Course 4: Quality Management for Extended Enterprise

Course Objective: The extended enterprise concept has been adopted to collaborate in the entire supply chain. Quality and efficiency issues, therefore, extend well beyond the traditional enterprise. This course constructs student competencies of management skills, particularly on how to define, develop, implement and manage the strategy to improve and build the quality system to align with the digital domains. Students will be trained on the modern quality management methods used in product design, product development,and production planning, as well as, the quality management methods focused on statistical quality control methods and data analytics, under the context of the extended enterprise. This course will also develop a technical skill for students to implement quality control and monitoring system that covers both process operation and supply chain operations.

Learning Outcomes:

The students on the completion of this course would be able to

1. Understand the impact of digitalization on quality management system, particularly on processes and people.
2. Identify the strategy to assess the need and define the suitable technologies in order to transform the production system and organization, quality culture and processes to maximize value
3. Analyze operational quality-related data for sustaining the process and Enterprise as well as identify the improvement by using quality monitoring tools such as SPC and modern data analytic technique and be able to embed quality management principles and tools in the value chain of operations and integrate with business operation strategy.
4. Design a data visualization platform and Create its system components based on operational data such as quality and productivity output characteristics as well as Enterprise data (Enterprise Quality Metrics visualization).
5. Design the proper quality management system for smart factories that can integrate the production and quality operations under the digital quality management concept

Prerequisite: None

Course Outline:

Module 1: Strategic Digital Quality Management System

- Quality Management Concept under the Digital Era
- Organization Performances and Quality System Strategy for I4.0
- Quality Strategy for Digital Quality Management System

- Quality System Structures for I4.0

Module 2 Automated Quality Control and Monitoring System

- Quality Control Concept under Digital Data Collection
- Automated SPC Strategy
- Multivariate SPC Strategy
- Data Analytic for Quality Monitoring

Module 3 Automated Quality Report System

- Automated Quality Report Concept
- Strategic Quality Improvement under I4.0
- Real-Time Quality Control
- Quality System Transformation

Workshop Sessions:

Module 1

1) Review, criticize, discuss and present the concept of quality management under the Industry 4.0 era. Individual presentation of the conceptual design of a case-based quality management concept.

2) Report, discuss, and present the key performance indexes (KPI) and key results indexes (KRI)of the organization that supports quality management under the Industry 4.0 era. Design and construct the KPI and KRI of the quality domain that is the basis for the digital quality management strategy.

3) Identify the strategy to (i) assess the need and (ii) define the suitable technologies and (iii) transform the production system and organization, quality culture and processes to maximize value

4) Criticize and select the quality system structure among the existing standard-based quality structure to improve or design the new quality system structure for the organization that matches the chosen quality management strategy.

Module 2

5) Select and define the quality control concepts and tools that coherences with the automated data collection processes under the Industry 4.0 structure. Group project presentation of case-based vision technology quality control concept at the shop floor will be used for demonstration and learning.

6) Design and implement the automated SPC that supports automated quality control and consistent with Digital quality management.

7) Understand the multivariate SPC for aggregated data from different quality characteristics collected from different machines and processes. Apply the multivariate data analytics to analyze the effectiveness of the processes. Cased-based learning will be used for demonstration and learning

8) Understand the different quality data analytic tools used to monitor the univariate and multivariate quality characteristics of product and process. Apply the data analytic and data mining techniques to analyze quality status.

Module 3

9) Discuss and present the concept of the automated quality report that coherences with the KRI, KPI generated from the digital quality management structure. Individual project presentation of the conceptual design of digital quality report concept

10) Understand the strategy of quality improvement of the Industry 4.0 quality management. Identify the quality improvement initiative and its strategy from the automated quality report system.

11) Identify the structure, components of the quality control tools and devices and their schematic relations for real-time process management.

12) Develop and identify the project of the quality system transformation. The contents of project initiation, project implementation, and project evaluation must be presented along with the scope, project schedule, project resources, and budgets, and project implementation plan and evaluation scheme.

