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Abstract Proceeding QR

2025 KSQM-QMOD-ICQSS Joint International Conference

PROCEEDINGS

Quality Management in the Age of AI

Date

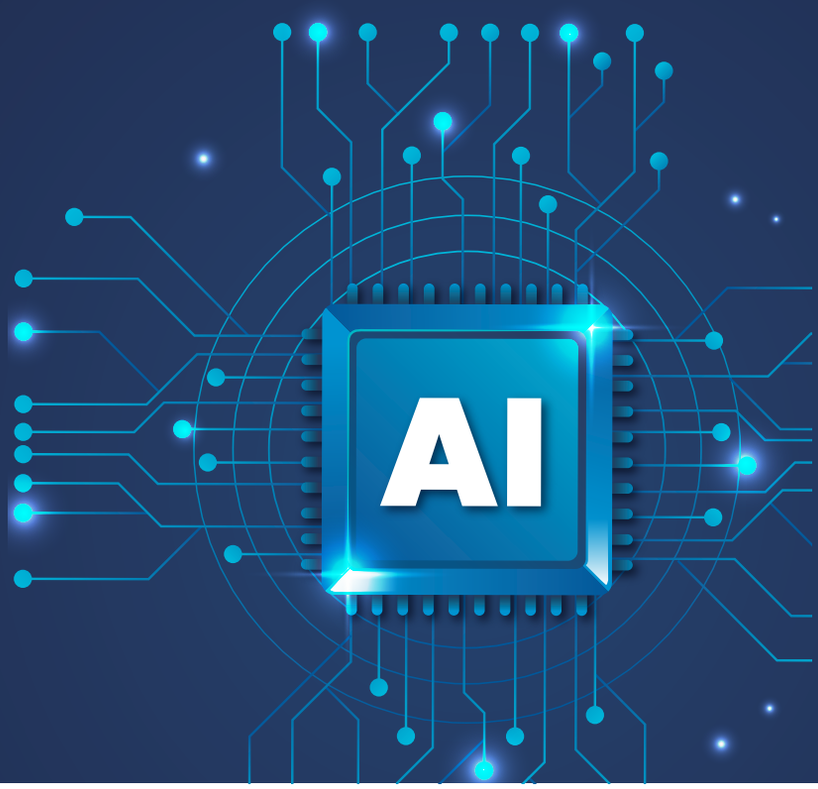
26–28 September 2025

Location

Yonsei University, Seoul, Korea

Organized by

QMOD-ICQSS, KSQM, Yonsei University



KATS Korean Agency for Technology and Standards
KSA KOREAN STANDARDS ASSOCIATION
YONSEI UNIVERSITY
연세대학교 140주년 YONSEI 140th ANNIVERSARY
NRF National Research Foundation of Korea
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the KSQM-QMOD-ICQSS 2025 Conference on Instagram & Facebook.
We kindly invite you to follow us and stay connected.

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2025 KSQM-QMOD-ICQSS Joint International Conference

26th - 28th October 2025, Seoul, Republic of Korea

This work was supported by the NRF(National Research Foundation of Korea) Grant funded by
the MOE(Ministry of Education)(NRF-2025S1A8A4A01013547)

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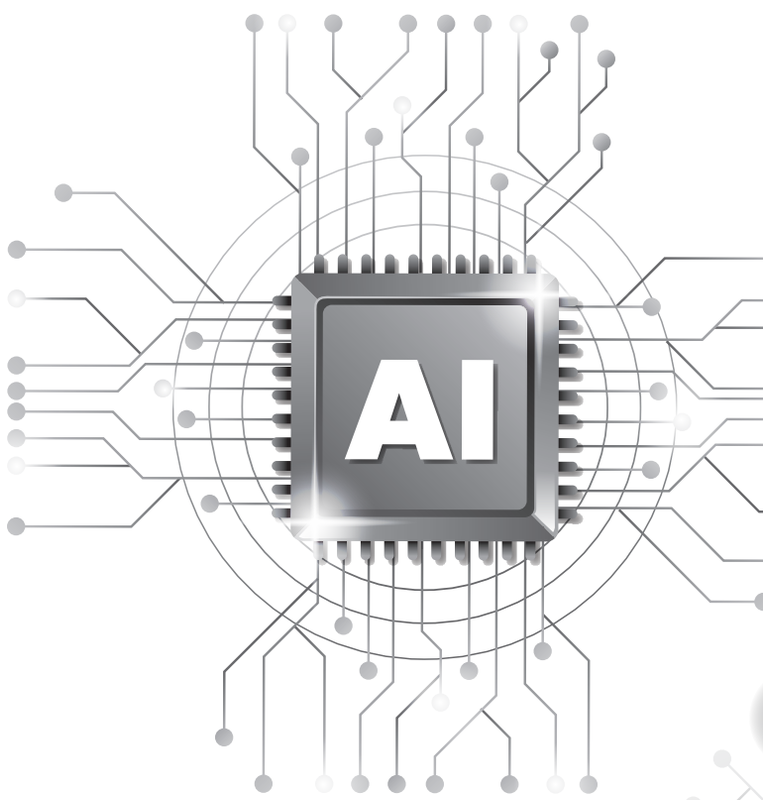

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26th September, Friday

17:00-20:00	**QMOD-ICQSS Registration**	Choi Young Hall, Baekyang Nuri
17:00-18:00	**Welcome Reception**	
18:00-20:00	**Welcome Dinner**	

27th September,Saturday

Conference Opening — Location: Grand Ballroom, Baekyang Nuri

09:30-10:30

■ **Opening Speech**
Heejun Park, Local chair, President, KSQM
Su Mi Dahlgaard-Park & Jens J. Dahlgaard, Conference Co-Chairs

■ **Congratulatory Speech**
Dong-Sup Yoon, President, Yonsei University
Daeja Kim, President, Korean Agency for Technology and Standards
Dongmin Moon, President, Korean Standards Association

■ **Awards Ceremony**

Global Excellence Award in Quality Management
Myungho Kwon, President & CEO, Korea East-West Power Co., Ltd.

Sustainable Management Quality Award
Yongbae Lee, President & CEO, Hyundai Rotem Co., Ltd.

Distinguished Service Award
Joonho Kim, Former Advisor, LG Electronics

Chief Quality Officer Award
Taeho Lee, Vice President, Korea South-East Power Co., Ltd.

Excellent Quality Manager Award
Donghyun Kim, Principal Researcher, Korea Institute of Nuclear Nonproliferation and Control

Excellent Quality Engineer Award
Insuk Im, Director, GoldVan Co., Ltd.

Plenary Session — Location: Grand Ballroom, Baekyang Nuri

10:30-12:00

Robin Mann, Head, Centre for Organizational Excellence Research, New Zealand,
The Power of Benchmarking for Real Business Impact-Improving People, Processes, Products, and the Planet

Moontae Lee, Senior Researcher, LG Corporation, Korea,
Reasoning, Alignment, and Creativity: The Triptych of Super intelligence

12:00-13:30 ■ **Lunch** — **Location: Grand Ballroom, Baekyang Nuri**

Parallel Sessions 1 — Location: Lee Youn Jae Hall 5th & 6th Fl.

14:00-15:30

QMOD		
Q1.1. / Room: L505 Big Data & AI in Quality Management I	Q1.2. / Room: L509 Quality in Education & Public Relations	Q1.3. / Room: L511 AI, Machine Learning & Quality Management I
Q1.4. / Room: L604 Safety, Reliability & Applied Statistics I	Q1.5. / Room: L614 Industry 4.0 & Digital Transformation in Quality	Q1.6. / Room: L615 Performance Management & Organizational Excellence I
KSQM		
K1.1. / Room: L503 Quality 4.0 & Industrial Digitalization	K1.2. / Room: L504 Defense Quality & Procurement Innovation	K1.3. / Room: L617 Poster Session I

15:30-15:45	**Coffee Break**		**Location: Lee Youn Jae Hall 2nd Fl.**
Parallel Sessions 2			Location: Lee Youn Jae Hall 5th & 6th Fl.
	QMOD		
15:45-17:15	Q2.1. / Room: L505 Big Data & AI in Quality Management II	Q2.2. / Room: L509 Service Quality & Digitalization	Q2.3. / Room: L511 Continuous Improvement: Lean, Six Sigma & Supply Chain
	Q2.4. / Room: L604 Quality in Healthcare & Hospitality I	Q2.5. / Room: L614 AI, Machine Learning & Quality Management II	Q2.6. / Room: L615 Business Excellence, Innovation & Sustainability I
	KSQM		
	K2.1. / Room: L503 Safety, Reliability & Applied Statistics II	K2.2. / Room:L504 Digital Transformation & R&D Quality	K2.3. / Room: L617 Poster Session II
18:00-21:00	■ **Conference Gala Dinner**		**Location: Grand Ballroom, Baekyang Nuri**

28th September, Sunday

Plenary Session			Location: 4th Engineering Hall 5th Fl., D504
10:00-10:45	**Yamada Shu,** Professor, Keio University, Japan, *What should and should not be changed on Quality Management in the age of AI*		
10:45-11:00	**Coffee Break**		**Location: 4th Engineering Hall 5th Fl., D504**
Parallel Sessions 3			Location: Location: 4th Engineering Hall 5th Fl.
	QMOD		
11:00-12:30	Q3.1. / Room: D502 Quality Management Systems & Supply Chain Management	Q3.2. / Room: D503 Business Excellence, Innovation & Sustainability II	Q3.3. / Room: D504 Quality in Healthcare & Hospitality II
	Q3.4. / Room: D507 Benchmarking & Best Practices in Quality Management		Q3.5. / Room: D508 Performance Management & Organizational Excellence II
10:45-11:00	■ **Lunch**		**Location: 4th Engineering Hall 1st Fl., Lobby**
Plenary Session			Location: 4th Engineering Hall 5th Fl., D504
14:00-14:45	**Forrest Breyfogle,** CEO, Smarter Solutions, Inc. United States, *How to Reduce AI Implementation Risks: A Smarter Strategy for Business Success*		
14:45-15:00	**Coffee Break**		
15:00-15:45	**John Oakland,** Professor, Leeds University, United Kingdom, *Quality 4.0 – concept definition, principles & practice*		
Closing Session			Location: 4th Engineering Hall 5th Fl., D504
15:45-16:15	**Best Paper Awards and QMOD 2026 Announcement**		

Plenary Session

Chairs: Prof. Su Mi Dahlgaard-Park & Prof. Jens J. Dahlgaard, Conference Co-Chairs, Sweden

Location: Grand Ballroom, Baekyang Nuri

Location: 4th Engineering Hall 5th Fl., D504

QMOD Parallel Sessions 1

Location: Lee Youn Jae Hall 5th & 6th Fl.

Q1.1. Room L505 — Big Data & AI in Quality Management I

Chairs: Prof. Tatjana Tambovceva, Latvia

Q1.2. Room L509 — Quality in Education & Public Relations

Chairs: Prof. Jelena Titko, Latvia

Q1.3. Room L511 — AI, Machine Learning & Quality Management I

Chairs: Prof. Chi-Kuang Chen, Taiwan

Q1.4. Room L604 — Safety, Reliability & Applied Statistics I

Chairs: Prof. Wan Seon Shin, Korea

Q1.5. Industry 4.0 & Digital Transformation in Quality

Room L614

Chairs: Prof. Sungmin Bae, Korea

Q1.6. Performance Management & Organizational Excellence I

Room L615

Chairs: Prof. Gerson Tontini, Brazil

KSQM Parallel Sessions 1

Location: Lee Youn Jae Hall 5th & 6th Fl.

K1.1. Quality 4.0 & Industrial Digitalization

Room L503

Chairs: Prof. Sang-Jun Lee, Korea

K1.2. Room L504 — Defense Quality & Procurement Innovation

Chairs: Prof. Sung Uk Lim, Korea

K1.3. Room L617 — Poster Session I

Chairs: Prof. Yonghan Ju, Korea

Q2.3. Room L511 — Continuous Improvement: Lean, Six Sigma & Supply Chain

Chairs: Prof. DonHee Lee, Korea

Q2.4. Room L604 — Quality in Healthcare & Hospitality I

Chairs: Prof. Max Christoph Urban, Germany

Q2.5. Room L614 — AI, Machine Learning & Quality Management II

Chairs: Prof. Sung Hyun Park, Korea

Q2.6. Room L615 — Business Excellence, Innovation & Sustainability I

Chairs: Prof. Davor Labaš, Croatia

KSQM Parallel Sessions 2

Location: Lee Youn Jae Hall 5th & 6th Fl.

K2.1. Room L503 — Safety, Reliability & Applied Statistics II

Chairs: Prof. Dongmin Kim, Korea

K2.2. Room L504 — Digital Transformation & R&D Quality

Chairs: Prof. Gye Soo Kim, Korea

K2.3. Poster Session II

Room L617

Chairs: Prof. Seungbeom Kim, Korea

QMOD Parallel Sessions 3

Location: 4th Engineering Hall 5th Fl., D504

Q3.1. Quality Management Systems & Supply Chain Management

Room D502

Chairs: Prof. Wen-Huan Wang, Germany

Q3.2. Business Excellence, Innovation & Sustainability II

Room D503

Chairs: Prof. Jens J. Dahlgaard, Sweden

Q3.3. Quality in Healthcare & Hospitality II

Room D504

Chairs: Prof. Masahiko Munechika, Japan

Q3.4. Benchmarking & Best Practices in Quality Management

Room D507

Chairs: Prof. Johye Hwang, Korea

Q3.5. Performance Management & Organizational Excellence II

Room D508

Chairs: Prof. Terje Slåtten, Norway

2025
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Plenary Session

Quality Management
in the Age of AI

01 / Grand Ballroom, Baekyang Nuri

The Power of Benchmarking for Real Business Impact
- Improving People, Processes, Products, and the Planet
Robin Mann, Head, Centre for Organizational Excellence Research, New Zealand

02 / Grand Ballroom, Baekyang Nuri

Reasoning, Alignment, and Creativity:
The Triptych of Superintelligence
Moontae Lee, Senior Researcher, LG Corporation, Korea

03 / 4th Engineering Hall 5th Fl., D504

What should and should not be changed on Quality Management in the age of AI
Yamada Shu, Professor, Keio University, Japan

04 / 4th Engineering Hall 5th Fl., D504

How to Reduce AI Implementation Risks:
A Smarter Strategy for Business Success
Forrest Breyfogle, CEO, Smarter Solutions, Inc. United States

05. / 4th Engineering Hall 5th Fl., D504

Quality 4.0 – concept definition, principles & practice
John Oakland, Professor, Leeds University, United Kingdom

The Power of Benchmarking for Real Business Impact

- Improving People, Processes, Products, and the Planet

Robin Mann
Head, Centre for Organizational Excellence Research, New Zealand

Dr. Robin Mann is the Head of the Centre for Organisational Excellence Research (COER), New Zealand, Chairman of the Global Benchmarking Network, and a Board Member of the New Zealand Business Excellence Foundation.

He is also the Co-Founder of BPIR.com Limited, a leading best practice resource website, and the Founder of both the International Best Practice Competition and the TRADE Best Practice Benchmarking Methodology.

Robin leads major benchmarking initiatives, facilitating over 50 benchmarking projects for the Dubai Government in recent years and supporting hundreds of projects worldwide. He has served as a Business Excellence and Productivity Advisor to numerous countries and published over 50 peer reviewed journal papers on business excellence. Originally from the UK, he earned his PhD in Total Quality Management (TQM) from Liverpool University in 1992.

Abstract

Benchmarking is a powerful tool for driving breakthrough thinking, fostering innovation, and achieving exceptional performance. At its core, benchmarking is about learning from the experiences of others and applying that knowledge to enhance organizational performance.

This paper highlights two major initiatives that showcase the impact of benchmarking from both formal and informal perspectives. The first initiative demonstrates a structured benchmarking approach used by organizations to undertake in-depth benchmarking projects, while the second illustrates how informal benchmarking facilitates the rapid exchange of best practices.

The first initiative focuses on a Dubai Government program that trains government entities in systematic benchmarking. Through a year-long program, participants are mentored in applying the TRADE Best Practice Benchmarking Methodology, which consists of five key stages: Terms of Reference, Review Current State, Acquire Best Practices, Deploy Best Practices, and Evaluate Outcomes. The acronym "TRADE" underscores the importance of strong, two-way partnerships for the mutual exchange of valuable knowledge. On average, each project generates

between 50 to 120 ideas and best practices, with the most promising ones selected based on feasibility and expected impact. This paper reviews over 40 TRADE Benchmarking Projects in Dubai, tackling challenges ranging from COVID-19 response to reducing household electricity consumption to creating a next generation airspace. A 2024 impact study revealed that TRADE projects generated an average of US$3.9 million in savings or revenue for the government or society.

The second initiative highlights the International Best Practice Competition (IBPC), a platform for sharing and learning best practices in a simple yet effective format. The IBPC invites organizations of all sizes to present their best practices through a five-page written application, an eight-minute video presentation, and a ten-minute Q&A with a jury. The competition provides a fast, engaging, and structured way to exchange best practices, helping organizations learn from each other while receiving feedback for improvement. Practices are assessed using a star-rating system, with 5-star and above practices recognized as international best practices of potential interest to organizations worldwide. Since 2012, over 800 best practices have been shared through the IBPC. The competition's success has inspired several countries to establish national competitions, and many large organizations have adopted similar internal best practice-sharing frameworks.

By showcasing these initiatives, this paper underscores how both formal and informal benchmarking can drive innovation, efficiency, and performance excellence across organizations, industries, and nations.

Reasoning, Alignment, and Creativity:
The Triptych of Superintelligence

Moontae Lee
Senior Researcher, LG Corporation, Korea

Moontae serves as Head of Superintelligence Lab at LG AI Research. He is concurrently a faculty member of Information and Decision Sciences at the University of Illinois Chicago. His journey into Large Language Models (LLMs) began in 2019 as an invited scholar at Microsoft Research Redmond, where he initiated the ambitious Universal Language Modeling project. His current research spans text, code, and time-series foundation modeling, with an industry service on synthesizing high-quality domain-specific reasoning datasets for agent building and verifiable thinking verification. Moontae has served as Area Chair and Senior Committee member for NeurIPS, ICML, ICLR, ACL, NAACL, EMNLP, AAAI, AISTATS, and CVPR. Beyond the machine learning community, his work have also been recognized in Operations Research and Management Information Systems, where he received the Best Paper Award at INFORMS 2017. His research in Computational Social Science won the Amazon Research Award. More recently, he received the Social Impact Award at NAACL 2024 and the Best Paper Award at NAACL 2025.

Abstract

The pursuit of superintelligence requires advancing three interdependent pillars: *reasoning, alignment, and creativity*. Reasoning calls for foundation models that can perform multi-step thinking and workflow modeling supported by scalable methods for structured planning and evaluation. This requires synthesizing domain-specific reasoning datasets, designing protocols for verifiable thinking, and establishing principled evaluation frameworks to ensure reliability and trustworthiness in Agentic AI. Alignment bridges these capabilities with human preferences, requiring rigorous and safe guardrails for societal values and collective goods. Creativity, in turn, expands the frontier—enabling AI not only to interpolate within learned patterns but also to extrapolate toward novel insights. By treating reasoning, alignment, and creativity as a triptych rather than isolated challenges, this talk aims to envision AI systems that are not only more capable and reliable, but also generative in expanding scientific discovery and human knowledge.

What should and should not be changed on Quality Management in the age of AI

Yamada Shu
Professor, Keio University, Japan

Dr. Shu Yamada is a professor at Keio University. He earned his Doctor of Engineering (1993) and Master of Engineering (1989) from Tokyo University of Science under the mentorship of the renowned Prof. Noriaki Kano. Dr Yamada is an internationally recognized expert in quality management, statistical quality control, and social systems engineering. His prolific research has resulted in over 50 peer-reviewed publications and 10 books, with notable recognition including the prestigious Nikkei Quality Control Literature Prizes in 1993, 1997, 1999, and 2005. Additionally, he has served as the Editor in Chief of Total Quality Science and played key editorial roles in respected journals such as the Journal of the Japanese Society for Quality Control (JSQC), Quality Engineering, and Asian Journal on Quality. As a leading authority in his field, Dr. Yamada has contributed to global standard-setting initiatives, serving on committees such as the Deming Prize, ISO TC 176 (Quality Management), and IEC TC 111 (Environmental Conscious Design). His expertise has been instrumental in advancing international quality standards and practices. Beyond academia, Dr. Yamada has collaborated extensively with industry, promoting Total Quality Management (TQM), developing innovative management systems, and providing specialized training tailored to organizational needs.

Abstract

If we consider the proposal of control chart by Shewhart as the origin of Quality Management, approximately 100 years have passed since this proposal was made. In order to adapt to changes in the business environment, Quality Management has developed various basic principles such as customer orientation and process approach. It has also produced a variety of activities such as improvement, all member participation, daily management, policy management and so forth. Recent developments in AI contribute to the evolution of Quality Management in various ways. For example, it is expected to be applied to improvement activities and to the search for potential customer requirements. On the other hand, there are some things that should not be changed in the age of AI. In this keynote speech, it will first be reviewed the history of the development of quality management to date. It will be explained the basic principles, activities, and organizational promotion related to Quality Management that have been developed so far, what should be changed because of the age of AI, and what should not be changed even in the age of AI.

How to Reduce AI Implementation Risks:
A Smarter Strategy for Business Success

Forrest Breyfogle
CEO, Smarter Solutions, Inc. United States

Forrest Breyfogle is a professional engineer, an ASQ fellow, and the CEO of Smarter Solutions, Inc. (https://smartersolutions.com). He has authored or co-authored over fifteen books about enhancements to Lean Six Sigma process improvement techniques, KPI performance metric reporting, and business management techniques.

His books, *Management 2.0* and *Leadership 2.0*, offer an enhanced Integrated Enterprise Excellence (IEE) system, accompanied by free predictive process output metric reporting software, in a novel book format.

His books offer radical management advancements in utilizing and integrating scorecards, strategic planning, and process improvement.

Mr. Breyfogle was named Quality Professional of the Year for 2011 by Quality Magazine and, in 2012, received the Alumni of the Year award from the Missouri University of Science and Technology. He also received the prestigious Crosby Medal from ASQ in 2004 for an earlier book, *Implementing Six Sigma, 2nd edition*. He received the Leadership Award at the 2013 Lean & Six Sigma World Conference.

Forrest has given numerous keynote presentations on Lean Six Sigma, business systems, and their metrics worldwide.

Abstract

As organizations invest heavily in artificial intelligence (AI) to enhance operations and decision-making, many face underwhelming results due to weak implementation foundations. Common pitfalls include siloed projects, inconsistent metrics, and lack of strategic alignment.

Effective AI requires a deep understanding of business processes, goals, and performance indicators. Without this context, AI insights remain fragmented and fail to deliver organization-wide value.

This presentation introduces the Integrated Enterprise Excellence (IEE) System as an ideal foundation for AI Implementation 2.0. IEE offers:

- Enterprise-wide process visibility and standardized metrics

- Predictive 30,000-foot-level KPI reporting
- Alignment of AI and improvement efforts with strategic goals

By embedding AI within the IEE framework, businesses can ensure that AI initiatives are impactful, integrated, and sustainable.

In the race to gain a competitive advantage, organizations are rapidly investing in artificial intelligence (AI) technologies.

From machine learning to natural language processing, AI promises to revolutionize how companies operate, make decisions, and deliver value to their customers. However, many businesses are discovering that implementing AI without a strong foundational framework often leads to siloed projects, disjointed insights, and disappointing returns.

Common Issues with current AI Implementation practices:
- Siloed deployments that don't integrate with enterprise-wide goals
- Lack of standardization in processes and data definitions
- Inconsistent metric reporting, making enterprise-level decision-making difficult
- Reactive AI usage rather than proactive, strategic deployment

For AI to be truly transformative, it must have a deep understanding of the business — its workflows, objectives, constraints, and opportunities. In other words, it needs a business-centric foundation.

AI models are only as powerful as the data and context they are given. When implemented in a vacuum, they generate insights that may improve a piece of the puzzle but not the entire picture.

To avoid these pitfalls, organizations must first build a foundation that:
- Maps out (from a system-wide perspective) enterprise processes with their performance metrics
- Establishes predictive performance metrics improvement objectives, which have alignment with strategic goals
- Provides 24 x7 accessible, real-time insights across the business
- Enables AI to recommend improvements that align with big-picture priorities

The Integrated Enterprise Excellence (IEE) System provides an AI Implementation 2.0 (Quality Management System) foundation, offering a modern, strategic, and integrated approach that sets the stage for enterprise-wide success.

The AI Implementation 2.0 foundation of IEE provides:
- A system-wide view of processes, goals, and metrics
- Predictive 30,000-foot-level reporting for KPI and process output metric responses that identify performance trends with confidence
- A clear roadmap for aligning improvement efforts with enterprise objectives
- A platform for AI to generate meaningful, organization-wide value

Quality 4.0

– concept definition, principles & practice

John Oakland
Professor, Leeds University, United Kingdom

Professor Oakland is Chairman of The Oakland Group (www.weareoakland.com) and Head of its Research and Education Division, The Oakland Institute. He is also Emeritus Professor of Business Excellence at Leeds University Business School.

Over more than forty years he has worked with top management in all aspects of quality, business excellence, performance improvement, and more recently in data analytics, in literally thousands of organisations. He has directed several large research projects in Europe, funded by the British Government and EU programmes, and the Chartered Quality Institute, which have brought him into contact with a diverse range of organisations. His work has been widely acknowledged and published.

He is author of several books, including the bestselling: *Total Organisational Excellence, Total Quality Management and Operational Excellence 5ed, Total Construction Management and Statistical Process Control & Data Analytics 8ed,* all published by Routledge, and *Production and Operations Management* published by Pearson. He has written literally hundreds of papers, articles and reports on various topics in these fields.

Professor Oakland is a Fellow of the Chartered Quality Institute, Fellow of the Royal Statistical Society, an Honorary Life Member of the Research Quality Association, Member of the American Society for Quality and a Fellow of the Cybernetics Society.

Abstract

Business and organisations are continuing to evolve out of necessity, responding to an onslaught of disruption, new business models and technology. This continuous change, including that precipitated by the global coronavirus pandemic, is affecting operations at all levels, with customers demanding real-time interactions, regulators applying increasing levels of scrutiny and governance, and stakeholders requiring assurance in this complex and dynamic risk environment. The technology revolution that has been called 'Industry 4.0' and 'Digital Transformation,' and includes Artificial Intelligence, Machine Learning and robotics, has exposed weaknesses in the traditional approaches to quality management and questions have been raised whether they are still relevant and efficient.

Digitalisation and the highly connected nature of global systems means that organisations now operate in a complex and tightly coupled environment. A single flaw in one part of the system can rapidly cause catastrophic systemic failures. In contrast the impact of the same significant flaws could perhaps more easily be contained in previously complex but loosely coupled systems. Tight coupling is being increased by Industry 4.0 related technologies.

What is clear is that business models will continue to change dramatically over the next three to five years, and business/organisation leaders will need to focus on aggressively seeking out opportunities to innovate within rapidly changing and increasing risks. As the risk landscape becomes more complex and fast-moving, it will be crucial for organizations to identify and respond quickly and effectively to emerging events and risks. If the so called 'Quality 4.0' (Q4.0) is to be part of the solution, it needs to be properly understood, defined and developed to play a key role in helping organisations manage during this evolution.

The CQI commissioned a consortium comprising Leeds University Business School and The Oakland Institute for Business Research and Education to carry out research into the concepts and principles that underpin the evolution of Q4.0. The focus was to review existing literature and consult an appropriate sample of industry leader and practitioner views with the objective of developing an understanding of Q4.0 that would form the basis for further research into the practices and tools that quality professionals will need to thrive in this emerging world. This Keynote address will present the initial findings of that research.

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Parallel Sessions 1

Lee Youn Jae Hall 5th & 6th Fl.

27th Saturday, 14:00-15:30

QMOD

Q1.1. / **Room: L505**
Big Data & AI in Quality Management I

Q1.2. / **Room: L509**
Quality in Education & Public Relations

Q1.3. / **Room: L511**
AI, Machine Learning & Quality Management I

Q1.4. / **Room: L604**
Safety, Reliability & Applied Statistics I

Q1.5. / **Room: L614**
Industry 4.0 & Digital Transformation in Quality

Q1.6. / **Room: L615**
Performance Management & Organizational Excellence I

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Room: L503 / K1.1.
Quality 4.0 & Industrial Digitalization

Room: L504 / K1.2.
Defense Quality & Procurement Innovation

Room: L617 / K1.3.
Poster Session I

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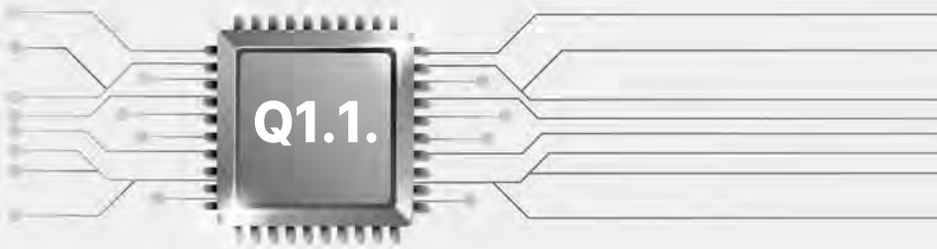

Big Data & AI in Quality Management I

Chairs: Prof. Tatjana Tambovceva, Latvia

Q1.1.-1

Fernando F. Padró, Heejin Chang, Australia

Tacit knowledge as a barrier to the Artificial Intelligence-Academic Integrity (AI-Ai) nexus: The challenge of checklist formation

Q1.1.-2

Sung Hyun Park, Korea

Challenges and Development Strategies of Data Science and Artificial Intelligence

Q1.1.-3

Hong Hwan Ahn, Korea

Designing a Dual Quality Framework for Responsible AI in the Public Sector: A Case-Informed Application to Incheon International Airport

Q1.1.-4

Turgut Refik Caglar, Elena Andrushchenko, Jonathan Thelen, Roland Jochem, Germany

Enhancing Failure Management with Large Language Models (LLMs): Developing and Validating a Proof of Concept for AI-Driven Quality Management

Tacit knowledge as a barrier to the Artificial Intelligence-Academic Integrity (AI-Ai) nexus

: The challenge of checklist formation

Fernando F. Padró[1], Heejin Chang[2]

[1] CGS Consulting
[2] University of Southern Queensland

Abstract

The ever-changing environment of the AI-Ai nexus represents a major risk to quality assur-ance in higher education for higher education institutions (HEIs) and regulators. Academic credentials assure employers, governments and society at-large that students have been ex-posed and demonstrated an acceptable level of competence in developing skills within aca-demic subjects. Similarly, academic staff need to exhibit their research that establishes part of their professional standing meets ethical requirements and rigour. HEIs and regulators have to provide evidence that academic credentials actually demonstrate skill acquisition leading to competency within these credentials. Inappropriate use of AI by students when completing assessable tasks is sometimes aided and abetted by unclear direction via insti-tutional policy and procedures (P & P), pedagogical practices and curricular design and assessment practices. These lead to Ai problems that HEIs have to investigate and adjudge. There are various mechanisms to identify, investigate, and determine whether AI has oc-curred and the consequences those found guilty. This also applies to academic staff whose research could be compromised through the use of AI.

This paper focuses on student-related issues from the institutional perspective. A mecha-nism that has been proposed to reduce AI-Ai nexus problems by the authors (Padró et al, 2024) is the creation of checklists that can be done at the individual, program and/or insti-tutional level (Winters et al., 2009). An element of the checklist formation process are focus groups of staff and students to provide their views on what their views are on must-haves and must-avoid elements in their creation. What was found in running a focus group of international academics and regulators is that they were unable to clearly identify the basic value structure on which to base the elements of a checklist. Much was taken for granted. Traditional notions of academic freedom were proffered but without a clear indication that these long-standing notions were being presented. Also found was a clash of values with current mores regarding student consumerism and its impact on student approach to aca-demic performance (Bunce, 2022, Bunce et al, 2017; Padró, 2023). The difficulty could be traced to participant tacit knowledge and how tacitness (Polanyi, 1966; Wagner & Sternberg, 1985) made value consensus problematic. The discussion, therefore, is about strategies to overcome tacit thinking to establish a basis for checklist formation to support institutional QA processes.

