InCASST

International Conference on Applied Sciences and Smart Technologies

Science and Technology Disruption in the Post Pandemic Era with Sustainable Development for Better Life Quality

18th October, 2023

Keynote Speakers

Prof.Ir. Sudi Mungkasi,Ph.D.
Sanata Dharma University
Indonesia

Assoc. Prof. Dr. Peerapong Uthansakul
Suranaree University of Technology
Thailand

Prof. Tokuro Matsuo
Advance Institute of Industrial Technology
Japan

Asst. Prof. Dr. Rando Tungga Dewa
The Republic of Indonesia Defense University
Indonesia

Call For Paper

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- Renewable energy technologies and systems.
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- Environmental impact assessment and management.
- Energy policy and planning.
- Clean energy and green technologies.
- Waste management and recycling.
- Air and water pollution control.
- Environmental biotechnology and microbiology.
- Carbon capture and sequestration.

Important Dates

- Extended New Submission : August 15, 2023 (Full Paper only)
- Accepted Notification : August 22, 2023
- Early Bird payment : April 30, 2023
- Late payment : August 31, 2023
- Full Paper Submission of Accepted Abstract : September 18, 2023
- Conference Day : October 18, 2023

Registration Fee :

Presenter :

- Offline :
  - Early bird : Rp. 3.250.000 / US$235
  - Late : Rp. 3.500.000 / US$250
- Online :
  - Early bird : Rp. 2.950.000 / US$185
  - Late : Rp. 3.200.000 / US$200

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- Full Board : Rp. 750.000 / US$60
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Publisher : E3S Web of Conferences

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Eastparc Hotel, Yogyakarta, Indonesia

InCASST
International Conference on Applied Sciences and Smart Technologies

30 tahun
FAKULTAS SAINS DAN TEKNOLOGI
UNIVERSITAS SANATA DHARMA

PROGRAM BOOK & ABSTRACTS

INTERNATIONAL CONFERENCE ON APPLIED SCIENCES AND SMART TECHNOLOGIES

SCIENCE AND TECHNOLOGY DISRUPTION
IN THE POST PANDEMIC ERA
FOR BETTER LIFE QUALITY

ORGANIZED BY
FACULTY OF SCIENCE AND TECHNOLOGY
SANATA DHARMA UNIVERSITY

October 18, 2023
Yogyakarta, Indonesia

CO-HOST

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MESSAGE FROM DEAN'S

Dear participants,

First of all, all praise and gratitude should go to God Almighty for His blessings, the first international conference organized by the Faculty of Science and Technology of Sanata Dharma University can be held.

It is with pride and pleasure that I welcome you all to this special event, the International Conference on Applied Sciences and Smart Technologies (InCASST 2023). This International Conference organized by the Faculty of Science and Technology of Sanata Dharma University is not just an ordinary conference, but also a milestone to celebrate our thirty years of service in the field of education, knowledge, research, and innovation at the Faculty of Science and Technology of Sanata Dharma University.

For three decades, we have witnessed tremendous growth in the field of science and technology, and we have been involved in it. We have witnessed our lecturers conducting deep research and advancing the frontiers of knowledge. We have witnessed cross-country collaborations that connect us to the global scientific community.

This conference is a pivotal moment in our journey. It is a platform for thinkers, researchers and innovators from around the world to come together, share and inspire one another. Our conference theme, "Disrupting Science and Technology in the Post-Pandemic Era with Sustainable Development for a Better Quality of Life" reflects our determination to continue pushing the boundaries of knowledge, facing future challenges, and creating sustainable solutions.

This program book contains a summary of the events that will take place during the conference, a list of prominent speakers, and other important information. It is your guide to everything that will happen during the conference.

I would like to thank Prof. Tokuro Matsuo, Prof. Sudi Mungkasi, Ph.D., Assoc. Prof. Dr. Peerapong Uthansakul and Assist. Prof. Rando Tungga Dewa, for sharing as keynote speakers in this conference. I would also like to thank all the speakers who came from different parts of the world, who have been willing to share their knowledge with us.

I would also like to thank all those who have contributed in making this conference a reality. Thank you to the organizers who have worked hard to prepare this event carefully.

We believe that this conference will be a platform to build new collaborative networks, stimulate innovative ideas, and deepen our understanding of global challenges that require scientific solutions. Together, we will illuminate the path to a better and brighter future.

Warm greetings from us at Sanata Dharma University, Yogyakarta. May this conference be a fulfilling and rewarding scientific experience for all participants.

Thank you very much.

Ir. Drs. Haris Sriwindono, M.Kom., Ph.D.
Dean of Faculty of Science and Technology, Sanata Dharma University

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KEYNOTE SPEAKERS

Prof. Ir. Sudi Mungkasi, Ph.D.
(Sanata Dharma University-Indonesia)

Prof. Ir. Sudi Mungkasi is a full professor at the Department of Mathematics, Faculty of Science and Technology, Sanata Dharma University, Yogyakarta, Indonesia. He obtained the degree of Sarjana Sains (S.Si.) in Mathematics from Gadjah Mada University, Yogyakarta, Indonesia in 2004. He received the degrees of Master of Mathematical Sciences (M.Math.Sc.) and Doctor of Philosophy (Ph.D.) in Mathematical Sciences from The Australian National University, Canberra, Australia in 2008 and 2013, respectively. He was a postdoctoral fellow at the Mathematical Sciences Institute of The Australian National University in 2013. The professional degree of Insinyur (Ir.) in Engineering Sciences was obtained from Sanata Dharma University in 2021. His research interests include applied and computational mathematics as well as modelling and simulation for physical, biological, chemical, and engineering problems. Currently, he serves as Vice Rector for Academic Affairs of Sanata Dharma University.

