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THESIS

A SIMPLE EFFICIENT SELECTION MODEL TO SET BOUNDARY SAMPLE FOR MULTIPLE CRITERIA ALTERNATIVES

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A Thesis Submitted in Partial Fulfillment of

the Requirements for the Degree of

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Decision making when faced with several alternatives is not simple. At an automobile manufacturer, the review boundary sample activity for reducing cost and maintaining the best quality for customers is quite complex; it requires criteria-based judgments, e.g., defect ratio and claimed history of customers' parts. This study will propose a decision support system for this multiple criteria selection problem. The system applies Analytic Hierarchy Process (AHP) techniques, which enable this problem to be solved without an optimizer. At the normal work, the questionnaires were used to survey quality control engineers and to determine the weights of the criteria. With this system, an automobile manufacturer can collect data and use it to consider the selected alternatives (proposals). Even a new or an inexperienced engineer can use this system to identify the best selection and ensure objective selection. In addition, this system can reduce decision making time from two – three days per proposal to 5 minutes per proposal.

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Student's signature Thesis Advisor's signature

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Unchitha Kachawong
September 2011

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LIST OF ABBREVIATIONS

AHP	=	Analytic Hierarchy Process
ATIS	=	Approval Inspection Standard
CPU	=	Central Processing Unit
CVIS	=	Complete Vehicle Inspection Standard
DEA	=	Data Envelopment Analysis
DMUs	=	Decision Making Units
JIT	=	Just-In-Time
OM	=	Operation Management
QC	=	Quality Control
SQA	=	Shipping Quality Audit
SSMS	=	Supplier Selection Management System
TQM	=	Total Quality Management
VBA	=	Visual Basic for Applications

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A SIMPLE EFFICIENT SELECTION MODEL TO SET BOUNDARY SAMPLE FOR MULTIPLE CRITERIA ALTERNATIVES

INTRODUCTION

The automobile company currently faces with defect outflow problems from suppliers, and the quality control department needs to work hard in detecting those defect outflow problems to customers. Because the automobile company tries to keep the concept of "Customers Come First", it must strictly control suppliers to the highest quality.

However, the automobile company generally does not have an assessment of the suppliers' capability in those suppliers sometimes cannot control parts' quality and cause defect outflow to the automobile company. In addition, some suppliers have to scrap and repair parts in order to deliver acceptable parts to the automobile company to suppliers even though they may be not defects; this activities unnecessarily cost money to suppliers

"Boundary Sample" is a defective limit of vehicle parts that the automobile company needs to set to suppliers to judge the quality of their parts and to screen incoming parts. For example, the maximum acceptable dimension of scratch defect at hood panel is 0.5 mm. However, the automobile company does not set boundary samples for all vehicle parts. Normally, the automobile company has 3 conditions to set the boundary sample; when suppliers cannot control their process; when the defective part does not clearly meet the standard; and when the parts are in the area that is visible to customer.

Therefore, the automobile company always sets boundary sample stricter than required to meet the customer satisfaction. The automobile company has 3 main standards for quality control. Firstly, the complete vehicle inspection standard (CVIS) is used to control vehicle quality in the automobile company by referring to Japanese fitting standards. Secondly, the shipping quality audit (SQA) standard is used for control vehicle quality by referring to customer satisfaction. CVIS is

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normally more stringent than SQA. Finally, the approval inspection standard (ATIS) is used for controlling part quality of suppliers by referring to engineering drawing. However if a defective part is the section that is shown in CVIS or a drawing, the company would not set boundary sample. On the other hand, if a defective part is the section that is not shown in CVIS or a drawing, the automobile company would set boundary sample based on SQA (Figure 1). It needs to be more severe than SQA. Generally, the automobile company sets boundary sample for suppliers tighter than SQA as much as possible to achieve the highest quality for customers.