Challenges and Development Strategies of Data Science and Artificial Intelligence

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Abstract

Amid the era of digital transformation, big data and artificial intelligence (AI) are emerging as key technologies driving national competitiveness. Today, AI is having a significant impact on academia, industry, and daily life. Data science is the field that conducts fundamental academic research on big data and AI technologies.

This study provides an overview of data science, examining its essence and the current state of education in the field. Next, it explores the applications of AI in science and industry, as well as investigates the AI competitiveness of various countries. Additionally, the study delves into the essence, current status, and future prospects of the data industry, which revolves around data as a medium. It also reviews the current status of AI promotion laws designed to foster AI development and AI regulation laws aimed at preventing its misuse. Finally, the study discusses strategies for advancing data science and AI. For the strategies, promotion of data science education, globalization of data science, revitalization of data/AI industry, enhancing domestic companies' market share in the cloud industry, standardization of data platforms and data quality management, and developing the data/AI industry as a major export sector are suggested and discussed.

Keywords: Data Science, Artificial Intelligence, Big Data, Data Industry.

Designing a Dual Quality Framework for Responsible AI in the Public Sector

: A Case-Informed Application to Incheon International Airport

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Abstract

Purpose: This study aims to examine the strategic value tensions between technical efficiency and social responsibility that arise during the adoption of high-risk artificial intelligence (AI) technologies in the public sector. To address these tensions, the study proposes a dual quality evaluation framework that enables a parallel assessment of performance and institutional legitimacy, referred to as the Efficiency–Responsibility Quality Indicators (E-QI / R-QI).

Methodology/Approach: The framework comprises two indicator groups. The Efficiency Quality Indicators (E-QI) are derived from the Technology Acceptance Model (TAM) and the Diffusion of Innovation (DoI) theory, including metrics such as processing speed, automation rate, and resource turnover. The Responsibility Quality Indicators (R-QI) are grounded in Responsible AI principles and informed by traditional quality management frameworks such as SERVQUAL, TQM, and ISO 9001, encompassing indicators such as explainability, user rights protection, and auditability. To examine the applicability of this framework, a qualitative case-informed scoring approach was applied to the biometric-based Smart Pass system currently in operation at Incheon International Airport.

Findings: The dual quality framework is designed to simultaneously assess both technological performance and ethical responsibility. The Smart Pass case demonstrated strong performance in the E-QI domain but revealed that R-QI indicators—such as explainability, user control, and external audit mechanisms—remain at a nascent stage of institutional development. These findings underscore the need for public AI strategies to transition from performance-driven logic to more balanced, responsibility-centered governance.

Research Limitation/Implication: As an exploratory qualitative study based on a single case, the research has inherent limitations regarding generalizability and quantitative validation. Future studies should employ structured methodologies such as Analytic Hierarchy Process (AHP) or Multi-Criteria Decision Making (MCDM) to validate indicator weightings and extend the framework to comparative analyses across various public institutions.

Originality/Value of Paper: This study integrates public value theory, AI ethics, and quality management to propose a novel analytical framework tailored to the public sector. The dual quality framework contributes both theoretically and practically by offering a diagnostic tool that supports the design of public AI strategies which are not only performance-oriented but also ethically and institutionally grounded.

Keywords: Responsible AI, Value-Based Quality, Public Sector Innovation, Technology Acceptance, AI Governance

Enhancing Failure Management with Large Language Models (LLMs) : Developing and Validating a Proof of Concept for AI-Driven Quality Management

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Abstract

The integration of Large Language Models (LLMs) in industrial quality management presents new opportunities for automating failure detection, classification, and resolution. This study explores the potential of LLMs to optimize failure management within production environ-ments. Through a structured Proof of Concept (PoC), key use cases such as automated failure classification, contextual retrieval of failure reports, and prioritization of critical fail-ures were examined. The automated classification system achieved a 95% accuracy rate compared to manual classification, reducing labor-intensive tasks while improving data con-sistency. A semantic clustering approach enabled efficient identification and prioritization of recurring failures, which was validated by expert interviews. However, limitations such as data privacy concerns, model transparency (”black-box” issue), and processing constraints were identified as challenges to full-scale implementation. The findings highlight the poten-tial of LLMs to increase efficiency in quality management processes, reduce human effort, and improve decision-making in industrial environments. This study contributes to the ongoing discourse on AI-driven quality management, demonstrating how LLMs can be systematically integrated into manufacturing workflows.

Keywords: Artificial Intelligence, Quality Management 5.0, Large Language Models, Smart Failure Management, Machine Learning in Production.

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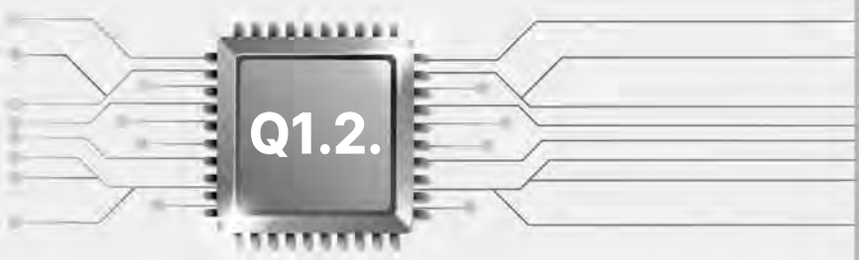

Quality in Education & Public Relations

Chairs: Prof. Jelena Titko, Latvia

AI Chatbot for Higher Education Bridging Student and Engineer Perspectives

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Abstract

Purpose: In higher education, managing both academic and administrative support is vital for universities, especially when addressing students' frequent, often unmet, information-related needs. This study explores the development of an AI-powered FAQ chatbot at a leading Hungarian university, designed to assist students throughout their educational journey. The paper aims to identify the key service quality attributes and technical requirements of such a chatbot using the Quality Function Deployment (QFD) methodology.

Methodology: The dual-phase research approach gathered the voice of customers (VoC) via literature review and 59 focus group sessions with 267 Hungarian and international students. Simultaneously, the voice of the organization (VoO) was captured through literature review, a mixture of topic-related requirement processing, expert interviews, and software development lifecycle best practices leading to a proof-of-concept implementation.

Findings: Based on the results, 9 service quality dimensions (accurate, reliable responses, fast responses, decision-supportive information, lack of technical issues, proper handling of inaccuracies, user-friendly interface, reference to sources, handling of complex or specific queries, clear and structured presentation) were determined. 10 technical functions (document-based or online-based knowledge, cloud-based infrastructure, feedback mechanism, guard rails, document change and update management, document hierarchy management, error handling process, privacy, security, multimodal document management, multi-step question handling and reasoning) were differentiated. The correlation matrix between the VoC and VoO, also among the VoO elements highlighted a critical need for balancing between the technical functions.

Originality: By systematically linking service quality attributes with engineering design requirements, the research contributes to building more responsive, accurate, and effective AI-driven student support systems.

Keywords: artificial intelligence (AI), service quality, quality function deployment (QFD), chatbot, higher education, large language models (LLM)

Artificial Intelligence for Continuous Improvement in Higher Education

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Abstract

Purpose: The overwhelming goal of the research is to evaluate the role of Artificial Intelligence (AI) in ensuring the continuous improvement at higher education institutions (HEIs). The current paper reflects the results of the authors' conducted survey aimed at assessing the perceptions of AI by higher education students.

Design/methodology/approach: The main method for data collection was survey among Latvian students to evaluate the perceived AI's role in study quality and its impact on students' engagement. The authors used their own developed research instrument. To process the data, we applied frequency, regression and cluster analysis.

Findings: The research revealed the personal characteristics contribute to the level of AI-based enhancement of academic engagement and performance. In particular, both generation Z and millennials tend to indicate AI solutions increase their academic performance. One of the main challenges is that academic staff support for use of AI is evaluated lower, than requested from the students.

Research limitations/implications: Research is limited by the number of respondents and geography. However, a cross-country study is planned for the future. Considering the research gap in the field of AI applications in higher education in the Baltic countries, the paper contributes to the theoretical knowledge base. The practical implications are related to the strategic planning and development of procedures in HEIs, in particular, AI guidelines for staff and students.

Originality/value: The main value of the research is the developed and tested research instrument that can be used at HEIs to evaluate students' perception of study process with integrated AI-based elements. The research distinguish itself from other studies with the focus on specific and practical recommendations for AI implementation in study process. Besides, the paper's originality is related to the local context and specific of the educational fields.

Keywords: artificial intelligence, quality of study process, higher education, Latvia.

A Study on the Impact of Corporate Mecenat Activities on Relationship Quality and Corporate Legitimacy

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Abstract

This study empirically analyzed the impact of Corporate Mecenat Activities (CMA) on Relationship Quality (RQ) and Corporate Legitimacy (CL) in an era where culture has become a crucial constraining factor. We categorized CMA into Value-Oriented (VO), Stakeholder-Oriented (SO), and Performance-Oriented (PO) activities to examine their effects. The results indicate that both Value-Oriented activities and Stakeholder-Oriented activities posi-tively influence both Relationship Quality and Corporate Legitimacy. Furthermore, we confirmed positive effects in the mediating relationships between these variables. However, Performance-Oriented activities, while positively impacting Corporate Legitimacy, did not significantly affect Relationship Quality, showing similar results in their mediating relationships. These findings suggest that corporate mecenat activities serve as an adaptive response to rapidly changing societal shifts and can be an effective strategy within a company's Operational Management (OM). Nevertheless, due to the specific characteristics of the sample, there are limitations in universally applying these research findings to all forms of corporate mecenat activities. We propose the need for future research to develop models applicable to diverse situations.

This study can contribute to companies seeking to build stable relationships with internal and external stakeholders and to explore Customer Relationship Management (CRM) and Customer Experience Management (CEM) strategies.

Keywords: Corporate Mecenat Activities (CMA), Relationship Quality (RQ), Corporate Le-gitimacy (CL), Corporate Social Responsibility (CSR)

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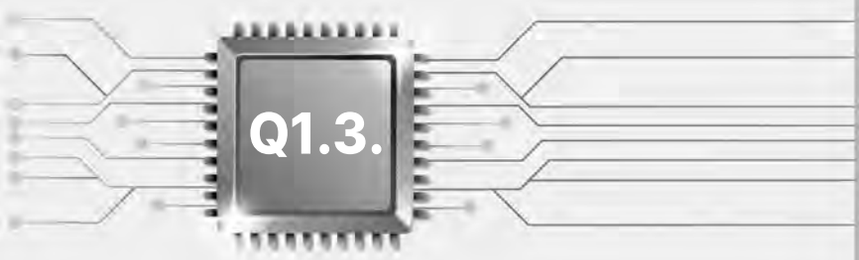

AI, Machine Learning & Quality Management I

Chairs: Prof. Chi-Kuang Chen, Taiwan

Q1.3.-1

Shu Yamada, Taisei Kajihara, Hiroki Kawabe, Keisuke Shida, Japan

Application of machine learning techniques to millisecond injection data in a highly controlled process

Q1.3.-2

Elena Andrushchenko, Turgut Refik, Caglar, Dogan Efe, Roland Jochem, Germany

The Impact of Prompt Engineering on AI-Driven Failure Management in Manufacturing

Q1.3.-3

Seungbeom Kim, Korea

A Study on the Emotional Transmission of Virtual Humans:
Through Eye-Tracking and Brainwave (fNIRS) Measurement

Application of machine learning techniques to millisecond injection data in a highly controlled process

Shu Yamada[1], Taisei Kajihara[2], Hiroki Kawabe[3], Keisuke Shida[4]

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Abstract

In highly controlled processes, the range of variation of the factors is extremely narrow, making it difficult to find correlations with the response variable that is the indicator of the outcome. In addition, with the development of sensors and information technology, it is possible to collect large amounts of time series data. For example, in an injection process that takes about 10 seconds, it is possible to obtain data on the state of the inside of the injection machine in milliseconds.

In this study, we use data collected in milliseconds during the injection process, which is difficult to find correlations between response and factors, to obtain the conditions for producing good products. The novelty of this approach is that it combines machine learning methods such as 1D EfficientNet, 1D CNN, and Grad-CAM, visualization using Gaussian process regression, and knowledge from the field. We show that the effective application of these methods increases the proportion of meeting the requirements.

Keywords: Gaussian process regression, 1D EfficientNet, 1D CNN, Grad-CAM

The Impact of Prompt Engineering on AI-Driven Failure Management in Manufacturing

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Abstract

Purpose: The increasing complexity of manufacturing systems has amplified the need for precise and efficient failure management strategies. Traditional approaches to failure detection and root cause analysis often struggle to effectively process the vast amounts of unstructured data generated within production environments. In this context, Artificial Intelligence (AI), particularly Natural Language Processing (NLP), has emerged as a transformative technology for automating the process of failure analysis. A crucial yet often-overlooked fac-tor in AI-driven failure management is Prompt Engineering, which greatly influences model performance and interpretability.

Methods: This paper examines the role of Prompt Engineering in optimizing the effective-ness of NLP models for failure detection and diagnosis within AI-based failure analysis. It explores the fundamental principles of this approach, emphasizing its influence on the accuracy, reliability, and contextual relevance of AI-generated insights. The analysis extends to AI-driven failure management strategies, including automated anomaly detection, predictive maintenance, and decision support systems. A comparative evaluation of traditional and AI-enhanced failure management methods is conducted, assessing improvements in detection speed, diagnostic accuracy, and decision-making efficiency, while also highlighting methodological challenges and key considerations for industrial adoption.

Findings: This research proposes a structured framework for leveraging Prompt Engineering in AI-driven failure management, offering both theoretical insights and practical guidelines for optimizing prompt design and implementation in industrial applications. It examines how this approach enhances failure identification and mitigation strategies, ultimately contributing to more resilient and adaptive manufacturing systems.

Limitation/Implication: Additionally, the study underscores the broader implications of Prompt Engineering in ensuring AI-driven solutions are transparent, reliable, and aligned with industrial needs, paving the way for more effective AI adoption in manufacturing environments.

Originality/Value of Paper: Prompt Engineering has a significant influence on the performance and interpretability of AI-driven failure management systems. This research systematically exam-ines its impact and provides a structured framework for its integration. It offers insights into im-proving detection speed, diagnostic accuracy, and decision-making efficiency while addressing key challenges in industrial implementation.

Keywords: Prompt Engineering, AI-Based Failure Analysis, Natural Language Processing, Machine Learning, Failure Management, Artificial Intelligence.

Q1.3. AI, Machine Learning & Quality Management I Q1.3.-3

A Study on the Emotional Communication of Virtual Humans:

Through Eye-Tracking and Brainwave (fNIRS) Measurement

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Abstract

Purpose: This study investigates how emotions expressed by virtual humans are perceived and transmitted to real human observers, and whether such emotional expressions evoke comparable neural and behavioral responses to those elicited by real human expressions. Given the rapid diffusion of virtual humans across advertising, branding, and entertainment, the research aims to clarify whether virtual emotional cues can generate genuine empathy, trust, and positive consumer attitudes.

Methodology/Approach: The research employed a mixed-method experimental design integrating survey responses, eye-tracking, and functional near-infrared spectroscopy (fNIRS). A total of 24 university students participated, all of whom provided informed consent under IRB approval (IRB no. 7002340-202409-HR-023). Seven basic emotions defined by Paul Ekman (happiness, sadness, anger, fear, disgust, surprise, contempt) were presented through both real human facial expressions and AI-generated virtual human faces. Eye-tracking measured fixation distribution and attentional focus on areas of interest (AOIs), while fNIRS recorded prefrontal cortex hemodynamic responses associated with emotional processing and regulation. In addition, surveys assessed perceived accuracy of emotion recognition, emotional contagion/empathetic response, and discomfort due to artificiality.

Findings: The results indicate that virtual human expressions can be recognized and processed to a certain degree, sometimes even comparable to or exceeding human expressions in specific contexts. However, participants' subjective responses and neural patterns suggest that virtual faces may not always evoke the same depth of emotional engagement as real human faces. Eye-tracking data pointed to broadly similar attention distribution between the two conditions, whereas fNIRS signals revealed nuanced differences in how emotional information was processed. Overall, while virtual humans demonstrate potential in emotional communication, limitations remain in replicating the authenticity of human-to-human interaction.

Research Limitation/Implication: The study's limitations include a relatively small, homogeneous sample of university students and the controlled laboratory setting, which may restrict generalizability to broader consumer populations and real-world advertising contexts. Future research should expand demographic diversity and incorporate longitudinal exposure to virtual humans. Nonetheless, the findings provide critical implications for human–computer interaction (HCI), advertising design, and metaverse development. Specifically, strategies are needed to reduce perceived artificiality and strengthen emotional authenticity in AI-generated avatars to enhance user trust and acceptance.

Originality/Value of Paper: This study is among the first to triangulate behavioral, neurological, and self-reported data in evaluating emotional communication by virtual humans. By combining eye-tracking and fNIRS measures, it provides empirical evidence that, although AI-generated expressions can approximate human emotional cues, they cannot fully substitute for the authenticity and depth of real human emotional contagion. The research offers valuable insights for both academic discourse in consumer neuroscience and practical applications in marketing, branding, and virtual human design.

Keywords: Virtual Humans, Emotion Transmission, fNIRS, Eye-Tracking, Consumer Neuroscience, Advertising

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Safety, Reliability & Applied Statistics I

Chairs: Prof. Wan Seon Shin, Korea

Q1.4.-1 **Junhyeok Seo, Sungmin Bae, Korea**

Corporate Response Strategy for the Serious Accident Punishment Act Using the IPA-AHP Technique

Q1.4.-2 **Angelos Pantouvakis, Nikolaos Tsoulakos, Greece**

The Role of Digitalization in Shipping Safety: Human Error and Near-Miss Prevention

Q1.4.-3 **Siil Sung, Korea**

How to select an Appropriate Confidence Level for Reliability Testing?

Q1.4.-4 **Sungim Lee, Korea**

A Comparative Study of Multivariate Control Charts for Covariance Shift Detection

Corporate Response Strategy for the Serious Accident Punishment Act Using the IPA-AHP Technique

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Abstract

Purpose: In South Korea, the Serious Accident Punishment Act (SAPA) was enacted in January 2021 and came into effect in January 2022. In the future, companies are required to identify, eliminate, and mitigate risk factors to comply with the obligations set forth in the law. However, even if these compliance measures are faithfully implemented, it may still be difficult to completely prevent catastrophic accidents. Therefore, this study aims to identify the key factors necessary for companies to respond effectively after the enforcement of SAPA and to evaluate the impact of each factor in order to help companies establish a systematic response strategy.

Methods: To achieve the objective of this study, we identified the 20 key factors necessary for companies to respond to the Serious Accident Punishment Act from various sources in the literature. The 20 key factors represent the company's response strategy to prepare for the obligations required by SAPA. We categorized these factors into five dimensions: Leadership, Organization, Budget, Education, and Awareness. We then analyzed the relationship between the importance of these key factors, the degree of actual implementation by compa-nies, and their relative weight using a combination of AHP (Analytic Hierarchy Process) and IPA (Importance- Performance Analysis) techniques. Additionally, we conducted both 2D and 3D IPA analyses, incorporating the importance, performance, and weight of the factors.

Findings: The study concluded that, in order for a company to respond effectively to the SAPA, it is necessary to establish a risk management system based on management leader-ship and to implement risk management governance.

Limitation/Implication: The results of this study may not be equally applicable to all manufacturing companies, as the study is presented by surveying members of a typical manufacturing company rather than taking into account the different characteristics of the companies.

Originality/Value of Paper: This study presents research results that are differentiated from existing studies by analyzing empirical data using AHP and IPA techniques, and by creating a 3D diagram that can measure the analysis results in depth in three dimensions, this study provides useful data that can be used for corporate strategy planning and management leaders' decision-making to respond to the SAPA.

Keywords: Serious Accident Punishment Act, 2D IPA, 3D IPA, AHP, Response Strategy.

THE ROLE OF DIGITALIZATION IN SHIPPING SAFETY
: HUMAN ERROR AND NEAR-MISS PREVENTION

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Abstract

This paper seeks to bridge the gap in academic literature by exploring the relationship between digitalization and maritime safety and quality management. The integration of various digital technologies and software applications have a significant impact on the shipping industry, aiming to enhance operational efficiency and competitiveness. Shipping companies increasingly view digitalization as an inevitable progression in the maritime industry and are actively involved in implementing various strategies to support this pivotal shift.

This research offers an examination of the current landscape regarding the utilization of digital technologies by leveraging real-time high-frequency data, incorporating also historic data from maritime casualties reports, collected from a sample fleet of a reputable shipping company operating 51 bulk carriers over a six-year period from 2017 to 2022. The goal is to identify and analyze the various characteristics linked to the digitalization implementation within the organization focusing on human error and its impact on operations and safety.

The results firmly suggest that the integration and execution of digitalization strategies by shipping companies can significantly reduce the likelihood of maritime casualties.

This empirical study seeks to analyze and evaluate the overall impact that digitalization has on the occurrence of maritime casualties.

Keywords: Digitalization, Shipping, Digital technologies, Maritime Casualties, Human Error, Near-miss

Q1.4. Safety, Reliability & Applied Statistics I Q1.4.-3

How to select an Appropriate Confidence Level for Reliability Testing?

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Abstract

Purpose: This study aims to address the under explored issue of selecting appropriate confidence levels in system reliability testing, a factor that significantly affects test design, sample size, duration, and cost.

Methodology/Approach: A structured decision-making method based on the SMART (Specific, Measurable, Aggressive and Achievable, Relevant, Time-bound) principles was developed. The model integrates both qualitative and quantitative factors, and its application is demonstrated through a case study involving a newly developed control PCB.

Findings: The proposed framework enables test designers to select confidence levels that are both statistically valid and realistically aligned with available resources, thereby optimizing test efficiency and cost-effectiveness.

Research Limitation/Implication: The approach was validated using a single case study; broader application across various system types and operational contexts is needed to generalize its effectiveness.

Originality/Value of Paper: This study introduces a systematic, resource-conscious method for selecting confidence levels, addressing a gap in existing standards and providing a practical tool for reliability test planning.

Keywords: Confidence level, Reliability test, SMART

A Comparative Study of Multivariate Control Charts for Covariance Shift Detection

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Abstract

Purpose: Monitoring the covariance structure in multivariate processes is essential for detecting structural changes that may not manifest through shifts in the mean. While Hotelling's T^2 chart is widely used for mean shift detection, it is not optimized for identifying subtle or complex covariance shifts. This study aims to systematically compare multiple control charts that are specifically designed for detecting covariance changes, focusing on both classical and recently developed statistics.

Methodology/Approach: We evaluate four representative methods: the generalized variance ($|S|$) chart, the Hotelling's T^2 chart, the VMAX statistic, and the Penalized Likelihood Ration (PLR) chart. In addition, we include a machine-learning based Autoencoder (AE) approach to contrast statistical and learning-based perspectives. A structured simulation study is conducted using predefined covariance shift scenarios derived from seven types of covariance matrices with different shift patterns (e.g., uniform variance increase, sparse correlation change, and mixed structures). Performance is compared in terms of out-of-control average run length (ARL_1), standard deviation of run length (SDRL), and sensitivity to specific types of structural changes.

Findings: The study is expected to clarify the comparative strengths and weaknesses of various control charts in detecting different types of covariance shifts. Through simulation under structured scenarios, we aim to identify which methods are more sensitive to particular covariance shift patterns such as variance only or correlation only changes, and which offer practical advantages in terms of interpretability and ease of implementation.

Research Limitation/Implication: This study focuses on Phase II process monitoring under the assumption of multivariate normality and subgroup-level observations. The methods are evaluated in settings where the number of variables is moderate relative to subgroup size. Future work may consider non-normal distributions, autocorrelation, or extensions to high-dimensional cases.

Originality/Value of Paper: By evaluating and contrasting classical ($|S|$, T^2), simple statistics (VMAX), penalized likelihood (PLR), and machine-learning (AE) approaches under consistent conditions, this provides practical insight into their comparative performance and potential for real-world monitoring applications.

Keywords: Covariance change detection, Hotelling's T-squared, Generalized variance, VMAX, Penalized likelihood ratio, Autoencoder

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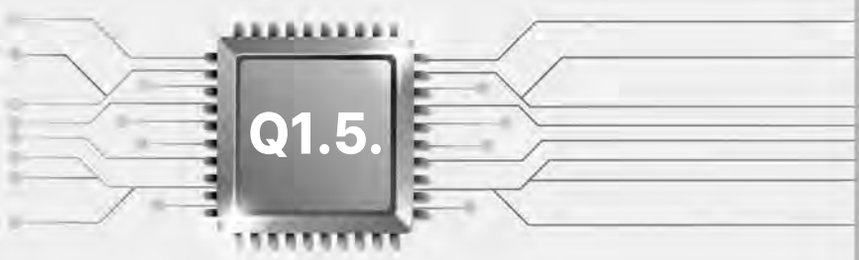

Industry 4.0 & Digital Transformation in Quality

Chairs: Prof. Sungmin Bae, Korea

Q1.5.-1	**Malikah, Wan Seon Shin, Korea** Quality 4.0: Current Trends, Key Approaches and Future Directions – A Systematic Review
Q1.5.-2	**Frédéric Ponsignon, Gregory Bressolles, Naser Valaei, France** The role of the digital transformation in influencing the orientation of quality management practices: a contingency theory perspective
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Quality 4.0: Current Trends, Key Approaches and Future Directions – A Systematic Review

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Abstract

Purpose: Industry 4.0 (I4.0) technologies are transforming quality management into quality 4.0 by integrating advanced digital practices with traditional methods. Despite its transformative potential, quality 4.0 faces significant adoption barriers that necessitate a deeper understanding of these challenges and their solutions. This study systematically reviews cur-rent trends, implementation barriers, and adoption strategies, offering insights and future directions to help decision-makers overcome these obstacles.

Methods: This study followed the PRISMA (Preferred Reporting Items for Systematic Re-views and Meta-Analyses) protocol for transparent data extraction. Adhering to PRISMA, 119 peer-reviewed articles from 2011 to November 2024were analyzed using Bibliometrix (Biblioshiny) and VOSviewer.

Findings: Bibliometric analysis identified publication trends, influential authors, leading journals, and collaborative networks, whereas content analysis revealed eight primary topics: success factors, key barriers, adoption frameworks, technologies, benefits, evolution, key features, and quality 4.0 professionals. Thematic categorization revealed motor themes (leadership, barriers, innovation), basic themes (I4.0, AI), niche themes (sustainable development, digitalization), and emerging or declining themes (blockchain, TQM 4.0). A focused review classified barriers into technological, organizational, data and analytics, workforce, and economic categories.

Limitation/Implication: This research equips practitioners, and decisionmakers with actionable knowledge to leverage quality 4.0 for organizational development and sustainable competitive advantage.

Originality/Value of Paper: This study systematically identifies and categorizes the key barriers to quality 4.0 implementation into five distinct classes, providing a structured frame-work for policymakers, researchers and practitioners to better understand these challenges. It also presents actionable strategies and approaches tailored to address each barrier, facilitating an effective and more efficient transition to quality 4.0 adoption.

Keywords: Quality 4.0, Industry 4.0, Bibliometric analysis, Content analysis, Thematic anal-ysis, Systematic literature review, PRISMA framework.

Q1.5. Industry 4.0 & Digital Transformation in Quality Q1.5.-2

The role of the digital transformation in influencing the orientation of quality management practices:

a contingency theory perspective

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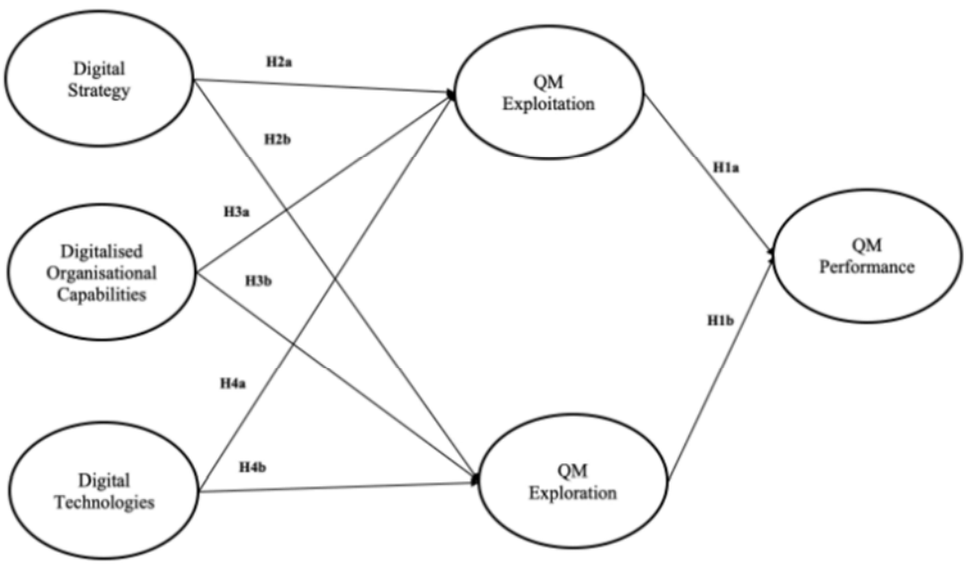
Abstract

Purpose: Quality management (QM) has become a key function that makes a strong contribution to a company's performance. Recent research suggests that the QM function has started to adopt modern digital technologies that enable improvements in performance. However, limited research has been conducted to explore how the digital transformation plays a role in influencing the orientation of QM practices and, subsequently, QM performance. The purpose of this study is therefore to examine empirically how digital transformation endeavours affect quality management. To achieve this objective, we build on the contingency theory to develop a model (see Figure 1) proposing relationships among the digital transformation, QM practices, and QM performance. We select three contingency factors referring to digital strategy (strategy level), digitalized organizational capabilities (tactical level), and digital technologies (operational level). Following recent QM literature, organizational response represents the exploration and exploitation orientations of QM practices. Performance outcomes relate to the performance of the quality management system (QMS).

Figure 1. Theoretical framework and hypotheses



Methods: We apply this theoretical model by collecting survey data from 213 practicing quality managers in manufacturing and service companies in France to test these relationships. A diverse set of industries, company sizes, as well as digitalization and QM duration programs were represented. The measures used were existing multi-item measurement scales that have been validated in previous research, providing confidence that the questionnaire exhibits content and face validity.

Findings: Overall, our results support the notion that the digital transformation plays a central role in enabling QM to successfully enact both exploration-oriented and exploitation-oriented practices to pursue superior QM performance. The results indicate that digital strategy and digitalized organizational capabilities exert positive effects on QM exploration and QM exploitation practices, which in turn influences QM performance. Put differently, ensuring that the digital strategy adopts a broad scope, pursuing a range of strategic objectives, and that organizational capabilities are digitalized are pivotal facets of an organization's digital transformation initiative that play a key role in influencing the orientation of QM practices. However, the results suggest that the relationship between the use of digital technologies and QM orientation is not supported empirically. Moreover, the results of the analyses provide evidence indicating that QM exploration and QM exploitation practices positively influence the performance levels of the QMS.

Originality/Value of Paper: To the authors' knowledge, this is the first study that has provided an overarching theoretical rationale articulating how three distinct facets of the digital transformation may affect the orientation of QM practices. Framed within the contingency theory, this study empirically examines strategic, tactical and operational digital antecedents to the deployment of QM as recommended in recent research. This study ex-tends prior work on the digitalization of QM through the development of a theory-driven research model subjected to a large-scale empirical validation using a sample of service and manufacturing organizations.

Keywords: Digital transformation, Quality management, Contingency theory, Quality ex-ploitation, Quality exploration.

