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DATA QUALITY ASSESSMENT FOR MANUFACTURING PROCESSES

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Abstract. *Data quality is getting as important as product quality in manufacturing process. The purpose of this paper is to apply data quality assessment defined in ISO 8000 to manufacturing processes defined in IEC 62264. Considering data quality management assessment, parts of manufacturing processes are selected with regard to data processing and the manufacturing processes are restructured according to process description of ISO 8000-61 with purpose, outcomes and activities. The assessment model for the manufacturing process is defined so that data manager can assess the data quality management level of their organization. The achievement degree of manufacturing process purpose can be verified through this model.*
Keywords: Data quality management, Data processing, Assessment, Manufacturing process

1. **Introduction.** Data just keeps getting bigger. By 2020, it is estimated that for every person on earth, 1.7 MB of data will be created every second. It means one terabyte of hard disk is needed per person a week [1].

As data size and the number of systems grow, there are many organizations undergoing data integration and data migration. The unplanned challenges plaguing data migrations include data quality issues, the number of systems, and limited skills and expertise. These unforeseen challenges can result in project delays, duplicate information, poor data quality in new systems, and require additional budget [2].

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Poor data quality is also hitting organizations where it hurts – to the tune of $15 million as the average annual financial cost in 2017, according to Gartner's Data Quality Market Survey. And poor data quality practices undermine digital initiatives, weaken their competitive standing and sow customer distrust. However, innovative organizations like Airbnb and Amazon are using good quality data to allow them to know who their customers are, where they are and what they like. Good quality data empowers business insights and starts new business models in every industry. It allows enterprises to generate revenue by trading data as a valuable asset [3,4].

ISO 8000 is set of data quality management standards developed by ISO TC 184/SC4/WG13. ISO 8000 defines which characteristics of data are relevant to data quality, specifies requirements applicable to those characteristics, and provides guidelines for improving data quality. ISO 8000 is applicable within all the stages of the data life cycle.

This paper applies ISO 8000 standards to manufacturing processes defined in IEC 62264 (Enterprise-control system integration). Manufacturing processes defined in IEC 62264 are restructured according to processes of ISO 8000-61. Each process consists of purpose, outcomes and activities. Achievement of each process can be confirmed with work products.

2. Overview of Data Quality Assessment.

This paper focuses on the data quality management process reference model of ISO 8000-61 [7] and process assessment of ISO 8000-62 [8]. ISO 8000-61 specifies the processes required for data quality management. Each process is defined by the purpose, outcomes and activities that are to be applied for planning, controlling, assuring and improving data quality. The processes are used as a reference model in assessing and improving data quality management. ISO 8000-62 identifies those elements of the maturity model that exist in other standards and specifies additional elements of the maturity model. ISO 8000-62 provides guidance on assessing the maturity level of an organization. The purpose of assessing the organizational maturity level for data quality management is to understand how well the organization is fulfilling the requirements identified by the process reference model specified by ISO 8000-61.

3. Data Quality Management in Manufacturing Processes.

IEC 62264-1:2013 defines the functions of an enterprise involved with manufacturing and the information flows between the functions that cross the enterprise-control interface [9]. The shaded areas in Figure 1 represent the manufacturing operations management. This paper takes the manufacturing operations as the manufacturing processes. These manufacturing processes generate or modify the information according to the role of its process. Operation, function and process are considered as a synonym in this paper. Figure 1 shows the functional enterprise-control model in IEC 62264.

This paper considers only operations with the grey shaded area of Figure 1 in terms of data processing. There are four groups of operations management: Production operations management, Inventory operations management, Quality operations management and Maintenance operations management. Production control has three sub-operations: Process support engineering, Operations control and Operations planning.

Each manufacturing process is described according to the ISO 8000-61 as the following:

- title, which is a descriptive heading for the process;
- purpose, which describes the goal of performing the process;
- outcomes, which express the observable results expected from successful performance of the process. The information generated or modified by the functions in IEC 62264 applies to the outcomes in this paper.
- activities, which is a list of actions that can achieve the outcomes. The general functions in IEC 62264 apply to the activities in this paper.