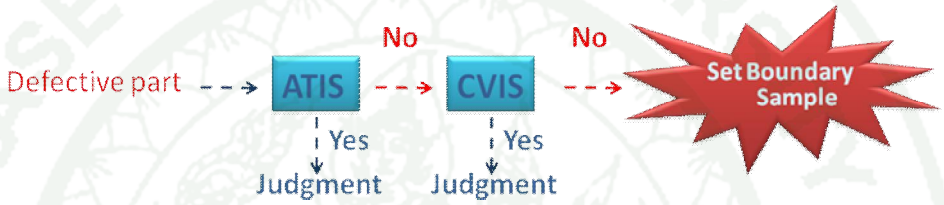

Figure 1 Judgment Defective Part Process**.**

Therefore, the Quality Control (QC) department needs to set up the activity called "Review Boundary Samples" to countermeasure this problem by using multiple criteria to make decisions, e.g., defect ratio, benefit cost analysis, supplier's history, dimensions of defects, and acceptable defects based on SQA (Figure 2). Suppliers present many dimensional defects and benefit in Baht/vehicle. Many other types of decision problems involve multiple conflicting criteria.

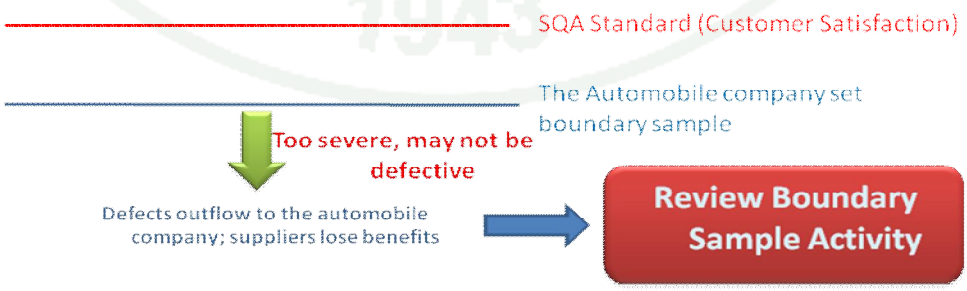

Figure 2 Set Boundary Sample Problems**.**

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As a result, the automobile company needs to create a decision making system for evaluating several alternatives in order to ensure the best solution. Suppliers' data and SQA's constraints will be built into a decision making system by using the Analytic Hierarchy Process (AHP) framework for determining the best criteria and selection for judgments. This decision support system is implemented on Excel because it is one of the tools that are easy to keep or manipulate data. The current and ideal situations of reviewing boundary samples are shown in Figures 3 and 4.

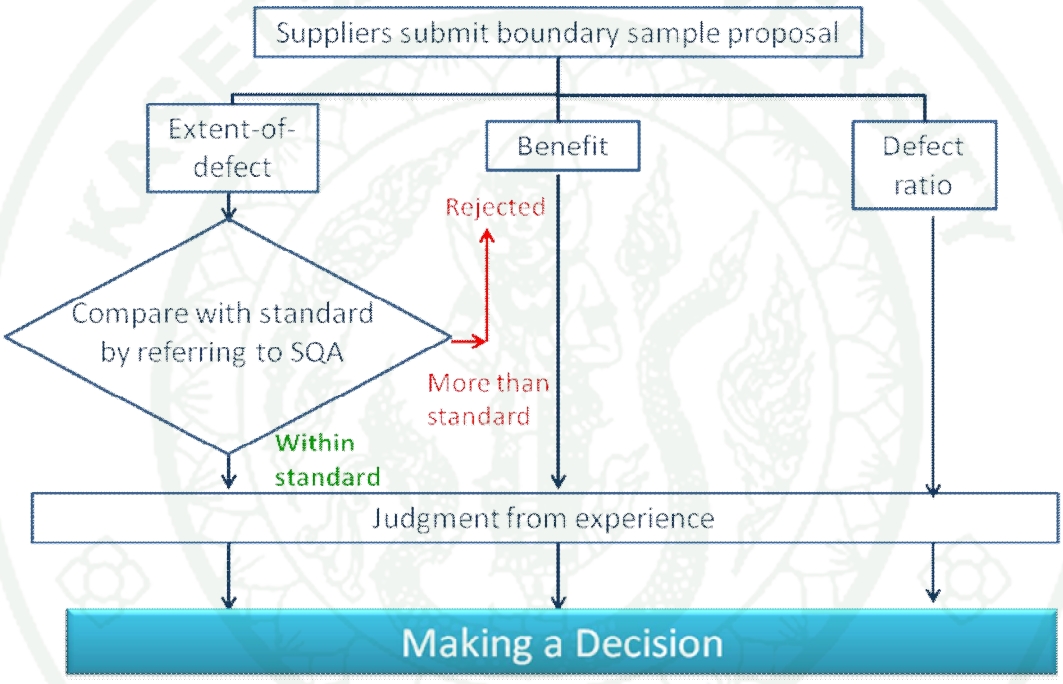

Figure 3 The current situation for reviewing a boundary sample.

