Artificial Intelligence in Automotive Components Industrial Clusters at Chennai

Bhaskaran E[1], Harikumar Pallathadka[2], Baskara Sethupathy S[3]
[1]*Doctor of Science Scholar, Mechanical Engineering, Manipur International University, Manipur, India*
[2]*Vice Chancellor, Manipur International University, Manipur, India*
[3]*Professor and Head, Automobile Engineering, Velammal Engineering College, Chennai, India*
Corresponding Author: e.bhaskaran19@gmail.com

Abstract*: Chennai is also called as Detroit of India due to its automotive industry presence producing over 40 % of the India's vehicle and components. The Automotive Component Industries (ACI) in Tirumudivakkam Industrial Estate, Chennai has faced problems on infrastructure, technology, procurement, production and marketing. Under the Cluster Development Approach (CDA), they formed Precision Engineering Clusters (PEC) with 40 MSMEs got 70% grant under Mega Cluster Scheme from Government of Tamil Nadu, 10% from Bank Loan and 20% contribution under Public Private Partnership Concept. Due to this the infrastructure, technology, procurement, production and marketing interrelationships taken place among PEC. Now the objective is to study on Integration of Artificial Intelligence and Robotics for Smart Production Optimisation in PEC. The methodology adopted is collection of primary data from 40 MSMEs and analyzing using Artificial Intelligence Technics Models and secondary data from Government of India and Tamil Nadu websites. To conclude Critical gaps in the PEC are identified and using Common Facility Centre like design, product development, testing and standardization the MSMEs in PEC is able to reduce the service charges by using latest machineries in the CFC when compared to Market Service Charge which is exorbitant and individual MSMEs are unable to use with private players. For better utilization of Production optimization Moderate and Mediating Variables and various structural equation models are developed to reduce cost of production and maximize profit to compete it globally. By Integration of Artificial Intelligence and Robotics Smart Production Optimisation techniques are evolved in ACIC at Chennai. The Artificial Intelligence Business Analytics Models are developed using Descriptive Analytics, Diagnostic Analytics, Predictive Analytics and Prescriptive Analytics. Government of India and Tamil policy and regulations on CDA will benefit PEC in general and individual Micro, Small and Medium Automotive Components Manufacturers at Chennai in particular. To conclude, the integration of artificial intelligence and robotics represents a transformative approach to smart production optimization in PEC at Chennai. Through continued research and innovation, stakeholders / Micro, Small and Medium Automotive Components Manufacturers can unlock new opportunities, address challenges, and drive sustainable growth in the automotive manufacturing sector at Chennai.

***Keywords*: Precision Engineering Cluster, Integration, Artificial Intelligence, Robotics, Production Optimization.**

1. Introduction

Tamil Nadu has a highly developed industrial manufacturing eco-system. It has evolved into the largest hub to produce automobiles and auto-components, textiles, leather products, light and heavy engineering, pumps and motors, electronic software, and hardware. The State continues to be a national leader in exports of automobiles and automotive components, leather products, software, and ready-made garments. Many globally renowned companies have set up their manufacturing facilities in Tamil Nadu. At present, Tamil Nadu has 173 industrial parks/ complexes/ estates/ growth centres/ SEZs promoted by SIPCOT, SIDCO and DIC. Tamil Nadu is number one in number of Cluster development which is around 60 due to 3rd highest number of MSMEs with more than 50 lakh MSMEs, 23.60 lakh registered MSMEs,8% of India's MSMEs share,151.61 lakh employment and 2.73 lakh crore investment.

2. Methodology

The Micro and Small enterprise (MSE) sector occupies a significant role in the total manufacturing sector of India, and Tamil Nadu in particular. The integration of artificial intelligence (AI) and robotics for smart production optimization in automobile components industrial clusters has been a subject of extensive research. Overall, the literature review highlights the growing importance of integrating AI and robotics in automobile components industrial clusters for smart production optimization. It identifies key applications, benefits, challenges, and future research directions in this rapidly evolving field.

Review of the literature on the integration of artificial intelligence (AI) and robotics for smart production optimization in automotive components industrial clusters in Chennai reveals a growing body of research and studies focusing on various aspects of this topic. In conclusion, the study on the integration of AI and robotics for smart production optimization in automotive components industrial clusters in Chennai

Manuscript revised December 16, 2024; accepted December 17, 2024. Date of publication December 22, 2024.
This paper available online at www.ijprse.com
ISSN (Online): 2582-7898; SJIF: 5.59

addresses critical needs, offers compelling justifications, holds significant implications for regional development and industry leadership, and encompasses a broad scope covering technological, economic, environmental, and policy aspects.

