IMPROVING ELECTRONIC DOCUMENT CONTROL APPROVAL PROCESS THROUGH E-CERTIFICATION

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Article History: Received 27 July 2018; Revised 30 October 2018; Accepted 11 February 2019

ABSTRACT: This paper analysed factors that influenced the document rejection rate in a semiconductor manufacturing facility. One of the factors that affected document rejection rate was a wrongly written process parameter which caused failure in data extraction. This resulted in many processes on the manufacturing floor to be placed on hold, hence, delaying product delivery to customers. Through current approval workflow, specification writers are required to be trained and certified prior to submitting any revised or new documents for approval. It is important to have the revised specifications approved on first time submission to ensure prompt document update. Hence, the main idea of this work was to improve the approval workflow through reducing number of documents rejection rate during the approval process. This approval workflow was conducted through electronic certification using an electronic document management system (e-DMS). A 3-level electronic certification process for specification writers was introduced to ensure that only certified writers could revise or edit any specifications. The new certification process was successfully implemented and the data were closely monitored for the period of 6 months. The outcome showed 4% improvement on document rejection rate during the approval process. The number of documents submitted for approval within the same period was also increased by 28%.

KEYWORDS: *Document Management System; Approval Workflow; Online Certification Process; Document Rejection Rate*

1.0 INTRODUCTION

Quality management system is acknowledged as one of the major tools adopted for any organizations to survive and succeed such as medical fields [1-3], service industries [4-5], non-Governmental Organizations (NGOs) [6], and education institutions [7]. Some of the reasons why quality management system is implemented worldwide have been cited [1-3]. These reasons include well defined and documented procedures which help with consistent outputs. Well defined procedures enable employees to understand their work method better, hence, executing effective work methods.

Electronic document management system (e-DMS) has been adopted worldwide in the past twenty years mainly for cost savings, time saving and efficiency [8-10]. A study found that excess time and resources can be involved in manual documentation system [11], and paperless documentation system, in turn, simplifies compliance procedures, optimizes processes, automates information exchange and reduces administrative overhead. Data or forms used by individual parties in an organization that used to be scattered are now stored in a centralized storage area, eliminating papers and work transfers [12]. Standardized work methods resulting in centralized data storage location is best for data compilation because data can be annotated, indexed, searched, stored, retrieved, processed and transferred electronically [13-15]. This paper focused on the electronic workflow in an electronic document management system in a semiconductor wafer fabrication facility. The purpose of the study was to identify factors that influenced the document approval process. The objective was to get a document approved as outlined in the workflow on the first time submission.

2.0 RESEARCH BACKGROUND

A study was conducted on the factors that can influence the electronic document approval process in a semiconductor manufacturing facility. This facility is ISO9001 certified and interlinked with a factory automation system. The core application, Manufacturing Execution System (MES) which runs the production lot is supported by various online applications. Figure 1 shows the interlinked of MES with other systems that run the manufacturing floor. These interlinked systems include DMS, Recipe Management System (RMS), Statistical Process Control (SPC), Corrective Action Tracking System and Equipment Management and Interface System. Production lots are tracked and controlled by these systems. Information is retained by inserting date,

time, tool identification number, results of measurement data and operator identification number.