Q1.5. Industry 4.0 & Digital Transformation in Quality Q1.5.-3

Development and validation of a digital maturity model for Industry 4.0

: perspective of Chinese SMEs

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Abstract

The rapid evolution of Industry 4.0 has heightened the complexity for manufacturing en-terprises in organizational, technological, and strategic aspects, introducing uncertainties in their digital transformation. Chinese Small and Medium-sized Enterprises (SMEs) are confronted with growing complexities. This has made the scientific assessment of SMEs'maturity levels under Industry 4.0 a focal concern for both academia and industry. This study targets manufacturing SMEs, aiming to develop a scientific and systematic Industry 4.0 maturity assessment model. This model will offer theoretical and practical guidance for digital transformation. Drawing on literature reviews and expert consultations, and in-corporating the core features of Industry 4.0, this study identifies an evaluation indicator system across six dimensions: technology application, data-driven interconnection, process and business, strategic planning, organization, and sustainability. This research not only enriches the theoretical framework for assessing Industry 4.0 maturity but also provides ac-tionable strategies for manufacturing SMEs to achieve digital transformation.

Keywords: Industry 4.0; Maturity Assessment; Manufacturing Enterprises; Digital Trans-formation.

Digital Maturity and Quality:

Innovation Perspectives and Maturity Models

Sara Slålie Cvijetic[1], Une Newermann Wick[2], Siw M. Fosstenløkken[3]

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Abstract

This paper aims to explore the relationship between digital maturity and competitiveness for quality in small and medium-sized businesses (SMBs) in the Norwegian construction industry. The industry is generally characterized by a low degree of digitalization, and research on SMBs in the industry is limited. We investigate (i) the firms' current level of digital maturity and (ii) their resource utilization through the following research questions: How digitally mature are the SMBs? How are digital resources utilized to enhance competitive ability? Our theoretical framework is based on the four categories of digital maturity by Westerman et al. (2014), and Ma's (2000) definition of competitive advantage is applied. An exploratory case study was conducted based on data from nine interviews in five different companies. This study is one of the few empirical studies investigating digital maturity and competitiveness in SMBs in the construction industry in Norway. Thus, the study will contribute understanding of a different context to enrich the existing literature on digital maturity in highly competitive environments.

Keywords: digitalization, digital maturity, competitive advantage, construction industry, digital strategy, digital resources

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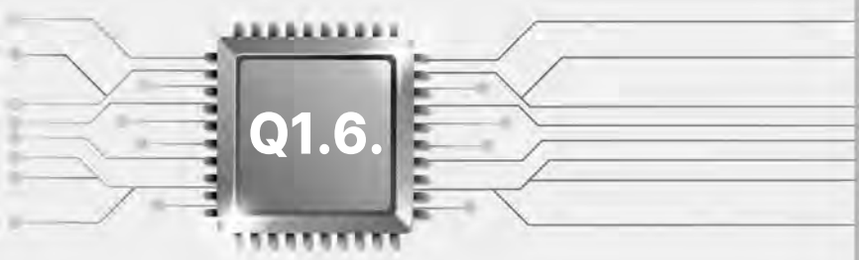

Performance Management & Organizational Excellence I

Chairs: Prof. Gerson Tontini, Brazil

Q1.6.-1

Anette Knutsen Finstad, Barbara Rebecca Mutonyi, Terje Slåtten, Norway

Cultivating a Thriving Workforce in Hospitality Organizations
- An Empirical Study of Its Antecedents and Consequences

Q1.6.-2

Barbara Rebecca Mutonyi, Victoria Rustad Bjerke, Terje Slåtten, Norway

The impact of service employees' ambidexterity and leadership display of curiosity on a firm's innovative culture and competitive advantage

Q1.6.-3

Giancarlo Gomes, Gérson Tontini, Mohamed Amal, Regiane Krause, Brazil

Learning To Innovate Globally: Does International Orientation Enhance Innovation Performance?

Q1.6.-4

Anastasia Gerou, Angelos Pantouvakis, Greece

Sustainable Business Models Innovation: A Knowledge Synthesis

Cultivating a Thriving Workforce in Hospitality Organizations - An Empirical Study of Its Antecedents and Consequences

Anette Knutsen Finstad[1], Barbara Rebecca Mutonyi[2] and Terje Slåtten[1]

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Abstract

Purpose: This paper focuses on cultivating employees' experience of thriving at work (TAW) within the context of hospitality organizations. Specifically, it conceptualizes and empirically tests a selection of antecedents to employees' thriving at work, as well as its consequences.

Design/methodology/approach: The study gathered data from 346 employees working in the hospitality industry. Partial Least Squares Structural Equation Modeling (PLS-SEM) was utilized with Smart PLS 4 to examine and validate the proposed conceptual framework.

Findings: The results revealed that leadership autonomy support, working as a team, and employee engagement have positive impacts on cultivating employees' thriving at work (TAW). Moreover, TAW has positive consequences on service quality and organizational attractiveness. Additionally, both work as a team, and employee engagement was found to mediate the relationship between leadership autonomy support and TAW.

Research limitations/implications: The study is limited to exploring only a selection of antecedents and consequences of TAW. However, the paper contributes theoretically to the field of hospitality research by enhancing our understanding and insights into the concept of TAW, as well as having several practical implications for managers of hospitality organizations.

Originality/value: The study contributes to a relatively new research domain within positive psychology, focusing on employees' thriving at work.

Keywords: Thriving at work, Leadership, Teamwork, Employee engagement, Service quality, Organizational attractiveness.

The impact of service employees' ambidexterity and leadership display of curiosity on a firm's innovative culture and competitive advantage

Barbara Rebecca Mutonyi[1], Victoria Rustad Bjerke[2], Terje Slåtten[2]

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[2] University of Inland Norway

Abstract

Purpose: This paper explores the impact of two organizational-related factors: (i) the leadership's display of curiosity and (ii) service employees' ambidexterity. Specifically, the paper examines how these two factors enhance a firm's innovative culture and competitive advantage.

Design/methodology/approach: The study involved *N* = 201 employees from various hospitality organizations. The proposed conceptual model was analyzed and tested using Partial Least Squares Structural Equation Modeling (PLS-SEM) with Smart PLS 4.

Findings: Leadership's display of curiosity was found to directly drive employee ambidexterity, firms' innovative culture and competitive advantage. However, displaying curiosity in leadership is related to a firm's competitive advantage through an organization's innovative culture and employee ambidexterity. Additionally, the results reveal that employee ambidexterity promotes a firm's competitive advantage, mediated through the organization's innovative culture. In summary, the leadership display of curiosity and employees' ambidexterity account for 30 percent of the variance in an organization's innovative culture and about 35 percent of the variance in a firm's competitive advantage.

Research limitations and implications: The study demonstrates how firms can utilize leadership displays of curiosity and employee ambidexterity as tools to achieve desirable company goals, such as fostering an innovative culture and enhancing their competitive advantage. An implication of the study is the magnitude of business managers focusing on developing both "instruments". However, leaders' central position and role in influencing subordinates in organizations makes, prioritizing the cultivation and development of leaders' curiosity of fundamental importance. Investing in stimulating leaders' curiosity will pay off in three ways: by strengthening the ambidexterity among employees, fostering an innovative organizational culture, and contributing to maintaining a firm's competitive advantage.

Originality/value: The study contributes to a relatively neglected area of research by revealing the potential multifaceted effects of leadership curiosity and employee ambidexterity in organizations.

Keywords: Service, Employee Ambidexterity, Leadership, Curiosity, Organizational Culture, Competitive Advantage

Learning to Innovate Globally

: Does International Orientation Enhance Innovation Performance?

Giancarlo Gomes[1], Gérson Tontini[2], Mohamed Amal[3], Regiane Krause[4]

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Abstract

Purpose: This study aims to assess the effects of International Growth Orientation (IGO) and Organisational Learning Capability (OLC) on Innovation Performance (IP).

Design/methodology/approach: We used a survey with closed questions to collect data from a sample of 353 Brazilian manufacturing companies. The data were analyzed using structural equation modeling.

Findings: Our study shows that the relationship between Organisational Learning Capability and Innovation Performance is positive and statistically significant. In addition, we found that the International Growth Orientation mediates the effects of the Organisational Learning Capability on Innovation Performance. The theoretical contribution of this study lies in providing a framework that shows international orientation is not just an outcome but a mechanism that amplifies the organisations innovation performance.

Practical implications: From a managerial perspective, this research highlights the importance of developing organisational capabilities, such as learning, to enable companies to tap into external markets as sources of innovation, ensuring sustained competitive advantages.

Originality/value: This advances the theoretical understanding of the interactions between Organisational Learning Capability and Innovation Performance in the manufacturing sector, with an emphasis on the mediating role of International Growth Orientation. We also contribute to the innovation literature by empirically testing such relationships and providing the mechanisms by which International Growth Orientation can operate as a mechanism of transmission of the effects of the Organisational Learning Capability on Innovation Performance.

Keywords: International growth orientation, Organisational learning capability, Innovation performance

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Sustainable Business Models Innovation : A Knowledge Synthesis

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[2*] School of Maritime and Industrial Studies, University of Piraeus, Piraeus, Greece

Abstract

Purpose: Business strategy and management disciplines are increasingly integrating sus-tainable development into their established assumptions and frameworks. However, there remains a lack of clarity, conceptual consensus and consistency in the usage of terms such as 'business model innovation' and 'sustainable business models' (SBMs). Additionally, these concepts lack established theoretical grounding in economics or business studies, as discussed comprehensively by Evans et al. in their prominent paper in the Journal of Business Strategy and the Environment in 2017. Since then, the volume of papers specifically focused on SBMs has exponentially increased from 51 to 303 (including scientific peer-reviewed articles and articles in press). This work aims to contribute to our understanding of SBMs innovation by adding the recent bibliography to the debate.

Methods: The current scientific bibliography of the examined topic mainly includes quali-tative data, thus we present a narrative review which is based on the PRISMA list. In order to search published scientific articles for the examined terms we have used two different electronic databases Scopus and Web of Science. The first step of our research was to track potential synonyms, broader or narrower terms of the SBMs and define the exclusion and inclusion criteria. We aim at a full representation of the available research on SBMs topic with broader and more generalizable conclusions, thus we chose to include a larger number of studies rather that more focused studies, for that reason we selected articles that refer to the term of SBMs in the title, the key words or the abstract. In practice, we were searching for articles that include in their abstract, title or key words the term of "Sustainable Business Models". The result for our research quest was 303 articles from 2009 to date (with only two articles in 2003-2004).

Findings: This research systematically examines the literature on Sustainable Business Models (SBMs) to identify innovative practices over time. The main findings focus on two key areas: firstly, understanding SBMs through theoretical definitions and practical business applications, and secondly, tracing the evolution of this concept based on the reviewed literature.

Originality/Value of Paper: Scholars in the current literature mention that business model innovation has seen a recent surge in academic research and business practice. Changes to business models are recognized as a fundamental approach to realize innovations for sustainability. However, little is known about the successful adoption of SBMs. Thus, based to the gaps identified in the SBMs literature, we respond to this call for further investigation by writing this Literature Review article.

Keywords: Sustainable Business Models, Business Models, Innovation, Management, Literature Review

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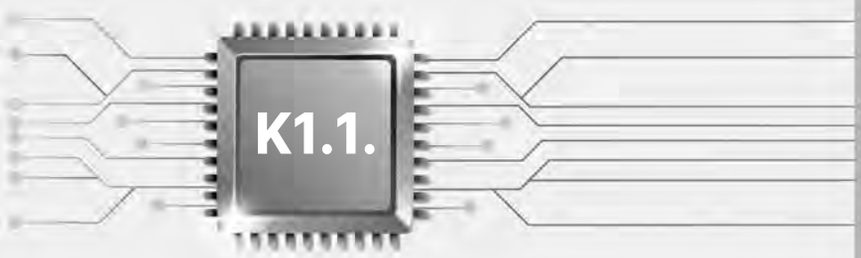

Quality 4.0 & Industrial Digitalization

Chairs: Prof. Sang-Jun Lee, Korea

K1.1.-1	**Su-Hyun Ahn, Sang-Jun Lee, Korea** Visual-Workflow Machine Learning in Higher Education
K1.1.-2	**Su-Hyun Ahn, Sang-Jun Lee, Korea** Evaluating the Effectiveness of a Global Citizenship Education Course
K1.1.-3	**Sangho Baek, Jinho Ahn, Jaewoong Kim, Joonsu Kim, Namsu Ahn, Korea** Study on setting protection levels of major facilities based on risk assessment
K1.1.-4	**Hojun Song, Wan Seon Shin, Kyung geun Lee, Siyoul Kim, Korea** Research on the Analysis of Key Issues for Digital Quality Management Adoption and Development

Visual-Workflow Machine Learning in Higher Education

A Qualitative Comparison of Orange with Code-First (R/Python) and GUI Peers (KNIME/RapidMiner)

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Abstract

Purpose: This study problematizes persistent barriers in code-first instruction for introductory machine learning (ML) courses and explores the perceived educational value of a click-and-drag visual-workflow tool (Orange), contrasted with code-first environments (R/Python) and GUI peers (KNIME/RapidMiner).

Methodology/Approach: We conducted focus group interviews with undergraduate learners who completed code-first ML labs and subsequently trialed a short visual-workflow session. Using a structured protocol, we elicited comparative perceptions on accessibility (onboarding, error anxiety), learning processes (conceptual grasp, feedback immediacy), and challenge ("desirable difficulty"). Transcripts were thematically analyzed with two-cycle coding to derive convergent themes and actionable design implications.

Findings: Students reported that the visual workflow promoted rapid onboarding, immediate feedback on pipeline design, and lower perceived error costs in early tasks relative to R/Python. When compared with KNIME/RapidMiner, Orange was perceived as lightweight and class-ready for concept visualization, although concerns were raised about advanced extensibility, assessment validity, and transfer to code. Participants endorsed a phased adoption model: early-semester concept formation with Orange followed by code replication tasks to foster transfer.

Research Limitation/Implication: Findings are perception-based and context-bound (single course setting; qualitative FGI without controlled experiments). We provide a pragmatic adoption guideline—phased infusion (GUI→code), common datasets and rubrics, logging of time/attempts, and transfer assignments (workflow-to-code mapping)—as a basis for future quasi-experimental evaluation.

Originality/Value of Paper: Rather than reiterating tool "feature" comparisons, this work centers student experience and instructional design, articulating where a visual workflow can lower extraneous burdens while preserving challenge and preparing for code-level transfer. The study offers a concrete, researchable roadmap for subsequent repeated-measures or mixed-methods trials.

Keywords: Datamining education, Visual workflow, Orange, R/Python, KNIME, RapidMiner

Evaluating the Effectiveness of a Global Citizenship Education Course

A Three-Wave Repeated-Measures Analysis of Cognitive, Socio-Emotional, and Behavioral Change

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Abstract

Purpose: This study evaluates the learning outcomes of a higher-education Global Citizenship Education (GCE) course using a three-wave repeated-measures design (pre-, mid-, and post-course). The instrument consists of 36 items aligned with UNESCO APCEIU (2015) and reorganized into three domains: cognitive (items 1–11), socio-emotional (items 12–24), and behavioral (items 25–36).

Methodology/Approach: Undergraduate students enrolled in the Spring 2025 course "Global Citizenship for All" completed the same survey at three scheduled time points. Within-person change was estimated with procedures suitable for repeated measures, including repeated-measures ANOVA (with Greenhouse–Geisser corrections when sphericity was violated) and complementary linear mixed-effects models. We summarize time effects and trajectories by domain and subtopic and outline sensitivity checks for missingness and unequal spacing across time points.

Findings: We report whether time effects emerge over the semester, examine heterogeneous trajectories across cognitive, socio-emotional, and behavioral domains, and describe the timing of change by subtopic. Exact estimates and effect sizes (e.g., partial η^2, standardized mean-change indices), together with robustness checks, are provided in the paper and presentation.

Research Limitation/Implication: The study is limited to a single institution, a course-based self-selected sample, self-report measures, and a one-semester window. Nonetheless, it proposes a performance-measurement framework for GCE that informs course design—embedding midpoint formative feedback, aligning rubrics with targeted outcomes, and scaffolding practice-oriented tasks.

Originality/Value of Paper: Beyond single pre/post comparisons, the study advances a replicable three-wave protocol for evaluating change processes in higher-education GCE and for strengthening evidence-based quality assurance.

Keywords: Global citizenship education, Repeated measures, Longitudinal evaluation, Cognitive–socio-emotional–behavioral domains, Learning outcomes

Study on setting protection levels of major facilities based on risk assessment

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Abstract

Purpose: This study aims to establish criteria for setting appropriate protection levels for major facilities by utilizing a rigorous risk assessment framework. Recognizing the growing complexity of modern threats, the research seeks to provide a rational basis for decision-making in security-critical infrastructure.

Methodology/Approach: The paper introduces quantitative definition on calculation methods hit probability and lethality ratio. These parameters are integrated to enable a comprehensive evaluation of actual enemy threats. Using the calculated hit probability and lethality ratio, a tiered, three-level protection criterion is developed, facilitating a graded approach to facility hardening and resource allocation.

Findings: Analysis reveals that the severity of some enemy threats may be over-estimated, indicating opportunities to optimize protection resources, while other threats have been underestimated and require additional scrutiny. The proposed framework thus enables a more tailored and systematic logic for determining the appropriate level of protection.

Research Limitation/Implication: All numerical data and scenarios employed in this study are entirely hypothetical, serving to illustrate the methodology rather than providing recommendations for specific real-world cases. Because current standards and detailed criteria for protection levels are classified, which presents challenges in benchmarking or validation. Another inherent limitation is the simplified modeling of lethality probability using a 'cookie-cutter' assumption—where damage is considered only within a defined lethal radius—potentially overlooking more nuanced damage mechanisms.

Originality/Value of Paper: By proposing a systematic, quantitative criterion for differentiating protection levels, based on probability theory, statistical analysis, and risk assessment, this work fills a gap in the field of critical infrastructure protection.

Keywords: Protection level, Risk assessment, Protection level, Major facilities

Research on the Analysis of Key Issues for Digital Quality Management Adoption and Development

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Abstract

Purpose: This study aims to provide key issues for adopting and expanding Digital Quality Management (DQM) throughout the industry.

Methodology/Approach: In order to analyze the thorough issues of Digital Quality Management in terms of practical level, HOPE model is proposed. In addition, Delphi survey is conducted with 50 quality related experts.

Findings: Key considerations for Digital Quality Management in regard to human, operation, physical and environment are derived with relative importance for each factor. Total 32 considerations for Digital Quality Management were derived, which leads to proposing pathway for quality digitalization.

Research Limitation/Implication: This study provides practical pathway for quality digitalization and insights for adopting Digital Quality Management in real case.

Originality/Value of Paper: This paper is unique in that both practical and theoretical insights for Digital Quality Management is provided through thorough Delphi survey.

Keywords: Digital Quality Management, Digitalization, Delphi Survey, Quality Strategy, Quality Issues

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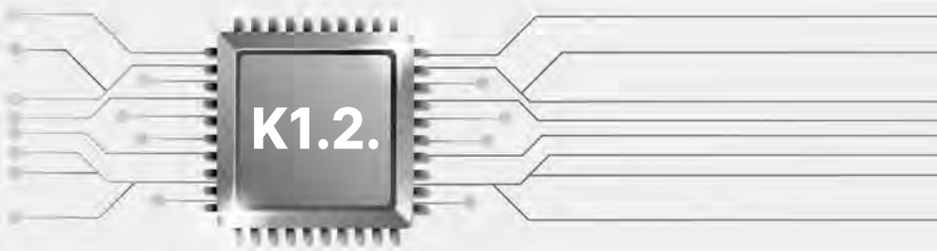

Defense Quality & Procurement Innovation

Chairs: Prof. Sung Uk Lim, Korea

K1.2.-1

Myungjin Chung, Jingu Heo, Jeong il Choi, Sunguk Lim, Korea

A Study on Quality Assurance System Improvement for Military Commercial Goods Procurement

K1.2.-2

Seok-Hee Ryu, Jin Gu Heo, Gye Soo Kim, Seo-Young Kim, Jeongil Choi, Korea

A Study on Improving Liquidated Damages Practices for Delays and Failures in Defense Weapon System R&D through a Technical Committee Approach

K1.2.-3

Yong-Kwan Beak, Gye Soo Kim, Seo-Young Kim, Jeongil Choi, Korea

A Study on the Strategic Importance of Assessing Quality Management Maturity in Defense Product Manufacturers

K1.2.-4

Jahoon Jeong, Junyeol Ryu, Namsu Ahn, Korea

Text Regression with an Explainable AI Approach for Defense Project Budget Prediction

A Study on Quality Assurance System Improvement for Military Commercial Goods Procurement

Myung jin Chung[1], Jin gu Heo[2], Jeong il Choi[3], Sung uk Lim[4]

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Abstract

Purpose: This study aims to analyze the problems of the current quality assurance system for military commercial goods and propose evidence-based improvement measures to enhance system efficiency and reduce workload burdens on end-user military units following the transfer of military procurement operations to the Public Procurement Service in 2020.

Methodology/Approach: Focus Group Interviews (FGI) were conducted with 36 field practitioners from military logistics agencies and the Procurement Quality Agency between July 14-22, 2025. The survey covered five organizations: Army Logistics Command (5 participants), Air Force Logistics Command (10 participants), Navy Logistics Command (7 participants), Marine Corps Logistics Command (9 participants), and Procurement Quality Agency (5 participants). The research analyzed current quality assurance operations, regulatory clarity, inter-organizational cooperation, and IT system status.

Findings: The study revealed critical systemic problems in Korea's military quality assurance framework. First, 86.3% of items delegated to the Procurement Quality Agency are re-delegated to end-user military units, creating severe workload imbalances where PQA inspectors handle 20 items annually while military unit inspectors manage 150 cases each. Second, all organizations (100%) lack integrated IT systems, relying entirely on manual Excel-based operations. Third, 80% of organizations reported unclear role definitions and insufficient information sharing systems. Fourth, quality assurance type classification criteria lack clarity and consistency, with 80% of respondents indicating inconsistent application in actual operations.

Research Limitation/Implication: While this study provides valuable insights from field practitioners, it has limitations in quantitative analysis and cost-benefit assessment of proposed improvements. The findings are specific to the Korean military procurement context and may require adaptation for application in other countries. Future research should include quantitative analysis of implementation costs and expected benefits, as well as comparative studies with international best practices.

Originality/Value of Paper: This research provides the first comprehensive empirical analysis of Korea's military quality assurance system problems following the 2020 procurement transfer, based on direct field practitioner feedback. The study offers practical, implementable solutions addressing real operational

challenges rather than theoretical frameworks. The findings contribute to defense acquisition policy by identifying specific inefficiencies and providing actionable recommendations for system reform that can enhance both operational efficiency and national defense capabilities.

Keywords: Military Goods Quality Assurance, Public Procurement Service Delegation, Quality Management System, DTaQ, PPS, End-User Military Unit Workload Reduction.

A Study on Improving Liquidated Damages Practices for Delays and Failures in Defense Weapon System R&D through a Technical Committee Approach

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Abstract

Purpose: Modern defense weapon system development faces constant risks of delays and failures due to high technical complexity and unpredictable, rigorous testing conditions. Such delays lead to substantial cost overruns and capability gaps, while imposing heavy financial burdens on contractors through excessive liquidated damages. Although the current liquidated damages system enforces contract performance, it may hinder challenging technology development and trigger unnecessary legal disputes between the government and contractors. This study addresses these issues by analyzing domestic and international cases of weapon system development failures, related legal frameworks, and committee operation systems, and proposes a proactive, systematic R&D management approach centered on a technical committee.

Methodology/Approach: The study compared and analyzed liquidated damages systems and weapon system development failures in South Korea, the United States, and Europe. It reviewed military test and evaluation (T&E) frameworks and standards such as MIL-STD-810 and STANAG 4370, identifying common testing philosophies and differences in regulatory structures. Case studies including Korea's 'Songgolmae', UAV, the U.S. F-35 program, and Europe's FCAS highlighted root causes such as high technical complexity, insufficient severe testing, and organizational inefficiency. A review of Korea's National Contract Act, defense procurement regulations, and contract review committee procedures revealed that, despite some R&D-specific provisions, the criteria for determining "justifiable reasons" remain unclear, reducing predictability.

Findings: First, the study proposes shifting technical committees from a post-review role to an early-stage engagement mechanism, participating from the outset of development. The committee should conduct regular stage-by-stage technical reviews, identify risks early, and minimize development failures. Second, it recommends clarifying criteria for liquidated damages exemptions based on high technical difficulty and rigorous testing conditions. Suggested benchmarks include unproven technologies below TRL 4–5, testing conditions exceeding MIL-STD requirements, and submission of preemptive risk management documentation, drawing from the U.S. FAR and the EU Defence Procurement Directive.

Research Limitation/Implication: While this study presents a conceptual framework for integrating technical committee operations with reformed liquidated damages practices, it does not provide a quantitative cost-benefit analysis. Future research should include such analysis and comparisons with international best practices.

Originality/Value of Paper: This study is the first to propose a flexible, rational liquidated damages system tailored to the unique characteristics of defense R&D, supported by an actively engaged technical committee. It aims to shift the paradigm from 'punishment for failure' to 'risk sharing and innovation promotion,' thereby accelerating defense technology self-reliance, enhancing K-defense competitiveness, and supporting efficient force deployment.

Keywords: Liquidated Damages, Weapon System Development, Technical Committee, Risk Management, R&D Policy

A Study on the Strategic Importance of Assessing Quality Management Maturity in Defense Product Manufacturers

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Abstract

Purpose: This study aims to address the increasing importance of securing quality competitiveness in the domestic defense industry, particularly following the rapid growth of K-defense exports. Despite this growth, the quality management activities of South Korea's defense product supply chain—especially small and medium-sized enterprises—remain at a relatively low level compared to civilian manufacturers. The research seeks to objectively assess the quality management maturity (QMM) of defense product manufacturers and to develop systematic measures for its enhancement.

Methodology/Approach: Over the past three years, a standardized diagnostic system and checklist for QMM assessment have been developed. This system is composed of strategic direction, organization and culture, processes, and support infrastructure, referring to domestic and international quality award evaluation criteria. It has been verified and improved through pilot assessments large, medium, and small enterprises. Its applicability is not limited to weapon system types or enterprise size, ensuring broad usability.

Findings: The developed QMM diagnostic system holds strategic importance as it objectively demonstrates a company's quality capabilities through a credible "Defense Product Manufacturer Quality Level Assessment Report," unifies previously fragmented quality evaluations across weapon systems to reduce audit and diagnostic burdens, and enables comparative analysis of QMM across the supply chain, thereby providing essential data for policy-making to enhance competitiveness.

Research Limitation/Implication: While this study establishes a foundational framework for QMM assessment, it does not include quantitative cost-benefit analysis of implementing the system. Future research should incorporate such analysis and compare with international best practices. Furthermore, it is necessary to reflect the results of this study in defense industry support policies and verify the effectiveness of the research results.

Originality/Value of Paper: This is the first study to develop and validate a standardized, universally applicable QMM diagnostic system for Korea's defense product manufacturers. It offers practical tools for both industry and policy-makers to enhance competitiveness and support sustainable export growth.

Keywords: Defence Products, Quality Management, Quality Management Maturity, Supply Chain Management

Text Regression with an Explainable AI Approach for Defense Project Budget Prediction

Utilizing a CBM-Based Framework with a Pre-trained Language Model

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Abstract

Purpose: This study introduces a novel, AI-driven framework for predicting defense project budgets, with a focus on both high performance and interpretability. Our work addresses a critical gap in existing literature, as the application of text regression to defense budget forecasting has not been widely adopted or actively pursued. The primary goal is to provide defense officials with a tool that not only predicts project costs but also offers transparent and justifiable reasoning for its projections, fostering trust and utility in the budget planning process.

Methodology/Approach: We present an end-to-end network based on the Concept Bottleneck Model (CBM), which integrates unstructured text data (e.g., project titles and research items) with a structured numeric variable (project duration). Our approach uses Latent Dirichlet Allocation (LDA) to extract key topics from the text, treating them as "concepts." A CBM is then trained using a pre-trained language model (BERT) to predict these concepts, transforming high-dimensional text embeddings into a low-dimensional, interpretable concept vector. This vector is then combined with the numeric data and passed through a simple linear layer to predict the final budget, ensuring the entire process is transparent.

Findings: The proposed framework successfully created an interpretable linear equation for budget prediction. This model achieved an impressive R2 score of over 85%, demonstrating that our approach does not sacrifice predictive accuracy for transparency. By analyzing the model's coefficients and the core words defining each topic, we can clearly explain the influence of each factor on the final budget, providing a rational basis for financial decisions.

Research Limitation/Implication: While the model was trained on a specific, publicly available dataset, its core implication is significant. This research proves that it's possible to build powerful, high-performing AI systems for public-sector applications without creating a "black-box." Our framework serves as a valuable blueprint for developing trustworthy AI tools in fields where accountability and explainability are paramount.

Originality/Value of Paper: This paper makes a key contribution by pioneering the use of an interpretable AI model for a mission-critical task: defense budget allocation. By leveraging a CBM to connect complex text data to tangible budget outcomes, our work offers a new paradigm that moves beyond traditional numeric-only or non-interpretable methods, providing a robust and trustworthy tool for decision-makers.

Keywords: Explainable AI, Text Regression, Budget Forecasting, Interpretability, Concept Bottleneck Model, Defense Projects

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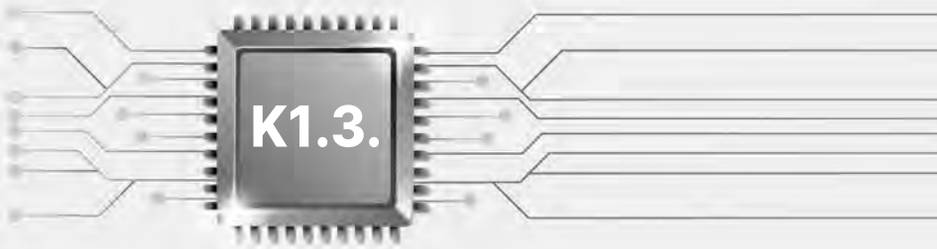

Poster Session I

Chairs: Prof. Yonghan Ju, Korea

P-1	**Jonggyu Song, Kwangkyun Jung, Kyumin Nam, Manki Jung, Jongpil Kang, Korea**	A Study by Technical Documents Review Function of Automated LLM(Large Language Model) Learning Based
P-2	**Kyumin Nam, Kwangkyun Jung, Yonghyun Jou, Manki Jung, Jongpil Kang, Korea**	A Study on the Operational cases of Next-Generation PLM after Introduction
P-3	**Junho Lee, Jungmin Kim, Donghyeon Kim, Bohye Seo, Jaehoon Lim, Korea**	Study on Improving the Abnormal Reboot Phenomenon of Rotorcraft SMFD
P-4	**Eunho Kim, Korea**	A Study on Digital Transformation and Efficiency Improvement of Aerospace Quality Management Based on AS9102
P-5	**Sanghoon Jeong, Korea**	Introduction of Phase-Array Ultrasonic Detection Testing (PAUT) Technology
P-6	**Woojin Lee, Jaeman Son, Korea**	Comprehensive Quality Management in the Mozambique Maputo Gas Pipeline Project
P-7	**Junhyeok Seo, Sungmin Bae, Korea**	Analysis of the impact of the introduction of the Serious Accidents Punishment Act on consumers using PEST-SWOT analysis: Focusing on serious civil accidents
P-8	**Chi-hyeong Park, Seok-ki Hong, Dong-hwan Kim, Hyun-chae Jung, Bo-gil Seo, Hyun-jun Kim, Korea**	Operational-Stage Quality Analysis for Assessing Equipment and Product Aging and Performance Changes, and Optimizing Force Deployment
P-9	**Inkyu Hwang, Hyoungjo Huh, Korea**	Open-Source OCR and On-Premises LLM in the Digital Transformation of Defense Quality Assurance

A Study by Technical Documents Review Function of Automated LLM(Large Language Model) Learning Based

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Abstract

A study presents a process for identifying, correcting, and supplementing errors in technical documents by utilizing data from technical writing guidelines that have been trained through a LLM (Large Language Model) and RAG (Retrieval-Augmented Generation) framework. Furthermore, by conducting a comparative analysis between the content of the technical documents and the established writing guidelines, the research applies learning-based AI technologies to data training, classification, and error detection. In particular, the study verifies the algorithm used by the AI to revise technical documents internally.

