6. DEVELOPMENT OF MODEL & FRAMEWORK

Conclusive observations from the literature review and company implementation demonstrated in the above-stated sections drew a number of research questions. The process followed for development of model and framework is as presented in Figure 13. Of particular interest, it has observed that; there is no such existence of model and frameworks for SMEs to achieve continuous quality improvement using auto core tools in the automotive sector. To overcome above drawback, model and detailed step by step framework for implementation is prepared to help industries in the implementation of auto core tools to achieve continuous quality improvement. The developed model is presented in Figure 14.

Figure 1. Model and framework development process flow
6.1 Auto core tools implementation framework

The developed framework consists of 19 steps for implementation of auto core tools which helps SMEs to achieve continuous quality improvement. The implementation framework is distributed into 3 phases, called planning, implementation and monitoring, improvement. The schematic presentation of implementation framework is shown in Figure 14 and detailed steps are explained hereafter.

**Step 1: Preparation of cross functional team (CFT)**

The first step for implementation is the formulation of the cross functional team (CFT) by management. The CFT must consist of at least one member from each process of the organization; technical experts, consultants, customers, suppliers, etc. may be included in CFT. Top management member involvement in CFT, may be a chairman, is desirable. The CFT will be overall responsible for the implementation of ACT, need to plan, implement and monitor auto core tools implementation process.

**Step 2: Training to CFT on quality principles, auto core tools**

As CFT being overall responsible, educating them on quality principles, auto core tools, etc. is the next step. Training always plays an important role and makes things easy. Training improves knowledge of quality concepts and auto core tools in all members of CFT as they are going to implement in the organization.

**Step 3: Detailed process study - variables & constraints**

It is a most important step in relation to outcome. The detailed process study, also called manufacturing process study, to be conducted by the cross-functional team. Process study must cover all processes starting from receipt of raw material to delivery of finished goods to the customer. Process study to be carried out in detailed to identify process & product variables and constraints.
Development of Model & Framework

Jigar A. Doshi

Figure 2. Continuous quality improvement model for automotive SMEs using ACTs

Formation of CFT (Cross Functional Team)

TRAINING

Setting KPIs - Cost of Quality, In process stage rejection, Final stage rejection, Customer return

Continuous Quality Improvement (Measurement through KPIs: Cost of Quality, In process stage rejection, Final stage rejection, Customer return, Customer Satisfaction)

Revision of KPIs target based on achievement – every year

IMPLEMENTATION OF IMPROVEMENT INITIATIVES

QUALITY IMPROVEMENT OPPORTUNITIES

MEANS FOR CQI
QMS, Visual Aids, Work Place Management, SOPs, WIs, Training, Poka Yoke, CSI, etc

CFT: Cross Functional Team;
APQP: Advance Product Quality Planning;
CP: Control Plan;
SPC: Statistical Process Control;
MSA: Measurement System Analysis;
PPAP: Production Part Approval Process

AUTO CORE TOOLS

APQP
FMEA
SPC
MSA
PPAP

Suggestions
Requirements
New Technology

Submission
Step 4: Selection and finalization of key performance indicators by top management

Top management commitment to continuous quality improvement is very crucial and essential. Their inputs to the identification of key performance indicators (KPIs) show their commitment towards continuous quality improvement. Top management to identify KPIs which helps the organization to grow; KPIs can be the cost of quality, in-process rejection, final stage rejection, customer return, etc. The KPIs selected are very crucial indicators of quality improvement that was supported by many researchers in their past work. The selected KPIs are presented in Table 18.

Table 1. Key Performance Indicators

<table>
<thead>
<tr>
<th>SR</th>
<th>PERFORMA NCE PARAMETERS</th>
<th>DEFINITION</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>% Reduction in In process stage Rejection</td>
<td>No. of product rejected during in-process inspection / Total production</td>
</tr>
<tr>
<td>2</td>
<td>% Reduction in Final stage reduction</td>
<td>No. of product rejected during final inspection / Total production</td>
</tr>
<tr>
<td>3</td>
<td>% Reduction in return goods</td>
<td>No. of product rejected from customer / No. of product dispatched</td>
</tr>
<tr>
<td>4</td>
<td>Cost of Quality</td>
<td>Summation of Preventive cost, Appraisal cost and failure cost</td>
</tr>
</tbody>
</table>

Step 5: Gap analysis

Gap analysis to be conducted by CFT to review the current status of concepts and system of quality management as well as to identify gaps in the quality management system, which will lead to continuous quality improvement. Initial improvement in quality is quite a bit dependent on gap analysis.
Step 6: Development of basic quality management system (QMS) with commitment of management

After identifying gaps through gap analysis, this step acts as bridging those gaps. CFT in consultation with management needs to develop basic quality management system. Developed QMS will provide means to capture all critical details of product and process - KPIs.

Step 7: Implementation of basic QMS

Implementation of QMS developed is the responsibility of all employees. Step 7 & 8 may be followed simultaneously, make all employees aware of the basics of quality management and inform them the importance and benefits of the same.

Step 8: Promote awareness to all - training to all employees

As mentioned in step 7, improve awareness of quality management and improvement to all employees. But now CFT have to promote the importance and implementation of auto core tools to all employees as well, especially employees of production, QA & QC (SMEs may not have separate QA & QC).

Step 9: Implementation of APQP, Preparation of Control Plan & Identification of Improvement opportunities

It is for implementation of first ACT, i.e. APQP (Advance Product Quality Planning). CFT plays an important role in APQP, members from all area-process provides a different point of view and makes product quality planning precise. The Organization needs to follow APQP guideline manual or customer (OEMs) APQP manual if provided, or APQP reference manual of AIAG. Implementation of APQP will lead to the identification of quality improvement opportunities, which needs to be documented and work on as a project.

