

# Gap Analysis Study on the Compliance of Automotive Standard IATF 16949 based on Internal Quality Audit Score in Automotive Industry

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PAPER INFO	ABSTRACT
<p><b>Chronicle:</b> Received: 15 September 2018 Revised: 04 November 2018 Accepted: 13 December 2018</p>	<p>In August 2016, IATF issued the new requirement of quality management system IATF 16949. With these new requirements, the automotive industry that is willing to migrate to the new version will face some challenges. The main challenge comes from the need to re-map the business processes that are needed for the internal audit. The other challenges are the readiness of the quality of the internal auditors, measure gaps, and predict the success of the certification audits. This research is based on a case study at one of the automotive manufacturing company. A framework for measuring the gap analysis of the compliance based on the automotive standards requirements (IATF 16949: 2016) through an internal quality audit score has presented in this research. The analysis has done by using a turtle diagram for the risk analysis and follows by a survey on an internal quality auditor's perception. Based on the analysis, it can be determined which processes need to be audited. The research has found that there are 32 processes in the company which is needed to be an audit. The survey has indicated that internal quality auditor is ready with the new requirement of the quality management system. The internal audit's result with a weighted score shows the level that can be achieved by the company to fulfil the standard IATF 16949:2016. The gap that has shown in the spider chart depicts that an automotive manufacturing company will be able to passe the certification audit.</p>
<p><b>Keywords:</b> Quality Management. Internal Audit. Gap. Automotive Industry.</p>	

## 1. Introduction

From the year 2006 to 2016, the automotive industry was at the highest peak in car sales [1]. In the next 20 years, it is predicted that the sales of the automotive spare parts from the original equipment manufacturer will growth 50% [2]. This growth is a good opportunity for OEM companies that are able to produce the high quality products with good efficiency, so they can produce products at competitive prices [5]. Hence, the implementation of quality management system is the first requirement that is required by automotive companies to their suppliers [3, 4]. With this condition, it is certain that the supplier will provide a product with a consistent level of quality and quantity, which in the end, the

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automotive industry will be able to deliver the final product with the quality of products and services that meet consumer expectations [7].

In August 2016 together with the release of the latest version of ISO 9001 (2015 version), ISO announced that ISO/TS 16949: 2009 had evolved into the IATF 16949: 2016 [6, 9]. This change has an impact on all companies related to the automotive industry that have implemented the ISO QMS Automotive/TS 16949 (2009 version) need to improve their product quality standards. The problems raised in this research are related to the impact caused by the changes in these standards. The focus of this research is on mapping the business processes needed for internal audit [14], readiness of the quality of internal auditors, measuring gaps, and predicting the success of certification audits. This is important, since companies that are willing to implement the quality standards need to assess the performance position of their quality management system [8].

## 2. Literature Review

### 2.1 Quality Management System ISO 9001:2015

The ISO 9001 quality management system standard (2015 version) is replacing the previous version (2008 version). This change has an impact on all existing management system standards [11, 12]. Table 1 below shows the differences between the two versions [10].

*Table 1. Differences of quality management principle [10, 12].*

<b>ISO 9001 : 2008</b>	<b>ISO 9001 : 2015</b>
<i>Customer focus</i>	<i>Customer Focus</i>
<i>Leadership</i>	<i>Leadership</i>
<i>Involvement of people</i>	<i>Engagement of people</i>
<i>Process Approach</i>	<i>Process approach</i>
<i>System Approach to Management</i>	<i>Improvement</i>
<i>Continual Improvement</i>	<i>Evidence-based decision making</i>
<i>Factual Approach to Decision Making</i>	<i>Relationship management</i>
<i>Mutually Beneficial Suppliers Relationship</i>	

### 2.2 Automotive Standard Requirement IATF 16949:2016

The fundamental change in the requirements of IATF 16949 [20] when is compared with the requirements in ISO/TS 16949 which are combined with changes to ISO 9001, is the addition of ‘Customer Specific Needs’ [13]. In the form of a formula, the change can be described as:

IATF = ISO 9001:2015 + CSR + 104 IATF New Clause.

The 104 new clauses from IATF include:

- 13 new requirements.
- 83 modifications requirements of IATF 16949.
- 8 carryover ISO\TS 16949 clause.

