International Journal of Engineering & Technology, 5 (x) (2017) xxx-xxx

International Journal of Engineering & Technology

Website: www.sciencepubco.com/index.php/IJET
doi:
Research paper, Short communication, Review, Technical paper

Enhancing Business Continuous Improvement Using TCI Model

Mohamad Fazali Ghazali, Rohaizah Saad.

School of Technology, Management & Logistics, Universiti Utara Malaysia, 06010, Sintok, Kedah, Malaysia

Abstract

Since the current world global economy has become competitive, most of the manufacturing industries are trying to improve productivity by adopting technology and spur the innovation such as quality improvement tools and technique. The most effective way to improve productivity is by establishing an Innovative Creative Circle as a problem-solving team to enhance manufacturing processes by reducing waste, and improving customer needs and quality of the product or services. By integrating Innovative Creative Circle with appropriate problem solving tools such as TRIZ methodology, the company is able to eliminate most of the unnecessary cost that will affect the operation cost, the products and the processes of the organizations. This paper provides a case study of an activity of TCI Model as part of continuous improvement tools and creatively solve daily problems including impossible-to-solve problems. TCI Model has succeeded in improving the quality of products or services with a lower cost operation. Hence, this has given a competitive advantage over other businesses.

Keywords: *Continuous Improvement, Innovative Creative Circle, TRIZ, Automotive.*

1. Introduction

The current world global economy has increased the pressure among customers and competitors in manufacturing, especially in the private sectors. Most organizations are in a constant need to reduce waste in every process, maintain a low cost of quality, improve production lines, improve customers' need and speed up manufacturing to achieve and sustain competitiveness.

TRIZ is a method based on logic and data but its ability to research and creatively solve daily problems is a concern including the impossible-to-solve problems. Sreebalaji and Saravanan (2009), said that the theory of solving inventive problems also provides repeatability, predictability, and reliability due to its structure and algorithmic approach. TRIZ does not solve every problem. Instead, it is a method to provide suggestions for improvement [7].

In order for the companies to remain competitive, Continuous Improvement (CI) has to be involved with a variety of organizational developments, initiatives, campaigns or programs, including the adoption of "lean manufacturing" techniques, total quality management (TQM), employee involvement, customer service, waste reduction, and innovation.

This strategy is supported by many researchers and quality Gurus. Among them is Juergensen (2000) who stated that CI is a strategy consisting of improvement initiatives that helped increase successes and reduce failures. According to Bessant et al., (1994) CI is a company-wide process of focused and continuous incremental innovation [5].

Therefore, this study seeks to analyze the implementation of TRIZ Continuous Improvement (TCI) Model in MODENAS as a company. This paper will also include an analysis of the relationship created between the TCI Model implementation and practices, successfully in CI implementation and organizational culture towards the organizational sustainability among the automotive manufacturing industry in Malaysia

2. Background of Study

In order to increase the quality of products, processes, services, and innovation, Continuous Improvement (CI) is the best method for any teams or groups in the organization to drive the program activity. Similarly, Webster, (1999); and Bessant et al., (2001) have mentioned that CI is more than just an application of certain tools and techniques as it requires an organizational culture that encourages and supports improvements [4]. Therefore, to compete with other competitors and sustain in their business, the organizations have to develop their own CI programs and take necessary actions in all opportunities for improvement.

TRIZ is the abbreviation of Theory of Inventive Problem Solving, and it was invented by Genrich Altshuller [10] and his scientist colleagues of the former Soviet Union in the 1950s. Altshuller has organized 39 engineering characteristics and 40 inventive principles by referencing over two million patented products. Its primary application has been for solving inventive problems in the areas of engineering, technology and design [1]. TRIZ is a method based on logic and data but it has the ability to research and creatively solve daily problems including the impossible-to-solve problems. Sreebalaji and Saravanan (2009), said that "the Theory of Solving Inventive Problem also provides repeatability, predictability and reliability due to its structure and algorithmic approach". TRIZ does not solve every problem, but it becomes a method that provides suggestions for improvement [2].