Prof. Tokuro Matsuo
(Advanced Institute of Industrial Technology - Japan)

Prof. Tokuro Matsuo is currently a Full Professor (tenured) at the Advanced Institute of Industrial Technology (AIIT) in Public University Corporation Tokyo Metropolitan University since 2012. Also, he is currently a Director of the Research Center for Artificial Intelligence and Service Science at AIIT and CEO of the International Institute of Applied Informatics (IIAI). His current research interests include agent-based electronic commerce, qualitative reasoning and simulation, material informatics, IT and business management, and IoT. He delivered 150 keynotes and invited talks at international conferences, symposia, and seminars in this decade. He also received over 10 awards on research and over 30 research grants from the government, research foundations, and companies.

Assoc. Prof. Dr. Peerapong Uthansakul (Suranaree University of Technology-Thailand)

Peerapong Uthansakul has been working as the Associate Professor at the School of Telecommunication Engineering and the Director of the Institute of Research and Development, Suranaree University of Technology, Thailand. He has got more than one hundred research publications and is the author/co-author of various books related to MIMO technologies. Furthermore, he is the editor of "Suranaree Journal of Science and Technology" and other leading Thai journals related to Science and Technology. He has won various national awards from the government of Thailand due to his contributions and motivation in the field of Science and Technology. His research interests include green communications, wave propagation modeling, MIMO, Massive MIMO, Brain Wave Engineering, OFDM and advanced wireless communications, wireless sensor network, embedded systems, the internet of things, and network security. His current research interest is in Artificial Intelligence and Bio-Signal studies.

Assist. Prof. Dr. Eng. Rando Tungga Dewa (The Republic of Indonesia Defense University-Indonesia)

Dr. Eng. Rando Tungga Dewa focuses on the fracture mechanics field in advanced technology. He is an Assistant Professor in the Mechanical Engineering Department, RIDU (The Republic of Indonesia Defense University). He has done some research topics including Nuclear Reactor Gen-IV design, vibration fatigue on structures, and advanced additive manufacturing technologies on energetic materials. He, at least published more than 20 peer-reviewed articles and attended 50 symposiums with H-index 8

SCHEDULE PROGRAM

1. InCaSST – October 18, 2023 07.30 AM, Eastparc Hotel.
2. Gala Dinner – October 18, 2023 06.00 PM, Eastparc Hotel.

Detailed Conference Program

Wednesday, 18th October, 2023

(Time based: Jakarta, Indonesia GMT+7)

Time	Event	Room
07.30 – 08.00	Registration and Welcome Drink	Garden Room
08.00 – 08.15	Opening Ceremony	
08.15 – 08.30	Greeting Speech	
08.30 – 08.45	Traditional Dance Performance	
08.45 – 10.35	Keynote Speakers Session: 1. Prof. Tokuro Matsuo 2. Asst. Prof. Dr. Eng. Rando Tungga Dewa 3. Prof. Ir. Sudi Mungkasi, Ph.D. 4. Assoc. Prof. Dr. Peerapong Uthansakul	
10-35 – 10.50	Parallel Session Preparation	
10.50 – 12.00	Parallel Session 1	Room 1: Orchid Room Room 2: Magnolia Room (3rd floor)
12.00 – 13.00	Lunch	Restaurant
13.00 – 14.40	Parallel Session 2	Room 1: Orchid Room Room 2: Magnolia Room (3rd floor)
14.40 – 15.00	Coffee Break	
15.00 – 16.10	Parallel Session 3	Room 1: Orchid Room Room 2: Magnolia Room (3rd floor)

Detailed Gala Dinner Agenda

Wednesday, 18th October, 2023

(Time based: Jakarta, Indonesia GMT+7)

Place: Garden Room

Time	Event	
18.00 – 18.15	Opening Live Music Performance	Registration
18.15 – 18.30		
18.30 – 18.45	Opening Ceremony and Greeting Speech	
18.45 – 19.00	Gala Dinner	Launching of "Bunga Rampai" book
19.00 – 19.20		Anniversary Celebration of FST
19-20 – 19.35		Awards
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20.00 – 20.30		
20.30 – 20.45		
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DETAILED PRESENTATION SESSION

Time based: Jakarta, Indonesia GMT+7

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Asst. Prof. Dr. Eng. Rando Tungga Dewa	Research and Development at RIDU: Technological Resources for Defense Equipment
Q&A	
Prof. Ir. Sudi Mungkasi, Ph.D.	Roles of Mathematics in Disaster Mitigations
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2825	Investigation of Eichhornia crassipes as a natural fibre in PMC for noise controller	10'
2840	Exploring The Potential of Go-Based Composite Hydrogels and Their Swelling Property for Controlled Drug Delivery	10'
2899	Alternative Method for Stop The Coconut Shell Charcoal Briquette Drying Process	10'
2889	The Effect of Chassis Weight Optimization on The Carbon Footprint of The Electric Prototype Vehicle	10'

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Room 2 : Magnolia Room **Moderator**: Dr. Adinda Ihsani Putri **Topic** : Waste Management and Recycling		
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2625	Readiness Assessment of Lean Six Sigma Implementation in Manufacturing Industry as A Way To Ensure Sustainability	10'
2659	Modelling study of boiler using oil waste as an energy source	10'
2681	SCADA for Waste Sorting System as an Environmental Conservation Effort	10'
2687	Antibacterial Properties of Enzymatically Treated PET Fibers Functionalized by Nitric Oxide	10'
2843	Design And Feasibility Study of Mobile Biodigester for Military Operation	10'
2877	Optimization of pyrolysis of polypropylene and polyethylene based plastic waste become an alternative fuel oil using bentonite catalyst	10'