A study applies a learning-based AI technology, developed using LLM (Large Language Models) and RAG (Retrieval-Augmented Generation), to an algorithm that compares technical writing guidelines with actual technical documents. Through the learning of comparison cases, the AI system was trained to detect inconsistencies, and the resulting algorithm was implemented and evaluated to verify its effectiveness.

Keywords: AI, LLM, RAG, data training, technical documents

A Study on the Operational cases of Next-Generation PLM after Introduction

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Abstract

PLM(Product Lifecycle Management) systems currently in use across domestic and global manufacturing industries are designed to manage all technical documentation generated throughout the entire product development lifecycle, from R&D to production. In recent years, the scope of development has expanded, leading to more diverse requirements and increased complexity in deliverables. Conversely, development timelines, costs, and available resources are being continuously minimized. In response to these changes and in pursuit of optimized development processes, many companies are either actively operating PLM systems or considering their adoption across development and production phases.

A study presents a cases in which a company enhanced the efficiency of technical document management throughout the entire product lifecycle—from R&D to production—by upgrading its legacy PLM system to a next-generation platform with improved functionalities.

Keywords: PLM, CAD, Process, Dependquality, Development-Product, Digital Twin

Study on Improving the Abnormal Reboot Phenomenon of Rotorcraft SMFD

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Abstract

Purpose: The SMFD (Smart Multi-Function Display) of rotorcraft not only provides mission and flight information to both pilot and co-pilot, but also controls avionics equipment linked to SMFD, making it critical for ensuring flight safety. Accordingly, the SMFD plays a critical role in rotorcraft, making recovery techniques necessary when a malfunction or error is detected. To address this, SMFD promptly restores its functionality via the OFP Reset command upon error detection. However, it was reported that SMFD was abnormally rebooted during flight in the absence of any malfunction or error. This paper aims to analyze the root cause of SMFD's abnormal reboot phenomenon and proposes corresponding techniques.

Methodology/Approach: To analyze the root cause of the abnormal SMFD reboot, the SMFD operation logs at the time of the incident were reviewed. The analysis revealed that the system issued a reboot signal due to a prolonged interruption in the heartbeat communication between internal SMFD boards. Intermittent transmission failures were identified in the existing heartbeat communication implemented via electrical signals between the boards. To address this issue, a method is proposed that supplements the existing single-interface heartbeat logic with a decision-making logic utilizing data communication (IPC-Ethernet).

Findings: Validation through nine fault injection scenarios confirmed the effectiveness of the IPC-Ethernet –based decision logic as a supplementary layer to the existing heartbeat mechanism in maintaining system stability.

Research Limitation/Implication: The proposed method utilizes IPC-Ethernet communication as a supplementary channel, which may be subject to limitations such as network latency, bandwidth constraints, and electromagnetic interference in certain operational environments.

Originality/Value of Paper: This paper presents a novel approach by integrating an IPC-Ethernet–based decision logic as a supplementary layer to the existing single-interface heartbeat communication, addressing the limitations of the conventional method in rotorcraft SMFD systems. The proposed solution significantly enhances communication reliability and system health management, providing a practical and effective means to improve avionics system stability and operational safety.

Keywords: SMFD, Rotorcraft, Abnormal Reboot, Heartbeat, IPC-Ethernet

A Study on Digital Transformation and Efficiency Improvement of Aerospace Quality Management Based on AS9102

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Abstract

Purpose: This study aims to address the growing challenges in aerospace quality management, where AS9102 First Article Inspection Reports (FAIR) generate excessive paperwork due to complex product structures and multi-tier supplier networks. Such inefficiencies not only increase administrative burden but also raise the likelihood of errors. To overcome these issues, the research explores the use of AS9100-based digital systems, including ERP, PLM, and MES, to streamline FAIR preparation and management. Beyond improving efficiency and reliability, the ultimate purpose is to highlight the necessity of transitioning toward Quality 4.0, where paperless processes, data-driven decision-making, and digital integration form the foundation for future aerospace quality assurance.

Methodology/Approach: The research mapped AS9100 clauses with AS9102 requirements to evaluate data linkage feasibility. A system-based FAIR optimization model was developed, including a proposed integrated form combining Forms 1, 2, and 3, and practical examples of system-to-FAIR data mapping were presented.

Findings: The study confirmed the applicability of AS9100 system data to AS9102 FAIR management. This enables a transition from inefficient hardcopy-based processes to digitalized quality management, reducing redundant entries and minimizing human errors.

Research Limitation/Implication: The study mainly focused on the feasibility of system-to-FAIR integration. Broader implementation across organizations and industries requires further validation. Nevertheless, it provides a foundation for advancing toward Quality 4.0 and full paperless transformation.

Originality/Value of Paper: This research proposes a novel approach to digitalizing AS9102 FAIR by utilizing existing AS9100 system data. It contributes to improving both efficiency and accuracy in aerospace quality management, offering a practical pathway toward paperless quality assurance.

Keywords: Quality 4.0, Digital Transformation, AS9100, AS9102, FAIR(First Ariticle Inpection Report), Quality Management System

Introduction of Phase-Array Ultrasonic Detection Testing (PAUT) Technology

A Case study of Integrity Assessment of Liquefied Natural Gas Storage Tanks and Supply Pipes

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Abstract

Purpose: Non-destructive inspection (NDT) is a measurement technique for quality control (assurance) of materials, equipment, and structures, and Radiographic Testing(RT) was mainly applied in domestic power generation, petrochemical, and gas fields. However, due to safety problems such as radiation exposure accidents, the introduction and use of phase array ultrasonic detection tests (PAUTs) is suggested as a solution to Radiographic Testing (RT) in line with strengthening regulations on the Nuclear Safety Act. Accordingly, KOGAS aims to improve the quality control level of gas facilities by conducting PAUT technology standardization research to secure the structural soundness of LNG storage tanks and supply pipes.

Methodology/Approach: A comparative analysis was conducted on the economic feasibility, safety, and reliability of the introduction of phase-array ultrasonic detection tests (PAUTs) compared to existing Radiographic Testing (RTs), and test inspection methods suitable for gas facilities of the corporation were standardized based on international codes such as KGS CODE AC115 and API Standard 620.

Findings: ▪ Non-destructive test comparative analysis: When introducing PAUT, the adequacy was verified as an alternative test method to shorten construction period (cost-effectiveness) by simplifying procedures, securing worker safety against radiation exposure (safety), high-speed detection, and improving defect detection reliability (reliability).

▪ Establishment of a Phase Array Ultrasonic Detection and Inspection (PAUT) system: Establishment of inspection equipment (probe, scanner, exploration equipment), skill test, and inspection procedures (techniques, acceptance standards, etc.) were standardized.

▪ Applying KOGAS storage tanks and supply pipe technology: The soundness of the LNG storage tanks was tested by applying the phase array ultrasonic inspection (PAUT) to the first stage of the construction of the KOGAS Dangjin LNG Receiving Terminal Construction Project (TK#1~4_storage tank), and the same inspection method was applied to the second stage of construction (TK#5~7_storage tank) to gradually replace the radiographic Testing (RT).

Research Limitation/Implication & Originality/Value of Paper: There were cases where the phase array ultrasonic detection test (PAUT) was applied to the domestic natural gas storage tank (Boryeong LNG receiving Terminal), but there were no cases applied to the supply pipe. Based on the results of this study, KOGAS plans to carry out phase-array ultrasonic detection (PAUT) to natural gas NG supply pipes (10% in 26 years, 100% in 30 years) and LNG supply pipes ('10% in 29 years, 50% in 30 years) and apply them to all gas facilities in the future.

Keywords: Non-destructive inspection, integrity test, and quality control of gas facilities

Comprehensive Quality Management in the Mozambique Maputo Gas Pipeline Project

A Case Study of Quality Assurance and Operational Excellence in International Gas Infrastructure

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Abstract

Purpose: This study explores how Korea Gas Corporation (KOGAS) achieved stable and safe natural gas supply in Mozambique—a region with underdeveloped gas quality regulations and challenging local conditions—since 2014. It focuses on the implementation of comprehensive quality management throughout the design, construction, and operational phases of the Maputo Gas Pipeline Project, emphasizing the adaptation of international standards and the development of robust procedures to ensure long-term reliability and safety in an emerging market

Methodology/Approach: A qualitative case study approach was adopted, utilizing primary project documentation, quality assurance procedures, and detailed operational manuals specific to the Maputo project. The analysis encompasses the full project lifecycle, from design to construction and ongoing operations. Special attention is given to the integration of ISO 9001, ISO 14001, and OHSAS 18001 standards, supplier and contractor qualification processes, and the creation of continuous improvement mechanisms.

Findings: Design Phase: International codes (API, ASME, ISO, IEC) were adopted, with local environmental and operational factors reflected in the design. Stringent specifications for gas composition, pressure, and safety were established to compensate for the lack of local regulation. Construction Phase: Strict supplier and contractor qualification was enforced, with local suppliers used only when quality matched international benchmarks. Non-conformities triggered immediate corrective actions, including work stoppages for major deviations. Operation Phase: Comprehensive operating and maintenance procedures were implemented, including regular inspections, preventive maintenance cycles, and emergency response protocols. The system featured real-time monitoring (SCADA/RTU), redundancy in critical equipment, and ongoing training for local staff, ensuring operational safety and reliability. Continuous Improvement: Feedback loops, internal and external audits, and lessons-learned workshops were institutionalized. Performance was measured through non-conformity reports, audit results, and customer surveys, driving ongoing enhancements to the quality management system.

Despite challenges such as language barriers, limited local expertise, and evolving regulations, KOGAS achieved high operational reliability and successful knowledge transfer, setting a benchmark for international gas projects in similar environments.

Research Limitation/Implication: This research is limited to a single, large-scale project, which may restrict the generalizability of its findings. Some operational data remain proprietary. Nevertheless, the case offers valuable insights for practitioners and policymakers on adapting global quality standards to local contexts, and demonstrates the importance of early and sustained investment in quality management for infrastructure projects in developing regions.

Originality/Value of Paper: The paper provides a rare, detailed account of comprehensive quality management in Africa's emerging gas sector, integrating real-world documentation and operational protocols from over a decade of successful operation. It illustrates practical strategies for bridging regulatory gaps and building sustainable, high-quality energy infrastructure in challenging environments.

Keywords: Quality Management, Gas Pipeline, Mozambique, Project Management, Continuous Improvement

Analysis of the impact of the introduction of the Serious Accidents Punishment Act on consumers using PEST-SWOT analysis: Focusing on serious civil accidents

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Abstract

Purpose: The Serious Accident Punishment Act is divided into serious industrial accidents and serious civil accidents. Serious industrial accidents have relatively clear objectives and response measures, and active research has been conducted on them. However, serious civil accidents involve diverse and often small-scale industries, and due to their low occurrence frequency, both public awareness of the relevant laws and academic research remain insufficient. Therefore, this study applies a PEST-SWOT analysis to examine the various impacts of implementing the Serious Accident Punishment Act on consumers, with the aim of supporting the successful establishment and management of serious civil accident prevention and response.

Methodology/Approach: Based on prior research, this study analyzes political (P), economic (E), social (S), and technological (T) factors related to the prevention of serious civil accidents. Subsequently, the PEST factors, as derived through SWOT analysis, are classified into strengths, weaknesses, opportunities, and threats, and strategies are formulated to maximize strengths and opportunities while minimizing weaknesses and threats.

Findings: In summary, the study found that the systematic accumulation and disclosure of Serious Civil Accident cases can enhance consumers' safety awareness and self-regulatory response capabilities, set clear expectations for legal protection, and provide predictable safety management standards. Furthermore, government financial support can bolster corporate safety capacity, while establishing a collaborative response system involving consumers, businesses, and public institutions can help minimize risks.

Research Limitation/Implication: This study did not specifically validate the PEST-SWOT factors derived from previous research, which may limit the generalization and application of the findings. Therefore, future research should conduct in-depth analyses—such as AHP or regression analysis—on the PEST-SWOT factors identified in this study.

Originality/Value of Paper: This study reviewed and analyzed prior research to summarize the impact of implementing the Severe Accident Punishment Act on consumers from a macro-environmental perspective. Furthermore, by categorizing each factor into strengths, weaknesses, opportunities, and threats, the study aimed to provide data to support companies, public institutions, and other stakeholders in establishing effective response systems.

Keywords: Serious Accident Punishment Act, Serious Civil Accidents, PEST, SWOT, PEST-SWOT analysis

Operational-Stage Quality Analysis for Assessing Equipment and Product Aging and Performance Changes, and Optimizing Force Deployment

- Development of a Customized Big Data Tool for Operational-Test Data Analysis Supporting Non-Expert Users

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Abstract

Purpose: During the operational stage of defense industry products, quality analysis is often limited despite the availability of relevant test data, due to a lack of specialized personnel in the military. In contrast, during the mass production stage, quality assessments are performed using manufacturer-owned data and professional expertise. This study aims to overcome such limitations by developing a customized analysis tool that enables non-expert users to reliably and systematically evaluate operational-stage test data.

Methodology/Approach: The developed tool provides basic statistical analyses such as mean, standard deviation, process capability index (Ppk), and Sigma Level calculations, as well as control chart generation (IMR, Xbar-R), histogram and box plot visualization, and time-series trend analysis. It also supports Mean Time Between Failures (MTBF) analysis for equipment reliability assessment, along with hypothesis testing functions including normality tests, mean comparison (paired and independent sample t-tests), and variance analysis (F-test). All functions are designed with an intuitive interface and automated procedures, enabling users with limited statistical knowledge to perform quality analysis with ease.

Findings: Using this tool, non-expert personnel can detect equipment and product aging and performance changes early in the operational stage, and make data-driven decisions on whether to deploy optimal products into service or to refer performance-degraded products for manufacturer repair. Currently, the tool is optimized for the collection and quality analysis of OO missile test data and is planned for operational deployment beginning in 2026. Furthermore, the tool's scalability ensures applicability to various other defense industry products.

Research Limitation/Implication: This study focuses on the development and application of the tool within a specific defense weapon system, and further validation in diverse operational environments and across multiple product categories is required. The design principles of the tool can be extended to non-defense industries experiencing difficulties in quality management due to a shortage of expert personnel.

Originality/Value of Paper: By integrating big-data-based statistical, visualization, and reliability analysis capabilities into a single platform, this tool is designed for use by non-experts, distinguishing it from traditional expert-oriented quality management systems. It addresses manpower limitations in operational-stage quality management and contributes to improved equipment reliability and efficiency in force deployment within the defense sector.

Keywords: Defense Industry, Operational Test Data, Quality Analysis, Normality Test, MTBF Analysis, Non-Expert Tools

Open-Source OCR and On-Premises LLM in the Digital Transformation of Defense Quality Assurance

Advancing Quality 4.0 in Defense Sectors through Automated Document Processing and Knowledge Assistance

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Abstract

Purpose: This study demonstrates a method for the digital transformation of defense quality assurance by combining open-source Optical Character Recognition (OCR) with on-premises Large Language Models (LLMs). The objective is to automate data extraction from military test reports, converting them into accessible and usable digital assets to enhance quality verification workflows.

Methodology/Approach: Our approach involved developing an OCR pipeline to digitize legacy, image-based PDF test reports. The pipeline was fine-tuned on three distinct report formats to accurately process both printed and handwritten text. Extracted data was then structured and stored in a database. Subsequently, we deployed an on-premises LLM with a Retrieval-Augmented Generation (RAG) framework to facilitate interactive querying and knowledge extraction from the newly created digital records.

Findings: The developed OCR pipeline achieved high accuracy for structured printed text and practical accuracy for unstructured handwritten notes detailing test anomalies, confirming the feasibility of digitizing military product test reports. Furthermore, the on-premises LLM integrated with OCR results successfully summarized test data and analyzed past issues to identify potential risks and key inspection points. This demonstrated that the approach can significantly enhance the efficiency of defense quality assurance operations.

Research Limitation/Implication: While the handwriting recognition requires further refinement and the LLM integration is at a pilot stage, this study demonstrates a significant potential to enhance operational efficiency in defense quality assurance. The primary implication is a viable pathway for transforming legacy data into strategic assets, accelerating the adoption of Quality 4.0 in the defense sector.

Originality/Value of Paper: This study provides a practical framework for converting unstructured, legacy defense test reports into structured, queryable data assets. By integrating OCR for both printed and handwritten text with on-premises LLM analysis, our approach unlocks previously inaccessible operational insights and offers a tangible roadmap for digital transformation and Quality 4.0 in the defense industry.

Keywords: Defense Quality Assurance, OCR, Large Language Model, Quality 4.0

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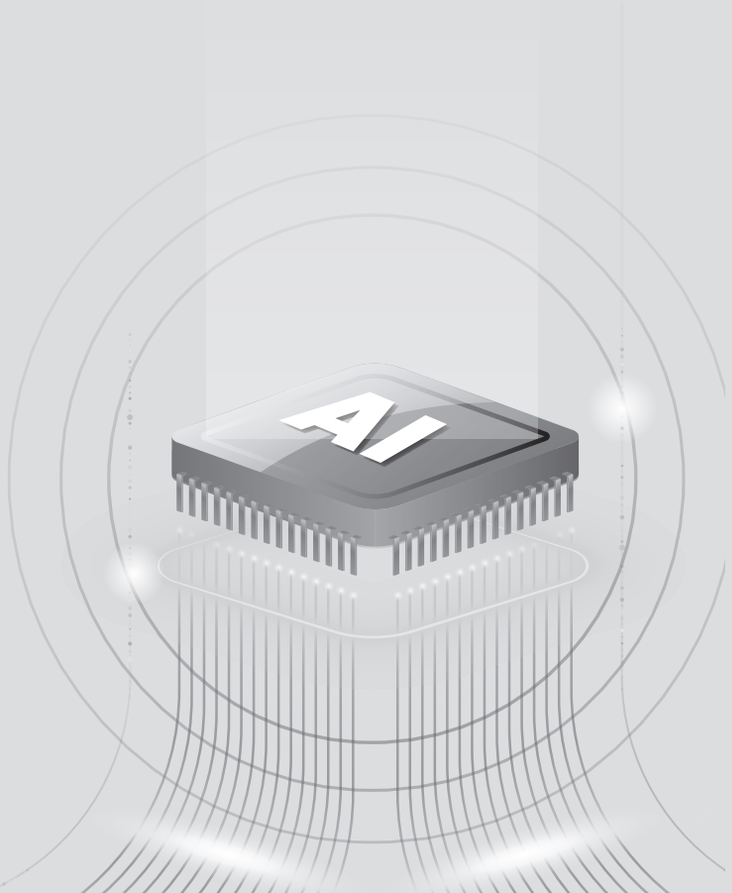
Quality Management in the Age of AI



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Parallel Sessions 2

Lee Youn Jae Hall 5th & 6th Fl.

27th Saturday, 15:45-17:15

QMOD

Q2.1. **/ Room: L505**
Big Data & AI in Quality Management II

Q2.2. **/ Room: L509**
Service Quality & Digitalization

Q2.3. **/ Room: L511**
Continuous Improvement: Lean, Six Sigma & Supply Chain

Q2.4. **/ Room: L604**
Quality in Healthcare & Hospitality I

Q2.5. **/ Room: L614**
AI, Machine Learning & Quality Management II

Q2.6. **/ Room: L615**
Business Excellence, Innovation & Sustainability I

KSQM 1965

KSQM

Room: L503 / K2.1.
Safety, Reliability & Applied Statistics II

Room: L504 / K2.2.
Digital Transformation & R&D Quality

Room: L617 / K2.3.
Poster Session II

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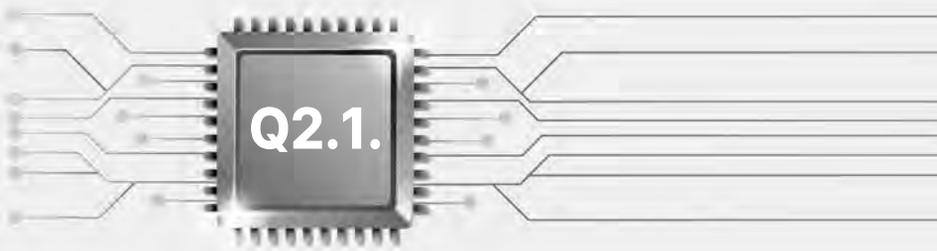

Big Data & AI in Quality Management II

Chairs: Prof. Grégory Bressolles, France

Q2.1.-1	**Soyoung Kim, Jun-sung Park, Youngju Cho, Heejun Park, Korea** Analyzing Battery Technology Trends Using Patent-Based Keyword Network Prediction and Clustering from Patent Analysis to Strategic Insights in R&D Planning
Q2.1.-2	**Younglak Shim, Ki Jung Choi, Jongman Kim, Dohyun Kim, Korea** Latent space oversampling for class imbalance mitigation
Q2.1.-3	**Youngju Cho, Junsung Park, Joonwoo Yoo, Junyoung Yoo, Soyoung Kim, Jiah Hwang, Heejun Park, Korea** Performance Enhancement of Deep Learning Models for Cable Defect Detection in LNG Tank Quality Inspection
Q2.1.-4	**Dogan Efe, Elena Andrushchenko, Turgut Refik Caglar, Roland Jochem, Germany** AI-Driven Failure Management: A Systematic Analysis of Methods, Challenges, and Industrial Integration

Analyzing Battery Technology Trends Using Patent-Based Keyword Network Prediction and Clustering

From Patent Analysis to Strategic Insights in R&D Planning

Soyoung, Kim[1], Jun-sung, Park[2], Youngju Cho[3], Heejun, Park[4*]

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Abstract

Purpose: This study aims to forecast the future development and convergence potential of battery technologies by leveraging patent data. Specifically, it applies a keyword network–based prediction model and clustering techniques to identify key research topics and analyze technology trends within the battery industry. The research provides a quantitative analytical framework that can support research and development (R&D) strategy formulation and industrial decision-making.

Methodology/Approach: A total of 72,258 U.S. battery-related patents, registered or published between January 1, 2000, and December 31, 2024, were collected. Keywords were extracted from the titles and abstracts of each patent, followed by preprocessing steps including stopword removal, lemmatization, and domain-specific filtering. The top 1,000 keywords based on TF-IDF scores were selected to construct a time-windowed keyword co-occurrence network, where nodes represent keywords and edges represent co-occurrence relationships. A supervised link prediction model, primarily logistic regression, was trained on the structure of previous time-window networks to predict the likelihood of future keyword connections. Based on the predicted network, a subgraph of the top 200 most connected nodes was extracted, and Spectral Clustering was applied to identify distinct technology topics.

Findings: The analysis revealed five major clusters representing future battery technology trends: (1) battery materials and components, (2) battery management and control systems, (3) battery pack structures and thermal management, (4) electric vehicle (EV) batteries and charging technologies, and (5) battery recycling and second-life applications. The predicted network comprised 1,000 keyword nodes and 98,331 links, with an average of approximately 197 connections per keyword, indicating a relatively dense structure. This suggests a high degree of interconnectivity among technology elements and strong potential for technological convergence.

Research Limitation/Implication: The study's predictive scope is limited to keywords that have already appeared in prior datasets, which constrains the ability to anticipate entirely new concepts or terms. Additionally, the performance of the machine learning models is sensitive to network configuration and

feature selection, underscoring the need for comparative analyses with different feature sets and model architectures. Future research could incorporate dynamic network structures, transformer-based time-series prediction models, and multimodal patent networks (including inventors, firms, and technology classifications) to enable more comprehensive analyses of technological evolution.

Originality/Value of Paper: This study is among the first to integrate patent-based keyword network prediction with clustering analysis to quantitatively examine future research topics and convergence potential in the battery technology domain. By combining 17 network-based features—including centrality, similarity, and connectivity measures—into edge embeddings and applying Spectral Clustering, the research provides a framework capable of simultaneously assessing both the structural importance of technologies and their potential for future linkage. The methodology offers practical value for industry stakeholders and academic researchers seeking data-driven insights into emerging technology landscapes.

Keywords: Battery Technology, Patent Analysis, Keyword Network, Link Prediction, Spectral Clustering, Technology Forecasting

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This research was supported by Basic Science Research Program through the National Research Foundation of Korea(NRF) funded by the Ministry of Education(No. RS-2024-00464034).

Latent space oversampling for class imbalance mitigation

Younglak Shim, Ki Jung Choi, Jongman Kim, Dohyun Kim

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Abstract

Purpose: This study investigates the use of well-established oversampling methods in the latent feature space of neural networks—rather than the input space—to improve classification performance on imbalanced binary datasets.

Methodology/Approach: Three oversampling techniques (SMOTE, ADASYN, and CTGAN) were applied in both input and latent spaces. Models were trained using a fixed neural architecture with stratified 5-fold cross-validation, and performance was evaluated over 10 repeated experiments.

Findings: Latent-space oversampling consistently outperformed input-space methods on both F1-score and Matthews Correlation Coefficient (MCC). The optimal latent layer for oversampling varied depending on the oversampling technique and dataset.

Research Limitation/Implication: This study was limited to binary classification tasks. Further validation on multi-class datasets is necessary to generalize the findings.

Originality/Value of the Paper: By directly comparing oversampling in the input versus latent feature spaces, this work demonstrates that latent-space oversampling is a more effective strategy for mitigating class imbalance in binary classification.

Keywords: Imbalanced Data Classification, Latent Space Oversampling, SMOTE, ADASYN, CTGAN

Performance Enhancement of Deep Learning Models for Cable Defect Detection in LNG Tank Quality Inspection

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Abstract

In the shipbuilding and offshore plant industry, the importance of automated quality inspection to ensure the safety of Liquefied Natural Gas (LNG) tanks is paramount. This study narrows its focus to the critical subdomain of cable quality inspection, using a specific subset of the publicly available 'LNG Tank Quality Inspection Image Dataset' from AI-Hub. Critical for monitoring systems, power supply, and sensor integrity, cable defects pose a significant risk to the operational safety of LNG tanks. To address the challenge of detecting both known and novel defects, this paper provides a comparative analysis across three deep learning paradigms: supervised classification, unsupervised anomaly detection, and zero-shot learning. Our results establish a clear performance hierarchy. Supervised models like ResNet-18 and EfficientNet-B0 set a near-perfect benchmark on known defects (F1-Score: 0.9967). Among unsupervised methods, embedding-based models significantly outperform reconstruction-based approaches, with PaDiM achieving a remarkable AUROC of 0.9392, demonstrating its strong potential for identifying unseen anomalies without prior labeling. In contrast, a general-purpose zero-shot model like CLIP struggled in this specialized domain (AUROC: 0.2938), highlighting the challenge of domain shift for models that lack specific training. This paper concludes that while supervised methods offer the highest accuracy, modern unsupervised embedding-based models provide a compelling and flexible alternative for developing practical, robust automated quality control systems where exhaustive defect data is unavailable.

Keywords: Shipbuilding Industry, Plant Industry, Quality Inspection, Liquefied Natural Gas, Cable Defect, Vision AI

AI-Driven Failure Management

: A Systematic Analysis of Methods, Challenges, and Industrial Integration

Dogan, Efe[1*], Elena, Andrushchenko[2], Turgut Refik, Caglar[3], Roland, Jochem[4]

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Abstract

Purpose: The integration of Artificial Intelligence (AI) into failure management has been steadily increasing, transforming the way failures are detected, diagnosed, and prevented. By leveraging Machine Learning (ML) and Natural Language Processing (NLP), AI-driven approaches offer significant advantages over conventional failure management methods, enabling automated anomaly detection, predictive maintenance, and real-time failure analysis. However, despite its potential, the adoption of these advanced technologies in failure man-agement remains hindered by challenges such as data scarcity, algorithmic bias, and limited interpretability, which affect reliability and industry acceptance.

Methods: This research systematically examines the role of AI in failure manage ment, focusing on its capabilities, limitations, and future prospects. It evaluates AI-driven failure detection and diagnosis methods against conventional approaches and explores key challenges such as data reliability, model explainability, and industrial integration. Additionally, it ad-dresses ethical and organizational concerns, proposing strategies to mitigate these barriers.

Findings: Aiming to establish a comprehensive framework for AI-driven failure management, this paper identifies research gaps and proposes a structured approach to failure prevention. It provides practical insights for enhancing industrial system reliability, resilience, and performance while outlining a detailed roadmap for integrating AI-driven solutions.

Limitation/Implication: By ensuring the development of efficient, adaptable, and pro active strategies, this research contributes to the advancement of intelligent failure management in modern industrial environments.

Originality/Value of Paper: This research systematically examines AI-driven failure management and provides a structured approach to failure prevention. It offers insights into enhancing reliability, resilience, and performance while addressing key challenges in integrating AI-driven solut ions into industrial environments.

Keywords: Failure Management, Artificial Intelligence, Machine Learning, NLP, Anomaly Detection, Predictive Maintenance

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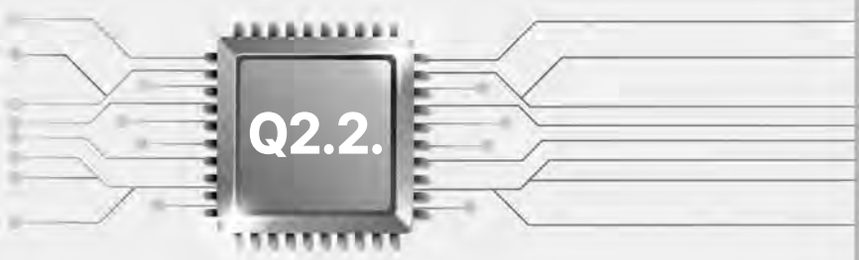

Service Quality & Digitalization

Chairs: Prof. Victoria Rustad Bjerke, Norway

Q2.2.-1 **Hojun Song, Ji Young Yoon, Wan Seon Shin, Korea**

Developing Quality Digital Index based on Machine Learning in Open Quality Era

Q2.2.-2 **Boyoung Lee, Insu Cho, Yonghan Ju, Korea**

A Framework for Selecting Offline Financial Service Branches for the Aging Adults

Q2.2.-3 **Victoria Rustad Bjerke, Barbara Rebecca Mutonyi, Terje Slåtten, Norway**

Linking Leader Humour to Employee Creative Performance: the mediating pathways of Psychological Safety, Humorous Work Climate, and Organizational Commitment

Developing Quality Digital Index based on Machine Learning in Open Quality Era

Hojun, Song[1], Ji Young Yoon[2], Wan Seon Shin[3*]

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[3*] Professor, Sungkyunkwan University, Suwon, 16419, wsshin@skku.edu

Abstract

Purpose: of this study is to develop Quality Digital Index (QDI) which identifies key quality aspects to be measured which significantly contribute to value cre-ation. This paper mainly focuses on providing specific approach for measurability in the Open Quality era.

Methods: This study provides a machine learning-based approach to comprehensively iden-tify the relationship between input aspects and output aspects. Quality is discussed in a process manner in this study in order to derive the most influential quality aspects for value creation. Specifically, causal inference methodology is used.

Findings: This study proposes a Quality Digital Index which identifies key quality measures to be managed which contributes to quality optimization. Specific machine learning model is provided and is adopted in real cases. Real data were utilized for deriving a Quality Digital Index.

Limitation/Implication: This paper mainly focuses on developing Quality Digital Index for Open Quality era. In future research, accuracy of the model can be discussed. Further-more, adopting the model into several industry sectors can be pursued.

Originality/Value of Paper: This paper is unique in that novice methodology for de-veloping quality measures are proposed. This contributes to fulfilling the flexibility of the quality activity, considering the unique characteristics and objectives of each organizations.

Keywords: Quality Digital Index, Open Quality, Machine Learning, Causal Inference, Mea-surability.