Therefore, MODENAS has strategically come with an idea to strengthen Modenas Production System through its lean manufacturing practices. This is done in order to eliminate waste and improve the cost reduction activities with a proper planning. In March 2009, Quality Management Department has established a new section called Total Quality Management (TQM) as a spearhead and an ultimate tool to achieve the organizational excellence. The objective of the new section is to carry out all CI and TRIZ initiatives by implementing TCI Model that can increase the organization performance in terms of organizational profits, product quality, motivations or brand image. TCI Model is basically based on the structured problem solving method such as Function Analysis, Engineering Contradiction, Contradiction Metric, and Inventive Principles.

3. MODENAS TCI Project Team

The TCI Model initiative in MODENAS starts after a group of employees participating in the training conducted by the Malaysian Productivity Corporation (MPC), Penang in October 2014. There are 24 staff from various departments consisting of technicians, supervisors, engineers, and managers joining for level 1 training. The project began after the Project Management Office (PMO) had set five teams as a pilot project as part of TCI Model activities in MODENAS. To enhance this project together with the objective of CI program, Malaysia Productivity Corporation (MPC) has made an arrangement with the trainer to assist this team to complete the project.

The five teams involved are from Production Engineering (PE), Research and Development (RND), Quality Management (QM), Manufacturing (MFG), and Production Planning Control (PPC).

There are five pioneer projects that have been selected to use TCI Model as a Problem Solving method for continuous improvement. They are listed as follows:

- Crankshaft stuck in jig during crankshaft drilling - PE
- Reduce engine vibration at higher engine speed (rpm) - RND
- Inability to lock seat - QM
- Reduce spray painting wastage – MFG
- High piece part inventory – PPC

4. TCI Model

The proposed model, TCI Model, is a basic structure for continuous improvement cycle using CI and TRIZ tool processes as methods of problem solving (refer Fig. 1). The model process begins with the inputs or requirements from customers, clients or the third party that require some issues to be solved. From the input data, all the problems shall be analyzed using Function Analysis tools. Then, the sub-tools will identify the interaction function by categorizing it into useful and harmful functions.

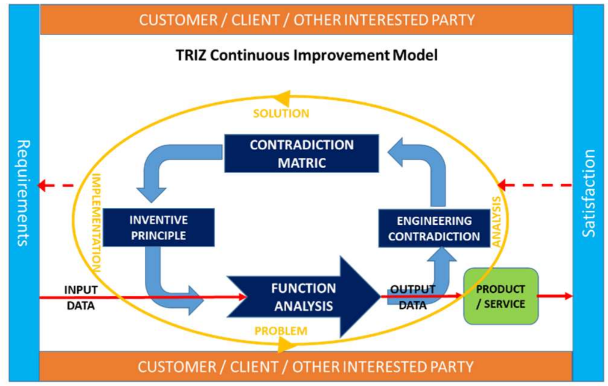

Fig. 1 TRIZ Continuous Improvement Model

At this stage, the improved products or services can be solved using Trimming and Future Transfer tools if the problems are simple, not really complicated nor having various contradictions. Otherwise, the process shall continue to Engineering contradiction. In this phase, the analysis is to clarify one of the worsening characteristics of an Engineering Systems result that leads to the worsening of other characteristics.

Based on these characteristics or parameters, it clearly illustrates which of them is improving and worsening with multiple recommendations. The art of using Contradiction Matrix however, lies in deciding the right improving and worsening parameters to be chosen. Furthermore, it will provide the solution to which parameter makes more sense from the Engineering Contradiction and Inventive Principle.

The intersections or cells in the Inventive Principle numbers, ranging from 1 to 40 are used as guidelines and recommended to make improvement. The number of recommendations may give more than one solutions and these ideas will give the most suitable solution for implementation to solve the Engineering Contradiction.

From the points of view of the improvement teams, an elegant and powerful way to improve the products or services is to retain the system's functionality while eliminating one or more of its components. Meanwhile, from the customer's point of view, if the cost is lower and simpler, it is able to provide a higher value compared to the previous ones. In addition, it is satisfaction guaranteed.