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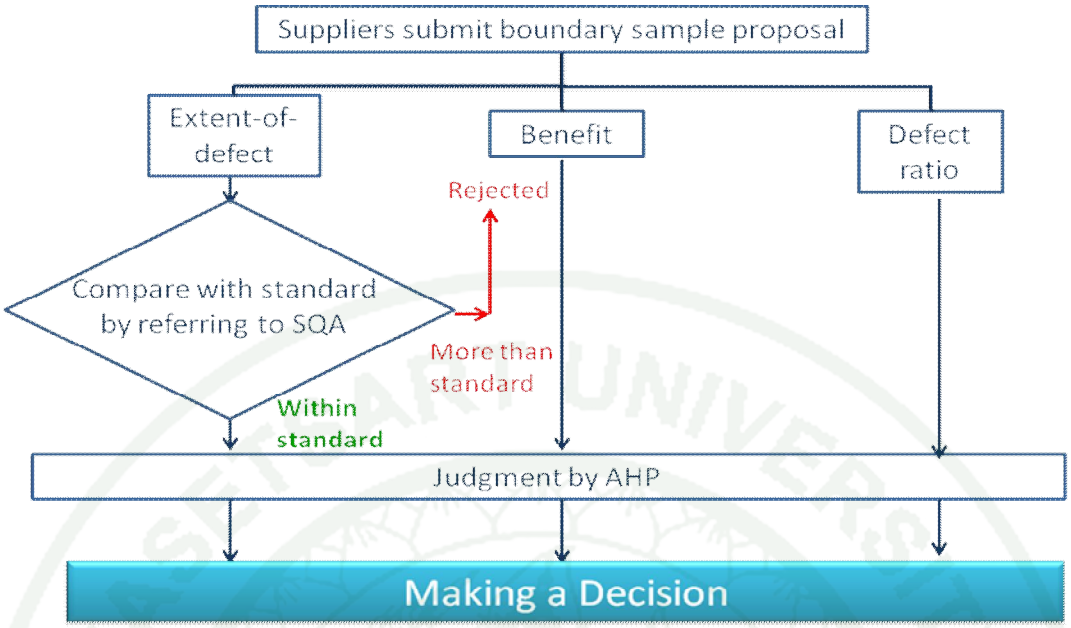

Figure 4 The ideal situation for reviewing a boundary sample.

Figure 3 shows suppliers submit boundary sample proposals that contain the extent of defects, benefit and defect ratio. Firstly the automobile company has to confirm the extent of defects by referring by SQA. If the extent of defects is more than standard, the automobile company will reject proposal. If it is not, we will judge this proposal by considering benefit and defect ratio criteria from experience. It is not ensure what the best solution is. Therefore, Figure 4 shows the decision support system by AHP that ensures the best solution.

In this study, we consider only numerical defects, for example, the length of scratch, or the dimension of seeds. Other types of defects include color defect that occur from dusts on parts before painting. We will not consider the defects that are reviewed by feeling; for example, discoloring or abnormal noise.

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OBJECTIVES

The purposes of this study are:

1. To develop a decision making system for reviewing many several selections to set boundary sample of parts for the automobile company.

2. To assess and evaluate the usefulness and effectiveness of improvement alternatives by analyzing the data from AHP before decision making.

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Scopes

We assume the following conditions:

1. The study was done in the Quality Control Department at one of the leading automobile companies in Thailand.

2. The study was done on 23 suppliers of the automobile company.

3. The study was collected data and information in June 2010 – August 2010.

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LITERATURE REVIEW

Pearman (1977) describes the formal models for multiple criteria decision making problems, the most common being "Weighting Models". One method of specifying weights adapts techniques from the literature relating to decision-making under uncertainty: maximin and maximum. The weighting scheme used is degenerate. The maximin-maximum approach is clearly of potential value in decision making situations where, for one reason or another, the information required to establish precise weights to be attached to each criterion is available.