Step 10: Implementation of FMEA & Identification of Improvement opportunities

Failure Modes & Effect Analysis, second ACT, is one of the important tools for CQI. FMEA is to be conducted following FMEA reference manual of their
customer (OEMs) if provided, or FMEA reference manual of AIAG. More in detail FMEA more the quality improvement opportunities identified. Implementation of FMEA will lead to the identification of quality improvement opportunities, which needs to be documented and work on as a project.

**Step 11: Implementation of SPC & Identification of Improvement opportunities**

Statistical Process Control (SPC) provides variations exists in the process. Refer SPC guideline or SPC manual published by AIAG for implementation of SPC. The capability of the process (Cpk) shall be improved and that will identify in SPC. As per automotive standards, Cpk shall be more than 1.3. Lesser the Cpk value, higher the quality improvement opportunities. Implementation of SPC for critical process variables will lead to the identification of quality improvement opportunities, which needs to be documented and work on as a project.

**Step 12: Implementation of MSA & Identification of Improvement opportunities**

Measurement System Analysis (MSA) tool is important to improve measurement process, which obviously lead to improvement in quality. Before implementing MSA, critical measurement systems will be identified based on critical parameters of the product and then apply MSA to them only. To implement MSA follow the MSA guideline or MSA reference manual published by AIAG. Implementation of MSA will show the R&R of the measurement system, higher the value of %R&R indicates opportunities for quality improvement. Using CFT experience and knowledge document all improvement opportunities and work on them as a project.

**Step 13: Preparation & finalization of PPAP**

Production Part Approval Process (PPAP) is the last ACTs. It is a procedure than a tool for taking customer approval and gaining customer confidence on the organization processes and products. Gather all details related to the product including results of above four Auto core tools including identified improvement points and prepare PPAP document. For preparing PPAP document, follow PPAP reference manual published by AIAG.
Step 14: Customer submission & receipt of improvement opportunities - suggestions, new requirements, new technology, etc.

This is to collect customer feedback on the processes and giving them confidence about the organization products and processes. PPAP documents need to be submitted with all necessary details of product and processes to the customer for their review and approval. The step of getting the approval of customer on production parts and processes is essential and helps in standardization.

Step 15: Implementation planning for identified improvement opportunities

This step is for the planning of implementing identified improvement opportunities, it is always recommended to start preparing an implementation plan and implementation as and when improvement opportunities are identified and not to wait until all ACTs are implemented. First, prioritize the identified improvement opportunities. Then define the team for an implementation project. Formulation of the team is only required if it is a big task or responsibility may be given to individuals asked on their skills and competence. The team has to identify the required facility for successful implementation and top management needs to provide full support.

Step 16: Training to project team

Making team knowledgeable is the base for successful implementation. Identified team or individual shall be given the training to achieve intended results; external training may be taken if internal sources are not available. Knowledge sharing techniques shall be promoted in the organization which helps in gaining all round competence.

Step 17: Implementation & monitoring of identified improvement opportunities

Implementation activity is to be started by team or individual with intense care and responsibility. Effect of implementation shall be reviewed on a frequent basis. Top management shall monitor whole implementation activity personally, at least once in a month. Continuous quality improvement can only be achieved if the implementation of each identified opportunity is taken seriously and monitored regularly.
Step 18: Continuous review of improvement project - effect on KPIs & status
This step is to review the effect of each identified opportunities for overall quality improvement, i.e. effect on KPIs. This is the responsibility of CFT to monitor the effect on KPIs, preparation trend charts are suggested. This guide CFT to take any corrective measure in cases anything goes unwanted.

Step 19: Review of improvement project & further improve the KPIs
CFT has to continuously look for further improvement possible. Implementation of one improvement opportunity always identifies another. Initial improvement of quality is very obvious but further improvement requires more efforts, minute monitoring, and teamwork. Deviations to the plan will be recorded and acted upon as separate project and opportunity. Several factors affect the quality of product and process and their effect can be measured through KPIs. It is necessary to review KPIs performance and also increase the KPIs target or change them in order to achieve continuous improvement throughout the organization. To overcome limitations of SMEs, mainly employee turnover and resource limitations, proper documentation of processes and procedures is to be encouraged.
<table>
<thead>
<tr>
<th>STEPS</th>
<th>PLANNING</th>
<th>EXECUTION &amp; MONITORING</th>
<th>IMPROVEMENT</th>
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</thead>
<tbody>
<tr>
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<tr>
<td>3</td>
<td>Selection &amp; Finalization of KPIs by Management - Cost of Quality, In process stage Rejection, Final stage Rejection, Customer Return, Customer Satisfaction</td>
<td>Detailed process study - Variables &amp; constraints</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Gap Analysis</td>
<td>Development of basic quality management system (QMS) with commitment of management</td>
<td></td>
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<tr>
<td>5</td>
<td>Implementation of basic Quality System</td>
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<tr>
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<td>Promote awareness to all - training to all employees</td>
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<td>Implementation of APQP, Preparation of Control Plan &amp; Identification of Improvement opportunities</td>
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<tr>
<td>12</td>
<td>Implementation plan for identified improvement opportunities</td>
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<td></td>
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<tr>
<td>13</td>
<td>Training to project team</td>
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<td></td>
</tr>
<tr>
<td>14</td>
<td>Implementation &amp; monitoring of identified improvement opportunities</td>
<td>Continuous Review of improvement project - effect on KPIs &amp; status</td>
<td>Review of improvement project &amp; further improve the KPIs</td>
</tr>
<tr>
<td>15</td>
<td>ACTs may be implemented simultaneously as well, refer ACT guideline for more detail.</td>
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</table>

Figure 3. Implementation framework schematic presentation