5. Result

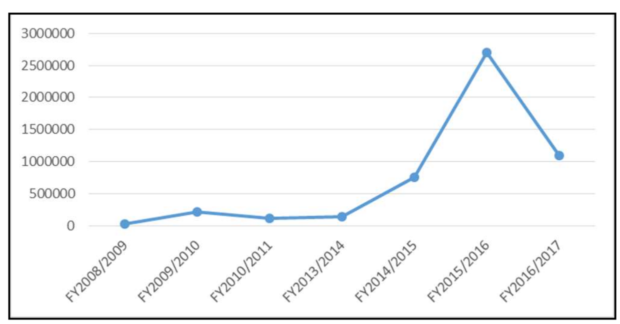

Fig. 2 Cost saving using TCI Model

This approach has changed MODENAS tremendously because the implementation of TCI Model has saved the organization with RM5.1mil cost saving recorded from 2008 to 2017 (see Figure 2). The first phase of the implementation of the TCI Model shows an overall cost saving of RM400, 000 from 2008 to 2010. After 2010 there was a slight decrease in cost saving but surged in 2014. Meanwhile, in 2015 the recorded cost saving was almost RM800, 000.

The cost soaring in 2016 was nearly at 2.7 million and slightly reduced though saving measures was continued after 2016.

Table 1 Cost saving from 2008 to 2017

Year	Part/Section	Cost Savings (RM)
2016/2017	Eliminate Piston seized problem – Dinamik model	RM 684,000.00
2016/2017	Cost reduction of Boiler diesel usage	RM 358,678.55
2016/2017	Implementation of e-survey in factory	RM 49,000.00
2015/2016	The improvement of Electrophoretic Deposition (ED) control system	RM 2.7 mil
2014/2015	Eliminate the problem of Oil Mark on Fuel Tank at P2 Line	RM 121,000.00
2014/2015	Reduce Downtime at Final Assembly Line 1	RM 488,687.00
2014/2015	Reducing Reject Crankshaft Balancing Out at Engine Assy. Line 1,	RM 145,000.00
2013/2014	Eliminate Filler Leaking during Welding Process on Fuel Tank	RM 146,000.00
2010/2011	Improve Throttle Housing Thread Slanting for Model GT128	RM 61,021.00
2010/2011	Reducing Cycle-Time at 2nd Spray Process on P3 Line for GT128 model	RM 60,000.00
2009/2010	Reduce inside Paint Trickle Problem on Muffler at P2 Line	RM 24,918.00
2009/2010	Reduce Pattern Rejection at P3 Line	RM 101,000.00
2009/2010	Reduce Masking Rejection for Passion Model at P3 line	RM 96,000.00
2008/2009	Reduction of Air Usage at SKG Spindle unit	RM 30,924.00

Sources: Modenas - Program Management Office (PMO) Report, 2017.

If Figure 2 shows the relationship between the total cost savings and the years involved, Table 1 shows the relationship of specific activities performed and the amount of cost savings according to a particular unit from 2008 to 2017. Modenas Program Management Office (PMO), in its latest report, had a decrease in the amount of cost reductions amounting RM1, 091,678.55, from 2016 to 2017, compared to the previous report from 2015 to 2016 amounting RM2.7mil. It is due to the improvement of Electrophoretic Deposition (ED) control system that had given more profit to the company in term of its daily operations. However, the improvement of Dinamik model piston seized, the cost reduction of the boiler diesel was utilized, and the implementation of e-Survey at production line contributed to CI sustainability.

With three improvement activities from 2014 to 2015, the amount rose to RM608, 687.00 compared to the previous period in 2013 and 2014. The above figures were based on the issues of Oil Mark at Fuel Tank, Crankshaft balancing and reducing downtime at the assembly line, and representing a great teamwork of cross-functional team from Production Engineering, Manufacturing and Quality Management Department.