A Framework for Selecting Offline Financial Service Branches for the Aging Adults

Boyoung, Lee[1], Insu, Cho[2], Yonghan, Ju[3*]

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[3*] Assistant Professor, Department of Industrial Safety and Management Engineering, Sun Moon University, Sunmoon-ro 221beon-gil, Tangjeong-myeon, Asan-si, Republic of Korea, 31460, juyonghan@sunmoon.ac.kr

Abstract

Purpose: This study aims to develop a framework for selecting optimal offline financial service locations that can serve as physical hubs for older adults and other digitally vulnerable populations. By integrating demographic needs with spatial distribution analysis, the research seeks to address the growing accessibility gap in financial services caused by the decline in physical branches and the increasing reliance on digital platforms.

Methodology/Approach: The research combines spatial data on bank branches and postal financial service points with demographic indicators, such as the proportion of older adults and the proximity of various welfare facilities. A location analysis framework is applied to first identify underserved areas and then refine hub selection based on both accessibility and demographic needs.

Findings: Significant disparities exist in service distribution. Postal branches are more evenly spread but less aligned with areas of high older adult concentration compared to some bank branches. Selected base branches demonstrate that coordinated use of bank and postal networks can improve rural coverage, with accessibility shaped by both proximity and surrounding community infrastructure.

Research Limitations/Implications: The study focuses on one region, so results may differ elsewhere. Operational factors such as transaction volume and service capacity were not included but could affect hub viability. Future work should add these factors, track demand over time, and engage stakeholders for practical implementation.

Originality/Value: This research shifts the focus of financial service location analysis from profitability and operational efficiency toward accessibility, equity, and social welfare. The proposed framework is data-driven yet adaptable, making it applicable to a variety of regional settings. It provides actionable insights for policymakers and financial institutions seeking to enhance financial inclusion for digitally and financially vulnerable groups.

Keywords: Clustering, Aging Adults, Financial Inclusion, Offline Service Accessibility, Hub Selection

Linking Leader Humour to Employee Creative Performance: the mediating pathways of Psychological Safety, Humorous Work Climate, and Organizational Commitment

Victoria Rustad Bjerke[1], Barbara Rebecca Mutonyi[2], Terje Slåtten[1]

[1] University of Inland Norway
[2] Kristiania University of Applied Sciences

Abstract

Purpose: Despite the growth of research on leader humour in the workplace, it is still underexplored, and more so in the context of creative performance. Further, there is limited understanding of how psychological safety can act as an underlying explanation of the leader humour and creative performance relationship. This empirical study has two aims. (i) To investigate whether leader humour can stimulate creative performance, via psychological safety. (2) To identify and empirically measure two sequentially mediating factors that attenuate this relationship, respectively (i) 'humorous work climate' and 'organizational commitment'.

Design/methodology/approach: The study involved 201 employees from different hospitality organizations. Partial Least Square Structural Equation Modelling (PLS-SEM) with SmartPLS 4 was used to analyse and test the suggested conceptual model.

Findings: The findings from this empirical study reveal that: (i) leader humour impacts creative performance, via psychological safety. (ii) Two mediating factors for this relationship is identified: a humorous work climate increases the effect of leader humour on psychological safety, explaining nearly 40% of psychological safety emergence. While organizational commitment positively influences how strongly psychological safety can help stimulate creative performance, with a total effect of about 30% on creative performance.

Research limitations/implications: Creative performance is an attractive skill in work settings. This study indicates that when leaders use humour, it helps create a more humorous work climate and influences psychological safety among employees. All of which seem to provide a beneficial base for ideation and innovation (creative performance). It also suggests that beyond creating safe conditions for exploration, creative performance requires that leaders ensure employees are actively engaged and dedicated. To this end, it seems leaders should take humour seriously.

Originality/value: This empirical study contributes to the emerging, but still limited literature on the impact of leader humour on creative performance, and the role of psychological safety in this relationship.

Keywords: Leader humour, creative performance, psychological safety, humorous work climate, organizational commitment.

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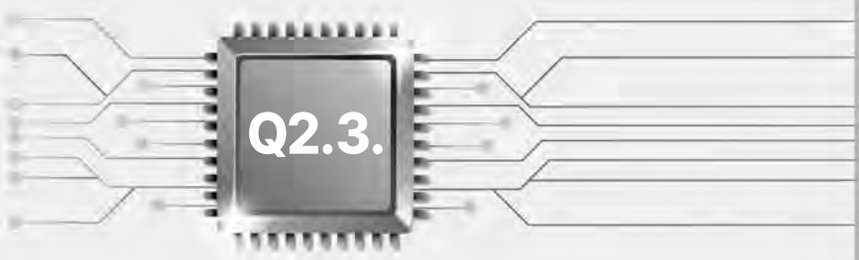

Continuous Improvement: Lean, Six Sigma & Supply Chain

Chairs: Prof. DonHee Lee, Korea

Q2.3.-1	**Roy Andersson, Eduardo Bridi, Per Hilletofth, Rudrajeet Pal, Juliano Endrigo Sordan, Sweden** Improving collaboration by Lean Six Sigma for enabling agile supply chain
Q2.3.-2	**Su Thwe Phyo, DonHee Lee, Sang-Shik Lee, Korea** The Impact of Contract Farming on Sustainable Supply Chain Activities
Q2.3.-3	**Naif Almakayeel, Saudi Arabia** Enhancing Process Efficiency Through the Integration of Lean Manufacturing and Six Sigma: A Data-Driven Approach
Q2.3.-4	**DonHee Lee, EuiBeom Jeong, Korea** Enhancing Supply Chain Resilience through Network Characteristics: A Quality-oriented Approach to Structural Analysis

Improving collaboration by Lean Six Sigma for enabling agile supply chain

- A Swedish multi case study

Roy Andersson[1], Eduardo Bridi[2], Per Hilletofth[3], Rudrajeet Pal[4], Juliano Endrigo Sordan[5]

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Abstract

Purpose: Collaboration is vital to get an integrated supply chain that is agile. The purpose of the study is to investigate whether a combined Lean Six Sigma philosophy can help to improve collaboration to get a more integrated supply chains that is more agile. Supply chain integration is recognized as very difficult to achieve in practice, and use of Lean Six Sigma might help to fulfil this integration.

Design/methodology/approach: Multiple case study, face-to-face interviews and observations on-site in seven large companies, which have a combined Lean Six Sigma philosophy.

Findings: It has been indicated that by using Lean Six Sigma companies will be more agile, design and innovated led in supply chain. However, to achieve greater resilience, companies must involve both suppliers and customers more actively in their internal processes and supply chain, working together to co-design products, develop processes, and address problems and opportunities collaboratively. The next step for these companies should be to engage and collaborate with a broader range of partners across the entire supply chain and consider the full value chain in their strategies.

Originality/value: The paper provides guidance to organizations regarding the applicability and properties of quality philosophies and concepts in logistics. The paper will also serve as a basis for further research in combining Lean and Six Sigma for supply chains to become resilient i.e. become design and innovation-led, adopt agile thinking, cultivate a risk management culture and encourage collaboration.

Keywords: Lean Six Sigma, supply chain, collaboration, supply chain integration, agile

Q2.3. Continuous Improvement: Lean, Six Sigma & Supply Chain Q2.3.-2

The Impact of Contract Farming on Sustainable Supply Chain Activities

Su Thwe Phyo[1], DonHee Lee[2], Sang-Shik Lee[3]

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Abstract

Purpose: This study examines how contract farming influences sustainable supply chain activities by focusing on farmers' capabilities (as production capabilities and quality man-agement capabilities) and farmer-buyer relationships. It also investigates the relationship between farmers' capabilities and their relationships with buyers.

Methods: This study uses a quantitative research design to examine the role of contract farming in promoting sustainable supply chain activities.

Expected Findings: The study is expected to show that information sharing and process coordination within contract farming positively influence farmers' capabilities and farmer-buyer relationships, thereby contributing to the promotion of sustainable supply chain ac-tivities. In addition, farmer capabilities are expected to positively influence the quality of farmer-buyer relationships.

Limitation/Implication: The data for this study were collected in Myanmar. As a result, the findings may not be generalizable to all contract farmers nationwide. Nevertheless, the findings are expected to provide valuable insights for policymakers and agribusiness stake-holders aiming to strengthen farmer engagement in sustainable agricultural supply chains.

Originality/Value of Paper: This study provides a new perspective by examining the contribution of contract farming to sustainable supply chain activities in Myanmar's agri-cultural sector. While previous research has predominantly focused on the social impacts of contract farming, this study contributes to the growing sustainability discussion in the agricultural industry.

Keywords: information sharing, process coordination, farmers' capabilities, farmer-buyer re-lationship, sustainable supply chain activities, contract farming

Enhancing Process Efficiency Through the Integration of Lean Manufacturing and Six Sigma

: A Data-Driven Approach

Naif Almakayeel

Dr., Industrial Engineering Department, King Khalid University, Abha, Saudi Arabia

Abstract

In today's dynamic and highly competitive industrial environment, organizations are con-tinuously seeking innovative methodologies to enhance operational efficiency, reduce waste, and improve product quality. Lean Manufacturing and Six Sigma have emerged as two of the most effective process improvement strategies, each offering distinct but complementary advantages. While Lean focuses on eliminating non-value-added activities and improving flow efficiency, Six Sigma emphasizes reducing variability and defects through data-driven decision-making. The integration of these two methodologies, commonly known as Lean Six Sigma (LSS), provides a structured approach to achieving sustainable process excellence. This study explores the synergistic relationship between Lean and Six Sigma within modern manufacturing and service industries. It delves into the core principles of both methodolo-gies, emphasizing the importance of waste elimination, process standardization, and contin-uous improvement. By analyzing real-world case studies across various sectors, this research identifies key success factors that contribute to the effective implementation of LSS. These include leadership commitment, a data-centric culture, employee engagement, and the use of advanced statistical tools. The study also highlights common barriers to LSS adoption, such as resistance to change, lack of proper training, and insufficient data analytics capabilities. A crucial aspect of this research is the role of Industry 4.0 technologies in enhancing the effec-tiveness of Lean Six Sigma initiatives. The integration of real-time data analytics, Internet of Things (IoT) devices, artificial intelligence, and machine learning enables organizations to monitor processes more accurately, predict inefficiencies, and make informed decisions for continuous optimization. These technologies facilitate predictive maintenance, real-time defect detection, and automated process adjustments, further strengthening the impact of LSS on operational performance.

The findings of this study demonstrate that organizations implementing a well-structured LSS framework experience significant improvements in productivity, cost reduction, and process reliability. By integrating Lean's efficiency-driven philosophy with Six Sigma's rigor-ous statistical approach to quality control, businesses can achieve higher levels of customer satisfaction and gain a competitive edge in the global market. Furthermore, the research underscores the necessity of fostering a culture of continuous improvement, where employees at all levels are actively involved in problem-solving and process enhancement.

Ultimately, this study provides valuable insights into best practices for Lean Six Sigma de-ployment, equipping industry professionals with the knowledge and tools needed to drive measurable improvements. As industries continue to evolve in response to technological advancements and market demands, the adoption of Lean Six Sigma, supported by digital transformation, will remain a key strategy for achieving operational excellence and long-term sustainability.

Enhancing Supply Chain Resilience through Network Characteristics

: A Quality-oriented Approach to Structural Analysis

DonHee Lee[1], EuiBeom Jeong[2]

[1] College of Business Administration, Inha University, Korea
[2] Department of Business Administration, Hanshin University, Korea

Abstract

Purpose: This study explores how fundamental structural characteristics of supply chains—such as centrality measures, clustering coefficients, and alternative resource paths—impact sup-ply chain resilience (SCR) and quality management. Unlike previous research that relies on predefined network typologies (e.g., scale-free, small-world), this study shifts the focus to dynamic, multi- layered network structures to enhance SCR, improve supply chain quality, and strengthen quality management practices.

Methods: The study integrates Bayesian networks with an agent-based modeling (ABM) simulation framework to assess disruption propagation and recovery processes in supply chains. Bayesian networks are used to capture structural dependencies and probabilistic interactions among network components, while ABM simulates how disruptions spread and how the system recovers. This novel methodological approach provides insights into the role of key nodes, inter-layer interactions, and alternative risk propagation paths.

Findings: The research reveals that analyzing core structural properties of supply chain net-works, rather than relying on predefined network typologies, leads to a deeper understanding of SCR. The integration of Bayesian networks and ABM allows for adaptive, data-driven net-work metrics that improve resilience. These findings highlight the importance of key nodes, flexible resource paths, and dynamic interactions in mitigating disruptions and enhancing overall supply chain quality.

Practical Implication: The study provides actionable insights for supply chain managers by demonstrating how structural characteristics can be leveraged to improve resilience and quality management.

Originality/Value of Paper: This study advances SCR research by moving beyond rigid network typologies and introducing a novel integrated approach using Bayesian networks and ABM.

Keywords: Supply chain resilience, Structural characteristics, Quality management.

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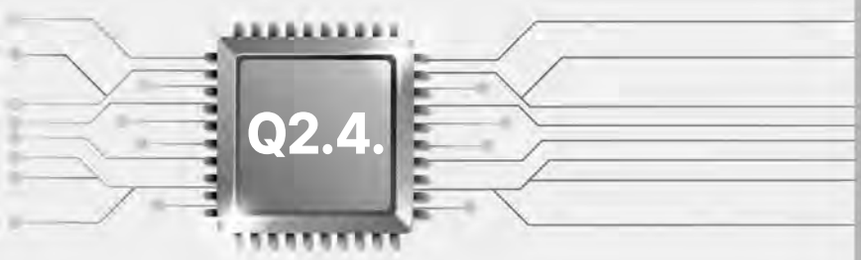

Quality in Healthcare & Hospitality I

Chairs: Prof. Max Christoph Urban, Germany

Q2.4.-1

Wen-Huan Wang, Fareeha Afzal, Alexander Geist, Max Christoph Urban, Germany

AI-Enhanced Pulsed-Wave NMR Device for Point-of-Care Blood Analysis and Market Access Simulation in the Early Development Phase for Risk Improvement

Q2.4.-2

Parisa Afshin, Barbara Rebecca Mutonyi, Erlend Nybakk, Norway

Healthcare Workers' Well-being: Digital Demands and Organisations' Resources

Q2.4.-3

Jiin Hwang, Jongwoo Park, Korea

A Study on the Impact of Cultural Quotient on the Cooperative Behavior; Focusing on Effects of Self-Efficacy and Collective-Efficacy

AI-Enhanced Pulsed-Wave NMR Device for Point-of-Care Blood Analysis and Market Access Simulation in the Early Development Phase for Risk Improvement

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Abstract

Today, clinical methods for assessing blood oxygenation concentration – such as pulse oximetry - rely primarily on indirect, non-invasive optical techniques. In contrast, Nuclear Magnetic Resonance (NMR) spectroscopy offers direct molecular insights into the structure–function relationship of hemoglobin, enabling more precise blood analysis at the point of care (POC). One-dimensional proton NMR (^{1}H NMR) can detect changes caused by oxygenation, such as shifts in the chemical environment, hydrogen bonding, and relaxation properties of key amino acid residues near the heme pocket. While high-field NMR provides this detailed information, its large size, high cost, and need for cryogenic cooling make it unsuitable for point-of-care use. To address these limitations, an academic research group is developing an AI-enhanced pulsed-wave low-field NMR device that is both affordable and specially designed for hemoglobin oxygenation analysis at the point of care. Although low-field systems naturally offer lower spectral resolution than high-field NMR, artificial intelligence will support spectral interpretation by detecting subtle but consistent patterns associated with different oxygenation states and molecular bindings.

Developing AI-based medical devices requires not only technological innovation but also early alignment with regulatory quality and safety requirements. Academic research groups often struggle to incorporate perspectives of industrial product development into their processes. To bridge this gap, a case study investigates a risk-based market access simulation during the early development phase of the AI-powered NMR blood analyser described above. This case study highlights the importance of integrating a comprehensive risk assessment framework early in the development process - alongside market access planning - to identify and mitigate potential technical and translational risks.

This technical research leverages artificial intelligence to overcome the inherent spectral limitations of low-field NMR systems. To achieve this, high-resolution blood sample data will first be meticulously collected using a 60 MHz NMR device. Following detailed data analysis and model development, an AI algorithm will be trained on this dataset and subsequently validated using the newly developed low-field device, with the goal of demonstrating reliable performance in a point-of-care setting. The methodological approach of the case study is based on a comprehensive, risk-oriented framework commonly used in medical technology development. The analysis is structured around distinct risk clusters and follows a

simulated market access pathway. This includes defining the intended use of the device and addressing risk management and regulatory strategies across the development process. A central focus is placed on the continuous integration of risk management throughout the entire lifecycle of the medical device software. Data for this study were gathered through literature research, qualitative observations, structured discussions, and analysis of project documentation.

The paper presents interim results from hemoglobin analysis using deep learning, exploring the potential of artificial intelligence to support spectral interpretation in low-field NMR systems. This approach is intended to lay the groundwork for reliable, point-of-care hemoglobin analysis. Additionally, the paper applies regulatory considerations early in the development of the AI-powered NMR blood analyzer. The study provides a simulated market access strategy, covering technical planning, risk assessment, and alignment with the target user group.

Key words: Medical AI, NMR Blood Analyzer, Product Development, Risk Management, Regulatory Affairs, Quality Assurance

Healthcare Workers' Well-being:
Digital Demands and Organisations' Resources

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Abstract

Digital innovations are rapidly transforming health care, reshaping work practices and exerting both positive and negative effects on employee well-being. To understand how these dual impacts unfold, it is crucial to identify the demands introduced by digital technologies and to evaluate whether key psychological and organizational resources remain effective in addressing them. This study investigates the role of digital innovation support (DIS), autonomy, and resilience in mediating the relationship between digital job demands and well-being outcomes among health care workers.

Data were collected from 292 health care professionals in the United Kingdom using purposive sampling via Prolific. Participants completed a validated quantitative survey, and hypothesized relationships were tested through covariance-based structural equation modeling (CB-SEM) in R 4.4.3.

Findings show that DIS, autonomy, and resilience were positively related to employee well being. Specifically, DIS was positively associated with thriving at work (TAW) ($\beta = 0.169$, $p = 0.016$), while resilience predicted job satisfaction (JS) ($\beta = 0.232$, $p = 0.003$). Digital system overload (DSO) was significantly related to TAW, but digital work overload (DWO) was not directly linked to either TAW or JS. Accordingly, hypotheses H1a, H1b, and H2a were not supported at the 5% significance level. Mediation analysis revealed two significant pathways: DIS mediated the relationship between DSO and JS, and resilience exhibited a complementary mediating effect between DSO and TAW.

The study contributes to health services research by offering a more nuanced understanding of how health care workers experience digital demands in highly digitalized contexts. The results suggest that digital demands may not consistently act as direct stressors but interact with specific resources to shape well-being outcomes. Theoretically, this work extends the Job Demands– Resources (JD-R) model by emphasizing the importance of demand-specific and context-sensitive resources. Practically, the findings highlight the need for targeted organizational investments in support mechanisms that directly address the pressures of digital transformation.

Keywords: Digital innovations, Job demands, Resources, Health care workers, Employee well being

Q2.4. Quality in Healthcare & Hospitality I Q2.4.-3

A Study on the Impact of Cultural Quotient on the Cooperative Behavior:

Focusing on Effects of Self-Efficacy and Collective-Efficacy

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Abstract

In today's increasingly uncertain business environment, cooperative behaviors (CB) have become critical for the survival and growth of organizations. This study empirically investigates the impact of cultural intelligence (CQ) on cooperative behaviors among 266 hospitality service employees at H Hotel, with a focus on the mediating roles of self-efficacy (SE) and collective efficacy (CE). The results indicate that cultural intelligence (CQ) has a positive effect on cooperative behaviors (CB). Moreover, both self-efficacy (SE) and collective efficacy (CE) serve as significant mediators in this relationship. These findings suggest that inherent personality traits and clearly defined roles within the hospitality industry play a crucial role in fostering cooperative behaviors. The study also reveals that high levels of collective efficacy (CE) promote groupthink and collaborative mentality (Janis, 1972). This finding supports the argument of Earley and Ang (2003) that individuals with high cultural intelligence tend to display greater behavioral flexibility and are more inclined to build cooperative relationships. However, the generalizability of these findings is limited due to the sample size being limited to a single hotel brand. Future research should include a more diverse sample and examine additional factors that influence cooperative behaviors, as well as conduct a more thorough analysis of self-efficacy and collective efficacy.

Keywords: Cultural Intelligence (CQ), Cooperative Behaviors (CB), Self-Efficacy (SE), Collective Efficacy (CE), Hospitality Service

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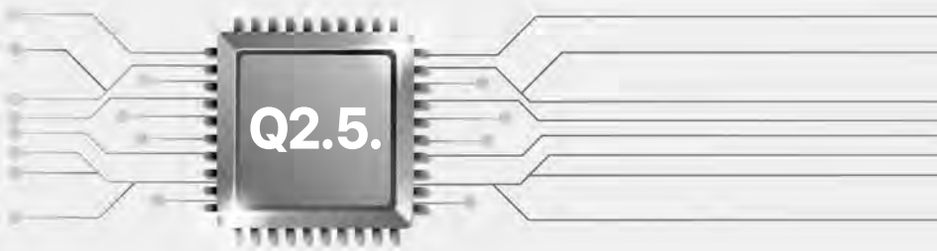

AI, Machine Learning & Quality Management II

Chairs: Prof. Sung Hyun Park, Korea

Q2.5.-1

Sa-Eun Park, Jung-Hwan Hong, Hojin Cho, Chiehyeon Lim, Hyemee Kim, Hyeong-Woo Choi, Jik-Hyun Yoon, Ki-Hun Kim, Korea

Development of a Compounded Rubber Property Prediction Model Based on Integrated Use of Recipe and Mixing Process Sensor Data

Q2.5.-2

Tatjana Nikitina, Tatjana Tambovceva, Latvia

How Artificial Intelligence Can Improve Project Management Practices in the Context of Circular Economy

Q2.5.-3

Tatjana Tambovceva, Regina Veckalne, Tatjana Nikitina, Lilita Abele, Oskars Lescinskis, Diana Bajare, Latvia

Advancing Material Quality and Sustainability through Industrial Symbiosis with Biomass Ash in the Circular Economy

Development of a Compounded Rubber Property Prediction Model Based on Integrated Use of Recipe and Mixing Process Sensor Data

Sa-Eun, Park[1], Jung-Hwan, Hong[2], Hojin, Cho[3], Chiehyeon Lim[4], Hyemee, Kim[5], Hyeong-Woo, Choi[6], Jik-Hyun, Yoon[7], and Ki-Hun, Kim[8*]

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Abstract

Purpose: The rubber mixing process is a critical stage in rubber manufacturing, where multiple raw materials are combined according to a predefined recipe to achieve the desired properties of the compounded rubber. However, the properties are evaluated through physical and chemical tests conducted only after the mixing is complete, and the results are typically available approximately 30 minutes thereafter. Consequently, any quality issues are identified retrospectively, limiting opportunities for timely intervention. To address this limitation, this study proposes a predictive model that can estimate the rubber properties immediately after the mixing process.

Methodology/Approach: The proposed model maximizes its prediction performance with the integrated use of heterogeneous input data that comprises recipe and mixing process sensor data collected during the mixing process. The model comprises data-type-specific encoders and a fusion network. The encoders extract key information from each data type, and the fusion network subsequently integrates this information to predict the compounded rubber properties.

Findings: The proposed model outperformed state-of-the-art benchmarks in the experiments using real-world datasets from a rubber manufacturing company.

Research Limitation/Implication: By predicting the compounded rubber properties immediately after mixing, the proposed model enhances the timeliness of defect detection and process control.

Originality/Value of Paper: This study presents a novel predictive model that integrates recipe data with mixing process sensor data for the accurate and timely estimation of rubber properties.

Keywords: Compounded rubber property prediction, Data fusion, Rubber mixing process, Recipe data, Mixing sensor data

This research was supported by Basic Science Research Program through the National Research Foundation of Korea (NRF) funded by the Ministry of Education (No. RS-2025-25430849), by the National Research Foundation of Korea (NRF) grant funded by the Korea government (MSIT) (No. RS-2023-00218913), and by the National Research Foundation of Korea (NRF) grant funded by the Korea government (RS-2023-00213823).

How Artificial Intelligence Can Improve Project Management Practices in the Context of Circular Economy

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Abstract

Purpose: of this paper is to examine the potential of artificial intelligence (AI) in enhancing quality management within project management, particularly in the con-text of the circular economy. It highlights how AI can address the complexities and multi-stakeholder involvement inherent in circular economy projects by improving decision-making processes, resource allocation, and stakeholder collaboration throughout the project's lifecy-cle.

Methods: This study employs a conceptual approach, reviewing recent literature on the in-tegration of AI in project management practices, particularly for circular economy projects. It explores how AI technologies c an optimize various project stages such as initiation, plan-ning, execution, and monitoring. The analysis focuses on th e role of AI in improving collaboration, decision-making efficiency, and predictive capabilities within these projects.

Findings: The findings reveal that AI technologies significantly enhance project manage-ment in the circular econo my by automating routine tasks, improving forecasting, and streamlining stakeholder communication. AI's predictiv e capabilities help managers better anticipate risks and stakeholder expectations, contributing to more effective susta inability efforts and supporting the circular economy transition. Furthermore, AI aids in bridging competency gaps within project teams by providing tools for real-time analytics, knowledge sharing, and fostering entrepreneurial orie ntation and innovation.

Limitation/Implication: The research is primarily conceptual, and its implications are based on existing studies and theoretical frameworks. A limitation of this approach is the lack of empirical data on real-world applicati ons of AI in circular economy projects. Nonetheless, the study underscores the importance of integrating AI technol ogies into project manage-ment practices to improve decision-making, collaboration, and sustainability outcomes in circular economy contexts.

Originality/Value of Paper: This paper provides an original contribution by focusing on the integration of AI in pr oject management for circular economy projects. It demonstrates how AI can enhance managerial competencies and project outcomes through automation, predictive analytics, and improved stakeholder engagement. This research off ers valuable insights for both academics and practitioners seeking to leverage modern technologies to support the tra nsition to a circular economy.

Keywords: Artificial Intelligence, Project Management, Circular Economy, Open Innovation, Sustainability, Decision-Making

Advancing Material Quality and Sustainability through Industrial Symbiosis with Biomass Ash in the Circular Economy

Tatjana, Tambovceva[1*], Regina, Veckalne[2], Tatjana, Nikitina[3], Lilita, Abele[4], Oskars, Lescinskis[5], and Diana, Bajare[6]

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Abstract

Purpose: This paper explores how industrial symbiosis (IS) can advance both material quality and environmental sustainability by repurposing biomass ash within a circular economy framework. The study focuses on the Liepaja region (Latvia), investigating opportunities to transform ash waste from wood chip-fueled heating systems into high-quality, eco-friendly construction materials.

Methods: A literature review and bibliometric analysis provide the theoretical foundation for understanding IS and its relationship to circular economy principles. Empirical data is collected through surveys and in-depth interviews with key stakeholders in the Liepaja region, including energy providers, cement manufacturers, and local authorities. Geographic mapping is conducted using Python and Open Street Map API to visualize potential IS networks. Financial and economic analyses assess the feasibility and benefits of incorporating recycled biomass ash into material production. Several circular economy business models are evaluated to identify the most effective approach.

Findings: The study identifies significant potential for creating value from biomass ash by integrating it into the local construction sector, improving material quality while reducing environmental impact. IS practices in the region can lead to reduced waste, cost savings, and enhanced resource efficiency. The digital mapping of stakeholders enables strategic planning and fosters collaboration. Multiple circular economy business models are proposed, with the most promising one selected and tailored to regional needs.

Limitation/Implication: The research is region-specific, focusing on Liepaja, which may limit generalizability. Practical implementation could face challenges related to stakeholder coordination and logistical constraints. Nevertheless, the framework and methodology offer valuable guidance for replicating similar IS initiatives in other regions.

Originality/Value of Paper: This paper presents a unique integration of industrial symbiosis and circular economy strategies to enhance both sustainability and product quality. It demonstrates the practical use of digital tools, stakeholder engagement, and economic analysis in developing viable IS systems. The findings contribute original insights into how biomass ash can be transformed from waste into a valuable resource in sustainable construction.

Keywords: Industrial Symbiosis, Circular Economy, Biomass Ash, Sustainable Construction, Innovative Material, Waste-to-Resource

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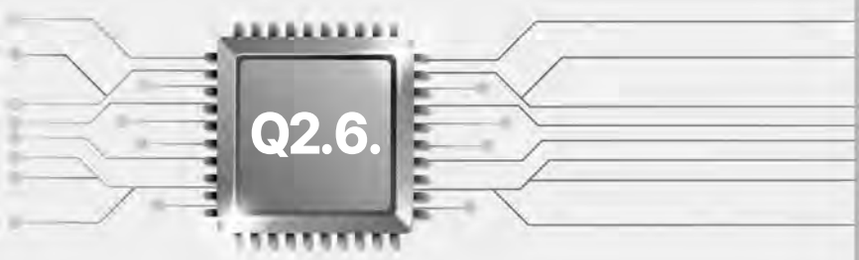

Business Excellence, Innovation & Sustainability I

Chairs: Prof. Davor Labaš, Croatia

Business Excellence Governance Structures and Resource Deployment: Insights from Award-Winning Organizations

Atif Baig and Robin Mann
Centre of Organisational Excellence Research (COER), Massey University, Palmerston North, New Zealand

James Lockhart and Wayne Macpherson
Massey Business School, Massey University, Palmerston North, New Zealand

Abstract

Purpose: The purpose of the study was to examine how organizations design and implement their business excellence (BE) governance structure and deploy resources to implement and sustain excellence.

Methodology/Approach: This study employed an explanatory sequential mixed methods approach, collecting data from 50 organizations across 17 countries with diverse levels of BE maturity. Quantitative survey data were gathered from all organizations, followed by qualitative insights from structured interviews with 20 organizations, constituting 40% of the sample. These interviews provided a deeper exploration of various BE practices.

Findings: The study found that organisations classified as "Leading to World-Class" and "Progressing to BE Mature" more frequently had large, dedicated BE teams, assigned senior leaders as category or criterion leaders responsible for specific BE areas, utilised external consultants for specialised activities, and allocated dedicated financial resources to BE initiatives. Leadership commitment, such as the active involvement of CEOs and senior management, emerged as a critical enabler of effective BE implementation. No universally optimal BE governance structure was identified; however, two dominant governance structures, centralised and decentralised, emerged. A centralized governance structure provides consistency, standardization, and oversight across the organization, whereas a decentralized governance structure enables departmental ownership and organization-wide BE adoption. Additionally, the strategic deployment of external BE resources such as BE consultants, government programmes, and professional networks was found to strengthen internal capabilities and accelerate BE maturity.

Research Limitation/Implication: The lack of prior empirical research on BE governance structures and BE-related resource deployment has limited the ability to build upon previous findings. The present study contributes to addressing this gap and provides a foundation for subsequent investigations.

Originality/Value of Paper: This research provides a distinctive contribution to the BE literature by presenting contemporary, real-world evidence on how leading organizations design and operationalize governance structures and deploy resources to support the implementation of business excellence.

Keywords: Business excellence governance structure, Business excellence resources, Business excellence models, Business excellence implementation, EFQM, MBNQA, Organizational Excellence Architecture

Q2.6. Business Excellence, Innovation & Sustainability I Q2.6.-2

An Empirical Investigation of SWOT Analysis as Strategic Management Tool

: The Aspects of 4P and Business Excellence

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Abstract

Purpose: SWOT analysis is one of the well-known strategic management (SM) tool which was developed at the mid-1960 in the US. According to the literature, this technique is now getting more and more financial focus. Some of the research highlighted the benefits of SWOT analysis by combining with the quality factors/techniques. In particular, the Japanese SM, which is called Hoshin Kanri, shows that quality is a critical factor towards the long-term development in a company. This research then aims to investigate how SWOT analysis as a SM tool influences business outcome when the quality factors/techniques are involved in the business processes.