### 2.3 Process Approach

As the quality management system approach is basically use a process approach; therefore, in the IATF 16949: 2016 quality management system, it also uses a 'process approach' to develop and assess the suitability of product and process quality. In ISO 9001: 2015 clause 0.3.1 it is stated that the process approach refers to three important parts, i.e. input, process, and output. Furthermore, it is explained that input consists of customer needs, energy, and materials. The output is the end products and services or any management decisions, while the customer is a single process output receiver. Of course in this case there are internal and external receivers. In diagrammatic, the process approach is depicted in Fig. 1.

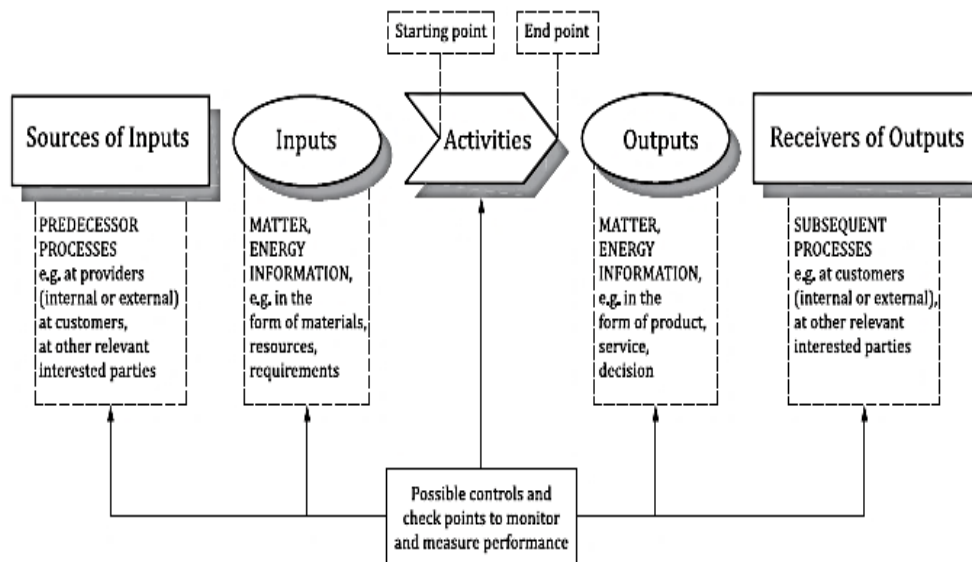


Fig. 1. Element of the single process ISO 9001: 2015.

### 2.4 Risk-Based Thinking

Another major difference in ISO 9001 (2015 version) is the inclusion of one main clause related to risk-based thinking [15]. The ISO 9001: 2015 clause for risk-based thinking are:

**Clause 4**–The company is required to has a process for establishing the risks and opportunities.

**Clause 5**– Clause 5 requires the company to promote the risk-based thinking.

**Clause 6**– Clause 6 requires the company to must identify the risk and opportunity related to the quality management system's performance. The appropriate's action must take the addressing to the risk and opportunity.

**Clause 7**– The company must provide the resources.

**Clause 8**– The company must manage the process's operation based on this clause.

**Clause 9**– Action addressing the problem should be monitored to be reviewed, measured, and be analyzed to be considered with the risks and opportunities.

**Clause 10**–Organizations require the corrective action to correct and prevent or reduce unanticipated impacts and also drive to improve the quality management system and renew risks and opportunities.

### ***2.5 Internal Quality Auditor Competency***

The competencies required for an internal auditor of IATF 16949 quality management standards are [16]:

- Internal quality audit according to ISO 19011.
- Know about process approach.
- Risk-based thinking.
- Know about requirements of ISO 9001 2015 and IATF 16949.
- Mastering IATF 16949 core tools such as Advance Product Quality Planning (APQP), Statistical Process Control (SPC), Measurement System Analysis (MSA), and Failure Mode and Effect Analysis (FMEA).

### ***2.6 OEM Customer Specific Requirement***

Some OEMs, in the 2018 IATF standard [17], issue the special requirements in order to provide superior products and services for their customers.

- General Motors with IATF 16949 - Customer Specific Requirements (CRS).
- Volkswagen with IATF 16949: Customer Specific Requirements (CSR's) of Volkswagen Group.
- Ford Motor Company with Customer-Specific Requirements For IATF-16949: 2016.
- BMW Group with Customer Specific Requirements - specific requirements of the BMW Group.
- Daimler with Customer specific requirements of DAG September 2017.