A. Aims and Objectives

1) The aims and objectives of the study on the integration of artificial intelligence (AI) and robotics for smart production optimization in automotive components industrial clusters in Chennai by studying on utilization of Common Facility Centre (CFC) before and after adoption of Cluster Development Approach using Business Analytics.
2) To find the effect of Moderator variable like Government Policy and Regulations.
3) To find the effect of Mediating variable like Government Resource / Subsidy provided to form Common Facility Centre.
4) To find the savings in Service Charge collected by CFC when compared to Market Value.

3. Modeling And Analysis

The methodology adopted is collection of primary data from 40 Auto Components Manufacturers from Tirumudivakkam by collecting input variables on Service Charges collected by CFC and Service Charges collected in market from 40 Automotive Components Manufacturer in Precision Engineering Cluster (PEC) at Tirumudivakkam Industrial Estate, Tamil Nadu.

The secondary data like critical gaps identified and rectified by installing Common Facility Centre and also calculating moderator variable on Government Policy and Regulations and Mediating variables like Government Resource which is grant provided to Cluster.

Table 1
Conceptual framework

Critical gaps identified	**CFC / Intervention**	**The setting up of the CFC will accrue benefits for MSMEs**
Xi1	Design Software	Xo1
Xi2	Manufacturing Machines	Xo2
Xi3	Design Software	Xo3
Xi4	Manufacturing Machines	Xo4
Xi5	Design Software	Xo5
Xi6	Testing Equipment's	Xo6
Xi7	Skill Training	Xo7
Xi8	Manufacturing Machines	Xo8
Yi1	Manufacturing Machines	Yo1
Input variables		Output variables

Source: Developed by researcher.

The data were analysed using SPSS, AMOS and Structural Equation Modelling by involving Moderator and Mediating variable and find the direct and indirect effect and also finding the business analytics techniques like Descriptive Analysis, Diagnostic Analysis, Correlation Analysis, Regression Analysis, Inferential Analysis Predictive Analysis, Prescriptive Analysis and Decision Analysis of Precision Engineering cluster. The Conceptual Framework is given in table 1.

4. Results And Discussion

The study results in smart production optimization of common resources available in PEC in the form of Common Facility Centre and Infrastructure Creation which leads to cost minimization and profit maximization of individual MSME units. Government of India has considered One District One Product as Engineering and Auto components for Chennai and Chengalpattu. (GOTN, 2021)

A. Cluster location(s)- Chennai, Tiruvallur and Kancheepuram Districts Project Location (s)

Common Facility Centre (CFC) at SIDCO Industrial Estate, Thirumudivakkam Testing centre at SIPCOT Industrial Park, Irungattukottai was formed by Precision Engineering Cluster (PEC)

B. M/s. Chennai Incubation Tech Centre is the Implementing Agency for the proposed project

It is newly formed Special Purpose Vehicle (SPV), incorporated on 29.01.2022 under Section 8 of Companies Act, 2013 with its registered office located at Plot No: PP3, SIDCO Industrial Estate, Thirumudivakkam, Chennai- 600 044.

- Precision engineering companies design and engineer components, machinery, equipment and systems for large range of use across industrial sectors.
- More than 30,000 MSMEs are involved in manufacturing of precision components in and around Chennai catering to varied sectors that include Automobile, Engineering, Aerospace and Defense, Machine tools, Elevators etc.
- ✓ Majority of the units are concentrated in the localities like Ambattur, Guindy, Thirumudivakkam, Thirumazhisai, Irungatukottai and Sriperumbudur.

PEC has informed that a stakeholder consultation was undertaken with representatives of Industrial Associations to assess the issues faced by precision engineering units and are as listed below:

Source: PEC

Fig. 3. Development plan

- Technological obsolescence
- Limited automation in the manufacturing process
- Lack of standardization facilities
- Lack of innovation for new product development
- Absence of testing facilities within the vicinity of units

To remove the above problems a Common Facility Centre created by PEC is given in figure 2 and the development Plan is given in figure 3.