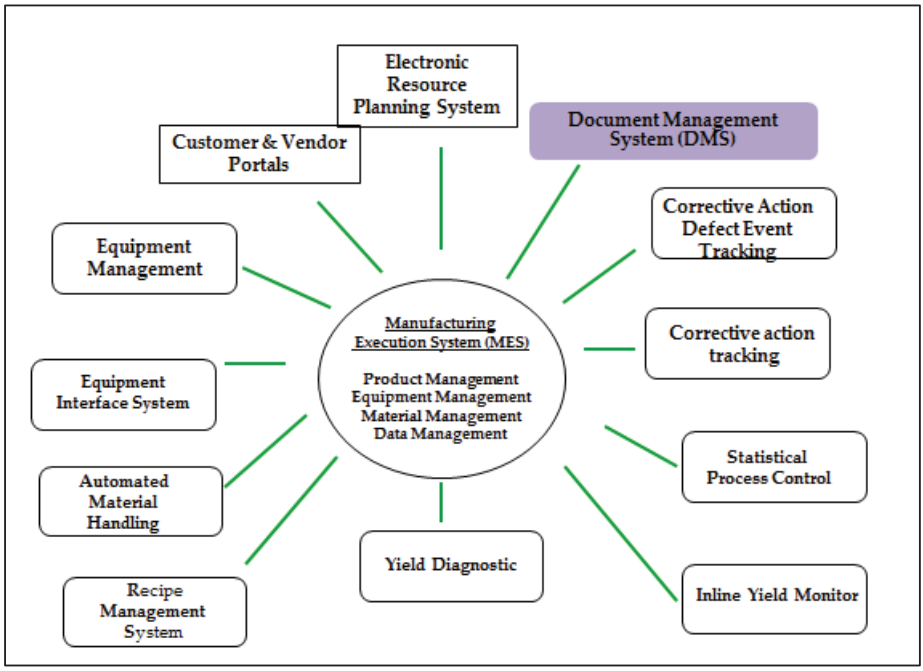

Figure 1: Interlinked manufacturing execution system

There are three main categories of documents in DMS. Each category has different document types. Table 1 lists the types of documents that are included in each category.

Table 1: Three document categories in DMS

Document category	Types of Documents Included	Remarks
General	1. Common 2. Control Plan 3. Design 4. Equipment 5. Operation 6. FMEA (Failure Mode Effect & Analysis) 7. OCAP (Out of Control Action)	General documents. Do not contain any process or tool recipes or parameters
Process	8. Process 9. Process Flow 10. Reticle 11. Test Wafer	Documents containing process and/or tool recipes or parameters
Statistical Process Control (SPC)	Electronic Data Collection / Statistical Process Control (EDC/SPC)	Documents containing statistical process control (SPC) parameters/limits

DMS plays an important role in running production lots. Figure 2 shows how data on process recipes are extracted from the DMS and transferred to other interlinked systems. Every tool which runs the lot will retrieve process recipes defined in specifications published in the DMS. Recipe management system (RMS) will manage these recipes every time a change is made to the specifications in the DMS. It checks and validates recipes/process steps. All critical parameters inside the recipe are verified with RMS specification created by the user to ensure the lot is running with a correct parameter setting. If the RMS finds any errors in the revised or new specifications created, it will display error messages and stop the tool from running. It is, therefore, important to ensure correct parameters are typed in the process recipes or process flow steps when a change or revision is made to the specifications.

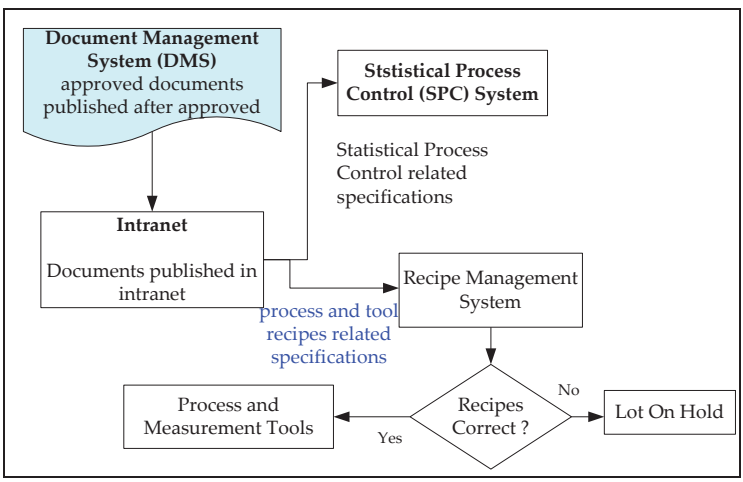

Figure 2: Data are extracted from DMS and transferred to other interlinked systems

Ideally, the total number of documents approved should be equal to the total number of documents submitted for approval, assuming that no document submissions are rejected. In practice, the total number of documents approved will normally be less than number of documents submitted for approval.

Figure 3 shows the approval flow for documents in the process category. A generic document approval workflow includes a specification writer submitting a specification for approval through document management system. A series of predefined approvers (in serial or parallel) in approval template will review the document. The last approver, MES group will make changes to the process recipes/steps as written in the documents. If rejected, the document

approval will be cancelled from the workflow. Typical rejected documents require documents to be revised and resubmitted for approval. There may be cases where documents need to be revised and approved urgently due to customer-related issues. This rework activity may prolong a document approval process. Product specifications that need to be modified based on the newly revised document may not get updated promptly. Product delivery schedules will be affected, and related external parties need to be notified.