### ***2.7 Process Mapping***

A quality audit which is done by a certification body is auditing the entire process within the organization. So that, process mapping is needed in the organization. The process mapping requires starting from the quality requirements and the needed elements to produce output including the output from the process to the customer. The same thing in the IATF automotive quality management system standards: 16949, where the organizations must have a process map, starts from the top management process, the main process for each function in the organization, and also supporting processes [18]. Fig. 2 below describes the process mapping.

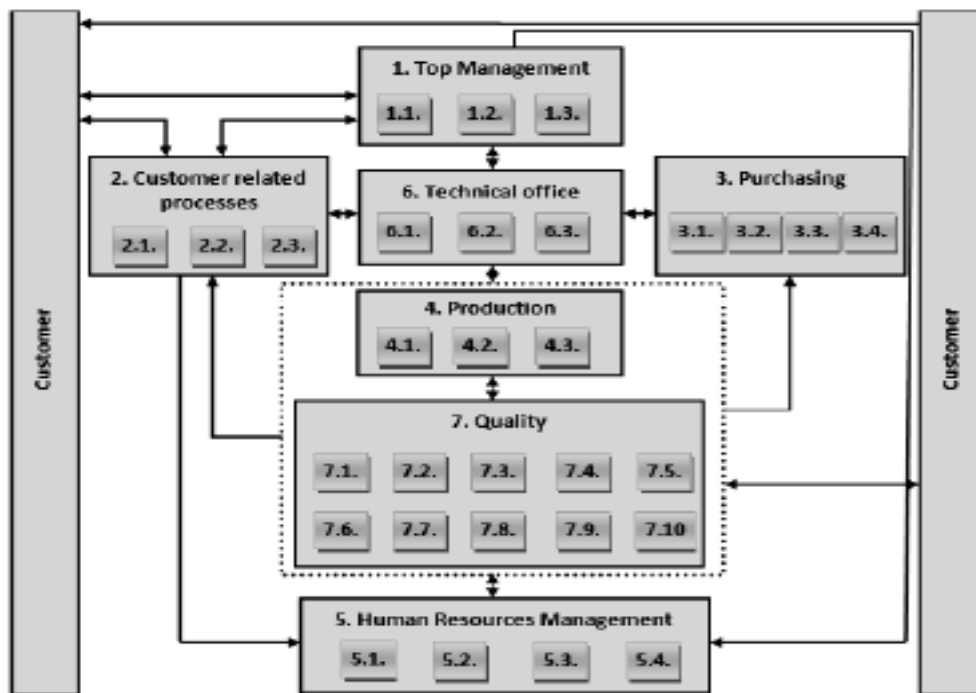


Fig. 2. Process mapping in the supplier industry automotive [18].

### 2.8 Internal Quality Audit and Gap Analysis

The gap analysis was done through an internal quality audit, which was based on the ISO 19011: 2011 guidelines. The components of the audit are as follow:

- Understanding about internal quality audit targets audit program.
- The internal quality audit's goal.
- Completed the audit's desired result.

The initial internal quality audit is required by the certification body as part of preparation for the company that would like to migrate from ISO/TS 16949 into automotive standard IATF 1649:2016. The purpose of this initial quality audit is to assess the compliance of the company's quality management against automotive standard IATF 1649: 2016 [19]. Since the level of compliance is determined, the company can find out what process activities are needed to meet the requirements and know the position and conditions of the implementation of QMS at this time [21].

### 2.9 Audit Scoring

The audit funding result is converted into radar charts. And based on this chart, the organizational performance can be easily determined. This becomes a valuable information for everyone in the company to set up a working plan and strategy for their quality improvement program [22].

### 3. Research Methodology

The research is basically a case study research. The study is one of the automotive industry companies that has an intention to migrate their quality management system from ISO/TS 16949 to automotive standard IATF 1649:2016. The data have gathered from the company and also based on the interviews to their management. Hence, the research has categorized as an applied research [24]. Based on the model from Cooper & Schindler [23], the flow process of methodology for the research can be depicted in Fig. 3 below:

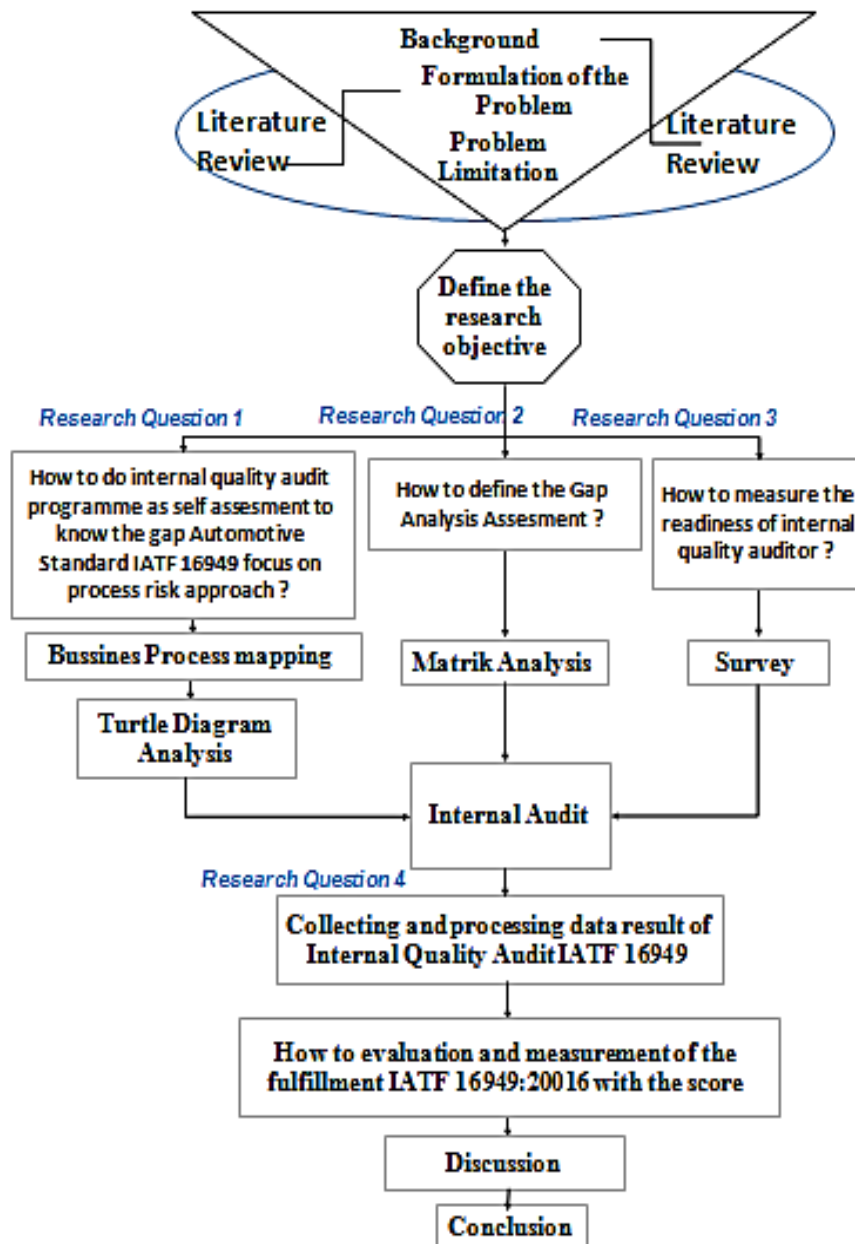


Fig. 3. The flow of the methodology [23].

The background for the research has initiated from the phenomena that many suppliers of the automotive industry have nonconformity during the certification's audit. Based on that phenomena, the research questions have developed as follows:

- How to make the internal audit with defining the necessary processes require to be audited.
- How to measure the internal quality auditor's perception with regarding to automotive standard IATF 16949: 2016.
- How to quantify the internal quality audit's result with the weighted internal audit's score.
- How to measure the certification audit's result probability from the score system gap analysis.

## 4. Result and Discussion

### 4.1 Analysis of Business Process Mapping

There are 32 processes in the process mapping of automotive manufacturing company that have been identified:

Top management processes:

- Management review.
- Business plan.
- Machine procurement and installation.
- Energy.

Main processes:

- Corrective and preventive action.
- Claim-complaint handling.
- Continuous improvement.
- Internal audit.
- Cost of poor quality monitoring.
- Customer satisfaction.
- Control of record and documentation.
- Backup recovery retention and data security.
- Control of measurement tool and testing.
- Order and contract review.
- Production planning.
- Discontinued product.
- Advance product and quality planning.
- Product and process change management.
- Create and change finish product specification.
- Change process.
- Material procurement.
- Maintenance and machine repair.
- Maintenance of hardware and application system.
- Request for the development machine.
- Management tooling.