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2666	Solar Power Control System on Smart Green Home	10'
2663	Numerical Investigation on the Effect of Blunt Body Deflector on Darieus Turbine Performance	10'
2773	Using A Stepper Motor as A Low-Power, Low-Rotation DC Generator for Renewable Energy Harvesting	10'
2786	Design And Implementation of A 232.2 KWP Rooftop and on Grid Solar Power Plant	10'
2812	An experimental investigation on CCFL characteristics during gas/low surface tension liquid counter-current two-phase flow in a small-scaling PWR hot leg typical geometry	10'
2830	Techno-Economic Analysis of Hybrid PV-Battery-Diesel System for Isolated Dockyard in West Papua	10'
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2019	Gamification Design for Tourism Mobile Applications Temple	10’
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2886	Aerial Object Detection Analysis: Challenges and Preliminary Results	10'
2887	The Performance of DST-Wavelet Feature Extraction for Guitar Chord Recognition	10'

PARALLEL SESSION 3.2. 15.00 – 16.10 WIB		
Room 2 : Magnolia Room **Moderator**: Dr. Lusia Krismiyati Budiasih **Topic** : Sustainable Agriculture and Land Use Practices		
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Readiness assessment of lean six sigma implementation in the manufacturing industry as a way to ensure sustainability

Fransisca Candra Dewi[1], *Lusia Permata Sari* Hartanti[1], *Dian Retno Sari* Dewi[1], *Julius* Mulyono[1,*] and *Ig. Jaka* Mulyana[1]

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Abstract. Lean Six Sigma (LSS) is a strategy to overcome the problems that occur to improve the efficiency and effectiveness of the company through the elimination of variation and waste. efficiency and effectiveness will ensure the sustainability of the company. Several factors affect the success of LSS implementation in the company. Therefore, to be successful in LSS implementation, an assessment is needed to measure the level of LSS readiness (Lean Six Sigma Readiness/LESIRE). This article discusses the measurement of the readiness level of the plastic industry in Indonesia in the implementation of LSS. In addition to measuring the level of readiness, this article also discusses what important factors must be prepared in advance to be ready for LSS implementation. Data was collected by distributing questionnaires and processed using the fuzzy method. Factors that influence success consist of 5 enablers, 19 criteria, and 55 attributes. The results showed that the industry studied was categorized as Almost Ready. Attributes that need to be improved to increase LSS readiness are company initiatives in development, learning processes in development, improving workforce skills, customer-focused organizations or companies, strategic and visionary leadership, responsibility, authority and communication, planning, feedback loop design, eliminating waste, high impact of customer satisfaction, and technology improvement.

1 Introduction

The manufacturing industry must prioritize product quality and excellence. In addition, manufacturing companies must also improve efficiency and efficiency to reduce waste. Waste is any activity contained in a process flow that does not provide added value to the final product which can affect the aspect of customer satisfaction. Hines & Taylor [1] explain that there are seven types of waste, and it has even grown to eight types of waste. Höfer et al. [2] explained that the eight wastes are defects and rework, overproduction, waiting, non-utilized talent, transportation, inventory, motion, and extra processing. Waste has an impact and results in losses, so the company needs the right strategy to reduce waste. Lean Six Sigma

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is a strategy that can be used in business and industry improvement. Lean started from Toyota's production system with the main emphasis on waste in the process, and Six Sigma originated from Motorola with a focus on reducing variation in the process to improve efficiency. According to Albliwi et al. [3] LSS is a widely accepted technique used for continuous improvement in quality-related issues in fields such as manufacturing and service sectors by combining both lean thinking (LT) and six sigma. LSS is widely used because it has been widely recognized and has proven to be the most successful to improve a company with operational efficiency, increasing productivity, and reducing costs [4].

The manufacturing sectors' principal concern in recent years has been to lessen their ecological imprint. With the help of developing technology, businesses are becoming more resource-efficient and shifting their focus to sustainability [5]. Meanwhile, Maria, et.al [6] stated that the LSS technique, in particular for firms using it as a methodology to accomplish and manage results and seek competitive advantage, contributes to the performance of organizations as it highlights environmental aspects. Furthermore, approaches like LSS would be more successful in meeting the rising demand while maximizing resource use and taking environmental concerns into account [5]. By using the LSS approach, it can reduce waste, which in turn will improve environmental and economic sustainability.

Organizational readiness is essential in developing LSS. The readiness to develop LSS will determine its success. By knowing the level of readiness to develop Lean Six Sigma, organizations can identify barriers to implementing LSS. Many factors affect the success of LSS implementation, so it is necessary to evaluate LSS readiness so that improvements or preparations for LSS implementation can be made. Identifying the level of readiness in an organization or company will help determine the company's potential to make the change process effective [7]. Several researchers have measured Lean Readiness in manufacturing and healthcare as well as in Higher Education Institution (HEI).

Fuzzy logic was used by Bayou & de Korvin [8] to measure the leanness of two automotive industries using fuzzy logic and determine how lean two car industries were. Fuzzy logic was also used by certain academics to measure leanness [9–11]. The leanness index and score can be used to identify areas that need to be improved. Furthermore, Wong et al. [12] used the Analytic Network Process (ANP) to quantify the leanness level (index) in a comprehensive method that took into account three factors (quality, cost, and on-time delivery). Other researchers have evaluated leanness using Interval-Valued Fuzzy Sets (IVFS) [13] and Data envelopment analysis (DEA), Fuzzy DEA (FDEA), Fuzzy Cognitive Map (FCM), DEMATEL, and AHP [14]. While working in the healthcare industry, Vaishnavi & Suresh [7] used fuzzy logic to assess a hospital. Mulyana, IJ et al. [15] used fuzzy method to measure lean readiness of Higher Education Institution.

This article discusses the assessment of the readiness level of the plastic industry for LSS implementation. Fuzzy logic is used to assess the readiness level.

2 Methods

The performance level and importance weight of each aspect makes up the two components of the assessment. The readiness level of each factor is assessed based on the evaluation of the performance level and importance weight of each factor. using the fuzzy approach to assess. The following are the steps to determine the readiness level:

2.1 Enabler, criteria, and attribute of readiness

LSS implementation enabler, criteria, and attribute. The enablers consist of organization culture, management and leadership commitment, LSS planning, linking LSS to business, and the external environment [7,11].