Methods: The 4P model, which was proposed by Professor Dahlgaard, is used as a con-ceptual model for the investigation of quality factors in this study. The 4P model indicates 'People,' 'Partnership,' 'Process' and 'Product' with 'Leadership' as the foundation of the 4P. The model suggests the awareness of human resources and their role in the organiza-tional context as the basic unit for any organizational improvement activity. The research framework adopts the European Foundation Quality Management (EFQM) business excel-lence model which consists of two parts: 'Enablers' and 'Business Results'. It starts from the Enablers, where SWOT analysis as the SM tool and the 4P with leadership are used to represent the rest of enablers. Business results are divided into two categories: quality results and key performance results. 12 cases, used SWOT as the strategic management tool, are chosen from the database of Malcolm Baldrige National Quality Award (MBNQA) winners as the secondary data sources for this empirical study.

Findings: In light of the analyses conducted in this study, it is found that the 4P with leadership and strategy (SWOT analysis) have a positive influence on not only the quality results, but also the business results. In addition, based on the stepwise regression anal-ysis, it is found that two enablers, 'Strategy' and 'Leadership', are the most influential to the quality and business results, while 'Process' and 'Products/Services' are the two second influential research variables to influence the business results.

Limitation/Implication: The findings derived from this study may imply that excellent business results in a company can be achieved by fullfilling a well-managed strategic plan-ning combining with an appropriate implemetation/deployment of the related quality activ-ities/techniques. However, some

limitations restricted the certainty of the research findings. The limitations include, first of all, the MBNQA winner cases used in this study are all the business excellent cases. Neither the medium nor even the low business performance case is investaged. It probably causes the bias of the research findings. Secondly, the research findings are also restricted by the summay reports which are the secondary data sources obtained from the database of MBNQA website. Thirdly, the evidences and the progress assessments are performed by the research authors. Despite the reliability and validity tests being conducted, it still exists certain degree of uncertainty.

Originality/Value of Paper: This is an empirical study being conducted to investigate how the use of SWOT analysis as the strategic management tool combining with the 4P model, the total quality factors, influences on the business results. Furthermore, instead of the case study method being used in most previous research to investigate the SWOT analysis tool and the quality management, the multiple case method adopted in this study intends to produce a rather generalized research result.

Keywords: SWOT Analysis, Strategic Management, 4P Model, Leadership, Business Excel-lence, Total Quality Management

Q2.6. Business Excellence, Innovation & Sustainability I Q2.6.-3

ASSESSMENT OF CONTEMPORARY TOOLS AND ACTIVITIES FOR EFFECTIVE ORGANIZATIONAL CRISIS PREPAREDNESS

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Abstract

Purpose: Organizations have recently experienced increased risks due to political, technological, social, legislative, and environmental volatility. Accordingly, effective management should strive to enhance crisis prevention and preparedness activities that mitigate risks and strengthen organizational resilience and response capabilities. Modern crises challenge traditional crisis management preparedness approaches and decision-making, ranging from modes of collaboration and application of emerging technologies to needs for real-time information sharing and ways of adequately addressing stakeholders. Hence, this research aims to assess the effectiveness and challenges of modern tools use and provide an overview of activities and approaches that organizations can employ in their contemporary crisis preparedness and resilience-strengthening strategies.

Methodology/Approach: Use of secondary data from relevant scientific and professional sources.

Findings: Proactive communication approach, collaboration, innovation, and digital transformation shape the current effective crisis management.

Research Limitation: Research limitations are in secondary data application and the extent of available, relevant literature.

Originality/ Value of Paper: This research provides insights towards a more comprehensive understanding of crisis preparedness and crisis management literature, as well as provides benefits to organizations by highlighting key trends.

Keywords: organizational crisis preparedness, crisis management, resilience, crisis prevention, risks, crisis management development

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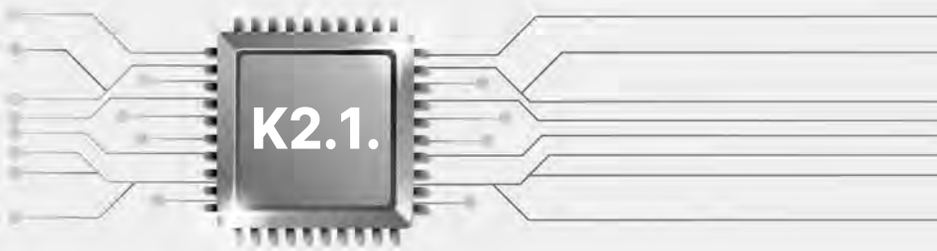

Safety, Reliability & Applied Statistics II

Chairs: Prof. Dongmin Kim, Korea

K2.1.-1 **Young-Jun Hyun, Korea**

Assessing the Relative Importance of Principle and Guidelines for Nuclear Safety Culture using KANO Model

K2.1.-2 **Dongmin Kim, Jinwook Kim, Sanghoon Jeong, Pureun Kim, Jungmin Chae, Korea**

Potential Changes in Natural Gas Quality and Their Impact on Gas Appliances Based on Global Climate Change Policies

K2.1.-3 **Wonjin Kim, Sangmun Shin, Korea**

Derivation of Noise-Robust Optimal Conditions via DoE-Based Small Data Augmentation

Assessing the Relative Importance of Principle and Guidelines for Nuclear Safety Culture using KANO Model

Young-Jun HYUN

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Abstract

Purpose: This study aims to identify the specific indicators having higher relative importance for increasing a nuclear safety culture and to examine their impact in the field of fusion energy.

Methodology/Approach: The level of nuclear safety culture was measured using an evaluation model developed by KHNP (Korea Hydro & Nuclear Power Co., Ltd.). The relative importance of indicators was assessed using KANO model. The relative importance was calculated through Customer Satisfaction Coefficient, which reflects Satisfaction Index (SI) and Dissatisfaction Index (DI) from KANO results.

Findings: This study indicated that specific indicators having higher relative importance have statistically a significant impact on foresting nuclear safety culture.

Research Limitation/Implication: This study used an evaluation model originally designed for fission energy. Therefore, there is a need to identify new elements and develop a model tailored to fusion energy, and to verify its effectiveness through the repeated studies.

Originality/Value of Paper: This study is the first attempt to assess the relative importance of nuclear safety culture in the field nuclear fusion energy.

Keywords: KANO model, Nuclear Safety Culture, ITER Project, Fusion Energy

Potential Changes in Natural Gas Quality and Their Impact on Gas Appliances Based on Global Climate Change Policies

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Abstract

This paper examines the potential changes in natural gas quality, driven by global climate change policies, and their subsequent engineering implications for gas appliances. As the world transitions towards a low-carbon energy mix with the goal of carbon neutrality, the gas grid is projected to incorporate a higher proportion of alternative gas fuels like biogas and hydrogen. This composition change presents significant technical challenges for existing gas systems and appliances, which were originally designed and optimized for conventional natural gas.

Keywords: global climate change, low-carbon energy mix, biogas, hydrogen, natural gas quality

Derivation of Noise-Robust Optimal Conditions via DoE-Based Small Data Augmentation

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Abstract

Purpose: This study aims to develop a method for simultaneously utilizing two robust design experiment formats Combined Array and Inner & Outer Array within a single experiment. Traditionally, each format required separate experiments. However, by employing an AI prediction model, this study aims to obtain data for both formats within a single experiment.

Methodology/Approach: This study proposes a data augmentation technique, DoEMix, which leverages the structural characteristics of design of experiments (DoE) data to generate new experimental points through Mixup-based linear interpolation between adjacent runs. DoEMix increases the quality and diversity of the training dataset, effectively addressing data scarcity issues in regression-based AI prediction models.

Findings: The AI prediction model trained with DoEMix-augmented data demonstrated better performance in predicting missing points for the alternative format compared to models using other augmented datasets. This confirms that both formats can be effectively utilized through a single experiment. In particular, DoEMix contributed to a relative improvement in prediction reliability by enhancing the quality and diversity of the training data.

Research Limitation/Implication: Due to large variations within the experimental data, True Function-based simulation data were used to ensure analytical reliability. Furthermore, this study demonstrates the feasibility of integrating statistical DoE methodologies with AI technologies, expanding the scope and practical value of traditional statistical methods.

Originality/Value of Paper: This research is original in its aim to overcome data scarcity in robust design through the integration of AI techniques. In particular, it differentiates itself by proposing DoEMix, a Mixup-based linear interpolation method that reflects the structural characteristics of DOE data and applies it to regression problems. This methodology efficiently generates training-optimized datasets, predicts missing experimental points, reduces the number of required experiments, and offers tangible value in improving efficiency and reducing costs.

Keywords: Robust Design, Mixup, Data Augmentation Design of Experiments, Combined Array, Inner & Outer Array

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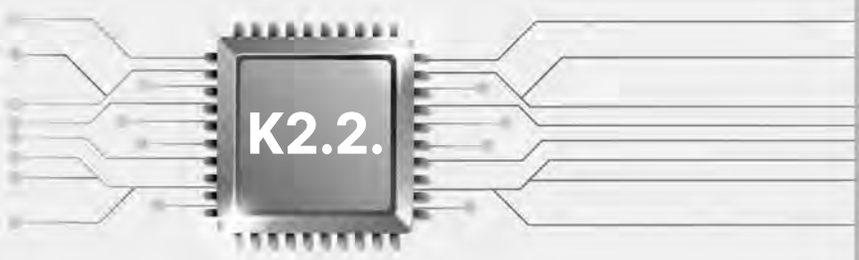

Digital Transformation & R&D Quality

Chairs: Prof. Gye Soo Kim, Korea

Digital Transformation of Food Safety Management

Korea's Smart HACCP and Advanced Traceability Systems in the US and EU

Seo ha, Kim[1], Jin wook, Jeon[2], Seo Yeong Kim[3], and Youn Sung Kim[4*]

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Abstract

Purpose: This study aims to compare and analyze Korea's government-led digital transformation strategy for food safety management through the Smart HACCP system with the advanced technology-based traceability systems adopted in the United States and the European Union (EU). By contrasting the policy-centered domestic approach with the innovation-centered global approach, the research seeks to derive strategic insights for accelerating the digital transformation of the food industry and enhancing global competitiveness.

Methodology/Approach: This study employs desk research based on literature and policy materials, analyzing domestic Smart HACCP implementation cases and leading traceability cases in the United States and the EU. Data were collected and analyzed from policy documents, industry reports, and case study materials across three dimensions: (1) food safety management systems, (2) the scope and level of technology adoption, and (3) governance structures.

Findings: The analysis revealed that Korea's Smart HACCP is being promoted through phased mandatory implementation, government-led pilot projects, SME support policies (incentives, training, etc.), and nationwide expansion efforts. In contrast, the United States and the EU emphasize rapid integration of advanced technologies such as AI, big data, IoT, and blockchain, driven by private sector innovation. The United States adopts a governance model based on public-private partnerships that combines preventive management with real-time supply chain control, while the EU implements comprehensive, legally mandated traceability across the entire product life cycle and integrates environmental and sustainability policies.

Research Limitation/Implication: The study emphasizes that Korea's government-led support system effectively promotes the digital transformation of the domestic food industry and highlights the need to explore ways to internalize the technological innovation elements seen in overseas cases. It also suggests that global companies can benefit from Korea's policy- and government-guaranteed approach to food safety management.

Originality/Value of Paper: This study directly compares Korea's policy-driven Smart HACCP model with the technology-driven traceability systems of the United States and the European Union, identifying their complementary strengths. Based on these findings, it provides actionable recommendations for policymakers and industry leaders on designing a hybrid model that balances governance stability with the speed of technological innovation. Such a model can serve as a strategic blueprint for achieving both robust food safety governance and rapid technological advancement.

Keywords: Smart HACCP_1, Food Safety Management_2, Digital Transformation_3, Traceability_4, Quality 4.0_5

A Study on The Rapid Requirement R&D Processes to Improve K-Defense Quality Competitiveness

Won Bum Seo[1], Jin Gu Heo[2], and Gye Soo, Kim[3*]

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Abstract

Purpose: The importance of national defense cannot be overemphasized. The need for AI and new technologies in the development of new military weapons is increasing day by day. In the military sector, rapid response to the demands of both military and foreign arms importers is key to competitiveness. This study aims to examine the challenges of existing weapons development processes and develop a rapid R&D process capable of responding to a rapidly changing environment. To achieve this, we will study R&D cases from benchmarking countries, identify rapid new product development initiatives in the private sector, and propose a hybrid model.

Methodology/Approach: This study examines rapid R&D practices in the United States and the United Kingdom. It also explains Advanced Product Quality Planning (APQP), agile methods, concurrent engineering, and the Spiral method, which are frequently used in the private sector, and proposes a hybrid R&D model that applies these methods.

Findings: The military new product development process can involve conflicts of interest among various stakeholders, so the decision-maker's vision, firm decision-making ability, responsibility, communication skills, and empathy are crucial.

Research Limitation/Implication: The hybrid model proposed in this study remains at the proposal level and cannot be applied to the development of new military products. Therefore, it is necessary to actively incorporate the opinions of each military branch and make improvements during the actual new product development process.

Originality/Value of Paper: As the growing importance of national security and growing interest in K-defense, this study will provide unique ideas for shortening the military new product development process.

Keywords: Rapid R&D Process, APQP, Agile Methods, Concurrent Engineering, Hybrid Model

K2.2. Digital Transformation & R&D Quality K2.2.-3

Digital twin design that combines virtual engine and AI algorithm based DoE

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Abstract

Purpose: This study addresses the challenges of conducting experiments that are difficult to implement in reality due to their extensive scope, high costs, and safety risks. This research aims to develop a novel virtual experiment environment (Digital Twin) by integrating a virtual engine with AI-based methodologies. The primary goal is to leverage this environment to generate virtual experimental data, enabling robust process optimization through AI-driven Response Surface Methodology (RSM) in scenarios where physical experimentation is impractical.

Methodology/Approach: The research methodology involves several key steps. First, a virtual experiment environment replicating a real process is constructed using Unity. Second, an AI model, primarily focusing on XGBoost, is trained with minimal actual DoE data. Third, a user interface (UI) is developed to allow users to select an AI model and generate AI-predicted data for RSM. Finally, the trained AI model is used to generate a comprehensive virtual dataset for RSM, which is then applied to find the optimal process conditions without the need for extensive physical trials.

Findings: study aims to successfully establish a virtual environment where practitioners can test various scenarios and variables using an AI model trained on real-world data. This will allow for the proactive assessment of risks associated with process variations and the analysis of virtual experimental data, enabling process optimization through RSM using this data. Furthermore, the study will demonstrate a viable method for generating large-scale data, which will resolve the issue of data insufficiency for training robust AI models and suggest a pathway for enhancing their predictive performance.

Research Limitation/Implication: This study aims to successfully establish a virtual environment where an AI model, trained on limited real-world data, can generate extensive and reliable data for process analysis. A key outcome will be the demonstration of process optimization performed through RSM using this AI-generated virtual experiment data. This approach provides a viable pathway to enhance process efficiency and product quality, effectively overcoming the limitations of physical data collection.

Originality/Value of Paper: The originality of this paper lies in its novel integration of virtual engine technology with AI-driven optimization techniques. By creating an environment where AI models generate virtual data specifically for RSM-based optimization, this study offers a unique solution to the persistent challenges of cost and safety in industrial experimentation. It provides significant value by improving the reliability of process analysis and offering a tangible, data-driven tool for industrial practitioners.

Keywords: Design of Experiment, Digital Twin, Machine Learning, Artificial Intelligence, Statistics, XGBoost, Process Optimization, Response Surface Methodology

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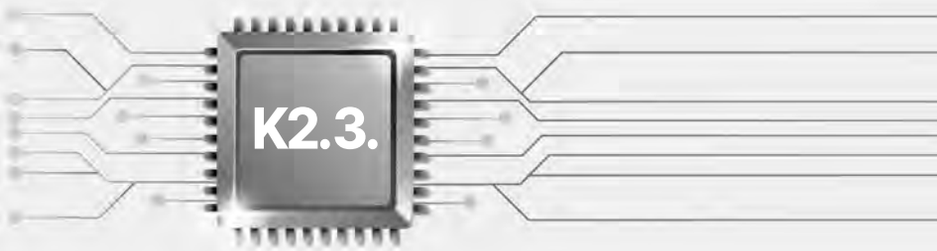

Poster Session II

Chairs: Prof. Seungbeom Kim, Korea

P-1	**Donghyeon Kim, Junho Lee, Korea** Quality Improvement of Helicopter Air Data Systems through Redundancy Optimization
P-2	**Hyoungjo Huh, Inkyu Hwang, Seung Hyun Baek, Korea** A Study on the Intelligent Integrated Quality Improvement Methodology
P-3	**YungChul Yoo, SungHoon Hong, Korea** Study on accelerated test method comparison for electric cable insulator
P-4	**YoungJin Son, SungMin Bae, Korea** A Study on the Optimization of Product Design Strategies Based on the Specification Design Index (SDI)
P-5	**Soonwoo Park, Seongdon Hong, Yeong Hyeon Kim, Dahoon Lim, Jun Su Kim, Korea** Stockpile Reliability Program Models for Missile Systems: Insight from Case Studies of Multinational Stockpile Reliability Activities
P-6	**Dae Yun Kim, Min Seo Park, Seo Young Kim, Youn Sung Kim, Korea** Exploring Service Quality, Customer Satisfaction, and Participation Factors among Youth Space Program Users through IDI
P-7	**Yeong Hyeon Kim, Seong Don Hong, Soonwoo Park, Da Hoon Lim,Yong Soo Kim, Korea** Integrated Big Data Analysis and Machine Learning-Based Approach for Guided Missile ASRP
P-8	**Seongdon Hong, Soonwoo Park, Yeonghyeon Kim, Dahoon Lim, Korea** Proposal for the Development of the Ammunition Stockpile Reliability Program (ASRP) for Guided Missile from the Perspective of Total Life Cycle System Management (TLCSM)
P-9	**Dahoon Lim, Yeong Hyeon Kim, Soonwoo Park, Seongdon Hong, Korea** Advancement of the guided missile ASRP through the application of a continuous probability distribution

Quality Improvement of Helicopter Air Data Systems through Redundancy Optimization

A Study on Preventing of Pitot Heat Fail

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Abstract

Purpose: The Air Data System (ADS) measures atmospheric parameters around the helicopter and provides the pilot with critical flight information such as airspeed, altitude, and outside air temperature. The accuracy of these measurements is directly linked to flight safety; therefore, any malfunction in the ADS must be identified and eliminated in advance.

Methodology/Approach: Potential malfunctions in the ADS were systematically identified in advance by applying Fault Tree Analysis (FTA) and the Fishbone diagram method.

Findings: While certain avionics systems are partially redundant to enhance flight safety, it was found that when the Air Data Computer 2 (ADC2) power supply is interrupted, the SMFD (Smart Multi-Function Display) incorrectly indicates a 'Norm' Pitot status and the CWP (Caution Warning Panel) caution lights remain extinguished while real status of Pitot was 'Fail'.

Research Limitation/Implication: This condition could lead to a situation where the pitot tube is non-functional without the pilot's awareness, potentially resulting in reliance on incorrect flight data and increasing the risk of a helicopter accident.

Originality/Value of Paper: A redundancy approach was adopted whereby the Air Data Computer 1 (ADC1) power supply is utilized to continue displaying accurate system status to the pilot even in the event of ADC2 power loss. This enhancement enables pilots to accurately recognize and respond to abnormal conditions, thereby contributing to improved flight safety.

Keywords: Rotorcraft, Air Data Computer, Automatic Flight Control System, Remote Data Concentrator, Caution Warning Panel, Smart Multi-Function Display

A Study on the Intelligent Integrated Quality Improvement Methodology

Augmenting the SVT (Six Sigma-VE-TRIZ) Methodology: A Next-Generation Approach to Integrated Quality Improvement Using AI

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Abstract

Purpose: The purpose of this study is to propose a practical methodology that enhances the quality improvement of defense systems by integrating Artificial Intelligence (AI) into established quality management frameworks.

Methodology/Approach: This study establishes a novel framework, "AI-SVT," which augments the Lean Six Sigma DMAIC process. Drawing on a systematic analysis of AI's evolutionary trends, this framework integrates AI-powered applications of Value Engineering (VE), TRIZ, and other Quality Control (QC) tools into the core methodology.

Findings: The proposed AI-SVT framework provides a step-by-step procedure based on the DMAIC lifecycle, where each phase is augmented by AI. At specific stages, AI-driven VE and TRIZ modules are systematically integrated to deepen value analysis and accelerate creative problem-solving. The framework's primary contribution is a new blueprint for a quality system that maximizes the speed, depth, and creativity of the improvement process.

Research Limitation/Implication: This study proposes a conceptual framework; therefore, its practical effectiveness requires validation through future case studies and quantitative assessments in industrial settings. Subsequent research should also address the challenges of establishing the necessary data infrastructure and enhancing organizational capabilities for its implementation.

Originality/Value of Paper: The originality of this paper lies in its systematic analysis of technological evolution to define a new quality paradigm for the AI era. It proposes the "AI-SVT" framework, which transforms the robust, yet conventional, SVT methodology into an intelligent, AI-powered solution. By providing a clear blueprint for integrating these advanced technologies, this study offers a practical guide to maximizing the speed, depth, and creativity of problem-solving in modern defense industry quality management.

Keywords: Defense Quality Improvement, AI, Lean Six Sigma, TRIZ, Value Engineering, AI-SVT

Study on accelerated test method comparison for electric cable insulator

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Abstract

Accelerated testing is used to rapidly predict the lifetime of electric cables. Accelerated testing is conducted under conditions more severe than the stress conditions of the typical service environment. The component that most significantly impacts the lifetime of a cable is the insulator, and its main failure modes are hardening and cracking due to thermal aging. Therefore, the accelerated model applies the Arrhenius model, which is appropriate for thermal stress. The failure criterion for insulators is when the elongation of the insulator is less than 100%.

This study compares the advantages and disadvantages of the currently used accelerated life test based on the IEC 60216 series and the newly developed accelerated degradation test. Accelerated degradation test uses a degradation model that represents performance changes over time measured under various accelerated stress conditions to estimate the time to failure and then predict the lifetime using the life-stress model. Accelerated degradation test may reduce the test time for cable lifetime prediction compared to existing accelerated life testing.

Keywords: Electric Cable, Insulator, Accelerated Life Test, Accelerated Degradation Test

A Study on the Optimization of Product Design Strategies Based on the Specification Design Index (SDI)

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[2*] Department of Industrial & Management Engineering, Hanbat National University, Daejeon, Korea

Abstract

Purpose: This study aims to systematically address the inherent structural complexity in non-standard product design processes of small and medium-sized enterprises (SMEs). To achieve this, a Specification Design Index (SDI) was developed that integrates measures of both design difficulty and design complexity. The SDI enables the early estimation of task difficulty in similar projects and provides an objective basis for resource allocation and schedule planning, thereby facilitating improvements in design quality and productivity.

Methods: This study analyzed 297 cases of non-standard product designs collected from SMEs. The SDI was constructed from eight key variables, including the number of components, development requirements, frequency of design changes, customer interactions, and drawing reusability. Each variable was normalized to a [0,1] scale, and weights were derived using the Analytic Hierarchy Process (AHP). The SDI was then calculated through a weighted linear combination of these variables.

Results: Empirical analysis confirmed that higher SDI values were associated with increased design time and cost, thereby validating its effectiveness as a quantitative indicator of design difficulty. Furthermore, the SDI facilitated the strategic classification of design approaches into Sequential Engineering Design (SED) and Concurrent Engineering Design (CED), thereby enhancing the efficiency of resource distribution and project scheduling.

Conclusion: The proposed SDI provides a pragmatic decision-making tool for SMEs by quantitatively evaluating design difficulty and supporting the selection of appropriate design strategies. Future research will expand the applicability of the SDI to diverse industries and further investigate its statistical relationship with design performance indicators to strengthen its generalizability and effectiveness.

Keywords: Concurrent Engineering Design (CED), Sequential Engineering Design (SED), Design Time Analysis, Design Optimization, Design Productivity

Stockpile Reliability Program Models for Missile Systems: Insight from Case Studies of Multinational Stockpile Reliability Activities

Soonwoo Park[1*], Seongdon Hong[1], Yeong Hyeon Kim[1], Dahoon Lim[1], Jun Su Kim[1]

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Abstract

Purpose: Missiles are unique weapon systems that remain in long-term storage for most of their lifetime and are ultimately used only once during an operational mission. Due to this one-shot nature, ensuring their stockpile reliability requires a management approach distinct from other weapon systems. From this perspective, the Ammunition Stockpile Reliability Program (ASRP) provides a key framework for monitoring and maintaining missile stockpile reliability throughout the storage time. This study analyzes various case studies on guided missile stockpile reliability management activities and proposes practical program models based on these analyses.

Methodology/Approach: This study reviews and analyzes diverse regulations, procedures, and prior research to identify activities aimed at ensuring guided missile stockpile reliability. Based on findings, several program models are proposed and categorized according to management objectives and target systems

Findings: Activities for verifying and managing guided missile stockpile reliability include (1) destructive component testing for performance evaluation, (2) periodic inspections to monitor storage conditions and system status, and (3) sample firing tests and operational training records. Depending on the activities' combination and technical sophistication, several program models are established, each designed to address specific reliability objectives and operational needs.

Research Limitation/Implication: This study analyzed and modeled structural activities of reliability management programs based on case studies and regulations. However, practical implementation requires further analysis of each model's overall effectiveness, including cost-efficiency and impacts stemming from sustainment procedures and interactions with other projects, such as demilitarization and performance upgrades, from a total life cycle perspective.

Originality/Value of Paper: This study investigates and categorizes reliability management programs and research cases of guided missiles from various militaries and countries. Based on these analyses, several program models tailored to weapon system characteristics are proposed, providing a structured framework for enhancing missile stockpile reliability management.

Keywords: Missile Stockpile reliability program, ASRP, TLCSM, reliability management program

Exploring Service Quality, Customer Satisfaction, and Participation Factors among Youth Space Program Users through IDI

Focusing on 'UU Camp' of Bupyeong, Incheon

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Abstract

Purpose: Recently, interest in supporting young people in Korea has grown significantly due to increasing challenges in economic stability, employment, and housing. This has led to the implementation of diverse policies and support programs. In line with this trend, cities in South Korea have been operating youth spaces as a public support projects; however, improving user participation remains a challenge. This study aims to analyze service quality factors of youth space programs, along with user-perceived service quality and satisfaction focusing on a single facility.

Methodology/Approach: Based on a review of prior studies on public service provision, space rental services, and the characteristics of young users, a set of interview questions was developed. Individual Depth Interviews (IDIs) were conducted with users and operators/staff members from a single center.

Findings: The anticipated results of this study include: (1) identification of key service quality factors in youth space support programs, (2) analysis of user-perceived satisfaction and dissatisfaction factors, and (3) implications for service improvement.

Research Limitation/Implication: Due to the nature of IDI, focusing on a single center as well as the small sample size limits the generalizability of the findings. By qualitatively analyzing the service quality of public youth services in Korea, this study is expected to contribute to policy refinement and the development of effective operational strategies. Future research will expand to empirical research including all 'youth spaces' in the Incheon area through empirical analysis.

Originality/Value of Paper: While there is limitation of prior research on public service for youth, this paper can suggest academic foundation for future research and practical implications for improving user satisfaction in youth support project or program.

Keywords: Youth Space, Public Service Quality, Customer Satisfaction, Youth Support Programs, IDI

Integrated Big Data Analysis and Machine Learning-Based Approach for Guided Missile ASRP

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Abstract

Purpose: This study aims to develop and validate degradation prediction and fault classification models for man-portable surface-to-air guided missiles by applying machine learning techniques based on the BigData-driven integrated ASRP management framework.

Methodology/Approach: Integrated analysis was performed using machine learning techniques with production quality data and operation/maintenance data. For parameters showing minimal differences between pass and fail data, Principal Component Analysis (PCA) was applied for feature extraction. Various machine learning algorithms were implemented and validate the performance of fault classification and operational month prediction models.

Findings: The application of machine learning models demonstrated that PCA-based dimensionality reduction can positively enhance fault classification performance. Additionally prediction models were constructed based on monthly operational data accumulated over X years

Research Limitation/Implication: Future work requires data acquisition under diverse environmental conditions and operational scenarios, along with ensuring model interpretability and reliability.

Originality/Value of Paper: This study proposes an integrated analytical approach by fusing production quality data with operation and maintenance data. Additionally, PCA-based fault prediction models were applied. These techniques are expected to support more reliable predictions in analyzing the stockpile reliability of guided missiles.

Keywords: Guided Missile, ASRP, BigData, Machine Learning, PCA anlsysis

Proposal for the Development of the Ammunition Stockpile Reliability Program (ASRP) for Guided Missile from the Perspective of Total Life Cycle System Management (TLCSM)

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Abstract

Purpose: The Ammunition Stockpile Reliability Program (ASRP) for guided missiles—representative one-shot weapon systems—has traditionally focused on ensuring combat readiness from a safety perspective during the operation and maintenance phase. However, in order to enhance the sustainability and readiness of such systems, there is a pressing need to adopt a Total Life Cycle Systems Management (TLCSM) approach that encompasses all life-cycle phases from development to disposal.

Methodology/Approach: This study performs a comparative analysis between the procedural framework of TLCSM and the current ASRP implementation processes for guided missiles. Based on this analysis, development directions for a Life Cycle Sustainment Plan (LCSP) are proposed, with emphasis on its role as an integrated planning document for system support and systematic management.

Findings: To achieve the overarching TLCSM objectives, it is essential to (1) revise and strengthen regulatory frameworks governing LCSP formulation and execution, and (2) establish a comprehensive and continuous data collection and feedback system. Such measures will enable proactive sustainment planning, improve reliability assessment accuracy, and enhance decision-making across the weapon system life cycle.

Research Limitation/Implication: Given the inherent operational nature of one-shot weapon systems, empirical datasets are significantly limited compared to reusable weapon systems, posing constraints on statistical analysis and predictive reliability modeling. Overcoming these limitations requires institutional measures aimed at policy and regulatory changes to expand data acquisition and implement long-term monitoring programs.

Originality/Value of Paper: This paper contributes to advancing guided missile sustainment by shifting the ASRP paradigm from an operation and maintenance-centered model to TLCSM-based framework, thereby integrating safety, reliability, and sustainment considerations into a cohesive life-cycle management strategy.

Keywords: Guided Missile, ASRP, TLCSM, LCSP, weapon system

Advancement of the guided missile ASRP through the application of a continuous probability distribution

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Abstract

Purpose: The domestic guided missile ASRP(Ammunition Stockpile Reliability Program) evaluates the reliability of the component units, but system reliability calculations are limited. This study aims to derive system-level reliability by improving the method of evaluating component unit reliability.

Methodology/Approach: The reliability of the current component unit is evaluated based on the discrete probability distribution (binary distribution), and the test results are divided into qualitative methods (pass/fail). In this study, the reliability analysis method based on the continuous probability distribution (normal distribution, etc.) is applied to estimate the reliability of the component unit. Then, the reliability of the component unit is combined to derive the reliability of the system unit.

Findings: If the population mean is estimated by applying the confidence level after confirming the normality of the test data, the current confidence estimate of the component population can be derived by comparing it to the failure criterion. Additionally, the reliability of the parent system can be derived from the estimation reliability of several components.

Research Limitation/Implication: Since there are multiple failure criteria within a component, different reliabilities are calculated for each failure. Additional consideration is needed on how to reasonably combine these into component unit reliability.

Originality/Value of Paper: This study suggests ways to improve the guided missile ASRP evaluation method. If the methodology is slightly improved to reflect the reality and applied in practice, it is expected to preserve military combat power and improve military safety and readiness.

Keywords: Guided Missile, ASRP, Continuous Probability Distribution, System-Level Reliability

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Parallel Sessions 3

4th Engineering Hall 5th Fl.