- Material storage.
- Production process.
- Finish product inventory.
- Delivery.
- Control of non-conforming product and material.

Supporting process:

- Training.
- Recruitment.

In general, the business process mapping for the automotive company has proposed by Mihail [18]. Fig. 4 depicts those business process mappings include the relationship between each sub-process.

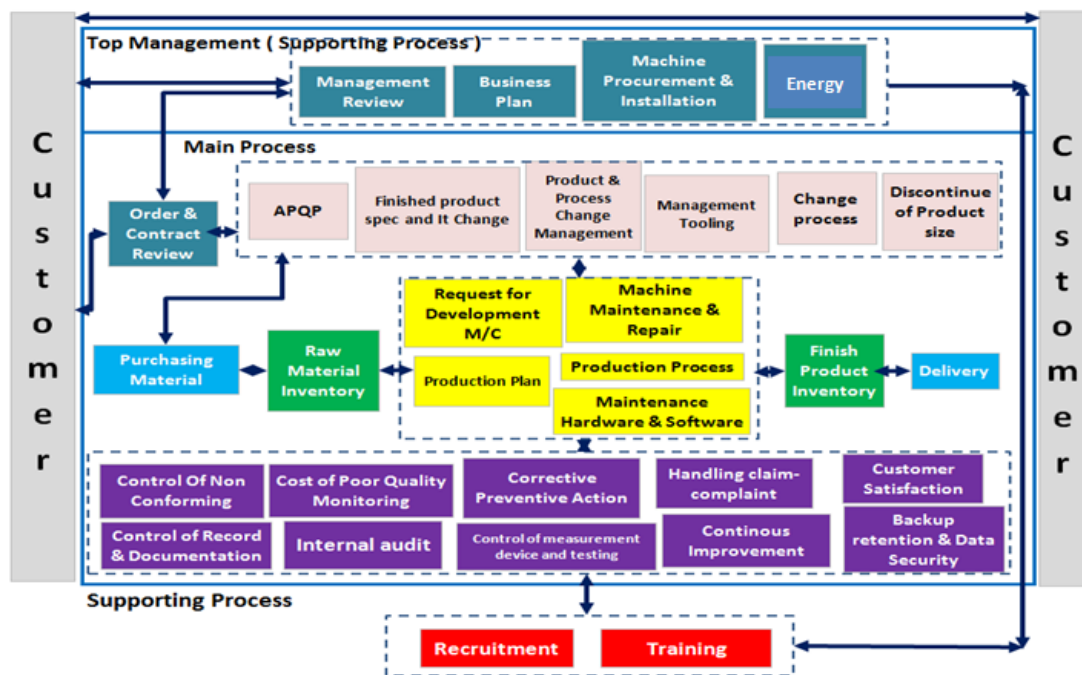


Fig. 4. Bussiness process mapping.

#### 4.2 Matrix Identification Clause and Process

In order to indicate the relevance between the 32 processes stated above with clauses in ISO 9001: 2015 and IATF 16949: 2016, the turtle diagrams have used [20]. The diagram has used for a risk analysis assessment. The assessment is based on the analysis that is done using an identification matrix. The Fig. 5 below depicts the turtle diagram of the risk analysis.