2.2 Determination of Likert Scale, Linguistic Scale, and Fuzzy Number of performance levels and importance weights of factors used in the assessment of LSS readiness

Assessment of performance level and importance weight by experts using the Likert Scale. Each expert's answer is converted to a fuzzy number according to Table 1.

Table 1. Linguistic Scale, Likert Scale, and Fuzzy Number.

	Performance Level			Importance Weight	
Linguistic Scale	**Likert Scale**	**Fuzzy Number (l,m,u)**	**Linguistic Scale**	**Likert Scale**	**Fuzzy Number (l,m,u)**
Worst	1	(1, 1, 2)	Very Low	1	(0.1, 0.1, 0.2)
Very Poor	2	(1, 2, 3)	Low	2	(0.1, 0.2, 0.3)
Poor	3	(2, 3, 4)	Fairly Low	3	(0.2, 0.3, 0.4)
Fair	4	(3, 4, 5)	Medium	4	(0.3, 0.4, 0.5)
Fairer	5	(4, 5, 6)	Fairly High	5	(0.4, 0.5, 0.6)
Almost Good	6	(5, 6, 7)	More Fairly High	6	(0.5, 0.6, 0.7)
Good	7	(6, 7, 8)	Almost High	7	(0.6, 0.7, 0.8)
Very Good	8	(7, 8, 9)	High	8	(0.7, 0.8, 0.9)
Almost Excellent	9	(8, 9, 10)	Almost Very High	9	(0.8, 0.9, 1)
Excellent	10	(9, 10, 10)	Very High	10	(0.9, 1, 1)

2.3 Aggregating fuzzy performance levels and importance weights

Calculation of fuzzy performance level and importance level of each criterion using equations (1) and (2) respectively,

$$H_{ij} = \frac{\sum_{k=1}^{n} G_{ijk} \otimes H_{ijk}}{\sum_{k=1}^{n} G_{ijk}} \quad (1)$$

$$G_{ij} = \frac{\sum_{k=1}^{n} G_{ijk} \otimes H_{ijk}}{\sum_{k=1}^{n} H_{ijk}} \quad (2)$$

Meanwhile to find the fuzzy performance level and importance level of each enabler using equation (3) and (4) respectively,

$$H_i = \frac{\sum_{k=1}^{n} G_{ij} \otimes H_{ij}}{\sum_{k=1}^{n} G_{ij}} \quad (3)$$

$$G_i = \frac{\sum_{k=1}^{n} G_{ij} \otimes H_{ij}}{\sum_{k=1}^{n} H_{ij}} \quad (4)$$

Where,

H_i = Fuzzy importance rating for readiness for the implementation of LSS of i-th enabler

H_{ij} = Fuzzy importance rating for readiness for the implementation of LSS of j-th criterion in the i-th enabler

H_{ijk} = Fuzzy importance rating for readiness for the implementation of LSS of k-th attribute of j-th criterion in the i-th enabler

G_i = Fuzzy importance weight for readiness for the implementation of LSS of i-th enabler

G_{ij} = Fuzzy importance weight for readiness for the implementation of LSS of j-th criterion in the i-th enabler

G_{ijk} = Fuzzy importance weight for readiness for the implementation of LSS of k-th attribute of j-th criterion in the i-th enabler

Then, calculate the fuzzy readiness index using equation (5).

$$\text{FRLSSI} = \frac{\sum_{i=1}^{l}(\boldsymbol{G_i} \otimes \boldsymbol{H_i})}{\sum_{i=1}^{l} \boldsymbol{G_i}} \quad (5)$$

2.4 Match the FRLSSI with an appropriate level

The Euclidean Distance technique is then used to compare the FRLSSI value to the term readiness level. Five language terms from Naranayamurthy [16] readiness level are used in this strategy consisting of Not Ready (NR), Low Ready (LR), Average Ready(AR), Close to Ready (CR), and Ready (R). Table 2 shows terms of readiness level and related fuzzy numbers

Table 2. Fuzzy number term readiness level.

Term Readiness Level	Fuzzy Number
Not Ready (NR)	(0, 1.5, 3)
Low Ready (LR)	(1.5, 3, 4.5)
Average Ready(AR)	(3.5, 5, 6.5)
Close to Ready (CR)	(5.5, 7, 8.5)
Ready (R)	(7, 8.5, 10)

Calculate Euclidean Distance using equation (6)

$$\text{D}(\text{FRLSSI}, \text{RLSSLi}) = \sqrt{\sum(\text{fFRLSSI}(\text{x}) - \text{fRLSSLi}(\text{x}))^2} \quad (6)$$

2.5 Determine the attribute must be improved

Variables that have a low level of readiness will become obstacles to making improvements. For this reason, the value of the Fuzzy Performance Importance Index (FPII) is calculated using equation (7)

$$\text{FPII} = \text{W}_{\text{ijk}} \otimes \text{H}_{\text{ijk}} \quad (7)$$

where Wijk = (1,1,1) – Gijk

Furthermore, calculate a rank score for each variable using equation (8)

$$\text{Rank Score} = \frac{\text{a}+4\text{b}+\text{c}}{6} \quad (8)$$

3 Result and discussion

In this study, enabler, criteria, and attributes of readiness Lean Six Sigma are adopted from Sreedharan, et. al [11] and Vaishnavi & Suresh [7] displayed in Appendix 1. The performance level and importance weight assessment of attributes LSS readiness was conducted by ten (10) middle managers. Each answer is converted to a fuzzy number according to Table 2. The conversion results are averaged using equation (7). Table 3 displays the average performance level and importance weight of attributes.