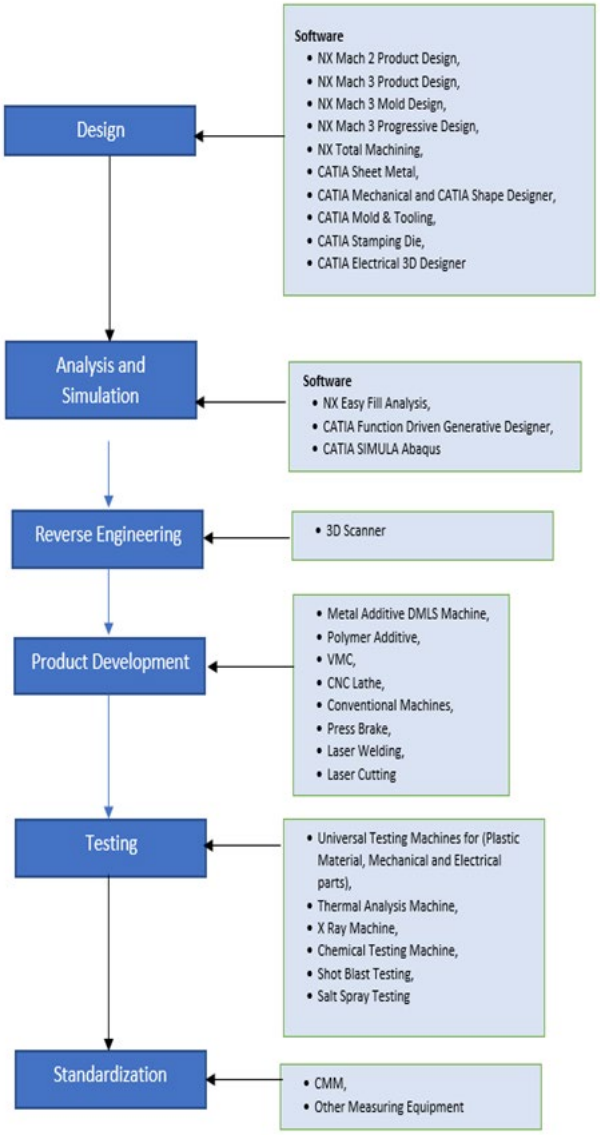
C. *Cost of Project*

Cost of Project is given in figure 4

The Means of Finance like Government of Tamil Nadu share of 7% equity share of 2% and term loan of 10% are given in figure 5.

D. *Operating Model of CFC*

- A SPV under Section 8 of Companies Act, 2013 in the name of "Chennai Incubation Tech Centre" has been formed



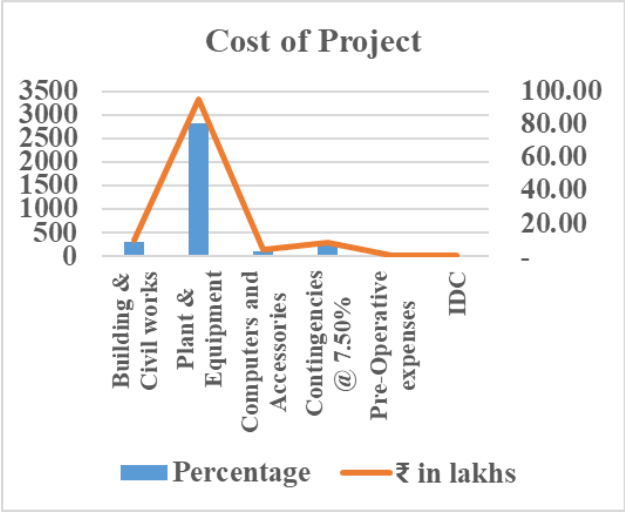
Source: PEC

Fig. 2. Common facility centre

- Presently 40 units are members in the SPV
- Roles & Responsibilities of the SPV
- The SPV would conceptualize, formulate, achieve financial closure, implement and manage the infrastructure.
- Obtaining relevant clearances and all statutory approvals required for the project.
- Undertake marketing to create project awareness among industrial units.
- Maintaining the facilities by collecting service and user charges so as to be self-sustaining with a positive revenue stream.

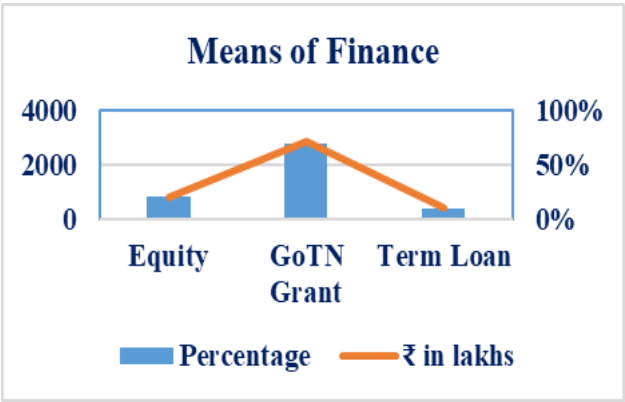
E. *Benefits to MSMEs*

- Improving the competitiveness of MSME by supporting them to develop innovative products for domestic and global market
- Support MSME's from concept to realization or from realized product to new concept (Reverse Engineering)
- Cater to the testing requirements of units on time
- Access advanced technologies which enable them to secure larger contracts at better margins.
- Upgrade in the value chain by offering higher value-added products.
- Substantial reduction in operational costs and increased capacity utilization.