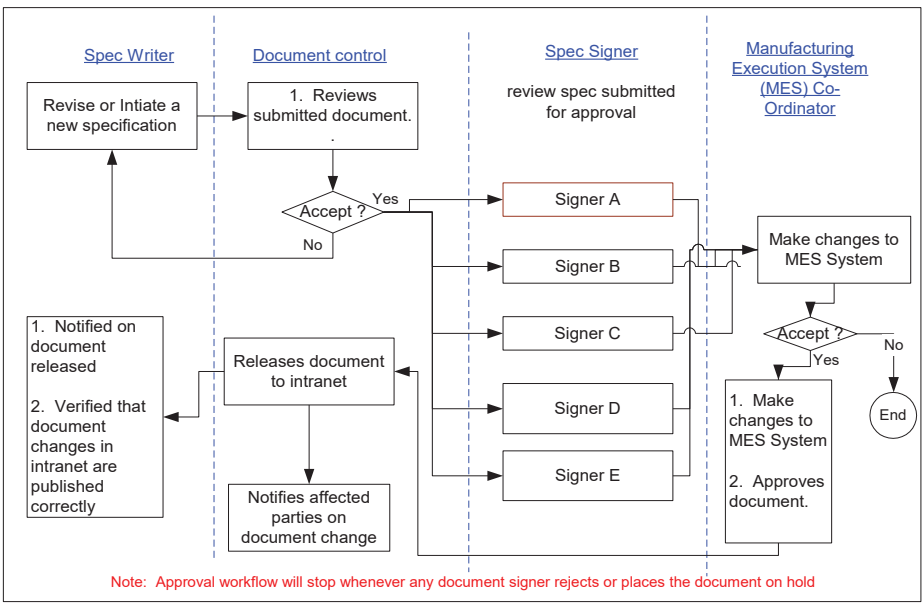

Figure 3: Document approval template for documents in process category

3.0 PROPOSAL FRAMEWORK OF DOCUMENT WRITING (ONLINE CERTIFICATION SYSTEM)

Figure 4 shows a proposed framework for new workflow approval. All documents or specification writers/engineers who will be editing document or specifications related to process steps or recipes are required to undergo an online process specification writing certification called E-Cert. This certification system consists of materials for users to read and a set of questions for them to answer. Users who pass the online questions are considered certified. All certified document writers names will be stored in the E-Cert. Everytime a document writer logs in the DMS, it will verify the certification status of this user in the E-Cert. The DMS will only allow certified document writers to revise or write a new document.