28th Sunday, 11:00-12:30

QMOD

Q3.1. **/ Room: D502**
Quality Management Systems & Supply Chain Management

Q3.2. **/ Room: D503**
Business Excellence, Innovation & Sustainability II

Q3.3. **/ Room: D504**
Quality in Healthcare & Hospitality II

Q3.4. **/ Room: D507**
Benchmarking & Best Practices in Quality Management

Q3.5. **/ Room: D508**
Performance Management & Organizational Excellence II

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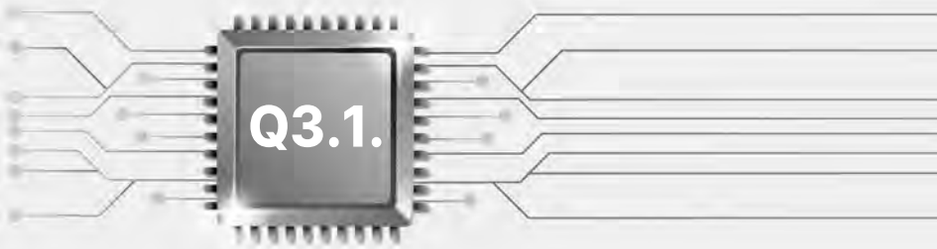

Quality Management Systems & Supply Chain Management

Chairs: Prof. Wen-Huan Wang, Germany

Graph Neural Imputation Method to Mitigate Information Loss in Reduced Semiconductor Wafer Probe Testing

Min-Kun, Shin[1], Sa-Eun, Park[2], Young-Mok, Bae[3,4*], Seung-Hyun, Choi[5], Ki-Hun, Kim[6*]

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Abstract

Purpose: Wafer probe testing (WPT) detects defective chips in a wafer by performing dozens of subtests on each chip, with each subtest measuring multiple parameters. To reduce the costs of WPT, semiconductor manufacturers employ chip-sampling-based test reduction (TR), in which only sampled chips undergo full testing while others skip certain subtests. This produces unsampled subtest parameters (USPs) that increase test-escape risk and degrade wafer quality analytics. In WPT data, a target chip in a wafer tends to have similar parameter measurements to those of its spatially adjacent chips (or neighbors) in the wafer since adjacent chips in a wafer undergo nearly identical process conditions. This target–neighbor correlation (TNC) is likely to enhance the USP imputation performance, but existing methods do not utilize it. This study proposes *TestImputer*, a graph neural network (GNN) that explicitly incorporates TNC for accurate USP imputation.

Methodology/Approach: Firstly, *TestImputer* converts tabular WPT data into a bipartite graph consisting of two types of nodes, representing chips in a wafer and subtest parameters, respectively. The measurement of a given chip on a specific subtest parameter is assigned to the edge connecting the corresponding chip node and the subtest-parameter node in the graph. Secondly, each chip node is connected to its neighbor nodes via additional edges, which are weighted according to each neighbor's contribution to the USP imputation. Together, the graph explicitly incorporates the complete set of parameter measurements and the test neighborhood correlation (TNC)—two key sources of information for USP imputation. By leveraging this graph, *TestImputer* ensures that both sources are effectively utilized in the imputation.

Findings: On real-world WPT data, *TestImputer* outperformed state-of-the-art methods with 25%, 50%, and up to 75% unsampled chips.

Research Limitation/Implication: The current implementation assumes a chip-sampling-based TR strategy in which the same subsets are skipped for all unsampled chips. Adapting *TestImputer* to heterogeneous TR schemes, where omitted subtests vary by chip, wafer lot, or product line, is a promising extension for broader applicability.

Originality/Value of Paper: This study proposes a novel GNN-based method that leverages two key sources of information to accurately impute USPs. This method is expected to contribute to lowering WPT durations and testing costs while preserving the completeness of WPT data.

Keywords: Semiconductor manufacturing, Wafer probe testing, Test reduction, Imputation, Graph neural network

This research was supported by Basic Science Research Program through the National Research Foundation of Korea (NRF) funded by the Ministry of Education (No. RS-2024-00463754), by the National Research Foundation of Korea (NRF) grant funded by the Korea government(MSIT) (No. RS-2023-00218913), and by the National Research Foundation of Korea (NRF) grant funded by the Korea government (RS-2023-00213823).

Quality Management Systems and Their Effect on ESG Principles in the Shipping Sector

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Abstract

Purpose: As there is a gap in the literature on how Quality Management Systems (QMS) impact Environmental Social and Governance (ESG) principles and outcomes in the ship-ping context (Andrikopoulos, 2025; Ronalter et al., 2023) this work aims to contribute by taking a closer look at the relationships between those constructs towards sustainable operational excellence in the maritime context (Tsatsaronis et al., 2024a).

Methodology/Approach: An in-depth literature review and analysis from 70 relevant papers is used focusing on how regulatory guidelines, international standards (such as ISO 9001, ISO 14001), the International Safety Management (ISM) Code and voluntary systems like the Tanker Management Self-Assessment (TMSA) affect current ESG frame-works. Moreover, the legislation affecting the maritime sector, including the EU Taxon-omy Regulation and the Sustainable Finance Disclosure Regulation (SFDR) (Tsatsaronis et al., 2024a) is also examined.

Findings: The literature review identifies certain practices and policies such as the large-scale empirical study by Ronalter et al. (2023) that found that companies implementing QMS and Environ mental Management Systems (EMS) demonstrated significantly higher ESG scores due to improved environmental data monitoring, stakeholder engagement and governance structures. In the shipping sector, ISO-certified firms show enhanced risk con-trol, energy efficiency and safety culture-key indicators within ESG frameworks (Ronalter et al., 2023; Tsatsaronis et al., 2024b). Furthermore, integrating QMS with ESG frame-works has been argued to enhance operational resilience and stakeholder trust, serving as a strategic lever for improving firm value and long-term sustain ability (Zhou, 2024; Ni et al., 2024).Following the above it is rather intriguing and logical to sup port that Quality Management System (QMS) practices strengthen ESG performance through sys-tematic environmental monitoring, social accountability, and governance transparency. Moreover, certain areas and suggestions for future research have been identified including the need for empirical case studies assessing firm-level implementation outcomes, de-velopment of sector-specific ESG-QMS maturity models and cross-regional comparative studies on ESG-QMS integration (Bernardo et al., 2023).

Research Limitation/Implication: The literature review conducted in this study could pave the way for more applied research by providing a foundational understanding of the interplay between Quality Management Systems (QMS) and Environmental, Social and Governance (ESG) principles. Future studies could strengthen this foundation by incorporating empirical evidence through case studies, interviews or

surveys with mar-itime companies to evaluate the real-world integration and practical implementation of these frameworks.

Originality/Value of Paper: This literature review has tried to identify the bound-aries between two major frameworks -QMS and ESG- within the context of the shipping sector. It highlights ho w quality-driven management practices can be instrumental in achieving sustainable, socially responsible and well-governed maritime operations. The review aspires to contribute to the dialogue on sustainable shipping by offering practical and regulatory insights valuable to both academia and industry practitioners.

Keywords: Quality Management Systems (QMS); ESG; Sustainability; Shipping Indus-try; ISM Code; ISO Standards

Acknowledgements

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An Open Quality Approach for Implementing A Smart Navigation System in the Coastal Area

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Abstract

Purpose: This paper applies the Open Quality to developing a spatial analysis framework for installing smart navigational aids in enhancing both maritime safety and operational efficiency in the coastal area.

Methodology/Approach: AHP has been used to determine the relative weights of evaluation criteria, which followed by a series of spatial quality measurement data processing. As an effort to quantify the grades of navigation aides, K-means clustering was also employed using SPSS. Finally, the final aggregated suitability indexes were computed based on the M-T-C-I framework of Open Quality.

Findings: Open Quality framework has been justified in prioritizing the installation of smart navigation aides in the coastal area. The M-T-C-I frame was effective in developing a systematic operational framework for scientific management of key safety issues in the coastal area,

Research Limitation/Implication: The data set was not sufficient in delineating all the navigation aides and thus the results seemed limited in expressing the actual reality. The relative weights were also determined through a survey with a small number of experts in the sector of maritime safety.

Originality/Value of Paper: It presents how the Open Quality concept can be utilized in developing a new framework for scientific quality management of maritime safety in the coastal area, which in turn expands the application domain of the new quality concept in the digital transformation era.

Keywords: Open Quality, Maritime Safety, Navigational Aids, AHP, K-Means Clustering, M-T-C-I

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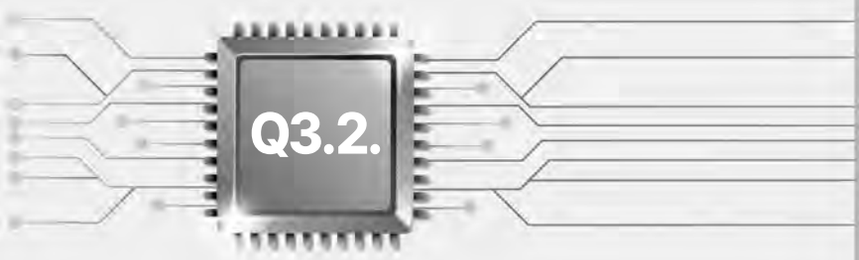

Business Excellence, Innovation & Sustainability II

Chairs: Prof. Jens J. Dahlgaard, Sweden

Q3.2.-1

Gye Soo Kim, Korea

Howard Gardner's Five Minds for Excellence in The AI Era: A Framework for Achieving Excellence Quality Performance

Q3.2.-2

Yafei Yu, Decheng Wen, Xiao Chen, China

How does green advertising serve as quality signal in gray market?

Q3.2.-3

Su-Yol Lee, Seho Jung, Korea

Corporate entrepreneurship, ESG-integrated management, and quality and operational performance: A focus on micro and SME suppliers

Q3.2.-4

Jung-Hwan Hong, Seo-Gyu Won, Ki-Hun Kim, Korea

Development of a Hawkes Process-Based Multimodal Deep Learning Model for Predicting Mortgage Delinquency at the Korea Housing Finance Corporation

Howard Gardner's Five Minds for Excellence in the AI Era: A Framework for The Excellence Quality Performance

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Abstract

Purpose: The purpose of this research is to develop a comprehensive framework that integrates Howard Gardner's Five Minds for the Future with Ethan Mollick's Co-Intelligence principles to enhance organizational quality in the era of human-AI collaboration. By mapping each of Gardner's Minds—Disciplined, Synthesizing, Creating, Respectful, and Ethical—to specific AI collaboration modes, this study aims to provide actionable insights into how organizations can leverage the convergence of human cognition and artificial intelligence to achieve superior quality performance.

Methodology/Approach: The research further seeks to demonstrate practical applications across various industries, propose effective implementation strategies, address potential challenges, and identify avenues for future research to guide the evolving relationship between human and AI capabilities in quality management.

Findings: The findings of this research reveal that integrating Howard Gardner's Five Minds for the Future with Ethan Mollick's Co-Intelligence principles provides a robust framework for enhancing organizational quality through human-AI collaboration. Specifically, the study finds that each of Gardner's Minds—Disciplined, Synthesizing, Creating, Respectful, and Ethical—can be effectively aligned with distinct AI collaboration modes to improve quality outcomes across industries.

Research Limitation/Implication: Howard Gardner's five minds—disciplined, synthesizing, creative, respectful, and ethical—build key capacities for thriving in the AI era. They help people adapt to technological change with expertise, integration of knowledge, innovation, and strong moral values. These minds empower individuals to work alongside AI while maintaining humanity and ethical decision-making.

Originality/Value of Paper: The originality and value of this research lie in its novel integration of two distinct but complementary theoretical frameworks—Howard Gardner's Five Minds for the Future and Ethan Mollick's Co-Intelligence principles—to address the evolving concept of organizational quality in the AI era. By bridging human cognitive development with human-AI collaboration modes, the paper presents a unique, comprehensive framework that goes beyond traditional quality management approaches.

Key words: Five Minds, Co-Intelligence, AI, Quality Performance

Q3.2. Business Excellence, Innovation & Sustainability II Q3.2.-2

How does green advertising serve as quality signal in gray market?

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Abstract

Our study investigates how a manufacturer strategically uses green advertising to navigate the complexities of gray markets and enhance overall supply chain profitability when selling through two downstream retailers to two different countries (regions). Green advertising, which causes less consumer aversion compared to traditional advertising, is increasingly used as a means to improve corporate reputation. In this framework, the manufacturer first de-termines the level of green advertising expenditure, then sets the wholesale price, followed by the retailers establishing the retail and gray market product prices, with the final decision on which product to purchase made by the consumers. The study finds that when consumers do not have the preference for green product, green advertising serves as an external signal to address quality information asymmetry, a cost that is solely borne by high-quality man-ufacturer. The level of investment in green advertising increases with the complexity of the gray market structure. When customers have a green preference, green advertising as an internal signal is a necessary investment for manufacturer and can act as a tool to activate or curb the gray market.

Corporate entrepreneurship, ESG-integrated management, and quality and operational performance

: A focus on micro and SME suppliers

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Abstract

Purpose: Environmental, social, and governance (ESG) has increasingly received attention for its expected capacity to simultaneously enhance sustainability performance and mitigate risks among micro, small, and medium-sized enterprises (MSMEs) in supply chains. The sustainability risks imposed on MSEMs can jeop-ardize the competitiveness of firms, supply chains, and countries. This study examines how external drivers, particularly the influences of buying firms and governments, as well as corporate entrepreneurship as an internal driver, foster MSME suppliers' ESG-integrated management and operational performance. Methods: This study empirically analyzed sustainability innovation management from an MSME supplier perspective. Consistent with this purpose, a survey was conducted of micro, small, and medium-sized suppli-ers in the automobile industry in the Gwangju metropolitan region of South Korea for the following reasons. This study obtained a sample of 384 B2B automobile industry suppliers that were registered in this region. The questionnaires were e-mailed to the potential respondents. As a result, a total of 119 responses (31.0% response rate) were collected in 2023. This study targeted single, well-informed respondents because a pos-sible bias engendered by a single respondent might be minimized in MSME cases.

Findings: The results of this study provide the following findings. First, the buyer's ESG initiatives in its supply chain contribute to facilitating MSME suppliers' ESG-integrated management. Second, corporate en-trepreneurship can foster MSME suppliers' ESG-integrated management. Third, corporate entrepreneurship accentuates the effects of external drivers on MSME suppliers' ESG-integrated management. Fourth, al-though a relationship between ESG-integrated management and operational performance was unconfirmed, this study demonstrates that corporate entrepreneurship enhances quality and operational performance. Limitation: This study provides several implications for academics, practitioners, and policymakers. First, this study is among the first to explore MSMEs' ESG-integrated management from a corporate entrepreneur-ship perspective. Second, this study's research framework provides a better understanding of how MSME suppliers' ESG-integrated management can be enhanced through the interplay of external stakeholders' influence and corporate entrepreneurship. Third, large buying firms, particularly those interested in how sustainability-competitiveness and risks are embedded in their global supply chains, should enhance ESG initiatives within their supply chains. Fourth, public policy must facilitate and encourage MSME suppliers to improve their sustainability performance.

Implication: This study has some limitations. First, the sample used in this study was extracted from a specific industry within a region. Second, this study focused on the ESG-integrated management of MSME suppliers, and was investigated in a South Korean context. Third, this study emphasized that external stake-holders and corporate entrepreneurship should provide theoretical contributions to the literature related to environmental and social issues in the context of MSME suppliers.

Keywords: Corporate entrepreneurship, ESG, micro and SME suppliers, quality and operational performance, supply chain, South Korea

Development of a Hawkes Process-Based Multimodal Deep Learning Model for Predicting Mortgage Delinquency at the Korea Housing Finance Corporation

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Abstract

Purpose: Mortgage delinquency in repayments at the Korea Housing Finance Corporation (HF) causes significant losses to both the corporation and its customers. Early prediction and prevention of delinquency are therefore essential to mitigate financial risks and maintain the stability of the housing finance system. This study aims to develop a robust and accurate prediction model to identify borrowers at high risk of delinquency, thereby enabling timely interventions.

Methodology/Approach: We utilize three years of mortgage performance data from approximately 60,000 customers. The dataset includes three distinct modalities: (1) static variables that remain unchanged over time (e.g., loan product type), (2) untraceable variables that may change over time but cannot be directly observed (e.g., customer income), and (3) traceable variables that are regularly recorded (e.g., credit score). This multimodal dataset is integrated into a deep learning architecture that incorporates the Hawkes Process to model self-exciting patterns, wherein borrowers with a history of delinquency are more likely to experience delinquency again. The model jointly learns cross-modality and self-exciting effects to improve prediction accuracy.

Findings: Experimental results show that the proposed model significantly outperforms baseline deep learning models in predicting high-risk borrowers. The integration of multi-modal features and the Hawkes Process enables the model to capture both heterogeneous variable interactions and temporal recurrence patterns, resulting in superior prediction performance.

Research Limitation/Implication: As new data are being collected over time, there is a potential for concept drift, which refers to changes in the underlying data distribution. This makes it essential to develop training methods that remain robust to such distributional shifts. In addition, given the importance of explainability in the financial domain, future work is required to incorporate explainable AI (XAI)

techniques to ensure that the reasoning behind model predictions can be clearly understood by practitioners.

Originality/Value of Paper: This study systematically identifies the three distinct modalities of the dataset and confirms the contribution of each modality to the prediction performance. In addition, it reflects both the mutual exclusivity and temporal dependency between delinquency and early repayment events, thereby implementing a delinquency prediction model that more accurately mirrors real-world financial transaction environments compared to single-event (delinquency-only) predictions. Unlike existing approaches that often rely on a single modality or overlook such event interactions, our model integrates heterogeneous data sources with a Hawkes Process–based deep learning framework, improving both prediction accuracy and practical applicability.

Keywords: Mortgage delinquency prediction, Multi-modal learning, Hawkes Process, Korea Housing Finance Corporation

This research was supported by Basic Science Research Program through the National Research Foundation of Korea (NRF) funded by the Ministry of Education (No. RS-2024-00393932), by the National Research Foundation of Korea (NRF) grant funded by the Korea government (MSIT) (No. RS-2023-00218913), and by the Ministry of Education of the Republic of Korea and the National Research Foundation of Korea (NRF-2024S1A5A8027053).

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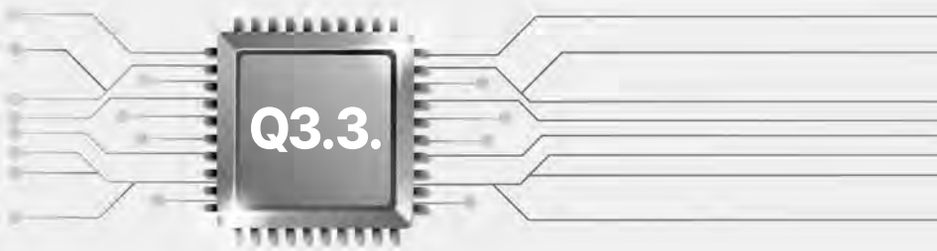

Quality in Healthcare & Hospitality II

Chairs: Prof. Masahiko Munechika, Japan

Q3.3.-1 **Masaaki Kaneko, Japan**

Proposal for a list of tasks that medical safety managers should carry out for effective quality and safety activities in healthcare

Q3.3.-2 **Chisato Kajihara, Riko Asahina, Akira Shindo, Masahiko Munechika, Japan**

Educational Components for Healthcare Professionals on Advance Care Planning (ACP) Based on a Cognitive-Behavioral Model

Q3.3.-3 **Chisato Kajihara, Yuki Nakamura, Haizhe Jin, Masahiko Munechika, Japan**

A Study on Difficulties and Implementation of Daily Management in Nursing Care

Q3.3.-4 **Ryoko Shimono, Yeuk Lam Tang, Masahiko Munechika, Japan**

Evaluation Model of Quality Management Education focusing on Learners' Motivation

Proposal for a list of tasks that medical safety managers should carry out for effective quality and safety activities in healthcare

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Abstract

Purpose: The role of healthcare safety managers is extremely important in promoting the quality and safety of healthcare in an organized manner. On the other hand, the tasks that they have to deal with are diverse, the specific tasks t o be performed are not clearly visible, and they are frequently transferred, so in many cases the tasks are not smooth y transferred, and it becomes difficult to maintain and transfer the quality and safety activities of healthcare performed in the hospital. Therefore, in this study, in order to reliably maintain and pass on healthcare quality and safety activities, we aim to systematize the specific tasks that healthcare safety managers should perform and propose them as a list of tasks.

Methods: The research method is divided into two main stages. In the first stage, we determined the framework (broad categories, medium categories, and small categories) for the list of tasks based on the work guide lines for healthcare safety managers from the Ministry of Health, Labor, and Welfare, and then detailed and organized the specific implementation details based on a survey of related literature and a survey of the work content implemented by healthcare safety managers in several hospitals. In the second stage, we conducted interviews with healthcare safety managers at four hospitals to confirm in detail whether the expression method for the obtained list of work items was easy to understand and whether the items were comprehensive, and revised the list. In addition, to confirm the versatility of the revised list, a questionnaire survey was conducted in eight hospitals, and the list was further revised based on the survey results.

Findings: As a result of the first stage, we were able to identify five main categories, 16 subcategories, and 41 sub-subcategories. In the second stage, as a result of interviewing four hospitals, we found that there were overlaps between hospitals, and we made 74 additions and 29 revisions, including minor ones. From the results of the questionnaire to the eight hospitals, we received 24 comments on the difficulty of understanding the notation and 23 comments on the addition of items. We revised the list of tasks in response to each of these comments. As a result, the list of work items was completed, with the tasks that medical safety managers should perform divided into four major categories, 12 major categories, 32 subcategories, and 97 sub-subcategories.

Originality/Value of Paper: The Japanese Ministry of Health, Labor and Welfare has issued guidelines for the tasks of medical safety managers, however they lack specificity. There are also many case studies that describe the tasks of medical safety managers in indi-vidual hospitals, but there are no previous studies that systematically show these t asks. The originality of this study is that it shows all the tasks that medical safety managers should perform in a concrete and systematic way.

Keywords: Healthcare quality, quality management system, Standardization.

Educational Components for Healthcare Professionals on Advance Care Planning (ACP) Based on a Cognitive-Behavioral Model

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Abstract

Purpose: In Japan, where the population is aging rapidly, the establishment of an integrated community care system is being promoted. For individuals to maintain their preferred way of life throughout their lifetime, it is important to establish a system wherein their wishes are fully respected in the final stages of medical treatment and care. Advance Care Planning (ACP) plays a key role in ensuring this. However, the recognition and implementation rates of ACP among healthcare professionals remain low. According to a survey conducted by the Ministry of Health, Labour and Welfare in 2022, less than 50

Methods: First, we developed the ACP model by referencing cognitive-behavioral models focused on pro-environmental behavior. Next, we identified the educational content necessary to address the factors outlined in the ACP model and to facilitate psychological processes. The results were systematically organized and compiled into a structured table to enhance usability for healthcare professionals. To validate the derived educational content, we developed educational videos based on selected components and asked healthcare professionals to watch them. The effectiveness of the videos was assessed through an analysis of post-viewing survey responses.

Findings: Through a literature review and interviews with healthcare professionals who ac-tively engage in ACP, we established an ACP model consisting of four psychological process stages and six influencing factors. Based on the ACP model, we identified 157 necessary educational components. To facilitate structured and purposeful education, these components were categorized into 13 major categories and 49 subcategories, which were compiled into a structured table. Using this table, we developed an educational video and had 19 partici-pants view it. All participants reported an improved understanding of ACP after watching the video.

Limitation/Implication: Not all of the educational content identified in this study has been validated. Additionally, improving ACP implementation rates requires increasing ACP awareness among the general public. Identifying the necessary educational content for this puspoese is an important future challenge.

Originality/Value of Paper: Although ACP education has been conducted in hospitals, it has often been limited to one-time training sessions. As a result, the education provided has been skewed toward specific areas. To address this issue, our study established an ACP model that clarifies the psychological processes healthcare professionals undergo from recognizing ACP to taking action, along with the factors influencing each stage. By structuring the educational content based on this model, we were able to systematically derive the necessary knowledge and skills without omissions. Utilizing this framework enables hospitals to implement systematic ACP education. Consequently, this approach is expected to contribute to improving both the awareness and implementation rates of ACP among healthcare professionals.

Keywords: Aging Society, Community-Based Integrated Care System, Hospital Education, Educational Effectiveness

A Study on Difficulties and Implementation of Daily Management in Nursing Care

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Abstract

Purpose: In recent years, public interest in improving the quality of healthcare has been increasing. Hospitals are working on building a quality management system (hereinafter, QMS) to improve healthcare services. As an important element of the QMS, it is necessary to have a mechanism (hereinafter, daily management) in place that performs tasks according to a predetermined plan and ensures implementation of the process. In this study, we ana-lyze the contents and management indices of the daily management that nurses carry out as part of their nursing work, and appraise the current situation. The Purpose of this study is to clarify the difficulties encountered when performing daily management in nursing care, and accordingly propose a method for implementing daily management.

Methods: First, we conduct interviews with nurses working as nursing managers, such as heads of nursing departments at various hospitals, on daily management initiatives and management indexes. Based on the results and literature survey, we clarify the difficulties encountered in daily management. When considering the difficulties, it is necessary to dis-tinguish between factors that arise from the inherent characteristics of healthcare and those that surface from the current healthcare system and business environment. While it is diffi-cult for the former to tackle the issues, the latter may be able to take countermeasures. In this study, we call the former a universal factor and the latter a variable factor. Next, we investigate the work data acquired at the hospital. From this data, we select the tasks to be subjected to daily management, taking into account the difficulties in daily management. Then, we examine the planning method of the selected task and the management index to evaluate each task. Based on the above, we propose a method of daily management. Lastly, we apply the proposed method to Hospital A and Hospital B, and verify its usefulness.

Findings: We clarified the healthcare characteristics related to daily management, such as urgency and changing patient status. We also extracted 31 universal factors and 28 variable factors arising from the characteristics. Next, we regarded daily management as one process, and organized the relationships between the components of the process and the characteris-tics of healthcare, universal factors, and

variable factors. As a result, it became clear which component of daily management triggered each factor. In this study, we focused on planned tasks that accounted for 70% of nursing tasks, taking into account the difficulties mentioned above. We proposed a daily management method to check whether or not the task to be performed was on schedule, using the Nursing Navigation Contents, which is a standardized planning tool, along with data on the extent of nursing necessity that needs to be recorded for medical service fees. We applied this method to Hospital A and conducted a three-day work survey in three wards, and confirmed that we could perform daily management using the proposed method. In addition, we investigated the planned task at Hospital B and con-firmed that the tasks to be managed in both hospitals were almost the same.

Implication: In this study, we examined the characteristics of healthcare and the difficul-ties of daily management, and proposed a management method to check whether or not the planned task was performed. In healthcare, even if the treatment given to a patient is same, the effect could be different, and the PDCA cycle cannot be performed only with the result-based evaluation index. Donabedian pointed out the structure, process, and outcome as a viewpoint of quality evaluation, and the proposed method accordingly enables the evaluation of the process. By checking the results-based indicators in conjunction with this method, the daily management of nursing work can be performed effectively.

Keywords: management index, planned task, sudden task, event-driven task, universal fac-tor, variable factor

Evaluation Model of Quality Management Education focusing on Learners' Motivation

: Case of Management Training for Healthcare Professionals by E-Learning

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Abstract

Purpose: In order to assure quality and safety in healthcare, it is necessary to have quality management promoters. In order to promote quality management, it is important to acquire systematic knowledge and skills, as well as to put them into practice. In this context, e-learning is useful because it allows learners to set their own study time, but the evaluation method for e-learning-based healthcare quality management education is not clear. The purpose of this study is to propose an evaluation method for E-learning training on quality management in healthcare that focuses on the motivation of healthcare professionals to learn. In this study, we take up the case of the Basic Course on Quality Management for Healthcare (hereafter, the "Q Course") conducted by the Japanese Society for Quality Control.

Methods:

1. Understanding the learning characteristics of trainees through an analysis of the current state of Q courses: We conducted an analysis of existing course participant questionnaires and interviews with lecturers and course participants, referring to Knowles's adult learning theory.
2. Understanding the motivation mechanism of medical professionals' learning: We analyzed the learning process of the participants based on Marzano's behavioral model. As a result of interviews and other research, it became clear that the issues were concentrated in the upstream planning stage.
3. Examination of an evaluation model focusing on the motivation of healthcare workers to learn: We first examined a model for evaluating whether the current situation and methods of motivation were appropriate.

Findings: We verified whether the evaluation model for learning motivation that we derived in this study could actually be applied. As a method of verification, the proposed model was applied to the Q Course publicity pamphlet and compared with the existing pamphlet. The two pamphlets, the existing one and the one to which the proposed method was applied, were evaluated on a five-point scale for seven survey items: "clarity of end results", "clarity of layout", "clarity of procedures", "positive feedback", "interest in content", "degree of support measures", and "attractiveness of trainee comments". Responses were

received from 11 Q Course trainees and 10 non-trainees.

As a result, the brochure that applied the proposed method received a better evaluation in all seven survey items. There was a variation in the scores for each item. Also, since the number of respondents was not large, the results should be interpreted with caution.

Limitation/Implication: This study examined the effectiveness of measures to further motivate learning, such as making the results of completion easier to understand, for the Q Course, which has a long track record of offering e-learning courses.

Originality/Value of Paper: In this study, we focused on the motivation to participate in e-learning courses in medical quality management education, and proposed a specific evalua-tion method to assess the motivation and methods of the participants. The proposed method focuses on the learning characteristics and motivation of the participants, and provides a new guideline that differs from the conventional evaluation method, which relies solely on knowl-edge comprehension and utilization.

Keywords: TQM, Quality in Healthcare, Statistical Analysis, Adult Education, ARCS Model

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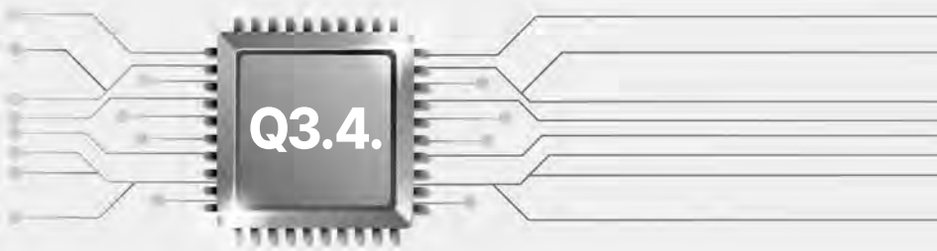

Benchmarking & Best Practices in Quality Management

Chairs: Prof. Johye Hwang, Korea

Q3.4.-1	**Shuaib, K. M., Inusa Auwalu, Nigeria** Impact of AI on Quality Management Practices in Nigerian Manufacturing Industries: The Case of Lagos
Q3.4.-2	**Sungwook Jung, Keehong Woo, Youn Sung Kim, Changhee Kim, Korea** Strategic Transformation for Quality, Innovation and Crisis Management under Effective Leadership: A Case Study of Korean Air
Q3.4.-3	**Haerang Jin, Johye Hwang, Korea** The Congruence Effects of Service Robot Appearance and Relationship Orientation on Consumer Expectancy in Restaurants
Q3.4.-4	**Min-Kun Shin, Hyun-Wook Lee, Sung-Zun Park, Sa-Eun Park, Yu-Bin Lee, Sun-Gahn Ko, Ki-Hun Kim, Korea** Heterogeneous Spatiotemporal Graph Neural Network for Port Air Quality Forecasting with the Integrated Use of Air-Quality, Weather, and AIS Data

Impact of AI on Quality Management Practices in Nigerian Manufacturing Industries

: The Case of Lagos

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Abstract

Purpose: The study examines the impacts of Artificial Intelligence (AI) on quality man-agement practices across Nigerian manufacturing companies with focus on Lagos, the host for large manufacturing and multi-national companies in Nigeria. The increasing AI technology adoption by Nigerian manufacturing industries for operational enhancement and quality improvement requires thorough evaluation of AI-driven quality management effects. The study investigates how AI implementation affects quality assurance together with process optimization and decision-making systems operating in manufacturing firms in Lagos.