Source: PEC

Fig. 4. Cost of project



Source: PEC

Fig. 5. Means of finance

F. Chennai Incubation Tech Centre "Industry – Innovation – Incubation"

1) Purpose

- Improve the competitiveness of MSMEs by supporting them to develop Innovative products for domestic and global market.
- Product Incubation Center (CITC), will support MSME's from concept to realization or from realized product to new concept.
- CITC will support the startup companies who has a concept design & willing to develop their own product before they start their own facility.
- Common facility centre for any new product development to all engineering Industries as a one stop solution.

2) Scope

- Product Design (Software CATIA, Siemens Uni-Graphics)
- Finite Element Analysis (FEA), Mould Flow Analysis, Stress Strain analysis.
- Reverse Engineering (Optical 3D Scanning),
- Prototype by using Plastics, Rubber, Sheet Metal, Diecasting and Nano - composite material.
- Vacuum Casting and 3D Printing (metal and plastics).
- Testing Lab with NABL Accreditation (as per the OEM requirements)
- Facilitating Patten and Trade mark registration.
- High Precision Machining Support for MSME's.

G. Technological Collaboration

1) Technology Partner: (Proposed)

- Siemens PLM or
- Dassault Design Studio
- TuV for Testing Facility

2) Institutional Partner: (Proposed)

- Indian Institute of Technology, Chennai
- Anna University, College of Engineering, Guindy.
- CIPET, Chennai.

3) Industry Partner

- MSME's engaged in manufacturing.

4) Special Purpose Vehicle (SPV)

Any MSME's in and around Chennai

- Product Design Companies
- Prototype manufacturer (Vacuum Casting and 3D printing)
- Diecasting Manufacturers
- Plastic Mould and Components Manufacturers
- Sheet Metal Industries
- Composite material manufacturer
- Electronics PCB manufacturer
- Product Testing Companies
- EV Chargers Manufacturing.
- Electrical Equipment Manufacturer

5) Beneficiaries'

- Start-up company who is planning to develop the new product & test and validate before the product launch.
- MSME's who is having the customer base and want to develop the new product for their customers, product testing and validation.
- MSME for their own product development.
- State and central Government Agencies who is looking for the new product design and development support.
- OEM's (Auto, Electrical and Aerospace Industries) for product testing and validation.
- MSME's who need the high precision machining support.

6) Software

- Product Design Software's (CATIA, NX)
- Mould Design Software's CAD/CAM (NX with Mould Wizard)
- Mould Flow Analysis & Simulation software
- Finite Element Analysis
- High Precision 3D Scanner

7) Testing

- Accelerated Product Life Cycle Testing
- Dynamic Testing
- Mechanical Testing
- Reliability Testing
- Environmental and Climatic Testing
- Vacuum Impregnation
- Metrology Equipment
- Electrical Cable and Connector Testing
- Packaging Testing

H. Diagnostic Analysis

Diagnostic Analysis is done for PEC and found the Critical

Table 1
Critical gaps identified

Input variables	Critical gaps identified
Xi1	Absence of or limited automation in the manufacturing process
Xi2	Lack of Standardization
Xi3	Design and develop new products in the emerging areas
Xi4	Low capacity and lack of capability
Xi5	Need for re-design to mitigate obsolescence
Xi6	Absence of testing laboratory nearby
Xi7	Lack of availability of skilled workers
Xi8	Hit and trial method is used to get final product which results in wastage of raw material, money and time and in addition affects their competitiveness in the market.
Yi1	Private players charge exorbitant price for their services like testing, machining etc