Dickson (1966) studies the vendor selection decisions. He lists distinct factors (characteristics of vendor performance), at least 50 from the purchasing literature that are presented by various authors as being meaningful to consider in the vendor selection decisions. He sends questionnaires to 273 purchasing agents and managers selected from the membership list of the National Association of Purchasing Managers. The list includes purchasing agents and managers from the United States and Canada. Dickson summarizes the findings of Dickson's study regarding the importance of 23 criteria for vendor selection.

Monczka and Trecha (1988) classify supply strategies as one of strategic operations choices. Additionally, with the increase in adoption of total quality management (TQM) and just-in-time (JIT) concepts by a wide range of firms, the supplier selection question has become extremely important. Benton and Krajewki (1990) classify the supplier selection process as an important operations management (OM) decision area. They suggest that OM research should attempt to identify the supply chain management practices that provide competitive advantage. Cardozo and Cagley (1971), Chapman (1989), Dempsey (1978), Hakansoon and Wootz (1975), and Monczka and Trecha (1988), and several other authors have evaluated the relative importance of quality, cost, delivery performance, and other supplier attributes. In summary, most of the articles referenced above suggest that managers should not select suppliers based on low cost only but should consider quality, delivery

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performance and other attributes. They adopt the AHP analysis to select qualified vendors.

Bhutta and Huq (2002) describe the AHP as an excellent approach that can be used in a multifactor decision-making environment, especially when subjective and/or intuitive consideration has to be incorporated. AHP provides a structured approach for determining the scores and weights for the multiple criteria used and standardized them, so that they can be compared and decisions made.

Lee *et al.* (2001) explain that the supplier selection and management system (SSMS) can use the AHP model to calculate the weights of tangible and intangible criteria for supplier selection and to rank the suppliers' performance. The weights of the criteria derived from the AHP analysis are applied to select the key criteria to reinforce the quality of each part. The weak criteria that are the poor performance of selected suppliers form the basis for the benchmarking process to compare in supplier performance with regard to each criterion. The SSMS system requires AHP evaluating alternative suppliers for each critical part selected. The role of the supplier selection is to rank the alternative suppliers and to select primary suppliers – the best suppliers – with respect to each critical part by AHP.

Liu *et al.* (2000) describe that data envelopment analysis (DEA) has been widely applied to address various decision analysis problems due to its usefulness in evaluating multi-criterion systems and providing improvement targets for such systems. A supplier selection selection problem is inherently a multi-criterion decision problem, and DEA has been applied to evaluate suppliers for an individual product.

Seydel (2005) describes that DEA is not developed as a technique for choosing among alternatives. Instead, DEA is intended to evaluate the results of decision making and to identify a set of Pareto-efficient outcomes from among a potentially large set of candidates. DEA is used for evaluating more than two

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decision outcomes and/or decision making units with respect to their relative efficiencies, based upon multiple criteria.

Boer *et al.* (2001) describe that reviewing the supplier selection methods accommodates the diversity of situations in terms of complexity and importance found in the present-day purchasing practice on one dimension. On the other dimension, it covers the different phases in the supplier selection process, ranging from (1) finding out exactly what we want to achieve by selecting a supplier (2) defining the criteria (3) pre-qualifying suitable suppliers to (4) making a final choice.

Narasimhan (1983) suggests using AHP for the supplier selection activity. AHP is the decision-making method for prioritizing alternatives when multiple criteria must be considered. The AHP offers a methodology to rank alternative courses of action based on the decision maker's judgments concerning the importance of the criteria and the extent to which they are met by each alternative. For this reason, AHP is ideally suited for the supplier selection problem.

Waber (1996) describes the use of data envelopment analysis (DEA) as a tool for measuring the performance of vendors on multiple criteria and identify benchmark values. He applies DEA model for measuring vendor efficiency to a baby food manufacturing that has 3 criteria and six vendors' selection.

Kuo *et al*. (2002) describe that AHP is one of the extensively used multi-criteria decision-making methods. One of its main advantages is the relative ease at which it handles multiple criteria. In addition, AHP is easier to understand, and it can effectively handle both qualitative and quantitative data. The use AHP does not involve cumbersome mathematics. AHP involves the principles of decomposition, pairwise comparisons, and priority vector generation and synthesis.