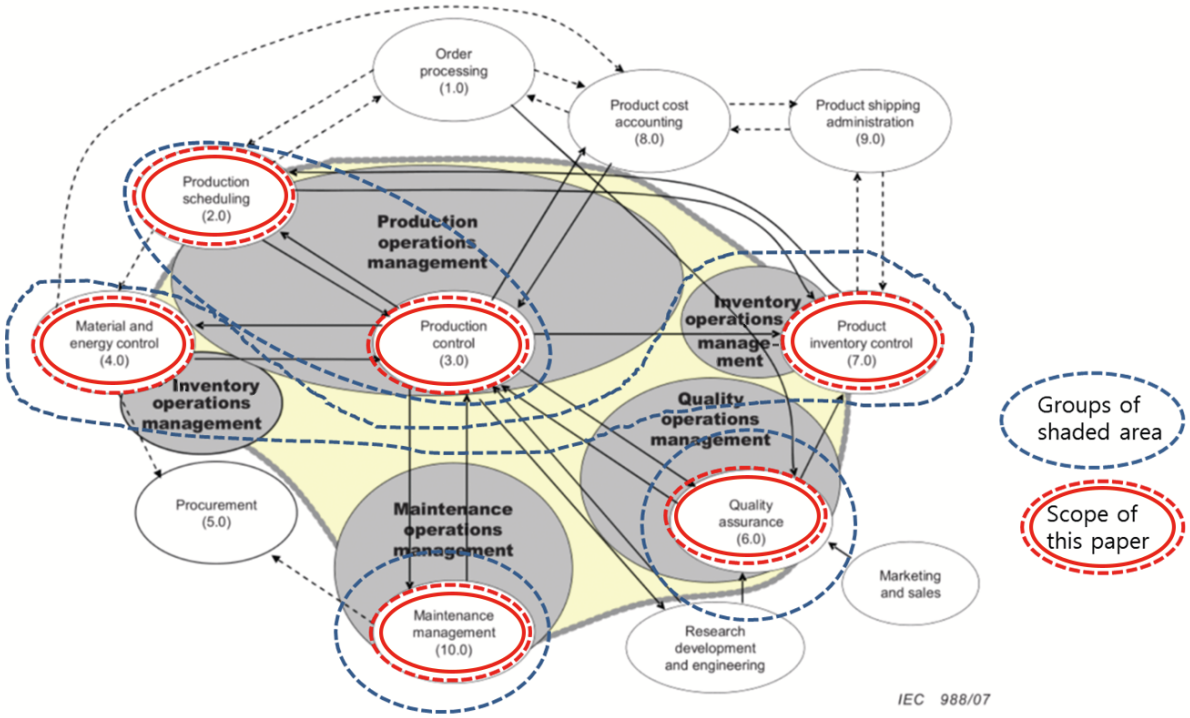

FIGURE 1. Manufacturing operations management model [IEC 62264-1]

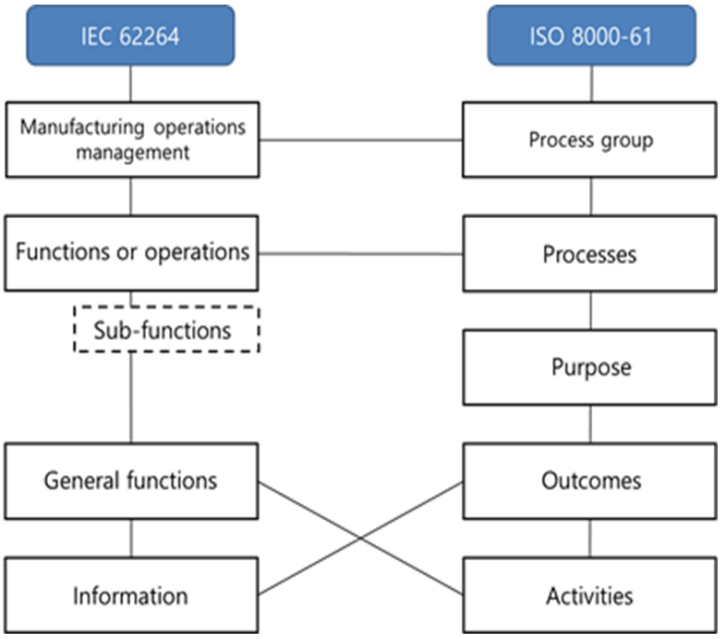

FIGURE 2. Comparison of process description between IEC 62264 and ISO 8000-61

Figure 2 shows the comparison of descriptions between functions in IEC 62264 and processes in ISO 8000-61.