Table 2
CFC setup

Output variables	The setting up of the CFC will accrue the following benefits for MSMEs in the region:
Xo1	Improving the competitiveness through development of innovative products for global market
Xo2	Supporting MSMEs from concept to commissioning
Xo3	Access to advanced technologies to secure larger contracts at better margins
Xo4	The CFC will generate more job opportunities at both the cluster and individual unit level due to the enhancement of capacity utilization.
Xo5	Support to develop higher value-added products
Xo6	Cater to the advanced testing requirements
Xo7	The CFC is also expected to enhance the levels of skill of workers through skill training
Xo8	The CFC is also expected to enhance the levels of cooperation and synergy amongst the stakeholders through common raw material procurement & joint marketing initiatives
Yo1	Substantial reduction in operational costs and service costs & CFC could help the industries in the cluster to achieve higher turnover (i.e., 10%-15% higher than usual turnover).

gaps are identified and given in table 1

$$Yi1 = C + \sum_{I=1}^{8} \beta i \, Xii \ldots\ldots [1]$$

$$Yi1 = C + \beta 1 \, Xi1 + \beta 2 \, Xi2 + \beta 3 Xi3 + \beta 4 \, Xi4 + \beta 5 Xi5 + \beta 6 \, Xi6 + \beta 7 Xi7 + \beta 8 Xi8 \ldots\ldots [2]$$

The setting up of the CFC will accrue the following benefits for MSMEs is given in table 2.

$$Yo1 = C + \sum_{I=1}^{8} \beta i \, Xoi \ldots\ldots [3]$$

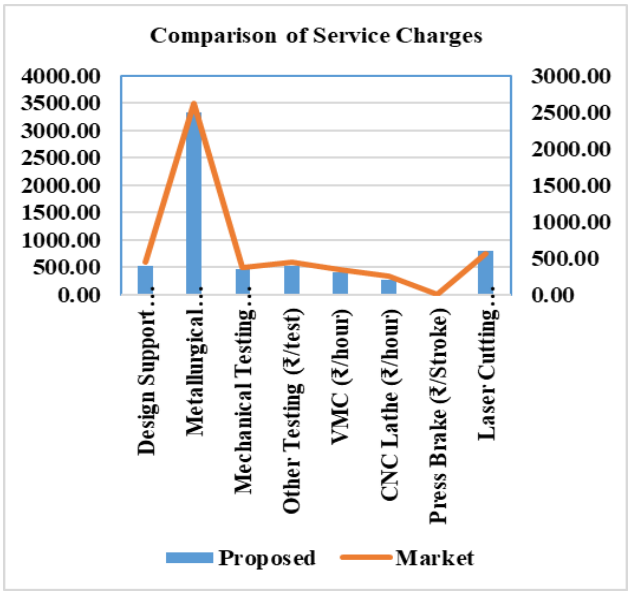
$$Yo1 = C + \beta 1 \, Xo1 + \beta 2 \, Xo2 + \beta 3 Xo3 + \beta 4 Xo4 + \beta 5 \, Xo5 + \beta 6 Xo6 + \beta 7 \, Xo7 + \beta 8 Xo8 \ldots\ldots [4]$$

I. Descriptive Analytics Revenue Model: As Per the Revenue Model Envisaged, the Project is Expected to Achieve a Return of 10% Per Annum

Comparison of Service Charges collected in Market and proposed in CFC are given in Figure 6.

The Descriptive Analysis is given in table 3.

The histogram graph for Service charge proposed is given in figure 7 and histogram graph for service charge collected in Market is given in figure 8.