PMO also reported that the lowest cost savings were recorded in 2010 and 2011, and it is due to the depletion of the saving amount and the number of projects. Quality Management and Manufacturing had made an improvement to Throttle Housing by reducing the cycle-time for Spraying process successfully. Meanwhile, from 2009 to 2010, the cost saving increased tremendously in the second year involving continuous activities that were improved. This is due to the awareness of a CI program from the Manufacturing department, motivated for the cost reduction program set by the company.

The department was managed to reduce its cost by RM221, 918.00, at painting line for Muffler parts and Passion model. In 2008 and 2009, in the beginning of the improvement activities, the Production Engineering team discovered that each machine of their SKG Spindle Unit contributed to the high utilization of air during operation. The team had generated a brilliant idea by developing an innovative air valve to control the air usage during the operation and noted RM30, 924.00, for the cost saving project.

Table 2 Project Team Activity Cost Saving

Project Team	Activity	Cost Saving (%)
RND	• Improve ED control system.	53.3%
PE	• Dinamik Piston seized • Boiler cost reduction • Crankshaft balancing • Fuel Tank oil mark	26%
QM	• Final Assy., reduce downtime • GT128 : improve Throttle housing	10.8%
MFG	• Fuel Tank, improve welding process. • GT128 : improve spray process • Muffler : improve paint process • Pattern / Masking : improve rejection process • SKG Spindle machine : improve air usage	8.5%
PPC	• e-Survey in factory	1%

The discussion presented in this study clearly shows the role and contribution of the Research and Development cross-functional team (RND) earning the highest cost saving of 53.3% (refer Table 2). PE team recorded the second highest cost saving of 26% followed by QM (10.8%), MFG (8.5%) and the lowest being PPC with only 1%. RND's involvement is very great for an organization in order to improve the quality of products or services that are offered at a very competitive price but more importantly the quality is not compromised.

According to Oakland (1999); Caffyn, (1997); Gallagher et al., (1997), some might consider a continuous improvement to be an offshoot of existing quality initiatives as a completely new approach of enhancing creativity and achieving competitive excellence in today's market.

6. Conclusion

In summary, with RM5.1 million of cost saving involved in TCI Model, it is extremely encouraging for MODENAS to take up new challenges by improving other areas and using the model as a new problem solving method. With this new continuous improvement activity, it is estimated that the project resulted in an effective and innovative solutions are generated, helps in resolving factory issues, producing good and quality product, in cost reduction and advantageously competitive to the organization. The impact of the TCI model implementation has been identified and classified into four elements as follows:

1. Breakthrough in product innovation.
2. Improvement in products and services
3. Increased work efficiency
4. Reduced downtime

Additionally, TCI Model is not for engineering applications only, but it can emerge and adapt to business applications such as innovative service design and business process improvement applications. Therefore, MODENAS plans to use the same approach for its future improvement projects, especially in Sales and Marketing areas to increase and enhance sales performance.

References

[1] Azlan, A., Ariz, B., & Yusof, K. (2014). Perceptions on TRIZ by Current TRIZ Experts in the Industry: A review in Malaysia. *2014 International Conference on Teaching and Learning in Computing and Engineering*, 325–331. http://doi.org/10.1109/LaTiCE.2014.71

[2] Bakar, N. A., & Rahim, Z. A. (2014). Design-To-Cost Framework in Product Design Using Inventive Problem Solving Technique (TRIZ). *Journal on Innovation and Sustainability*, *5*(52), 3–17.

[3] Brad, S. (2008). Vectors of innovation to support quality initiatives in the framework of ISO 9001:2000. *International Journal of Quality & Reliability Management*, *25*(7), 674–693. http://doi.org/10.1108/02656710810890872.

[4] Fryer, K. J., Antony, J., & Douglas, A. (2007). Critical success factors of continuous improvement in the public sector: A literature review and some key findings. *The TQM Magazine*, *19*(5), 497–517.