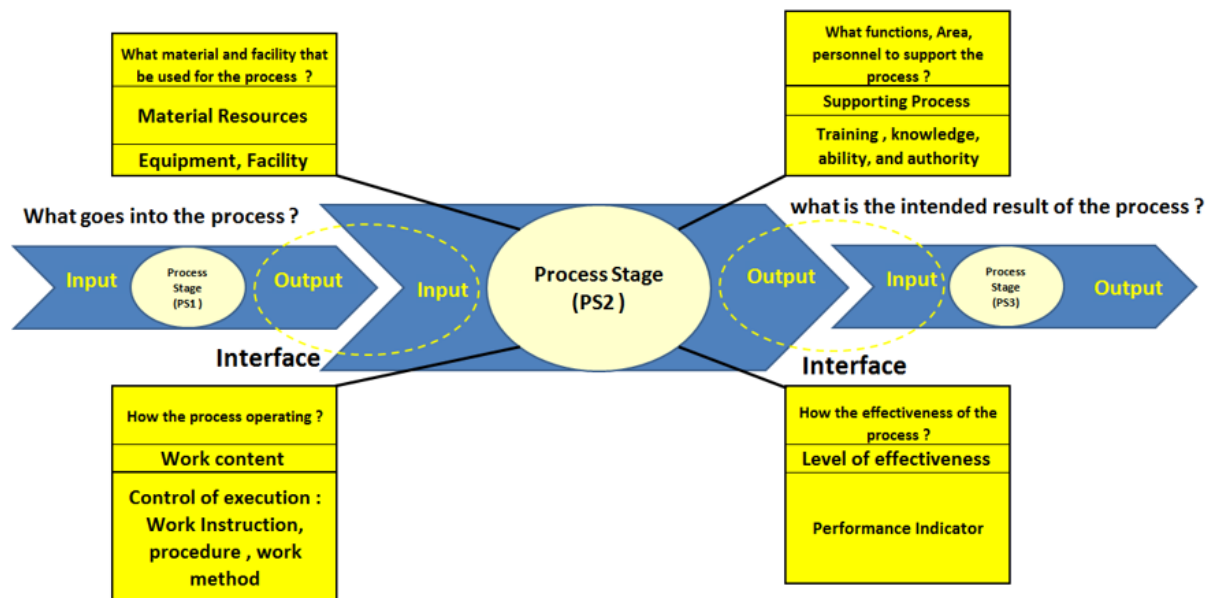


Fig. 5. Turtle diagram risk analysis [20].

Risk analysis is carried out using a turtle diagram, where the variable chose is derived from the VDA 6.3 standard. The input variables used in the analysis are those relating to resources, i.e. incoming raw materials and infrastructure facilities. Whereas, at the process category, the work content becomes the main variable together with the personnel capabilities, skills, knowledge, training, and authority as supporting variables in the process. The level of effectiveness of the existing process is used as a performance indicator variable, which is part of the output category. This result of the research creates minimum requirements for the fulfillment of the process risk that is associated with IATF 16949 standard requirements. Table 2 below depicts the items that need to be checked in order to develop the risk process, for each category.

In many cases, the automotive manufacturing company needs to identify their customer specific requirements into the organization's quality management system, for example, the customer specific requirement for the automotive manufacturing company Volvo's customer specific requirement, Volkswagen's customer specific requirement, and Daimler's customer specific requirement. Those customer specific requirements are listed in the CSR tables. The tables help the internal quality auditor in carrying out a conformity audit.

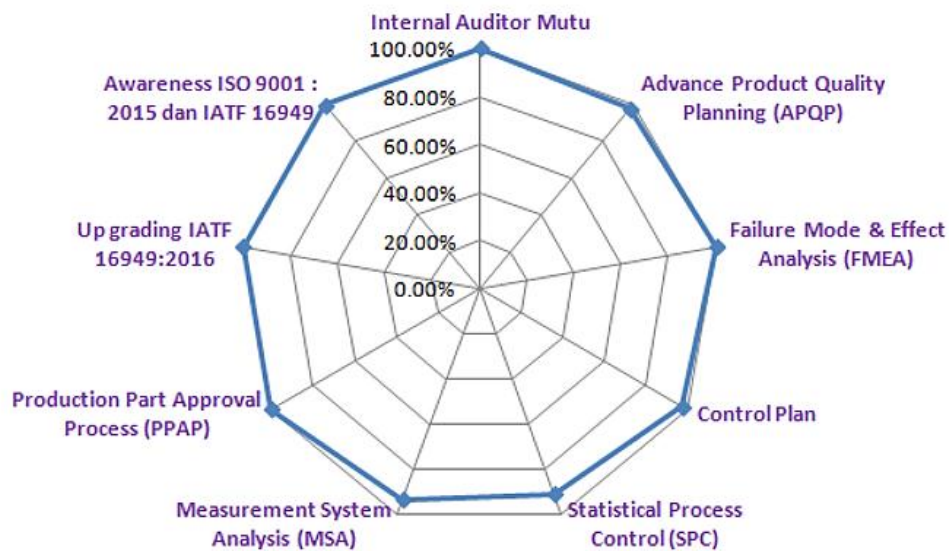
#### 4.3 Internal Auditor Competency Analysis.

The quality audit will examine the level of compliance on implementation of the quality management system in every process level and stages within the company. Also, the quality audit will look at the aspect of technical, managerial, and administration of the company. Hence, the competencies of the internal auditors become a crucial part of analysis of the quality audit reports. Fig. 6 is the example for the skill map of the internal auditor that has been assessed as the part of conformity.