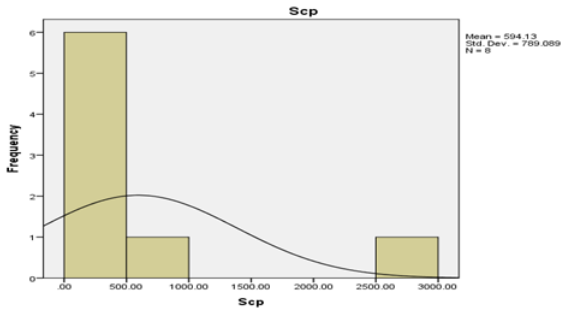


Source: PEC

Fig. 6. Comparison of service charges

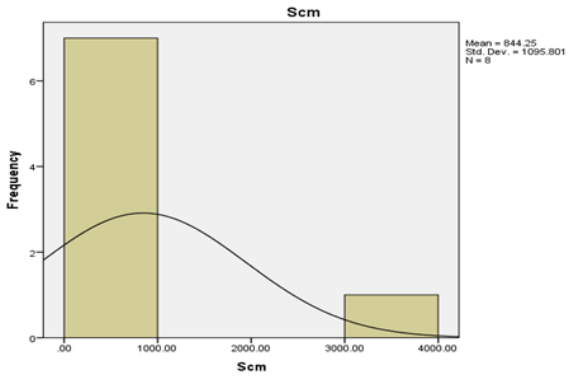
Table 3
Descriptive analysis

		Scp	Scm
N	Valid	8	8
	Missing	0	0
Mean		594.1250	844.2500
Std. Error of Mean		278.98518	387.42399
Median		375.0000	550.0000
Mode		400.00	600.00
Std. Deviation		789.08925	1095.80052
Variance		622661.839	1200778.786
Skewness		2.559	2.589
Std. Error of Skewness		.752	.752
Kurtosis		6.909	7.072
Std. Error of Kurtosis		1.481	1.481
Range		2497.00	3496.00
Minimum		3.00	4.00
Maximum		2500.00	3500.00
Sum		4753.00	6754.00



Source: Computed data

Fig. 7. Histogram-1



Source: Computed data

Fig. 8. Histogram-2

J. *Correlation Analysis*

Correlation Analysis is given in Table 4.

Table 4
Correlation analysis

		Scp	Scm
Scp	Pearson Correlation	1	.999**
	Sig. (2-tailed)		.000
	Sum of Squares and Cross-products	4358632.875	6047291.750
	Covariance	622661.839	863898.821
	N	8	8
Scm	Pearson Correlation	.999**	1
	Sig. (2-tailed)	.000	
	Sum of Squares and Cross-products	6047291.750	8405451.500
	Covariance	863898.821	1200778.786
	N	8	8

**. Correlation is significant at the 0.01 level (2-tailed).

Source: Computed data

K. *Predictive Analysis / Regression Analysis*

The regression analysis and the regression equation is given in equation 5.

Scp = -13.270 + .719 Scm , where p = 0.00<0.05, R^2 = 0.998…..[5]

L. *Inferential Analysis*

For one unit increase in service charge collected in the market there is only 0.72 units collected in CFC which makes CFC accessible for MSMEs in PEC thereby they will reduce the cost of manufacturing and increase their profit.

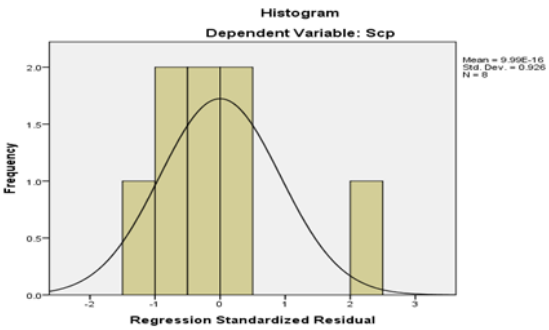
1) Null Hypothesis 1

There is no relationship between market and proposed service charge collected from MSMEs.

2) Alternate Hypothesis 1

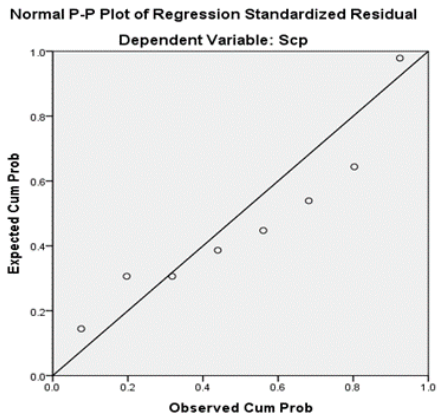
There is relationship between market and proposed service charge collected from MSMEs.

As per equation [5] the regression coefficient is 0.998 and as per table 4 of the correlation analysis the correlation coefficient is 0.999. Hence the null hypothesis is rejected and alternate hypothesis is accepted and it can be concluded that there is strong relationship between market and proposed service charge collected from MSMEs. However, the service charges collected in CFC is less when compared to Market.



Source: Computed data

Fig. 9. Histogram-3

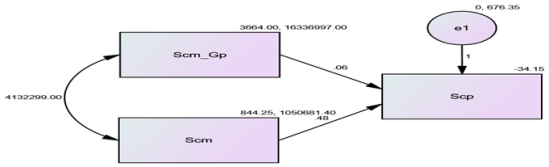


Source: Computed data

Fig. 10. Regression graph

Scp = -189.857 + 0.714 Scm , [p= 0.00, R^2 = 0.992]

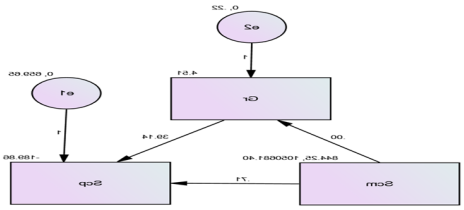
M. *Structural Equation Modelling*



Source: Computed data

Fig. 11. Moderator analysis- structural equation modelling

Scp = -34.152 + 0.480 Scm +0.061 Scm_Gp [p = 0.000, R2 = 0.997]



Source: Computed data

Fig. 12. Mediation analysis- structural equation modelling.