Saaty (2003) explains that AHP allows for inconsistency because in making judgments, people are likely to be cardinally inconsistent because they cannot estimate precisely measurement values even from a known scale and worse when they

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deal with intangibles (e.g., *a* is preferred to *b* twice and *b* to *c* three times, but *a* is preferred to *c* only five times) and ordinally intransitive (e.g., *a* is preferred to *b* and *b* to *c* but *c* is preferred to *a*). When we deal with tangibles, a pairwise comparison judgment matrix may be perfectly consistent but irrelevant and far off the mark of the true values. For several reasons, a modicum of inconsistency may be considered as a good thing and forced consistency, people would be required to be like robots, unable to change their minds with new evidence and unable to look within for judgments that represent their thoughts, feelings and preferences. The AHP also uses a principle of hierarchic composition to derive composite priorities of alternatives with respect to multiple criteria from their priorities with respect to each criterion. It consists of multiplying a priority of each an alternative by the priority of its corresponding criterion and adding over all the criteria to obtain the overall priority of that alternative. This is perhaps the simplest way for composing priorities. The additive approach is also crucial in doing composition using the limiting powers of priority rather than a judgment matrix when dependence and feedback are considered in decision-making. Different methods for deriving priorities within the same hierarchy can lead to different final values for the alternatives.

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Theory and Principle

A decision maker often uses more than one criteria or objective to evaluate the alternatives in a decision problem. Sometimes, these criteria conflict with one another. In making decision, a decision maker must identify the decision that achieves the most satisfying balance of many criteria. Multicriteria decision problems can be solved with many approaches for example, Section 1 describes the multicriteria scoring model and Section 2 describes the analytic hierarchy process.

1. The Multicriteria Scoring Model

In choosing suppliers, we evaluate criteria for each alternative, such as supplier history, customer complaints, dimension of defects and merit. The idea in a scoring model is to assign a number from 0 to 1 to each decision alternative that reflects its relative worth on each criterion. These weights can be thought of as subjective assessments of the utility that each alternative provides on the various criteria.

The multicriteria scoring model is a simple procedure in which we score (or rate) each alternative in a decision problem based on each criterion. We then take scores for each criterion and the decision maker specifies weights, w_{ij} that indicate the relative importance of each criterion. These weights must sum to 1. The score for alternative *j* on criterion *i* is denoted by S_{ij}. Weights (denoted by w_i) are assigned to each criterion indicating its relative important to the decision maker. For each alternative *j*, we then compute a weighted average score as:

$$\text{Weighted average score for alternative } j = \sum w_i S_{ij}. \quad (1)$$

We then select the alternative with the largest weighted average score.

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2. The Analytic Hierarchy Process

Sometimes, a decision maker finds it difficult to subjectively determine the criterion scores and weights needed in the multicriteria scoring model. In this case, the analytic hierarchy process (AHP) can be helpful. AHP provides a more structured approach for determining the scores and weights for the multicriteria scoring model preciously described in Section 1.

The first step in AHP is to create a pairwise comparison matrix for each alternative on each criterion. We perform pair wise comparisons of the criterion systems between alternatives; for example, X, Y and Z using the values shown in Figure 5 (Ragsdale).

Value	Preference
1	Equally Preferred
2	Equally to Moderately Preferred
3	Moderately Preferred
4	Moderately to Strongly Preferred
5	Strongly Preferred
6	Strongly to Very Strongly Preferred
7	Very Strongly Preferred
8	Very Strongly to Extremely Preferred
9	Extremely Preferred

Figure 5 Scale for pairwise comparisons in AHP.

Let P_{ij} denote the extent to which we prefer alternative i to alternative j on a given criterion.

$$P_{ji} = 1/P_{ij}$$

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Table 1 Pairwise comparisons of the criteria for three alternatives.

	X	Y	Z
X	P_{xx}	P_{xy}	P_{xz}
Y	P_{yx}	P_{yy}	P_{yz}
Z	P_{zx}	P_{zy}	P_{zz}
Sum	$A = P_{xx} + P_{yx} + P_{zx}$	$B = P_{xy} + P_{yy} + P_{zy}$	$C = P_{xz} + P_{yz} + P_{zz}$

The second step in AHP is to normalize the matrix of pairwise comparisons. We first calculate the sum of each column in the pairwise comparison matrix (see Table 1). We then divide each entry in the matrix by its column sum. We will use the average of each row in the normalized matrix as the score for each alternative on the criterion under consideration (see Table 2). These scores indicate the relative desirability of the alternatives to the decision maker with respect to those criteria.