Average fuzzy number =

$$\left[\frac{l_1+l_2+\cdots l_n}{n}, \frac{m_1+m_2+\cdots m_3}{n}, \frac{u_1+u_2+\cdots u_3}{n}\right] \quad (9)$$

Table 3. Average performance level and importance weight.

Enabler	Criteria	Attribute	G_{ijk}	H_{ijk}
LC1	LC11	LC111	(0.72, 0.89, 0.94)	(6.5, 7.69, 8.69)
		LC112	(0.75, 0.85, 0.92)	(6.31, 7.31, 8.25)
		LC113	(0.58, 0.68, 0.78)	(5.69, 6.69, 7.69)
		LC114	(0.65, 0.75, 0.85)	(5.56, 6.56, 7.56)
	LC12	LC121	(0.79, 0.89, 0.96)	(5.93, 6.93, 7.93)
		LC122	(0.8, 0.9, 0.95)	(6.06, 7.06, 8.06)
		LC123	(0.81, 0.91, 0.97)	(5.87, 6.87, 7.87)
	LC13	LC131	(0.64, 0.74, 0.84)	(4.81, 5.81, 6.81)
	LC14	LC141	(0.77, 0.87, 0.94)	(5.81, 6.81, 7.81)
		LC142	(0.76, 0.86, 0.93)	(6.43, 7.43, 8.43)
	LC15	LC151	(0.7, 0.8, 0.89)	(6.25, 7.25, 8.25)
		LC152	(0.75, 0.85, 0.92)	(6, 7, 8)
		LC153	(0.75, 0.85, 0.93)	(5.93, 6.93, 7.93)
LC2	LC21	LC211	(0.82, 0.92, 0.97)	(6.81, 7.81, 8.81)
		LC212	(0.77, 0.87, 0.94)	(6.43, 7.43, 8.43)
		LC213	(0.8, 0.9, 0.95)	(6.31, 7.31, 8.31)
	LC22	LC221	(0.66, 0.76, 0.86)	(5.75, 6.75, 7.75)
	LC23	LC231	(0.77, 0.87, 0.93)	(5.75, 6.75, 7.75)
		LC232	(0.8, 0.9, 0.96)	(6.43, 7.43, 8.43)
		LC233	(0.79, 0.89, 0.95)	(6.18, 7.18, 8.18)
	LC24	LC241	(0.79, 0.89, 0.95)	(6.25, 7.25, 8.25)

Enabler	Criteria	Attribute	G_{ijk}	H_{ijk}
		LC242	(0.77, 0.87, 0.93)	(6.37, 7.37 8.375)
		LC243	(0.79, 0.89, 0.95)	(6.37, 7.37, 8.37)
		LC244	(0.79, 0.89, 0.95)	(6.31, 7.31, 8.31)
	LC25	LC251	(0.78, 0.88, 0.94)	(6.5, 7.5, 8.5)
		LC252	(0.8, 0.9, 0.95)	(6.5, 7.5, 8.5)
		LC253	(0.77, 0.87, 0.93)	(6.25, 7.25, 8.25)
		LC254	(0.78, 0.88, 0.95)	(6.25, 7.25, 8.25)
LC3	LC31	LC311	(0.71, 0.81, 0.91)	(6.25, 7.25, 8.18)
		LC312	(0.69, 0.79, 0.89)	(4.93, 5.93, 6.93)
		LC313	(0.75, 0.85, 0.93)	(5.62, 6.62, 7.62)
	LC32	LC321	(0.78, 0.88, 0.94)	(6.06, 7.06, 8.06)
		LC322	(0.74, 0.84, 0.92)	(5.68, 6.68, 7.68)
		LC323	(0.74, 0.84, 0.91)	(6.06, 7.06, 8.06)
	LC33	LC331	(0.76, 0.86, 0.94)	(6.06, 7.06, 8.06)
		LC332	(0.77, 0.87, 0.93)	(6.06, 7.06, 8.06)
		LC333	(0.8, 0.9, 0.97)	(6.12, 7.12, 8.12)
LC4	LC41	LC411	(0.75, 0.85, 0.93)	(6, 7, 8)
	LC42	LC421	(0.74, 0.84, 0.92)	(5.93, 6.68, 7.68)
		LC422	(0.76, 0.86, 0.95)	(6.06, 7.06, 8.06)
		LC423	(0.73, 0.83, 0.92)	(6.12, 7.12, 8.12)
		LC424	(0.73, 0.83, 0.92)	(6.37, 7.37, 8.37)
		LC425	(0.74, 0.84, 0.93)	(5.81, 6.81, 7.81)
	LC43	LC431	(0.72, 0.82, 0.91)	(6.75, 7.75, 8.68)
		LC432	(0.72, 0.82, 0.91)	(6.37, 7.37, 8.37)
		LC433	(0.73, 0.83, 0.92)	(6.31, 7.31, 8.31)
		LC434	(0.79, 0.89, 0.96)	(6.75, 7.75, 8.68)
LC5	LC51	LC511	(0.78, 0.88, 0.95)	(6.31, 7.31, 8.31)
		LC512	(0.79, 0.89, 0.96)	(6.25, 7.25, 8.25)

Enabler	Criteria	Attribute	G_{ijk}	H_{ijk}
		LC513	(0.78, 0.88, 0.94)	(6.75, 7.75, 8.68)
	LC52	LC521	(0.76, 0.86, 0.94)	(6.5, 7.5, 8.5)
		LC522	(0.76, 0.86, 0.94)	(6.5, 7.5, 8.5)
		LC523	(0.73, 0.83, 0.93)	(6.25, 7.25, 8.25)
	LC53	LC531	(0.77, 0.87, 0.94)	(6.06, 7.06, 8.06)
		LC532	(0.79, 0.89, 0.95)	(6.12, 7.12, 8.06