N. *Prescriptive Analysis Decision Analytics*

Conclusion and decision analytics based on Results and Discussion are given in Table 7.

Table 5
Structural equation modelling

	Very Good	Good	Suffering	Bad	Observed Value	Result
X2/df	<=1	[1,2]	[2,5]	>5	0.00	Very Good
NFI	>=0.95	[09;0.95]	[08;0.9]	<0.8	1.00	Very Good
CFI	>=0.95	[09;0.95]	[08;0.9]	<0.8	1.00	Good
RFI	Close to 1				0.99	Very Good
TLI	>=0.95	[09;0.95]	[08;0.9]	<0.8	0.98	Very Good
RMSEA (P-value>=0.05	<=0.05	[0.05,0.08]	[0.08,0.10]	>0.10	0.00	Very Good

Source: Computed data

Table 6
Structural equation modelling

	Very Good	Good	Suffering	Bad	Observed Value	Result
X2/df	<=1	[1,2]	[2,5]	>5	0.00	Very Good
NFI	>=0.95	[09;0.95]	[08;0.9]	<0.8	1.00	Very Good
CFI	>=0.95	[09;0.95]	[08;0.9]	<0.8	1.00	Good
RFI	Close to 1				1.00	Very Good
TLI	>=0.95	[09;0.95]	[08;0.9]	<0.8	0.99	Very Good
RMSEA (P-value>=0.05	<=0.05	[0.05,0.08]	[0.08,0.10]	>0.10	0.00	Very Good

Source: Computed data

Table 7
Conclusion based on results and discussion

Sections	Before Intervention	After Intervention
Particulars	**Qty/Outcome**	**Qty/Outcome**
Units	3,830	The CFC enhances the levels of cooperation and synergy amongst the stakeholders through joint marketing initiatives, common raw material procurement etc.
Employment (Direct / Indirect)	More than 30,000 are involved in manufacturing of precision components in and around Chennai catering to varied sectors that include Automobile, Engineering, Aerospace and Defense, Machine tools, Elevators etc.	Increase by 15%
Market (local, regional, national, global)	Local, regional, national	Local, regional, national and global
Avg. Turnover (Rs. Cr.)	₹24,000 crores	Increase by 10% of average turnover every year
Export	Most of the units are unable to price their products competitively.	Units will be able to competitively price their products and compete with international players in the market with better export competitiveness
Quality	Lack of access to technologies like product development centre, etc. and heavy reliance on traditional methods leads to higher costs. Also, no modern testing facility Available nearby	Capability to produce high volumes and good quality products competitively
Profit of units (Average)	Now it is from 5% to 10%	Increase by 10% of average turnover every year
OPTIONAL		
Testing	Cost competitiveness of MSME units engaged in engineering process in the proposed cluster, is affected by absence of in-house testing facilities, and machining facilities. Most of the MSMEs are unable to individually afford such facilities.	The testing facility shall be equipped with latest machinery and equipment to cater to the requirements of the MSMEs
Energy Efficiency	Not yet adopted	Will adopt the energy efficient one
Environment and Social Management	Not yet Managed	Will manage the environmental and social management effectively.

Source: Computed data

5. Conclusion

The integration of artificial intelligence (AI) and robotics for smart production optimization in Automobile Components Industrial Clusters (ACIC) at Chennai holds immense potential to revolutionize manufacturing processes, enhance efficiency, and ensure competitiveness in the automotive industry. Through this study, it is evident that the integration of AI and robotics has led to significant improvements in production efficiency, product quality, cost-effectiveness, and sustainability. ACIC Enterprises that successfully implemented AI-driven decision-making and robotic automation gained a competitive advantage by producing high-quality components at lower costs and with shorter lead times.

Despite the evident benefits, the adoption of AI and robotics in automobile components manufacturing faced challenges such as initial investment costs, technological complexity, and workforce readiness. However, strategic planning, adequate training, and organizational commitment can help overcome these challenges and facilitate the successful integration of AI and robotics in industrial settings. Moreover, ensuring compliance with relevant regulations and implementing robust safety protocols are essential considerations to mitigate risks and ensure responsible deployment of these technologies at ACIC.