Table 2 Price scores obtained from the normalized comparison matrix.

	X	Y	Z	Average Scores
X	$A_1 = P_{xx}/A$	$B_1 = P_{xy}/B$	$C_1 = P_{xz}/C$	$V_1 = (A_1 + B_1 + C_1)/3$
Y	$A_2 = P_{yx}/A$	$B_2 = P_{yy}/B$	$C_2 = P_{yz}/C$	$V_2 = (A_2 + B_2 + C_2)/3$
Z	$A_3 = P_{zx}/A$	$B_3 = P_{zy}/B$	$C_3 = P_{zz}/C$	$V_3 = (A_3 + B_3 + C_3)/3$

In the third step in applying AHP, we check if the decision maker is consistent in the preference ratings given in the pair wise comparison matrix. A consistency measure for each alternative is obtained as:

$$\text{Consistency measure for X} = (V_1P_{xx} + V_2P_{xy} + V_3P_{xz})/ V_1$$
$$\text{Consistency measure for Y} = (V_1P_{yx} + V_2P_{yy} + V_3P_{yz})/ V_2$$
$$\text{Consistency measure for Z} = (V_1P_{zx} + V_2P_{zy} + V_3P_{zz})/ V_3$$

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If the decisions be to perfectly consistent in stating preferences, each consistency measure will equal the number of alternatives in the problem (which, in this case, is three). This is unusual. It is difficult for a decision maker to be perfectly consistent in stating preferences between a large numbers of criteria in pairwise comparisons. Provided that the amount of inconsistency is not excessive, the scores obtained from the normalized matrix will be reasonably accurate. To determine whether the inconsistency is acceptable, we compute the following quantities:

$$\text{Consistency Index (CI)} = (\lambda - n)/(n-1)$$

$$\text{Consistency Ratio (CR)} = CI/RI$$

Where:

λ = the average consistency measure for all alternatives

n = the number of alternatives

RI = the appropriate random index from Table 3

Table 3 Values of RI for use AHP.

n	RI
2	0.00
3	0.58
4	0.90
5	1.12
6	1.24
7	1.32
8	1.41

If the pair wise comparisons matrix is perfectly consistent, then $\lambda = n$ and the consistency ratio is 0. The values of RI in Table 3 give the average value of CI if all the entries in the pairwise comparison matrix were chosen at the random, given that all the diagonal entries equal 1 and $P_{ij} = 1/P_{ji}$. If $CR \leq 0.10$, the degree of consistency

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in the pair wise comparison matrix is satisfactory. However, if CR > 0.10, serious inconsistencies might exist, and AHP might not yield meaningful results.

We can repeat the process for obtaining the price criterion scores to obtain scores for the other criteria. We must also determine weights that indicate the relative importance of the criteria to the decision maker. The pairwise comparison process used earlier to generate scores for the alternative on each criterion can also be used to generate criterion weights.

The last step in AHP is to calculate the weighted average scores for each decision alternative.

The system will select the alternative with the largest scores.

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MATERIALS AND METHODS

Materials

1. The data collection

This study uses the data collected from 23 suppliers of the automobile company during January 2010 – August 2010.

2. Hardware

A laptop (CPU Intel Core i5, RAM 1 GB) is used to analyze the data and evaluate the statistical results.

3. Software

a) Microsoft Word is used to create this research document.

b) Microsoft Excel is used to create supporting documents and our AHP program.

c) Microsoft PowerPoint is used to create this research presentation.

d) http://spreedsheets.google.com is used to create questionnaires.

Methods

In this study, we propose to create a decision support system for reviewing boundary samples for several alternatives in order to ensure that it is the best solution by using AHP. The proposed system (Figure 6) consists of five main components: (1) define the criteria, (2) questionnaires design, (3) apply AHP scoring result, (4) create Excel program for users, and (5) evaluate our Excel-based program.