Furthermore, the calculation of fuzzy performance level and importance weight of each criterion (1) and (2), respectively. For example, the calculation of fuzzy performance level and importance weight of LC11 criteria is as follows:

$$H_{LC11} = \frac{\begin{matrix}[\big((0.72,0.89,0.94)\otimes(6.5,7.69,8.69)\big)\oplus \\ \big((0.75,0.85,0.92)\otimes(6.31,7.31,8.25)\big)\oplus \\ \big((0.58,0.68,0.78)\otimes(5.69,6.69,7.69)\big)\oplus \\ ((0.65,0.75,0.85)\otimes(5.56,6.56,7.56))]\end{matrix}}{\begin{matrix}[(0.72,0.89,0.94)\oplus(0.75,0.85,0.92)\oplus \\ (0.58,0.68,0.78)\oplus(0.65,0.75,0.85)\end{matrix}}$$
$$= (6.05, 7.11, 8.07)$$

$$G_{LC11} = \frac{\begin{matrix}[\big((0.72,0.89,0.94)\otimes(6.5,7.69,8.69)\big)\oplus \\ \big((0.75,0.85,0.92)\otimes(6.31,7.31,8.25)\big)\oplus \\ \big((0.58,0.68,0.78)\otimes(5.69,6.69,7.69)\big)\oplus \\ ((0.65,0.75,0.85)\otimes(5.56,6.56,7.56))]\end{matrix}}{\begin{matrix}[(6.5,7.69,8.69)\oplus(6.31,7.31,8.25)\oplus \\ (5.69,6.69,7.69)\oplus(5.56,6.56,7.56)]\end{matrix}}$$
$$= (0.68, 0.80, 0.88)$$

The complete calculation results for all criteria can be seen in Table 4

Table 4. Fuzzy performance level and importance weight of criteria.

Criteria	G_{ij}	H_{ij}
LC11	(0.68,0.80,0.88)	(6.05, 7.11, 8.07)
LC12	(0.79, 0.89, 0.95)	(5.96, 6.96, 7.96)
LC13	(0.64, 0.74, 0.84)	(4.81, 5.81, 6.81)
LC14	(0.76, 0.86, 0.93)	(6.12, 7.12, 8.12)
LC15	(0.73, 0.83, 0.91)	(6.05, 7.05, 8.05)
LC21	(0.79, 0.89, 0.95)	(6.52, 7.52, 8.52)
LC22	(0.66, 0.76, 0.86)	(5.75, 6.75, 7.75)
LC23	(0.78, 0.88, 0.94)	(6.12, 7.12, 8.12)

LC24	(0.78, 0.88, 0.94)	(6.32, 7.32, 8.32)
LC25	(0.78, 0.88, 0.94)	(6.37, 7.37, 8.37)
LC31	(0.71, 0.81, 0.91)	(5.61, 6.60, 7.58)
LC32	(0.75, 0.85, 0.92)	(5.93, 6.93, 7.93)
LC33	(0.77, 0.87, 0.94)	(6.08, 7.08, 8.08)
LC41	(0.75, 0.85, 0.93)	(6.01, 7.02, 8.04)
LC42	(0.73, 0.83, 0.92)	(6.06, 7.01, 8.01)
LC43	(0.74, 0.84, 0.92)	(6.55, 7.55, 8.51)
LC51	(0.78, 0.88, 0.94)	(6.43, 7.43, 8.41)
LC52	(0.75, 0.85, 0.93)	(6.41, 7.41, 8.41)
LC53	(0.78, 0.88, 0.94)	(6.09, 7.094, 8.06)

Calculate the fuzzy performance level and importance weight of each enabler using equations (3) and (4) and the results can be seen in Table 5.

Table 5. Fuzzy performance level and importance weight of enabler.

Enabler	G_i	H_i
LC1	(0.72, 0.83, 0.90)	(5.82, 6.83, 7.82)
LC2	(0.76, 0.86, 0.93)	(6.23, 7.23, 8.23)
LC3	(0.75, 0.84, 0.92)	(5.88, 6.88, 7.87)
LC4	(0.74, 0.84, 0.92)	(6.20, 7.18, 8.17)
LC5	(0.77, 0.87, 0.94)	(6.31, 7.31, 8.29)

The next step is to calculate the fuzzy readiness index (FRLSSI) using equation (5)

$$FRLSSI = \frac{\begin{array}{c}[((0.72,0.83,0.90)\otimes(5.82,6.83,7.82))\oplus \\ ((0.76,0.86,0.93)\otimes(6.23,7.23,8.23))\oplus \\ ((0.75,0.84,0.92)\otimes(5.88,6.88,7.87))\oplus \\ ((0.74,0.84,0.92)\otimes(6.20,7.18,8.17))\oplus \\ ((0.77,0.87,0.94)\otimes(6.31,7.31,8.29))]\end{array}}{\begin{array}{c}[(0.72,0.83,0.90)\oplus(0.76,0.86,0.93)\oplus \\ (0.75,0.84,0.92)\oplus \\ (0.74,0.84,0.92)\oplus(0.77,0.87,0.94)]\end{array}}$$

$$= (6.09, 7.09, 8.08)$$

The Euclidean Distance technique as equation (6) is then used to compare the FRLSSI value to the term level of readiness as in Table 3. As an example of calculating the Euclidean Distance level of readiness Not Ready:

$$D(FRLSSI, NR) = \sqrt{[(6.09-0)^2 + (7.09-1.5)^2 + (8.08-3)^2]} = 9.71$$

Similarly, other readiness levels can be determined from Euclidean distance, including:

$$D(FRLSSI, LR) = 7.12$$
$$D(FRLSSI, AR) = 3.69$$
$$\boldsymbol{D(FRLSSI, CR) = 0.73}$$
$$D(FRLSSI, R) = 2.54$$

In this case, the readiness level of this company is **Close to Ready (CR)** based on the term readiness level and the minimal grade of D.