Methods: The study adopts cross sectional research method. A survey data will be used to collect data from sampled manufacturing companies (unit of analysis) in the study area (Lagos), using purposive sampling technique. Thus, quality managers and production supervisors and IT specialists will serve as the respondents. The study will use descriptive and inferential statistical techniques as well as Structural Equation Modelling Patial Lease Squares (SEM-PLS) for the data analysis to determine AI's effects on quality management practices.

Findings: Although the study is at preliminary stage, the emergent findings will demonstrate how the adoption of AI technologies significantly enhances quality management practices, especially in real-time monitoring and predictive maintenance and defect identification. However, there may be challenges like insufficient infrastructure and skill deficiencies and organizational resistance to implement new methods, particularly common to many developing countries like Nigeria. Similarly, firms that achieve successful AI implementation in their quality management systems show better production efficiency while reducing errors and achieving enhanced customer satisfaction.

Limitation/Implication: The study only examines manufacturing industries in Lagos thus, it may limit the application of its findings beyond Lagos and neighboring states, looking at the Nigeria's vast landmass covering 36 states and federal capital. The findings risk obsolescence because AI develops at a rapid pace following the research completion. However, the study provides important understanding that helps policy makers together with similar industry stakeholders who aim to boost AI implementation in quality management practices.

Originality/Value of Paper: The study adds to the limited body of knowledge concerning AI's impact on quality management techniques in Nigerian industry. By focusing on Lagos, the study offers contextualized insights into the benefits and constraints of AI integration, supporting industry practitioners and policymakers in making data-driven decisions.

Keywords: Artificial intelligence (AI), Manufacturing industries, Quality management prac-tices

Strategic Transformation for Quality, Innovation and Crisis Management under Effective Leadership:

A Case Study of Korean Air

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Abstract

This study examines the strategic process by which Korean Air pursued a merger with Asiana Airlines to emerge as a global mega carrier during the unprecedented COVID-19 pandemic crisis. In 2019, Korean Air faced a series of internal and external challenges, including the inauguration of its new chairperson, Walter Cho, a high debt-to-equity ratio and disputes over internal management control. However, the company overcame these difficulties through timely decision-making and innovative approaches, such as converting passenger aircraft to cargo operations, implementing company-wide cost reductions, selling non-core assets and conducting capital increases. The merger process, which began with the decision to merge with Asiana Airlines in November 2020, underwent reviews by competition authorities in 14 countries and was finalised in December 2024. The findings show that, despite the crisis, Korean Air achieved a record-breaking performance and laid the foundation for becoming one of the top 10 global airlines. The case analysis demonstrates that the leadership of top management, which emphasized quality and innovation, drove this growth along with the dedicated participation of employees and strategic practices. This study provides valuable insights into effective crisis response strategies in the aviation industry and serves as a notable example of national-level restructuring in a key infrastructure sector.

Keywords: Korean Air, Leadership, Merger, Integration, Innovation

Q3.4. Benchmarking & Best Practices in Quality Management Q3.4.-3

The Congruence Effects of Service Robot Appearance and Relationship Orientation on Consumer Expectancy in Restaurants

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Abstract

Purpose: As service robots become more prevalent in restaurant service environments, their design has become a key factor in influencing consumer responses. This study investigates how different service robot appearances (zoomorphic vs. humanoid) influence consumer perceptions of warmth and competence, and how these perceptions align with restaurant relationship orientation (communal vs. exchange), affect consumers' healing and performance expectancy. It also considers the role of interdependent self-construal to understand individual differences in response to service robots.

Methodology/Approach: Two experimental studies were conducted to examine the congruence effects between service robot appearance and restaurant relationship orientation on consumers' healing and performance expectancy. The moderating role of consumers' interdependent self-construal was also explored.

Findings: The results indicate that zoomorphic service robots in communal relationship-oriented restaurants significantly increase intention to use by enhancing healing expectancy. In contrast, humanoid service robots in exchange relationship-oriented restaurants increase intention to use by enhancing performance expectancy. Additionally, consumers with a high level of interdependent self-construal demonstrate greater healing expectancy with zoomorphic service robots, while those with a low level of interdependent self-construal exhibit higher performance expectancy with humanoid robots in both communal and exchange-oriented restaurant settings.

Research Limitation/Implication: Drawing on established theoretical frameworks, this study offers important practical implications for the hospitality industry. The findings provide guidance on how to strategically align robot appearance with restaurant relationship orientation and consumer characteristics, such as self-construal. This alignment enhances consumers' healing and performance expectancy, ultimately enhancing service effectiveness in contextual environments. However, this study focuses on two types of robot appearance and restaurant relationship orientations, which may limit the generalizability of the findings to other service contexts.

Originality/Value of Paper: This study contributes to the literature by applying the Stereotype Content Model and Congruity Theory to the context of hospitality service robots. It is the first study to empirically examine how the congruence between robot appearance, restaurant relationship orientation, and interdependent self-construal jointly influences consumer expectations. The findings offer theoretical insights into how social perception and contextual congruence influence consumer responses in human-robot interactions.

Keywords: Service Robots, Stereotype Content Model, Relationship Orientation, Interdependent Self-Construal, Healing Expectancy, Performance Expectancy

Heterogeneous Spatiotemporal Graph Neural Network for Port Air-Quality Forecasting Integrating Air-Quality, Weather, and AIS Data

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Abstract

Purpose: Accurate forecasting is critical for port air quality management. Port air quality is driven by cross-type dependencies among air quality sensors, weather sensors, and vessels, with vessel dynamics captured by Automatic Identification System (AIS) data. We present a heterogeneous spatiotemporal graph neural network (HSTGNN) that explicitly integrates these factors to improve predictive accuracy.

Methodology/Approach: We define heterogeneous node types for air quality sensors, weather sensors, and vessels, and heterogeneous edge types that encode cross-type dependencies among these nodes. The method constructs a heterogeneous spatiotemporal graph by generating a graph at each time step and predicts port air quality.

Findings: Experiments were conducted using 1.5 years of real port data from Busan, Korea, and the results show that HSTGNN achieves lower error than spatiotemporal baselines.

Research Limitations/Implications: Operational logs such as truck movements, crane operations, and yard congestion are not integrated. Nevertheless, the forecasts enable early warnings; when hazardous air quality is predicted, authorities can reschedule vessel arrivals and issue public advisories to reduce

exposure.

Originality/Value of Paper: This work integrates air quality, weather, and AIS data via HSTGNN with heterogeneous nodes and edges. To the best of our knowledge, integrating air quality sensors, weather sensors, and vessels as nodes for port air quality forecasting remains largely unexplored. Therefore, this work is significant in that it underscores the need to consider dependencies among heterogeneous node and edge types, offering a novel direction for port air quality forecasting.

Keywords: Heterogeneous Spatiotemporal Graph Neural Network, Port Air Quality, Forecasting, Air pollution, Heterogeneous Data

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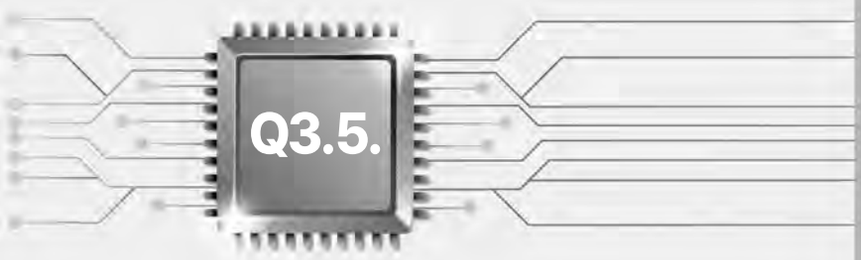

Performance Management & Organizational Excellence II

Chairs: Prof. Terje Slåtten, Norway

Q3.5.-1	**Minjae Park, Dong Ho Park, Korea** Two-Dimensional Warranty Strategy Considering Refund and Replacement
Q3.5.-2	**Barbara Rebecca Mutonyi, Victoria Rustad Bjerke, Terje Slåtten, Norway** Firm's Sustainable Innovation and Competitive Advantage: Examining the role of Leadership Display of Curiosity, Organizational Innovation Culture, and Leadership Support for Innovation
Q3.5.-3	**Loukas N. Anninos, Su Mi Dahlgaard-Park, Jens J. Dahlgaard, Greece, Sweden** Leveraging AI and Neuroscience: a Transformative Leadership Paradigm for achieving Sustainable Excellence
Q3.5.-4	**Victoria Rustad Bjerke, Barbara Rebecca Mutonyi, Terje Slåtten, Norway** Thriving Through Curiosity: Building Innovative, Attractive, and Competitive Organizations

Two-Dimensional Warranty Strategy Considering Refund and Replacement

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Abstract

Purpose: The purpose of this study is to propose and analyze an optimal two-dimensional warranty policy for a repairable multi-component system composed of both critical and non-critical components. Traditional warranty models often consider only a single dimension such as time or usage to define the coverage period. However, such models may not adequately reflect the operational realities of systems where both the elapsed time and the accumulated usage significantly affect component deterioration and system reliability. This research seeks to bridge this gap by introducing a warranty structure that simultaneously accounts for both age and usage in defining warranty terms, thereby improving the flexibility and ap-plicability of warranty policies in real-world contexts. Furthermore, this study extends the conventional two-dimensional warranty framework by incorporating a refund or replacement policy that is activated under specific failure conditions. In practice, manufacturers are often compelled to offer such measures—particularly when customers experience repeated failures within a short period of time—as part of consumer protection policies or corporate reputation management strategies. Therefore, the integration of a refund/replacement period based on failure frequency, especially within a defined early phase of the warranty period, reflects a more realistic and customer-responsive warranty mechanism. The study aims to determine the optimal lengths of the full warranty period and the early refund/replacement period in a manner that minimizes the manufacturer's expected cost rate while maintaining an acceptable service level.

Methodology/Approach: The research develops a mathematical model to evaluate and optimize a two-dimensional warranty policy from the perspective of a manufacturer. The model assumes that each component within the system deteriorates over time and is subject to minimal repair upon failure. Two types of components are distinguished: critical components, whose failure may significantly affect system performance or safety, and noncritical components, whose failure may be tolerated to some extent or repaired more flexibly. The warranty policy consists of two interlinked phases: the overall warranty period defined by age and usage thresholds, and a shorter refund/replacement period, which triggers compensation if failure counts exceed specified thresholds. To model the associated warranty costs, the study incorporates various cost elements, including minimal repair cost, preventive maintenance (PM) cost, and refund/replacement cost. A stochastic process is used to represent the failure behavior of components over time and usage, enabling computation of the expected number of failures within given

intervals. Using these probabilistic representations, the expected total warranty cost from the manufacturer's viewpoint is formulated as a function of the decision variables—namely, the warranty length and refund/replacement interval. The optimal policy is derived by minimizing the expected cost rate, which is defined as the ex-pected total warranty cost divided by the warranty length. Analytical derivations are supported by numerical experiments. These simulations explore the sensitivity of the optimal warranty length to variations in component failure rates, cost parameters, and threshold values for failure counts. The numerical optimization is conducted under multiple parameter scenarios to examine the robustness and adaptability of the pro-posed model across different system configurations and operating environments.

Findings: The numerical results demonstrate that the proposed two-dimensional warranty policy with an embedded refund/replacement period can significantly reduce the manufacturer's expected cost rate when compared to conventional single-dimensional or non-tiered policies. The analysis reveals that the optimal length of the warranty period and the early refund/replacement period are both sensitive to component failure intensities, particularly for critical components. Higher failure rates among critical components tend to shorten the optimal refund/replacement period, indicating a strategic need to intervene earlier to mitigate customer dissatisfaction and limit high compensation costs. Moreover, the findings highlight the importance of cost structure in shaping the optimal policy. When the cost of preventive maintenance is relatively low compared to replacement or refund costs, the model favors strategies that prolong warranty coverage but emphasize early detection and correction through PM actions. On the other hand, when the refund or replacement cost is dominant, the optimal policy favors a shorter refund/replacement period to quickly remove problematic units from circulation, thereby avoiding cascading warranty expenses. The model also demonstrates that threshold levels for failure counts serve as critical tuning parameters. Looser thresholds can delay the onset of refund or replacement obligations but may lead to higher overall failure-related costs, while stricter thresholds may increase early replacement costs but enhance customer satisfaction. The optimal balance between these factors is shown to vary across different component reliability profiles and usage conditions, validating the need for a flexible, data-driven approach to warranty design.

Limitation/Implication: This study offers several implications for both academic research and industrial practice. From a theoretical standpoint, the research advances the literature on warranty optimization by incorporating a dual-phased warranty structure that simultaneously considers age, usage, and early failure behavior. This integrated perspective reflects a closer alignment with real-world warranty practices, especially in sectors such as automotive, electronics, and heavy machinery where systems are composed of numerous interdependent components with varying criticality. Practically, the results provide manufacturers with a quantitative decision-making tool for designing customer-oriented warranty policies that also align with cost-efficiency objectives. The model enables manufacturers to better predict the cost implications of different warranty lengths and refund/replacement strategies under various usage scenarios and reliability conditions. This is particularly valuable in environments where customer satisfaction and brand reputation are closely linked to post-sale service responsiveness, such as in high-end consumer electronics or regulated industries. Moreover, the inclusion of preventive maintenance actions in the model emphasizes the importance of proactive service strategies in warranty management. By allowing for early intervention before refund/replacement conditions are triggered, manufacturers can potentially reduce warranty costs while extending product life and improving operational reliability. The findings also suggest that warranty design should not be static but rather tailored to product characteristics, customer expectations, and cost structures, reinforcing the need for data-driven and adaptive policy formulation.

Originality/Value of Paper: This paper contributes original insights to the field of warranty modeling by introducing a novel two-dimensional warranty policy framework that integrates refund/replacement mechanisms triggered by failure frequency thresholds. While prior studies have addressed two-dimensional warranty structures and various cost optimization techniques, few have considered the combined effect of critical vs. noncritical component failures, preventive maintenance interventions, and customer-responsive refund/replacement policies within a unified model. The proposed approach captures complex real-world considerations often observed in contemporary service and product support environments but seldom represented in the existing analytical literature. The originality also lies in the dual-stage policy structure, which reflects a more realistic treatment of warranty obligations. By distinguishing between a general coverage period and a focused early-stage re-fund/replacement window, the model enables more responsive and cost-effective warranty planning. Additionally, the mathematical formulation of expected cost rate under varying failure thresholds and maintenance strategies provides a flexible platform for extension into more elaborate models, such as those incorporating degradation processes, customer usage variability, or dynamic pricing. Furthermore, the research bridges the gap between theoretical warranty modeling and practical policy implementation under regulatory and consumer-protection constraints, such as lemon laws or fair trade standards. As such, it opens a pathway for future research on optimal policy design under legal and behavioral constraints, contributing both to operations research and to interdisciplinary applications involving law, marketing, and consumer behavior.

Keywords: Critical and noncritical component, Multi-component system, Optimization of warranty policy, Periodic preventive maintenance, Two-dimensional warranty

Firm's Sustainable Innovation and Competitive Advantage:

Examining the role of Leadership Display of Curiosity, Organizational Innovation Culture, and Leadership Support for Innovation

Barbara Rebecca Mutonyi[1], Victoria Rustad Bjerke[2], Terje Slåtten[2]

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Abstract

Purpose: Sustainable innovation is an emerging field of research. As a result, there are several gaps in the existing literature. Based on this, this paper has two aims. First, it investigates whether sustainable innovation relates to competitive advantage within firms in the tourism industry. Second, it conceptualizes and empirically tests the role of three factors promoting firms' sustainable innovation and competitive advantage. The three factors are (i) leadership display of curiosity, (ii) organizational innovation culture, and (iii) leadership support for innovation.

Design/methodology/approach: The study involved 201 employees from different hospitality organizations. Partial Least Square Structural Equation Modeling (PLS-SEM) with SmartPLS 4.1.1.2 software was used to analyze and test the suggested conceptual model.

Findings: The findings from the empirical test can be summarized as follows: (i) Firms' sustainable innovation was found to be directly related to their competitive advantage. Sustainable innovation accounts for nearly 50 percent (46.9%) of a firm's competitive advantage; (ii) leadership display of curiosity, organizational innovation culture, and leadership support for innovation were directly related to firms' sustainable innovation. The three factors accounted for 53.5 percent of the variance in sustainable innovation; (iii) The relationship between leadership displays of curiosity and sustainable innovation was found to be both directly and indirectly related, with the latter connection occurring through organizational innovation culture and leadership support for innovation.

Research limitations/implications: The study indicates that companies can use sustainable innovation as a business strategy to achieve a competitive advantage in their markets. Furthermore, the study highlights key drivers that business leaders must consider when implementing sustainable innovation. Of these, the leadership display of curiosity is a critical factor. Leadership display of curiosity promotes sustainable innovation strategy both directly and indirectly by cultivating organizational innovation culture and strengthening leadership support for innovation. A notable implication of the study is to encourage curiosity among organizational leaders and recognize it as a valuable resource that a firm can utilize to reach its desired goals.

Originality/value: The study contributes to a relatively new research domain that focuses on factors associated with firms' sustainable innovation and competitive advantage

Keywords: Curiosity, Leadership, Sustainable innovation, Organizational culture, Supportive leadership, Competitive advantage

Leveraging AI and Neuroscience:

a Transformative Leadership Paradigm for achieving Sustainable Excellence

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Abstract

Purpose: It is highly unlikely to find an aspect of the business realm untouched by discussions on the role of technological developments and transformational efforts for enhancing the potential of organizations to achieve sustainable excellence. Against the backdrop of groundbreaking changes and unpredictable events triggered by the 4th industrial revolution or unsustainable practices of the past, business models are being *reconfigured* to serve as safe roadmaps for organizations. *Quality* continues to be at the heart of success for organizations, currently in redefined excellence frames which, however, have the same profound principles and two pillars, namely hard and soft. *Technology,* on the one hand, facilitates higher efficiency and effectiveness of hard organizational factors and, *mindset,* on the other, cultivates and promotes quality intelligence and behaviour, namely affecting the soft organizational factors. *Performance* is the outcome of their dynamic interaction. This is not new. *The new is* the unprecedented power of technology in the form of artificial intelligence (AI), its capability and the profound knowledge that leaders and managers ought to have regarding the way people operate and behave. This insight comes from neuroscience, which has noted the relation of brain functions and specific behaviors, like leadership, motivation and learning. Having the revised EFQM Model (2025) as a beacon for sustainable excellence, the study at hand aims to investigate the role of technology in its most advanced conceptualization and the usefulness of neuroscientific findings for strengthening the hard and soft aspects of quality.

Methodology/Approach: The study reflects on literature findings and concerns regarding the use of AI and the implementation of neuroscientific conclusions for enhancing quality management systems.

Findings: In the frame of new excellence conceptualizations, such as sustainable excellence as it is manifested through the revised EFQM Excellence Model (2025), AI (regarding e.g. customer satisfaction, process automation) and biologically informed management (regarding, for instance, motivation, learning, change, leadership and social influence, decision making and managing emotions) may have considerable effects on quality management systems and their operation. Their combined utilization impacts certain hard (e.g. strategy formulation, process management, performance management and governance) and soft aspects (e.g. leadership, culture, human resources management) of quality management, thus resulting in strong or weak organizational potential for excellence. The integration of *artificial intelligence* with *neuroscientific findings* presents a transformative leadership paradigm for understanding and

achieving *sustainable excellence*.

Research Limitation/Implication: The study at hand can be used as an input for further research on assessing the effects of strong and weak use of AI and neuroscientific findings on improving quality practice and, ultimately, organizational performance.

Originality/Value of Paper: The study examines the hard and soft areas of quality management systems which may benefit from the use of AI and neuroscientific evidence within the frame of the new EFQM Excellence Model framework and organizational pursuit towards sustainable excellence.

Keywords: Sustainable excellence, artificial intelligence, neuroscience, quality, quality management

Thriving Through Curiosity: Building Innovative, Attractive, and Competitive Organizations

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Abstract

Purpose: Thriving at work receives growing attention from scholars and practitioners. However current research is still limited and lacks sufficient knowledge of its contextual antecedents and work-related consequences. Accordingly, this empirical study has two aims. (i) It examines whether an organizational context characterized by a climate of curiosity can promote thriving at work. (ii) It investigates whether thriving at work can contribute to organizational- level and individual-level outcomes. Outcomes of thriving at work are conceptualized as the three distinct factors: (i) competitive advantage (ii) innovative behaviour, and (iii) organizational attractiveness.

Design/methodology/approach: The study involved 201 employees from different hospitality organizations. Partial Least Square Structural Equation Modelling (PLS-SEM) with SmartPLS 4 was used to analyse and test the suggested conceptual model.

Findings: The findings from this empirical study reveal that: (i) thriving at work is strongly influenced by the contextual antecedent factor climate of curiosity, explaining about 30% of the variance in thriving at work. (ii) Thriving at work strongly relates to several work-related outcome variables. For the organization-level factor competitive advantage, it explains about 30%. For the individual-level factors innovative behaviour and organizational attractiveness, thriving at work explains respectively nearly 40 % and 60% of the variance.

Research limitations/implications: Ensuring that both individuals and organizations thrive in a volatile and rapidly changing business landscape, is a key challenge for today's leaders. This study indicates that one way to meet this challenge is to foster a work climate characterized by curiosity. More so, leaders that can enable thriving at work also provide a catalyst for attractive organizational and individual level outcomes. Specifically, thriving at work relates to the company's overall market position, quality-oriented employees, plus the ability to strengthen perceptions of an attractive workplace. In turn, these factors can serve as potent drivers that help retain talent and position the company for growth and long-term survival.

Originality/value: This study contributes to a promising but still limited area of research, by the identification of contextual antecedents to thriving at work, and work-related consequences.

Keywords: Thriving at work, climate of curiosity, competitive advantage/capability, innovative behaviour, organizational attractiveness

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DCXI(Digital Consumer eXperience Index)란?

디지털 기술을 통한 고객 접점의 중요성이 커짐에 따라 한국표준협회와 고려대학교 경영대학(김재욱 교수, 이건웅 교수)이 공동 개발한 디지털 전환 역량 평가모델로써, 디지털 채널을 이용해 해당 제품/서비스 구매 여정 경험이 있는 소비자를 대상으로 시스템 및 정보 품질과 개인화 요인에 대한 고객 경험을 조사하여 각 산업군별 1위를 선정 발표하는 지표

2025 디지털고객경험지수

DCXI 1위 기업

대한민국 국민이 선택한 디지털 경험의 기준,
DCXI 1위 기업을 소개합니다.

3년 연속 종합가전 | 삼성전자 SAMSUNG	2년 연속 시중은행 | KB국민은행 KB 국민은행	2년 연속 이동통신 | LG유플러스 LG 유플러스
2년 연속 기금관리형 준정부기관 공무원연금공단 공무원연금공단	2년 연속 종합병원 | 삼성서울병원 SMC 삼성서울병원	2년 연속 시장형 공기업 한국도로공사 ex 한국도로공사
1년 신용카드 | KB국민카드 KB 국민카드	1년 위탁집행형 준정부기관 한국교통안전공단 TS 한국교통안전공단	1년 준시장형 공기업 한국마사회 KRA 한국마사회

※본 광고는 '2025 디지털고객경험지수(DCXI) 수상기업'들이 공동으로 마련한 광고입니다.

주최 : KSA 한국표준협회

땅과 바다 그리고 하늘의 평화

누가 지켜갈까?

POONGSAN

우리 육해공군이 사용하는
다양한 탄약을 자체 개발 · 생산하는 풍산
대한민국의 평화와 국가 경제에 기여하고 있습니다.
국내 유일의 일관생산시스템을 갖춘 종합탄약 생산기업
풍산이 평화의 가치를 지켜가고 있습니다.

POONGSAN | 서울특별시 서대문구 충정로 23 풍산빌딩
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LG전자

당신을 중심으로 돌아가는
진정한 AI 세탁건조

AI WashTower

세탁부터 건조까지 모든 과정
당신에게 딱 맞춰 AI가 토탈케어

LG TROMM AI Objet Collection | AI 워시타워

| 국내 최초 최대 용량 세탁 25kg 건조 25kg | 와이드 디스플레이 | 세탁 건조 모두 듀얼 트루스팀 | All New 플랫 디자인 |

*소비자의 이해를 돕기 위해 연출된 이미지입니다. *국내 최초·국내 최대 용량 건조기 : 국내 판매중인 가정용 의류건조기 기준 ('25년 4월 에너지 관리공단 등록 기준) *국내 최대 용량 세탁기 : 국내 판매중인 전기세탁기(드럼) 기준 ('25년 4월 에너지 관리공단 등록 기준)

SAMSUNG

지금 나는
Bespoke AI 콤보와 삽니다

다시 만난 나의 세탁기, AI 콤보

세탁부터 건조까지 한 번에 돼요
세탁하고, 기다리고, 건조하고 ...
이젠 안 그래도 되니까, 내 시간이 커졌어요

AI가 옷감부터 오염도까지 감지해서
세탁 건조 코스까지 알아서 맞춰주니까
고민하지 않아도 돼요

시간을 아껴서 시간을 가지니까
나의 **Bespoke AI 콤보**

세탁과 건조를 한 번에
ONE 솔루션

세탁물에 맞는 최적의 코스로
AI 맞춤+

세탁 건조 후 자동 문열림
오토 오픈 도어+

삼성코리아 YouTube 채널에서 달라진 한가인의 일상을 확인해 보세요

*으뜸효율가전 환급 행사 2025.07.04 ~ 2025.12.31 *본 행사는 예고없이 변경 및 중단될 수 있음 *으뜸효율 가전제품 구매비용 10% 환급 행사는 산업통상자원부 총괄, 한국에너지공단 주관 *환급 적용 대상모델 구매 비용 10% 환급은 1인당 최대 30만원 한도이며, 재원 소진 시 조기종료됨 *삼성전자는 가전제품을 구매하는 대상고객의 이해를 돕기 위한 목적으로 행사 내용을 안내함 *구체적인 지원조건 및 자세한 내용은 한국에너지공단 신청페이지를 참고 *이해를 돕기 위해 연출된 장면으로 실제와 다를 수 있음 **[AI 맞춤+]** *옷감 종류 분석은 AI 맞춤 코스(세탁/모드)에서 최대 3kg의 세탁물 내에서 동작함 *세탁물의 오염도 감지는 AI 맞춤 코스(세탁/모드)에서 최대 9kg의 세탁물 내에서 동작함 *일반(면), 타월, 섬세, 데님, 아웃도어 등 5종의 옷감을 감지하며, 삼실이 다른 옷감을 함께 세탁하거나 기타 옷감을 세탁하는 경우 가장 유사한 옷감으로 감지함 *옷감의 대표적 특성에 따른 분류로 실제 옷감과 다르게 인식 할 수 있음 **[오토 오픈 도어+]** *위 기능은 세탁 단독 행정 종료 후, 건조 단독 행정 종료 후, 세탁과 건조 연속 행정 종료 후, 모든 상황에서 동작함 *코스 끝날 때 문열기 기본 설정은 5분 후 열기이며, 해당 기능은 설정에서 변경할 수 있음 (설정>세탁기>자동문열림) *코스 끝날 때 문열기 기능은 제품 및 모바일에서 '바로 열기/5분 후 열기/사용 안함' 중 선택하여 설정할 수 있음 *'즉시 문열기' 기능은 제품 및 모바일에서 설정할 수 있으며, 해당 기능을 모바일에서 사용하기 위해서는 제품을 SmartThings에 등록 후 스마트 컨트롤 기능이 활성화 되어 있어야 함 *SmartThings는 지원 환경 및 사용 방법에 일부 제한이 있음 *위 기능은 WD 9**F25AH** 모델에 한해 제공되며, 기존 오토 오픈 도어 기능에 송풍 기능이 추가됨

으뜸효율가전 10% 환급

삼성 으뜸효율가전 10% 환급
선착순 환급 혜택을 놓치지 마세요 (7/4~12/31)

수소 밸류체인 구축 확대
(수전해 기반 수소 생산기지,
블루수소 생산 플랜트 구축)

미래를 위한 끊임없는 도전,
발전사 최다 양수발전 사업자 선정
(구례, 봉화)

해외 운영사업장
발전5사 중 1위
(11개소)

아세안국가 전력시장 선점을 위한
TEAM KOMIPO 해외동반진출
(9년 연속 동반성장평가 최고등급 달성)

롯데케미칼

PROJECT LOOP

ecoseed

생활에 이로운 제품을 만드는
플라스틱 자원 선순환으로
세상을 더 가치있게

이롯케 세상에 이롭게

Every Step for GREEN

한화시스템

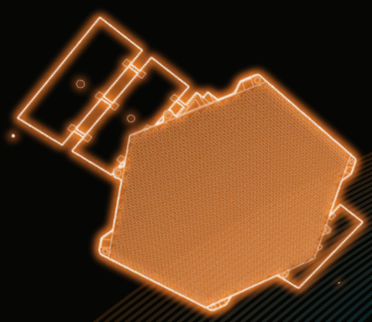
우리의 기술이 우리의 일상을 지킵니다.

정밀한 감시, 신속한 판단, 공간을 넘는 연결.

한화시스템의 기술이
육·해·공·우주를 하나로 연결합니다.

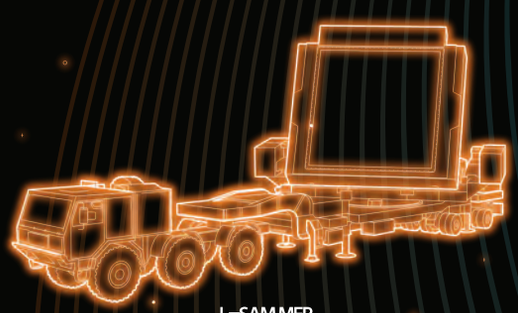
우리의 일상을 지키는 기술,
미래를 움직이는 기술을 향해

Connected Defense, Trusted Technology

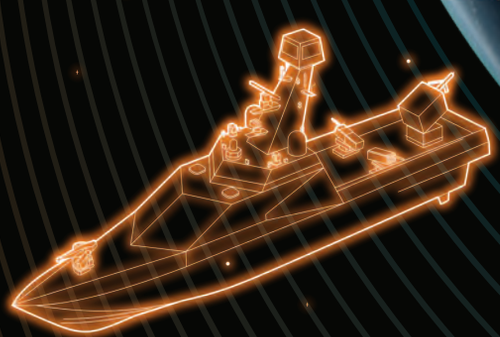


0.25m급 소형 SAR 위성

무인기/경전투기용 AESA 레이다



L-SAM MFR



전투용 무인수상정

HYUNDAI GLOVIS

GLOBAL SMART SCM SOLUTION PROVIDER

현대글로비스는 연결을 넘어 완결로 이어지는 물류의 새로운 기준을 세웁니다.

글로벌 스마트 SCM 역량으로 가치사슬 전반에 최적의 해답을 제시하며,

진보한 기술과 새로운 혁신으로 산업의 흐름을 선도합니다.

우리는 물류·해운·유통에서 미래 사업까지, 글로벌 공급망의 내일을 완성합니다.

한국동서발전㈜

깨끗한 에너지를 넘어
지속가능한 미래로

안정적인 전력 공급으로 국가 경제발전을 이끌어온
대한민국 에너지리더, **한국동서발전.**

이제 태양광,풍력, 수소, 암모니아 등을 활용한
무탄소 신재생에너지로
'친환경 에너지기업'으로 힘차게 도약합니다.

대한민국 에너지의
현재와 미래를 책임질
한국동서발전

CREATIVE INNOVATION FOR A BETTER FUTURE

Hyundai Rotem Hydrogen Fuel Cell Tram

무엇이 인공지능 시대를 가능하게 할까요?

저마다 답은 다르지만

한국수력원자력이 찾은 답은 에너지에 있습니다

내일을 만드는 건 기술이지만
내일을 움직이는 건 에너지입니다

내일의 에너지가 꿈틀

한국수력원자력㈜