3.1. **Production scheduling.**

a) Purpose of production scheduling is the process of arranging, controlling and optimizing work and workloads in a manufacturing process. Production scheduling is used to allocate plant and machinery resources, plan human resources, plan production processes and purchase materials.

b) Outcomes of production scheduling are the production schedule, the actual production versus the planned production, the production capacity and resource availability and the current order status.

c) Activities of production scheduling are the determination of production schedule, the identification of long-term raw material requirements, the determination of the pack-out schedule for end-products and the determination of the available product for sales.

3.2. **Production control – Process support engineering.**

a) Purpose of production control – process support engineering performs engineering support activity necessary to production control.

b) Outcomes of production control – process support engineering are minor equipment and process modifications, instructions on how to handle equipment, instructions on how to make products, instructions on how to install equipment, environmental and safety operating limits and constraints and engineering standards for process equipment design techniques and process operational methods, and online operating instructions.

c) Activities of production control – process support engineering are issuing requests for modification or maintenance, coordinating maintenance and engineering functions, providing technical standards and methods to operations and maintenance functions, following up on equipment and process performance, providing technical support to operators and following up on technological developments.

3.3. **Production control – Operations control.**

a) Purpose of production control – operations control is the activity of monitoring and controlling production necessary to production control.

b) Outcomes of production control – operations control are status of production requests, selected production data, selected process data, status of resources, Status of maintenance work order requests, requests for maintenance, diagnostic and self-test results, process history, requests for process support engineering support, and requests for analysis of material.

c) Activities of production control – operations control are producing the product, reporting production, process, and resource information, monitoring equipment, validating operational measurements, and determining the need for maintenance, preparing equipment for maintenance and returning it to service after maintenance, performing diagnostics and self-check of production and control equipment, balancing and optimizing production, and possible local site or area labor management and document management.

3.4. **Production control – Operations planning.**

a) Purpose of production control – operations planning establishes production plan to production control.

b) Outcomes of production control – operations planning are material and energy inventory report, material and energy requirements, site or area production plan and available capability of the production resources.

c) Activities of production control – operations planning are setting up a short-term production plan, checking the schedule, determining the per cent of capacity status and modifying the production plan.

3.5. **Material and energy control.**

a) Purpose of material and energy control identifies and manages the status of material and energy.

b) Outcomes of material and energy control are material and energy order requests, incoming confirmation of received materials and energy, material and energy inventory report and manual and automated transfer instructions for operations control.

c) Activities of material and energy control are managing inventory, transfers, and quality of material and energy, generating requests for purchasing of materials and energy, calculating and reporting inventory balance and losses of raw material and energy utilization, receiving incoming material and energy supplies and requesting quality assurance tests and notifying purchasing of accepted material and energy supplies.

3.6. **Product inventory control.**

a) Purpose of inventory control is a supervision of the supply and storage and accessibility of items in order to insure and adequate supply without excessive oversupply.

b) Outcomes of inventory control are finished goods inventory, inventory balances, pack-out schedule, release to ship, confirm to ship and storage requirements.

c) Activities of inventory control are managing the inventory of finished products, making reservations, generating the pack-out end product, reporting on inventory, reporting on balance and losses and arranging physical loading/shipment of goods.

3.7. **Quality assurance.**

a) Purpose of quality assurance is the operations undertaken to achieve desired quality [14].

b) Outcomes of quality assurance are test results, approval to release materials or waivers on compliance and applicable standards and customer requirements.

c) Activities of quality assurance are testing and classification, setting standards, issuing standards to manufacturing and testing laboratories, collecting and maintaining material quality data, releasing material for further use, certifying that the product was produced according to standard process conditions, checking of product data versus customer's requirements and statistical quality control routines to assure adequate quality before shipment, relaying material deviations to process engineering.

3.8. **Maintenance management.**

a) Purpose of maintenance management is all activities of the management that determine the maintenance requirements, objectives, strategies, and responsibilities, and implementation of them by such means as maintenance planning, maintenance control and the improvement of maintenance activities and economics.

b) Outcomes of maintenance management are maintenance schedules, maintenance work orders and diagnostic and self-test requests to be performed on the equipment.

c) Activities of maintenance management are providing maintenance, providing a preventative maintenance programme, providing equipment monitoring, placing purchase order requests, developing maintenance cost reports, and coordinating outside contract work effort and providing status and technical feedback.