To be successful in implementing LSS, improvements must be made to the LSS readiness attributes so that the readiness level becomes **Ready**. To determine the priority of attributes that must be improved, the Fuzzy Performance Importance Index (FPII) is calculated using equation (7) and the ranking value (rank score) using equation (8). Attributes with low-rank scores are prioritized for improvement. Rank score and priority improvement of attributes are displayed in Table 6.

Table 6. Rank score and priority improvement order.

Attribute	W_{ijk} = (1,1,1) – Gijk	H_{ijk}	FPII = $W_{ijk} \otimes H_{ijk}$	Rank Score	Priority Improvement Order
LC111	(0.06, 0.11, 0.28)	(6.5, 7.69, 8.69)	(0.39, 0.85, 2.43)	1.037	29
LC112	(0.08, 0.15, 0.25)	(6.31, 7.31, 8.25)	(0.51, 1.10, 2.06)	1.162	41
LC113	(0.22, 0.32, 0.42)	(5.69, 6.69, 7.69)	(1.25, 2.14, 3.23)	2.173	55
LC114	(0.15, 0.25, 0.35)	(5.56, 6.56, 7.56)	(0.83, 1.64, 2.65)	1.673	54
LC121	(0.04, 0.11, 0.21)	(5.93, 6.93, 7.93)	(0.24, 0.76, 1.67)	0.825	7*
LC122	(0.05, 0.1, 0.2)	(6.06, 7.06, 8.06)	(0.30, 0.71, 1.61)	0.792	4*
LC123	(0.03, 0.09, 0.19)	(5.87, 6.87, 7.87)	(0.18, 0.62, 1.50)	0.693	1*
LC131	(0.16, 0.26, 0.36)	(4.81, 5.81, 6.81)	(0.77, 1.51, 2.45)	1.543	52
LC141	(0.06, 0.13, 0.23)	(5.81, 6.81, 7.81)	(0.35, 0.89, 1.80)	0.952	20
LC142	(0.07, 0.14, 0.24)	(6.43, 7.43, 8.43)	(0.45, 1.04, 2.03)	1.107	36
LC151	(0.11, 0.2, 0.3)	(6.25, 7.25, 8.25)	(0.69, 1.45, 2.48)	1.495	51
LC152	(0.08, 0.15, 0.25)	(6, 7, 8)	(0.48, 1.05, 2)	1.113	37
LC153	(0.07, 0.15, 0.25)	(5.93, 6.93, 7.93)	(0.42, 1.04, 1.98)	1.093	32
LC211	(0.03, 0.08, 0.18)	(6.81, 7.81, 8.81)	(0.20, 0.63, 1.59)	0.718	2*
LC212	(0.06, 0.13, 0.23)	(6.43, 7.43, 8.43)	(0.39, 0.97, 1.94)	1.035	27
LC213	(0.05, 0.1, 0.2)	(6.31, 7.31, 8.31)	(0.32, 0.73, 1.66)	0.817	5*

Attribute	W_{ijk} = (1,1,1) – Gijk	H_{ijk}	FPII = $W_{ijk} \otimes H_{ijk}$	Rank Score	Priority Improvement Order
LC221	(0.14, 0.24, 0.34)	(5.75, 6.75, 7.75)	(0.81, 1.62, 2.64)	1.655	53
LC231	(0.07, 0.13, 0.23)	(5.75, 6.75, 7.75)	(0.40, 0.88, 1.78)	0.950	19
LC232	(0.04, 0.1, 0.2)	(6.43, 7.43, 8.43)	(0.26, 0.74, 1.69)	0.818	6*
LC233	(0.05, 0.11, 0.21)	(6.18, 7.18, 8.18)	(0.31, 0.79, 1.72)	0.865	11
LC241	(0.05, 0.11, 0.21)	(6.25, 7.25, 8.25)	(0.31, 0.80, 1.73)	0.873	12
LC242	(0.07, 0.13, 0.23)	(6.37, 7.37 8.375)	(0.45, 0.96, 1.93)	1.037	28
LC243	(0.05, 0.11, 0.21)	(6.37, 7.37, 8.37)	(0.32, 0.81, 1.76)	0.887	14
LC244	(0.05, 0.11, 0.21)	(6.31, 7.31, 8.31)	(0.32, 0.80, 1.75)	0.878	13
LC251	(0.06, 0.12, 0.22)	(6.5, 7.5, 8.5)	(0.39, 0.9, 1.87)	0.977	21
LC252	(0.05, 0.1, 0.2)	(6.5, 7.5, 8.5)	(0.33, 0.75, 1.7)	0.838	8*
LC253	(0.07, 0.13, 0.23)	(6.25, 7.25, 8.25)	(0.44, 0.94, 1.90)	1.017	25
LC254	(0.05, 0.12, 0.22)	(6.25, 7.25, 8.25)	(0.31, 0.87, 1.82)	0.935	17
LC311	(0.09, 0.19, 0.29)	(6.25, 7.25, 8.18)	(0.56, 1.38, 2.37)	1.408	49
LC312	(0.11, 0.21, 0.31)	(4.93, 5.93, 6.93)	(0.54, 1.25, 2.15)	1.282	45
LC313	(0.07, 0.15, 0.25)	(5.62, 6.62, 7.62)	(0.39, 0.99, 1.91)	1.043	30
LC321	(0.06, 0.12, 0.22)	(6.06, 7.06, 8.06)	(0.36, 0.85, 1.77)	0.922	16
LC322	(0.08, 0.16, 0.26)	(5.68, 6.68, 7.68)	(0.46, 1.07, 2.00)	1.123	38
LC323	(0.09, 0.16, 0.26)	(6.06, 7.06, 8.06)	(0.55, 1.13, 2.10)	1.195	42
LC331	(0.06, 0.14, 0.24)	(6.06, 7.06, 8.06)	(0.36, 0.99, 1.94)	1.043	31
LC332	(0.07, 0.13, 0.23)	(6.06, 7.06, 8.06)	(0.42, 0.92, 1.85)	0.992	23
LC333	(0.03, 0.1, 0.2)	(6.12, 7.12, 8.12)	(0.18, 0.71, 1.63)	0.775	3*
LC411	(0.07, 0.15, 0.25)	(6, 7, 8)	(0.42, 1.05, 2)	1.103	33
LC421	(0.08, 0.16, 0.26)	(5.93, 6.68, 7.68)	(0.48, 1.07, 2.00)	1.127	39
LC422	(0.05, 0.14, 0.24)	(6.06, 7.06, 8.06)	(0.30, 0.99, 1.94)	1.033	26
LC423	(0.08, 0.17, 0.27)	(6.12, 7.12, 8.12)	(0.49, 1.21, 2.19)	1.253	43
LC424	(0.08, 0.17, 0.27)	(6.37, 7.37, 8.37)	(0.51, 1.25, 2.26)	1.295	47