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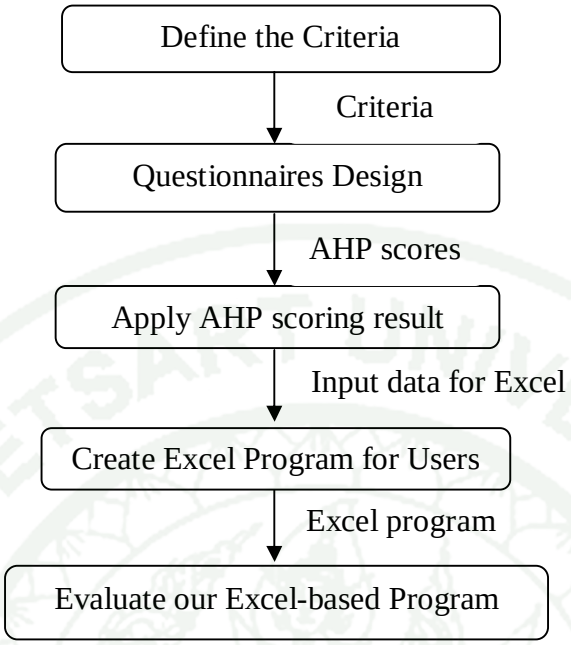

Figure 6 The decision support system for reviewing boundary samples.

1. Define the criteria

Firstly, we have to consider what criteria are included in the boundary sample reviewing process. In general, suppliers must submit basic information for approval, such as extent of defect, benefits for approval, and defect ratio. In addition, the important factor is suppliers' historied record. The suppliers' records are used to guarantee the suppliers' capability to control part's quality and not incur defect outflow to the automobile company. The supplier's records consists of two main components: customer complained records that are the defect outflow to customers, and part's claimed records that are also the defect part outflow to the automobile company but it can detect them. Therefore, in this study, we consider five criteria for boundary sample reviewing process:

1.1 Extent of defect: Extent of defect for reviewing boundary sample proposal.

1.2 Benefits (Cost down): Financial benefits for acceptable proposal.

1.3 Defect ratio: Fraction of defective parts of reviewing proposal.

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1.4 Customer complained records: Supplier records concern with customer complaint.

1.5 Claimed records: Supplier records concern with defect outflow to automobile company.

2. Design Questionnaires

AHP requires AHP scores to create a pairwise comparison matrix. Quality control engineers are responsible for reviewing boundary sample. Therefore, we have to design and distribute questionnaires to twenty-eight QC engineers. The questionnaire is designed for pairwise alternatives in each criterion according to AHP framework. For example, there are 3 alternatives: A, B and C, 5 criteria for judgment: extent of defect, defect ratio, benefits, customer complained records and claimed records. We design the pairwise comparison between A and B, A and C and B and C in each criterion (Figure 7). We can separate our questionnaire design for the criteria ranking (Section 2.1), extent of defects (Section 2.2), other criteria (Section 2.3) and criterion weights for pairwise comparisons (Section 2.4).