Laboratory Sessions: None

Learning Resources:

Textbook: No designated textbook, but class notes and handouts will be provided

Reference Reading materials:

1. Germany Trade & Invest, “Smart manufacturing for the future,” http://www.gtai.de/GTAI/Content/EN/Invest/_SharedDocs/Downloads/GTAI/Brochures/Industries/industrie4.0-smart-manufacturing-for-the-future-en.pdf; National Academy of Science and Engineering, “Securing the future of German manufacturing industry: Recommendations for implementing the strategic initiative of Industry 4.0”
2. Forces of change: Industry 4.0
3. A Deloitte series on Industry 4.0

4. Juran's Quality Handbook: The Complete Guide to Performance Excellence
5. Case study: FANUC, the Japanese robotics company, https://www.cbinsights.com/research/future-factory-manufacturing-tech-trends/#quality
6. 8 different steps of the manufacturing process to Future Factory, https://www.cbinsights.com/research/future-factory-manufacturing-tech-trends/#quality
7. Nikon Strategic Focus on Quality 4.0, https://metrology.news/nikon-strategic-focus-on-quality-4-0/
8. A strategist's guide to Industry 4.0, https://www.strategy-business.com/article/A-Strategists-Guide-to-Industry-4.0?gko=a2260
9. Suggested Indicators to Measure the Impact of Industry 4.0 on Total Quality Management, International Scientific Conference on Industry 4.0, At 3-16. DECEMBER 2017, BOROVETS, BULGARIA
10. Developing a Kano-Based Evaluation Model for Innovation Design, Mathematical Problems in Engineering 2015(2):1-8 · October 2015
11. The Complete Guide to the Kano Model: Prioritizing Customer Satisfaction and Delight https://foldingburritos.com/kano-model/
12. Perdikis, Theodoros, and Stelios Psarakis. "A survey on multivariate adaptive control charts: Recent developments and extensions." *Quality and Reliability Engineering International* 35.5 (2019): 1342-1362.
13. Mason, Robert L., and John C. Young. *Multivariate statistical process control with industrial applications*. Vol. 9. Siam, 2002.
14. Montgomery, Douglas C. *Introduction to statistical quality control*. John Wiley & Sons, 2012.
15. Luis Rocha-Lona, Jose A. Garza-Reyes, and Vikas Kumar. *Building Quality Management Systems*. CRC Press, 2013
16. J.D.T. Tannock. *Automating Quality Systems*. Chapman & Hall, 1992.
17. Chen-Burger, Yun-Heh, and Dave Robertson. *Automating Business Modelling*. Springer, 2005.

Teaching and Learning Method:

This is an activity-based course. During lecture sessions, class discussion will be conducted. During workshop sessions, the students, to be active learners, will practice several skills including, but not limited to, decision making, problem-solving, critical thinking, written communication, oral communication, presentation, debate, and teamwork.

Time Distribution and Study Load:

Lectures: 45 hours

Workshop: 60 hours

Self-study: 45 hours

Evaluation Scheme: The final grade will be computed according to the following weight distribution:

Assessment (CLO1): (20%)

- LogBook/Journal + Cases Study (5%)
- Oral Presentation (Individual Work Presentation & Report) (5%)
- Open Exam (10%)

Assessment (CLO2): 20%

- Role Play + Cases Study (5%)
- Extended Response Question (5%)
- Report of Strategy Plan and Analysis (10%)

Assessment (CLO3): (30%)

- Professional Discussion (5%)
- Cases Study +Simulation (10%)
- Assignment (15%)

Assessment (CLOs 4&5): (30%)

- Project (20%)
- Oral Presentation (5%)
- Oral Question (5%)

An "A" would be awarded if a student can design the proper quality management system for smart factories.

A "B" would be awarded if a student can evaluate the proper quality management system for smart factories.

A "C" would be given if a student can analyze the proper quality management system for smart factories.

A "D" would be given if a student can only remember some criteria for designing the proper quality management system for smart factories.

Instructor: TBA