Attribute	W_{ijk} = (1,1,1) – Gijk	H_{ijk}	FPII = $W_{ijk} \otimes H_{ijk}$	Rank Score	Priority Improvement Order
LC425	(0.07, 0.16, 0.26)	(5.81, 6.81, 7.81)	(0.41, 1.09, 2.03)	1.133	40
LC431	(0.09, 0.18, 0.28)	(6.75, 7.75, 8.68)	(0.61, 1.40, 2.43)	1.440	50
LC432	(0.09, 0.18, 0.28)	(6.37, 7.37, 8.37)	(0.57, 1.33, 2.35)	1.373	48
LC433	(0.08, 0.17, 0.27)	(6.31, 7.31, 8.31)	(0.51, 1.24, 2.24)	1.285	46
LC434	(0.04, 0.11, 0.21)	(6.75, 7.75, 8.68)	(0.27, 0.85, 1.82)	0.915	15
LC511	(0.05, 0.12, 0.22)	(6.31, 7.31, 8.31)	(0.32, 0.88, 1.83)	0.945	18
LC512	(0.04, 0.11, 0.21)	(6.25, 7.25, 8.25)	(0.25, 0.80, 1.73)	0.863	10*
LC513	(0.06, 0.12, 0.22)	(6.75, 7.75, 8.68)	(0.41, 0.93, 1.91)	1.007	24
LC521	(0.06, 0.14, 0.24)	(6.5, 7.5, 8.5)	(0.39, 1.05, 2.04)	1.105	34
LC522	(0.06, 0.14, 0.24)	(6.5, 7.5, 8.5)	(0.39, 1.05, 2.04)	1.105	35
LC523	(0.07, 0.17, 0.27)	(6.25, 7.25, 8.25)	(0.44, 1.23, 2.23)	1.265	44
LC531	(0.06, 0.13, 0.23)	(6.06, 7.06, 8.06)	(0.36, 0.92, 1.85)	0.982	22
LC532	(0.05, 0.11, 0.21)	(6.12, 7.12, 8.06	(0.31, 0.78, 1.70)	0.855	9*

Table 6 shows the top 10 attributes that have the highest rank score and are prioritized for improvement, namely (1). Workforce skill upgrade (LC123) (2). Customer-focused organization (LC211) (3). Eliminating waste (LC333) (4). Learning in the organization (LC122) (5). Strategic and visionary leadership (LC213) (6). Responsibility, authority, and communication (LC232), (7). Development initiatives (LC121) (8). Design of feedback loops (LC252) (9). Technology upgradation (LC532), and (10) High impact of customer satisfaction (LC512). Based on the 10 (ten) weaker attributes, some suggestions to improve readiness in implementing LSS as in Table **7**.

Table 7. Weaker and related suggestions.

Weaker	Suggestion(s)
Workforce skill upgrade	Upgrading workforce skills by appropriate continuous training Job analysis and recruiting a skilled workforce
Customer focused organization	Development of customer survey and feedback system Product design based on customer requirements.
Eliminating waste	Identification and classification of wastes both in shopfloor and office Uses appropriate Six Sigma methodology to reduce waste
Learning in the organization	Development sharing forum between departments. Competition for interdepartmental improvement projects Regular seminars or workshops

Weaker	Suggestion(s)
Strategic and visionary leadership	Improve managerial skills, planning and control, and teamwork development of all level leaders
Responsibility, authority, and communication	Distribute duties, responsibilities and rights equally among employees Giving power and responsibility for decisions made Encourage employee participation in achieving goals Plan and schedule regular meetings or discussions to maintain communication.
Development initiatives	Encourage all workforce to improve their work Provide reward system
Design of feedback loops	Improve feedback system at all levels of management
Technology upgradation	Update equipment, tools, and methods in production Replace the old equipment and machines. Proper training in handling machines and equipment Periodic review and analysis of all equipment
High impact on customer satisfaction	Accessibility of service and information of the company Simplicity in handling customer suggestions and complaints

Sustainability is a timely and important issue. Achieving sustainability has become important for organisations as they face increasing pressure from customers, regulators, and other stakeholders to become greener. In this context, moving towards greener operations can help organisations develop products and processes that are in line with stakeholder expectations [17]. LSS is one of the most effective initiatives for improving process performance. LSS approach to minimize different types of waste [18]. By minimizing waste sustainability of the environment and economy can be achieved. Environmental sustainability can be achieved by minimizing product defects. Otherwise, economic sustainability through effective and efficient resource utilization.

4 Conclusion

This article has discussed the readiness level of the plastic industry. The result shows that the readiness level of LSS this company is Close to Ready. It means that there are some opportunities to improve some attributes to Ready in implementing LSS. Some ideas have been suggested to improve the readiness level of the company. Implementing LSS will improve the environmental and economic sustainability of the company.

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