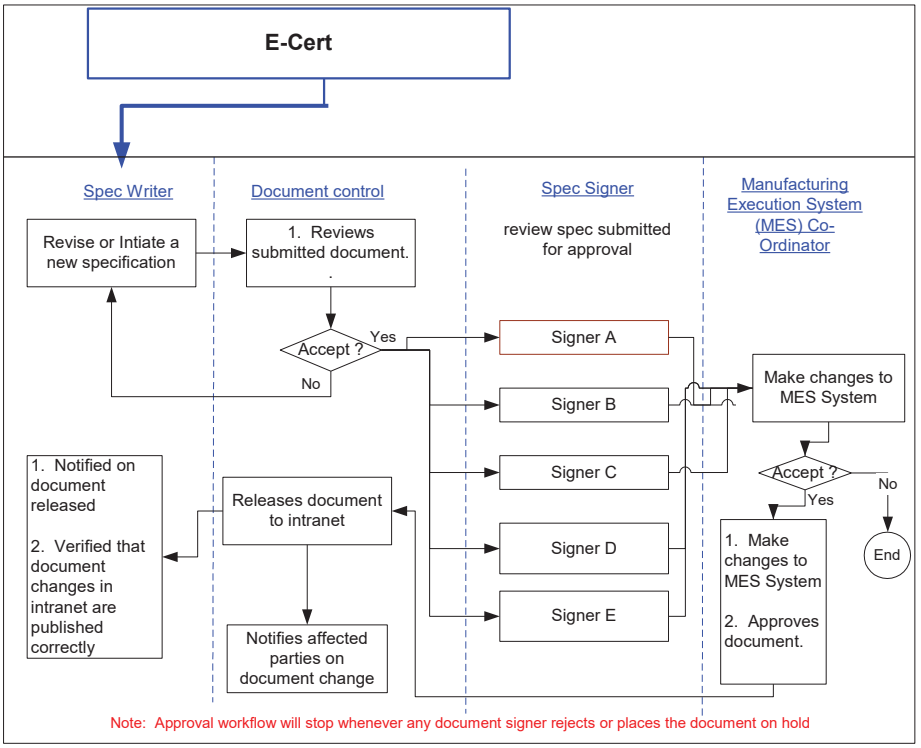

Figure 4: Proposed framework for new workflow approval

Three levels of document writing certification are created based on the three document categories :-

i. Level 1 – general. All document or specification writers must be certified to this level to edit all documents or specifications. Owner for this certification level is document control members.

ii. Level 2 – for technology process flow and process related documents or specifications. Document or specification writers must be certified to level 1 and level 2 to edit technology process flow and process related documents or specification. Owner for this certification level is the Manufacturing Execution system group.

iii. Level 3 – for statistical process control (SPC) related documents or specifications. Document or specification writers must be certified to level 1, 2 and 3 to edit or write an SPC related document or specification. Owner for this certification level is the SPC members.

4.0 DESIGN OF E-Cert

Figure 5 shows the proposed process flow of document certification writing process that a user or specification writer has to go through in order to edit any document or specification. Both the DMS and E-Cert are written using asp language. To set up the E-Cert levels, every certification level owner will need to prepare a set of training materials on the related topic in Microsoft Powerpoint. This training material is to be distilled to pdf format. Then, a set of objective questions related to these materials will be prepared. A total of 30 questions are prepared for each training material. Each of the objective question will have 4 possible answers. Every user is to answer 15 questions. These fifteen questions are randomly picked by the application from the 30 questions prepared. This creates small chance of a user getting the same 15 questions as others.