**Table 2.** Risk analysis linked with the clause IATF 16949.

Category	No	Item need to be checked	Clausul IATF 16949
<b>Input</b>	1	Planning the actions to address risks and opportunities.	6.1; 6.1; 6.2
	2	Risk analysis.	6.1; 2.1
	3	Requirement for products and service, Customer communication.	8.2 ; 8.2.1
	4	Determining the requirements for product and services.	8.2.2
	5	Review of the requirement for products and services.	8.2.3
	6	Statutory and regulatory requirement.	8.4.2.2
<b>Material Resources</b>	7	Acceptance criteria.	8.4.2.2
	1	Infrastructure.	7.1.3
	2	Plant facility and equipment planning.	7.1.3.1
<b>Supporting Process</b>	3	Environment for the operation of process.	7.1.4; 7.1.4.1
	1	Competence.	7.2; 7.2.1; 7.2.2
	2	Awareness.	7.3
	3	People.	7.1.2
	4	Organizational knowledge.	7.1.6
	5	Monitoring and measuring resources.	7.1.5; 7.1.5.1
<b>Work Content</b>	6	Organizational roles responsibilities and authorities.	5.3; 5.3.1; 5.3.2
	1	Documented information.	7.5.1; 7.5.1.1; 7.5.2; 7.5.3; 7.5.3.2
	2	Operation planning and control.	8.1
	3	Standardize work - operator instructions and visual standards.	8.5.1.2
<b>Level of Effectiveness</b>	4	Verification of job set-ups.	8.5.1.3
	1	Monitoring, measurement, analysis, and evaluation.	9.1.1
	2	Analysis and evaluation.	9.1.3; 9.1.3.1
	3	Quality objective and planning to achieve them.	6.2; 6.2.1; 6.2.2; 6.2.2.1
	4	Improvement.	10.1; 10.2
<b>Output</b>	5	Problem solving.	10.2.3
	1	Identification and traceability.	8.5.2
	2	Customer satisfaction.	9.1.2; 9.1.2.1
	3	Statutory and regulatory conformity.	8.6.5

### Skill Matrix Competency Internal Quality Auditor IATF 16949



*Fig. 6. Internal auditor skill map.*

The minimum knowledge that an auditor must have are as follows:

- 5 core tools of ISO/TS 16949 (SPC, MSA, APQP, PPAP, FMEA and control plan).
- Awareness of requirement ISO 9001: 2015 and IATF 16949: 2016.
- Internal auditor training.

The research study reviews the internal quality auditor's perception on:

- There are 31 number of auditor as a sampling in the company, based on Taro Yamane's Formula [27].
- The research uses a Likert's survey to capture the survey answer [28]. The score scales for the defined survey are as follows [32]:
  - Very understood: Given a score of 5.
  - Understand: Given a score of 4.
  - Neutral: Given a score of 3.
  - Not understand: Given a score of 2.
  - Very not understand given score of 1.

The questions in the survey are developed consist of 17 questions covering for the response information such as the history training, experience as the auditor, experience work in automotive part manufacturing, education background, and knowledge based on the perception of 13 new requirement IATF 16949. The survey data already is tested with the normality test; the survey resulted data is normal. The survey data is valid. Validity tests the evidence correlation  $r$  the value more than  $r$  in Table [25]. Reliability test showed the data was reliable; the Cronbach Alfa value more than 0.70 [26]. The index's score for analysis used the interval score with the formula:

$$\text{Interval} = (m - n) / b, \tag{1}$$

where, m: Max score, n: Min Score, and b: Total Class.

Data are defined as below table:

**Table 3.** Index score criteria analysis Likert.

Category	Index Score
Very Understand	$4,2 \leq x \leq 5$
Understand	$3,4 \leq x < 4,2$
Netral	$2,6 \leq x < 3,4$
Not Understand	$1,8 \leq x < 2,6$
Very not understand	$1 \leq x < 1,8$