By Integration of Artificial Intelligence and Robotics Smart

Production Optimisation techniques are evolved in PEC. The Artificial Intelligence Business Analytics Models are developed using Descriptive Analytics, Diagnostic Analytics, Predictive Analytics and Prescriptive Analytics. Government of India and Tamil Nadu policy and regulations on CDA will benefit PEC in general and individual Micro, Small and Medium Automotive Components Manufacturers at Chennai in particular.

To conclude Critical gaps in the PEC are identified and using Common Facility Centre like design, product development, testing and standardization the MSMEs in PEC is able to reduce the service charges by using latest machineries in the CFC when compared to Market Service Charge which is exorbitant and individual MSMEs are unable to use with private players. For better utilization of Production optimization Moderate and Mediating Variables and various structural equation models are developed to reduce cost of production and maximize profit to compete it globally. By Integration of Artificial Intelligence and Robotics Smart Production Optimization techniques are evolved in ACIC at Chennai.

The Artificial Intelligence Business Analytics Models are developed using Descriptive Analytics, Diagnostic Analytics, Predictive Analytics and Prescriptive Analytics. Government of India and Tamil policy and regulations on CDA will benefit PEC in general and individual Micro, Small and Medium Automotive Components Manufacturers at Chennai in particular.

To conclude, the integration of artificial intelligence and robotics represents a transformative approach to smart production optimization in PEC at Chennai. Through continued research and innovation, stakeholders / Micro, Small and Medium Automotive Components Manufacturers can unlock new opportunities, address challenges, and drive sustainable growth in the automotive manufacturing sector at Chennai.

6. Acknowledgements

The author is Joint Director (Engineering) / General Manager acknowledges Department of Industries and Commerce, Government of Tamil Nadu for sending him for UNIDO's Cluster Development Agent (CDA) training at EDII, Ahmedabad sponsored by UNIDO, New Delhi, acknowledges Tamil Nadu Small Industries Development Corporation (TANSIDCO) for guidance and also acknowledges University of Madras for giving Ph.D. on Industrial Cluster Development Approach in Management Sciences.

References

[1] CAAIIUC. (2002). *Chennai Auto Ancillary Industrial Infrastructure Upgradation Company(CAAIIUC)*. Retrieved from Ambattur Industrial Estate Manufacturers Association (AIEMA):

[2] DPIIT. (2001). *Department for Promotion of Industry and Internal Trade*. Retrieved from Ministry of Commerce and Industry, Government of India:

[3] EDII. (2001). *Entrepreneurship Development and Innovation Institute (EDII)*. Retrieved from MSME De partment, Government of Tamil Nadu: https://editn.in/

[4] GOI. (2023). *Ministry of Micro Small and Medium Enterprises (MoMSME), Government of India*. Retrieved from Micro & Small Enterprises Cluster Development (MSE-CDP): https://msme.gov.in/infrastructure-development-program

[5] GOTN. (2021). *Department of Industries and Commerce (DIC)*. Retrieved from Government of Tamil Nadu: https://www.msmetamilnadu.tn.gov.in/odop.php

[6] MoMSME. (2023). *Ministry of MSME*. Retrieved from Government of India: https://cluster.dcmsme.gov.in/

[7] MSME. (2001). *Micro, Small and Medium Enterprises Department (MSME)*. Retrieved from Government of Tamil Nadu(GOTN): https://www.tn.gov.in/documents/dept/29

[8] Porter, M. E. (1985). *CompetItive Advantage, Creating and Sustaining Superior Performance.* The Free Press. Retrieved March 1, 2023, from ISBN 0684 841460

[9] Porter, M. E. (1990). *The Competitive Advantage of Nations.* New York, USA, USA: The Free Press,. doi:ISBN 0-684-84147-9

[10] TANSIDCO. (2012). *Tamil Nadu Small Industries Development Corporation Limited(TANSIDCO)*. Retrieved from MSME Department, Government of Tamil Nadu: https://www.tansidco.tn.gov.in/sponsored.php

[11] TANSIDCO. (2022). *Coffee Table Book about CFCs in Tamil Nadu.* Chennai: Tamil Nadu Small Industries Development Corporation.

[12] TANSIM. (2018). *Tamil Nadu Startup and Innovation Mission (TANSIM)*. Retrieved from MSME Department, Government of Tamil Nadu: https://startuptn.in/tanseed/