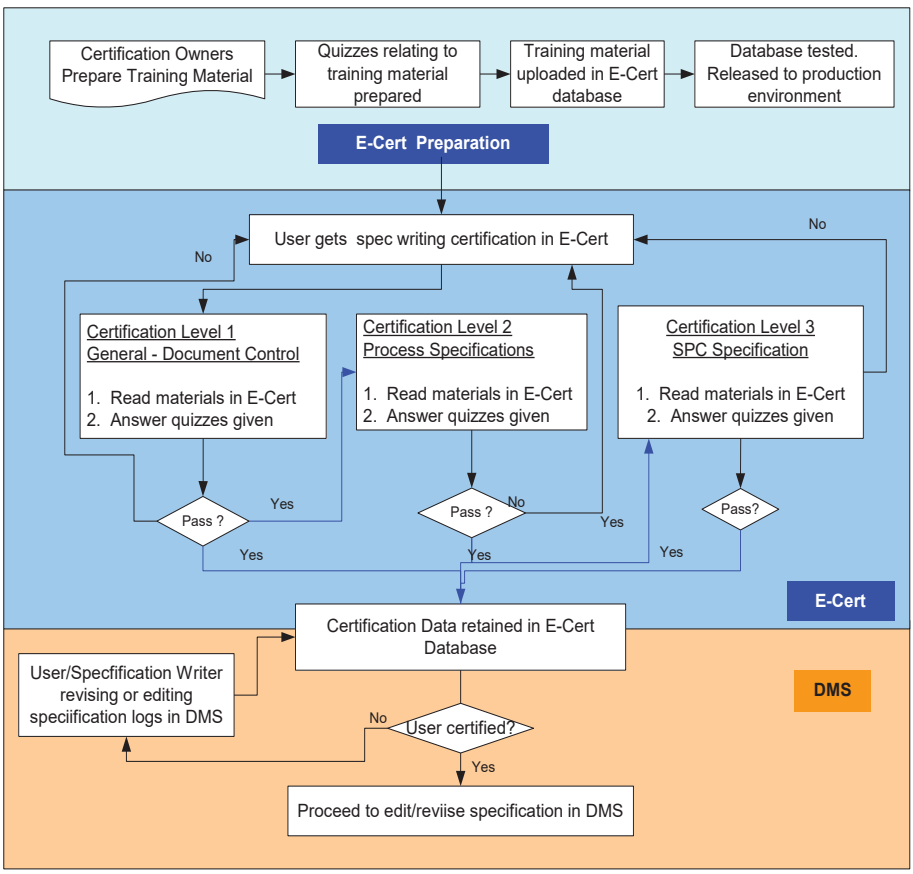

Figure 5: Proposed process flow of document writing certification process

The certification level owner creates sections in the E-Cert relating to his/her certification level. In each of the certification level section, the training material in pdf format is uploaded. Certification owner will then specify values for all the variables required for the quiz. The variables to be specified include number of questions to be answered in the certification level, minimum score required in order to pass the quiz given, maximum time allowed to take the quiz, and number of attempts a user is allowed to take the quiz.

Figure 6 shows an example of the training material and quizzes set up for level 1 certification (document control). In this level, each participant is required to answer 15 quizzes and the passing mark is set at 80. Entry limit is set at 0, indicating that a participant is allowed to take the quiz more than once. The training materials are divided into topics and displayed in a pdf format.After each participant reads and reviews the training material, he/she is required to answer questions from the quiz session.

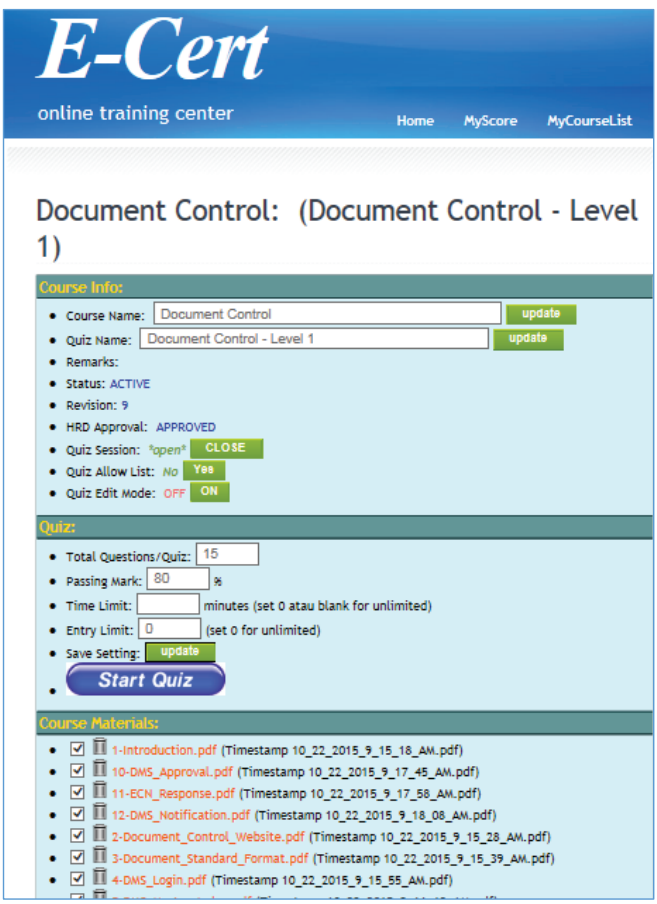

Figure 6: Settings defined in quiz for level 1 certification

Every participant who attempts each certification level must be able to get the minimum passing score required in order to pass the quiz. The E-Cert will not allow any participant who fails the quiz to proceed to the next certification level.The passing score for each level is as follows:

i. Level 1 – 80%
ii. Level 2 – 100%
iii. Level 3 – 80%

Training materials and questions for each level are prepared by the level owner. Upon successful certification, the certification level data will be shared with the DMS.

5.0 RESULTS AND DISCUSSION

All data on e-certification are stored in the database. The DMS will extract the E-Cert data upon login in DMS. All employees in the respective facilities will be able to see their certification levels in the DMS. As shown in Figure 7, an employee who logged in the DMS is only certified for level 1 certification. He/she can only initiate or revise a general document or specification.

