP documents of PT. XYZ which can be seen in table 5.

Table 5. List of DRP documents

It	Document Type	Sum
1.	Manual DRP	1
2.	Emergency Response SOP	1
3.	SOP Back up	1
4.	SOP for Computer Maintenance-Up *date Antivirus*	1

Source: by Researcher

This research design is in accordance with the needs of the company and can be applied to the company's operations. There were 4 panelists of company leaders who assessed the design. A recap of the assessment results can be seen in table 6.

Table 6. Recap of the Presentation Results in the Management of PT. XYZ

No	Assessment Criteria	Description	*Plant Manager*	AFM	Production and Maintenance Manager	Human Capital *Manager*
1	User-Friendly	The app is easy to use, intuitive navigation, and a user-friendly interface.	OK	OK	OK	OK
2	Feature Completeness	All the promised features are provided and work well.	OK	OK	OK	OK
3	Speed and Responsiveness	The app runs smoothly without any annoying lag.	OK	OK	OK	OK
4	Compatibility	The app is compatible with commonly used devices or *platforms* .	OK	OK	OK	OK
5	Data Protection	The app has features to protect user data	OK	OK	OK	OK
6	Document Management	The document storage, grouping, and access system is well organized.	OK	OK	OK	OK
7	Compliance with Standards	The application supports the implementation of quality standards (ISO 9001:2015).	OK	OK	OK	OK
8	Tracking Capabilities	Effective process tracking features	OK	OK	OK	OK
9	Aesthetics and Consistency	The display is professional, consistent, and supports the app's functionality.	OK	OK	OK	OK
10	Data Visualization	Data is presented effectively and is easy to understand.	OK	OK	OK	OK
11	Renewal Capability	The app supports updates for fixes and feature additions.	OK	OK	OK	OK
		Conclusion	Customized and applicable design	Customized and applicable design	Customized and applicable design	Customized and applicable design

Source: by Researcher

CONCLUSION

The results of the design of the quality management system document using cloud computing are made in accordance with the company's needs and can be applied to the company's operations. This research is expected to help PT. XYZ in managing quality management system documents digitally in the future. This study successfully designed a digital ISO 9001:2015 Quality Management System (*QMS*) document management platform by utilizing cloud computing technology, specifically through the integration of a web-based application with *Google Cloud Storage*. Developed using the *waterfall model*, the system underwent rigorous testing, verification, and evaluation by both users and company management. The results indicate that the system effectively meets PT. XYZ's operational needs for secure document storage, timely dissemination of information to external stakeholders, and protection against data loss. Thus, the designed system is not only technically sound but also practical and applicable for daily operations, supporting the digital transformation of quality management in the company.

Considering the scope and limitations of this study, future research is recommended to explore broader implementations by comparing other cloud service providers such as *Amazon Web Services* (*AWS*) or *Microsoft Azure*, focusing on cost-efficiency, access speed, and system scalability. Moreover, future studies may incorporate advanced *Quality 4.0* technologies such as big data analytics or artificial intelligence to enhance the system's predictive capabilities and support data-driven quality decisions. Longitudinal studies could also be conducted to examine user adoption patterns and the system's long-term impact on organizational performance. These directions will contribute to the ongoing development of adaptive and intelligent digital *QMS* platforms that align with the evolving demands of *Industry 4.0*.

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