**Table 4.** Interpretation result for survey question.

Question	Total of responden answer					Index Score	Interpretation
	Very Understand	Understand	Neutral	Not Understand	Very Not Understand		
(Q1)	2	21	8	0	0	3.81	Understand
(Q2)	2	19	9	1	0	3.71	Understand
(Q3)	0	16	14	1	0	3.48	Understand
(Q4)	1	26	4	0	0	3.9	Understand
(Q5)	5	23	3	0	0	4.06	Understand
(Q6)	3	26	2	0	0	4.03	Understand
(Q7)	5	25	1	0	0	4.13	Understand
(Q8)	2	22	7	0	0	3.84	Understand
(Q9)	2	25	4	0	0	3.94	Understand
(Q10)	3	25	3	0	0	4	Understand
(Q11)	1	19	9	2	0	3.61	Understand
(Q12)	1	20	9	1	0	3.68	Understand
(Q13)	2	25	4	0	0	3.94	Understand
(Q14)	6	25	0	0	0	4.19	Understand
(Q15)	3	24	4	0	0	3.97	Understand
(Q16)	3	26	2	0	0	4.03	Understand
(Q17)	0	23	7	1	0	3.71	Understand

From the analysis, auditor understand accordance with 13 new requirements risk-based thinking and 83 modify requirements of quality management system automotive standard IATF 16949: 2016.

#### 4.4 Developing List Internal Audit Question

The requirement IATF 16949 needs to ensure that take in the process and is well implemented with the basic foundation from the matrix identification clause and the process that already have determined at the beginning with integrating, and consider the customer specific requirement and minimum risk analysis question. A close question used to check all the requirement. The research uses the weighted score with the scale:

- The score 0, if the answering no evidence for the system implementation and no conformity to the requirement.
- The score 1, if the system in place and have no implementation's evidence.
- The score 2, if the system has found inconsistent's implementation and partial conformity to the requirement.
- The score 3, if achieving the full conformities.

#### 4.5 Plotting All the Result Audit into the Score

In the final stage of the research, all scores counted from the internal audit are listed into the worksheet and plotted into spider chart (Fig. 7).

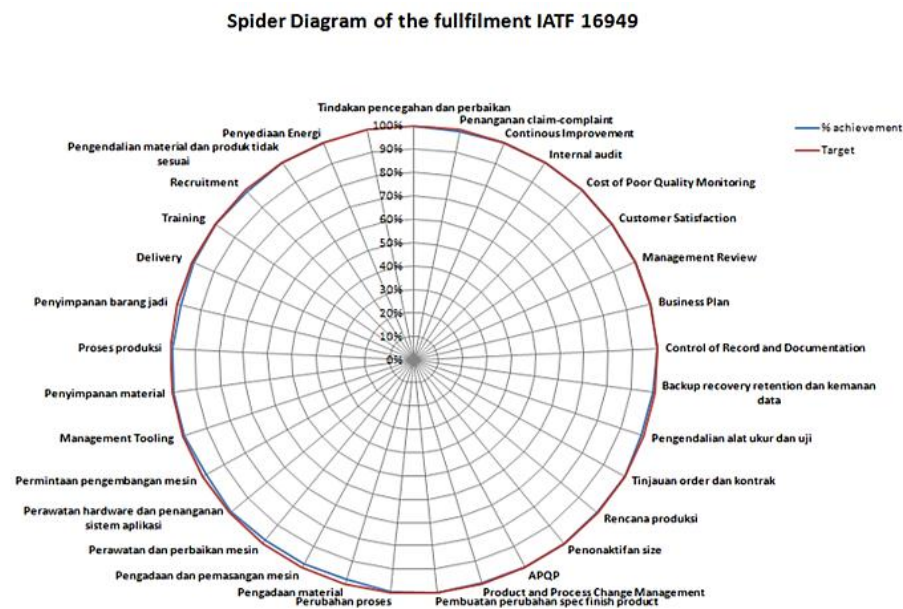


Fig. 7. Spider chart of audit result trial form.

Based on the chart, the decision can be takes as follows:

- The score of 90 to 100, potential pass from the certification audit.
- The score of 80 to 89.99, needs improvement.
- The score of 0 to 79.99, potentially not pass the certification audit.

## 4. Conclusion

The research found that basically most of the employees in the company need to improve their knowledge on the requirements of the new IATF 16949: 2016. Those conclusions can be drawn from the evidence that the score level for the clause 7.3 in many processes did not achieved the maximal score. Some points indicated from the research are:

- There were 32 processes in an automotive manufacturing company which were needed to be an audit.

- The survey indicated that internal quality auditor was ready with the new requirement of the quality management system.
- The internal audit's result with a weighted score can quantify the fulfillment of the automotive standard IATF 16949:2016.
- The quality management system's gap which shown in a spider's chart told that an automotive manufacturing company possible passed from the certification audit.

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