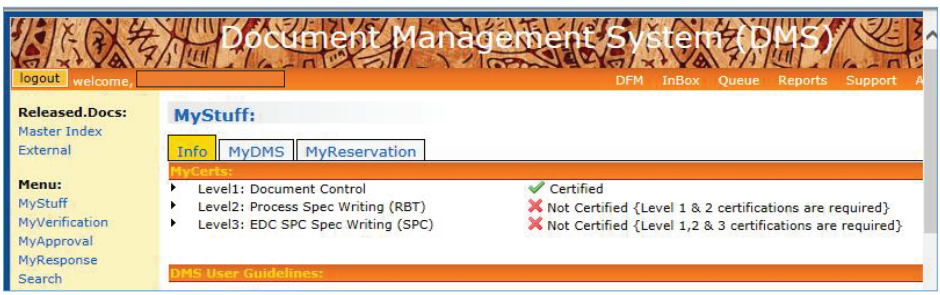

Figure 7: DMS Login of a user who is only certified to level 1 of DMS certification

A document or specification writer who is only certified for level 1 will have an error message from the DMS when trying to revise or initiate a document or specification for level 2 or 3. Figure 8 shows a sample of the DMS error message.

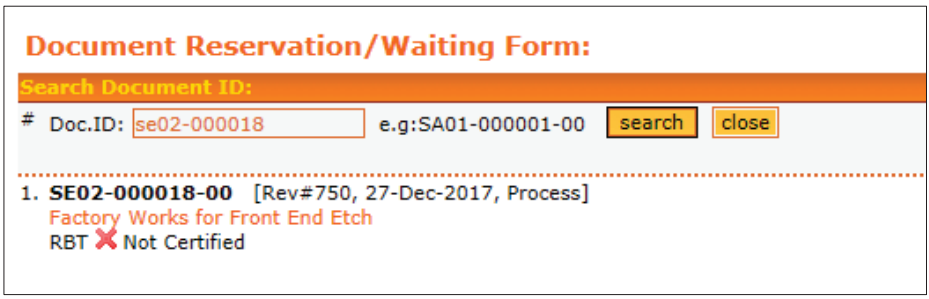

Figure 8: Sample of error message from DMS

In the case study conducted, three main reasons for the documents in the approval workflow to be rejected were identified ; wrong process steps were written, incorrect technical details were presented and further clarifications or changes were required to be made on the document. Data were extracted from the weekly reports of six month period for each set of data. These include data from the initial approval stage (document control), all document approvers and then back to document control. Table 3 summarizes data before and after the implementation of the E-Cert.

Table 3: Data on documents rejected due to wrong process steps written

# Documents for Approval		No (%) document rejected	No (%) documents rejected by category		
			General Documents	Process Steps Related	SPC
Before E- Cert	5660	623(11.0)	35.5	48.8	15.8
After E- Cert	7835	619(7.9)	49.3	40.5	10.2

The number of documents submitted for approval has increased from 5660 to 7835 (increase of 28%). Before E-Cert implementation, the number of documents rejected in the approval loop were 623, 11% from the number of documents submitted for approval. These rejected documents are divided into three document categories: general, process steps and SPC related. The highest in rejection are documents from process related steps with 48.8%, followed by SPC related documents with 15.8% and general category documents with 35.5% .

After the E-Cert implementation, the number of documents rejected in the approval loop were 619, which was 7.9% from the total number of documents submitted for approval. The percentage of documents rejected from process steps and SPC related reduced to 40.5% and 10.2 %, respectively. Fewer documents rejected will expedite the time taken to approve documents. Document writers are more competent

and able to write process steps with fewer errors. An online certification system gives freedom to an employee to get certified on document writing at his/her own pace. The need to be certified to write a document will motivate a document writer to write correctly. If he/she fails on the first attempt, he/she needs to review the training material again to get certified.

6.0 CONCLUSION

An implementation of the e-certification in this study has reduced the number of documents rejected in the approval workflow in the process steps and statistical process control related categories. Three levels of e-certification for three document categories help document writers in ensuring the documents with process and tool parameters settings are correct on the first time submission. Document rejection rate needs to be low to ensure all requests for changes are approved promptly and process recipes and parameters are updated according to customers' requirements.

ACKNOWLEDGMENTS

The authors are grateful to the Universiti Teknikal Malaysia Melaka (UTeM) for the support given in completing this study.

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