[5] Fryer, K., Ogden, S., Anthony, J., Fryer, K., & Ogden, S. (2013). Bessant ' s continuous improvement model : revisiting and revising. *International Journal of Public Sector Management*, *26*(6), 41 – 494. http://doi.org/10.1108/IJPSM-05-2012-0052

[6] Hyun Woong Jin, T. L. D. (2014). A comparison of Korean and US continuous improvement projects. *International Journal of Productivity and Performance Management*, *63*(4), 384 – 405.

[7] Ikovenko, S., & Bradley, J. (2004). TRIZ as a Lean Thinking Tool. *ETRIA TRIZ Future Conference 2004*, 7526–7528.

[8] Jagdeep Singh, H. S. (2012). Continuous improvement approach: state-of-art review and future implications. *International Journal of Lean Six Sigma*, *3*(2), 88 – 111.

[9] Jagdeep Singh, H. S. (2015). Continuous improvement philosophy – literature review and directions. *Benchmarking: An International Journal*, *22*(1), 75 – 119.

[10] Jani, H. M. (2013). An Overview of TRIZ Problem-Solving Methodology and its Applications. *IOSR Journal of Computer Engineering*, *13*(2), 83–92. http://doi.org/10.9790/0661-1328392

[11] Jiannan, Z., & Dongmei, Y. (2010). A TRIZ-based process model for technology evolutionary potential forecast. *2010 IEEE 11th International Conference on Computer-Aided Industrial Design and Conceptual Design, CAID and CD'2010*, *1*, 458–462. http://doi.org/10.1109/CAIDCD.2010.5681309

[12] Kim, S., Mabin, V. J., & Davies, J. (2008). The theory of constraints thinking processes: retrospect and prospect. *International Journal of Operations & Production Management*, *28*(2), 155–184. http://doi.org/http://dx.doi.org/10.1108/01443570810846883

[13] Laura Costa Maia, Anabela Carvalho Alves, C. P. L. (2012). How could the TRIZ tool help continuous improvement efforts of the companies ? *Portuguese Foundation for Science and Technology*, 1–10.

[14] Mostafa Jafari, Peyman Akhavan, Hamid Reza Zarghami, N. A., & Article. (2006). Exploring the effectiveness of inventive principles of TRIZ on developing researchers' innovative capabilities: A case study in an innovative research center. *Journal of Manufacturing Technology Management*, *24*(5), 747–767. http://doi.org/http://dx.doi.org/10.1108/09564230910978511

[15] Nahavandi, N., Parsaei, Z., & Montazeri, M. (2011). Integrated framework for using TRIZ and TOC together: a case study. *International Journal of Business Innovation and Research*, *5*(4), 309. http://doi.org/10.1504/IJBIR.2011.041053

[16] Sokovic, M., Pavletic, D., & Pipan, K. (2010). Quality improvement methodologies–PDCA cycle, RADAR matrix, DMAIC and DFSS. *Journal of Achievements in Materials and Manufacturing Engineering*, *43*(1), 476–483.

[17] Tzong-Ru (Jiun-Shen) Lee, Min-Chih Hsu, Anieszka M. Dadura, K. G. (2006). TRIZ application in marketing model to solve operational problems for Taiwanese aquatic products with food traceability systems. *Benchmarking: An International Journal*, *20*(5), 625–646. http://doi.org/http://dx.doi.org/10.1108/09564230910978511

[18] Zhang, T., Hui, X., Jiang, P., & Zhang, H. (2010). A method of technology roadmapping based on TRIZ. *5th IEEE International Conference on Management of Innovation and Technology, ICMIT2010*, 51–54. http://doi.org/10.1109/ICMIT.2010.5492841

[19] Zouaoua, D., Crubleau, P., Mathieu, J. P., Thiéblemont, R., & Richir, S. (2010). TRIZ and the difficulties in marketing management applications. *PICMET '10 - Portland International Center for Management of Engineering and Technology, Proceedings - Technology Management for Global Economic Growth*, 807–816. Retrieved from http://www.scopus.com/inward/record.url?eid=2-s2.0-78549281447&partnerID=tZOtx3y1