4. **Process Capability.** ISO 8000-62 is intended for use by those actors that have a vested interest in information or data quality, with a focus on one or more information systems both inter- and intra-organization views, throughout all data life cycle phases.

The purpose of assessing the organizational process maturity level for data quality management is to understand how well the organization is fulfilling the requirements identified by the process reference model for data quality management specified by ISO 8000-61.

4.1. **Relationship with other standards.** This paper has manufacturing domain defined in IEC 62264. The manufacturing operation involves the information while they execute the operation. In terms of data quality management all the data related activity correspond to data processing activity in ISO 8000-61. ISO 8000-62 assesses the organizational maturity for the process reference model specified by DQMP (data quality management process) of ISO 8000-61. This paper considers data processing only in terms

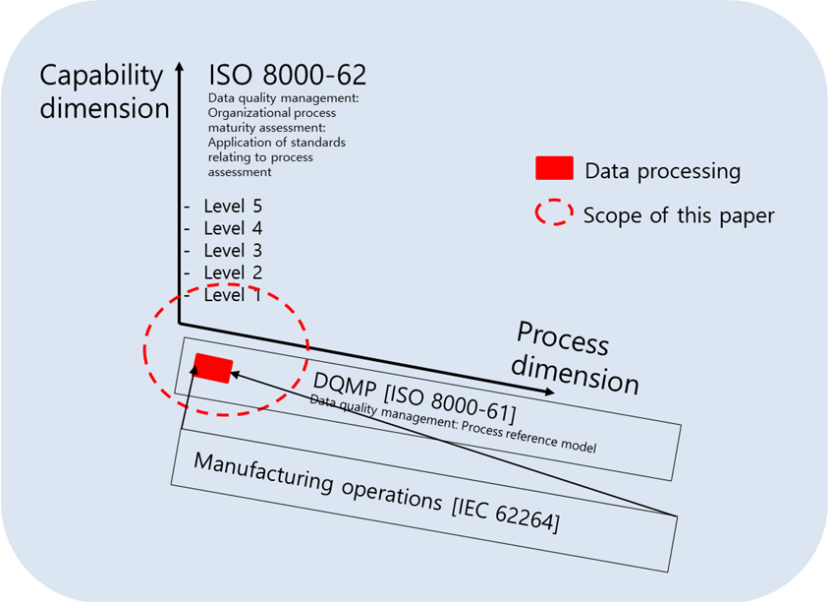

FIGURE 3. Relationship with other standards

of data quality management. Figure 3 shows the relationship with other standards and the position of this part of ISO 8000.

4.2. **Process capability levels and process attributes (ISO 8000-62).** As stated in ISO 33020, process capability is defined on a six-point ordinal scale that enables capability to be assessed from the bottom of the scale, incomplete, through the top end of the scale, innovating. The scale represents increasing capability of the implemented process – from failing to achieve the process purpose through continual improvements. To compute the process capability level is necessary to observe and assess the evidence of the achievement of the process attributes defined in ISO 33020, Section 5.2.

4.3. **Rating process attributes and process capability (ISO 8000-62).** Within the process measurement framework specified by ISO 33020, a process attribute is a measurable property of process capability. A process attribute rating is a judgement of the degree of achievement of the process attribute for the assessed process. A process attribute is measured using an ordinal scale in ISO 33020, Section 5.3.

Hence, when an organization is to be assessed with regard to the data quality management maturity level, assessors shall investigate on an evidence-basis how much the data quality management processes from the data quality management process reference model are achieved. As a result, it can be stated that one specific organizational process is capable of addressing the data quality management process with the level indicated by the ordinal in ISO 33020, Section 5.6.

5. **Conclusions.** This paper deals with the data quality assessment for the manufacturing processes. The manufacturing processes in this paper are selected among manufacturing operations or functions in IEC 62264 standard. The data quality assessment references ISO 8000 standards especially ISO 8000-61 and ISO 8000-62. Through this paper data processing process from data quality management processes is applied to manufacturing process so that the level of data quality management can be assessed in data created from manufacturing environment.

Additional work is needed to define the work products according to the purpose, outcomes and activities of each process. Achievement of each process can be evaluated from the evidences of work products.

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