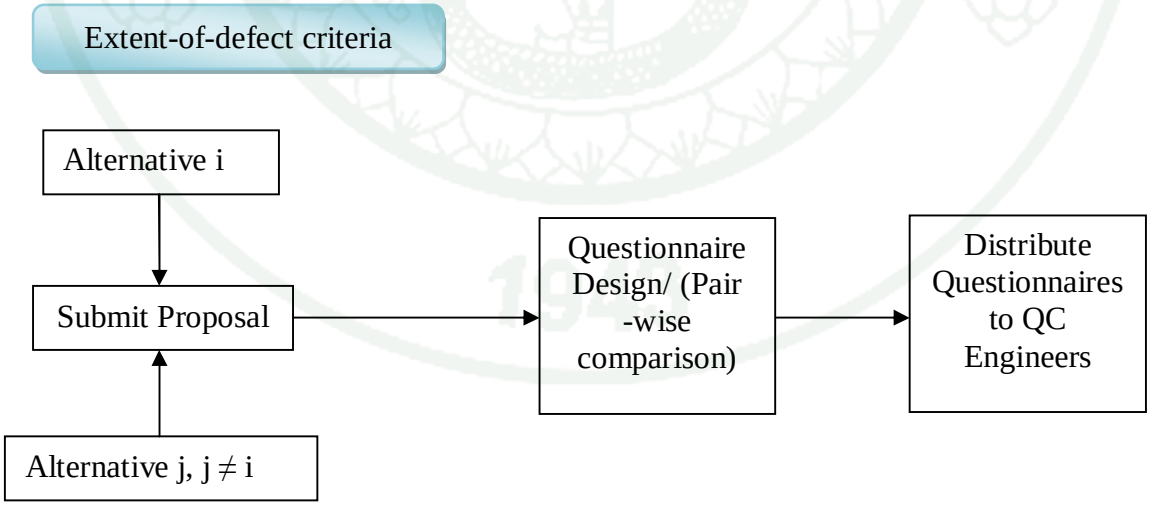

Figure 7 Questionnaire design process of extent-of-defect criteria.

2.1 Criteria Ranking

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We design the extent-of-defect questionnaire to find acceptable dimensions that are smaller than the standard of SQA. We find that the extent-of-defect criteria is difficult to establish, and the experience from respondents are needed. However, we are able to design questionnaires for other quality criteria. This includes the numerical data of acceptable defect ratios, sufficient benefits, the acceptable number of customer complaint cases and the acceptable number of claimed part cases when we accept the extent of defect presented by suppliers. However, we find it impractical for respondents to answer all the questions that come from suppliers' proposal. We design pairwise questionnaires for setting grades of alternatives in each criterion. Each alternative in each criterion is given a grade from its value. Therefore, we design one set of questionnaire for each criterion, and respondents feel convenient to answer them.

The remaining criteria simply require opinion and a sense of judgment; for example, we separate the extent-of-defect criteria in the questionnaire design with weight scores which are proportional to job positions (the more senior the positions, the higher the weights), e.g., engineer's weight equals to "1", chief engineer's weight equals to "3" and higher than assistant manager's weight equals to "6.5". The remaining criteria questionnaire is combined in another set of questions. QC department is contained eight engineers, six chief engineers and four assistant managers.

2.2 Design of an extent-of-defect questionnaire

Generally, Quality Control Engineers approve suppliers' proposals concerning the extent of defects by referring to the SQA; however, few engineers have sufficient understandings to properly judge the optimal position of defects in the SQA. Inexperienced engineers need to be supported by assistant managers with greater skills. We also give weight scores which are proportional to job positions to properly assess the result of questionnaire responses. Quality Control Department consists of twenty-eight engineers: eighteen fitting engineers and ten functional engineers. The fitting engineer is mainly responsible for reviewing boundary samples

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because it concerns with appearance of parts, not with function of parts. The scope of the defect questionnaire is distributed to eighteen qualified engineers in the Quality Control Department for setting the grade of suppliers who present the extent of defect for establishing boundary samples. The grades of A to E represent "surely acceptable", "acceptable", "may be acceptable", "need support from leader" and "not acceptable" grades. "Surely acceptable" and "not acceptable" grades are designed for minimum and maximum extent of defect. Remaining grades of suppliers are interpolated from minimum to maximum values (Figure 8 and Table4).

Figure 8 Grade of suppliers for the extent-of-defect criteria.

We do not categorize all grades of suppliers because answering questionnaires is a demanding task for respondents. Types of questionnaires have 44 questions with each 6 multiple choices; a question is classified by the zone of defect and the type of auto parts, following the SQA (See Appendix A). Each choice is designed by following the dimension of defect in the SQA (See Appendix B) and calculating average dimension to each choice. (See Appendix C)

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Table 4 Wording on questionnaires for the extent-of-defect criteria.

Grade	Wording
Surely Acceptable (A)	What do you think is the worst defect that you find acceptable?
Not Acceptable (E)	What do you think is the beginning dimension of defect for your not acceptable?

2.3 The questionnaire design for other criteria

The remaining questionnaire are on benefits, defect ratio, claimed records and customer complaint records are answered by all Quality Control Engineers because they do not require special skills for judgment. In addition, this questionnaire is an opinion question. Therefore it does not need experience to answer, and weight scoring is applied, similar to the extent-of-defect questionnaire. This questionnaire uses the same concept with extent-of-defect questionnaire; it is graded by using A to E scales, ranging from "surely acceptable", "acceptable", "may be acceptable", "need support from leaders" and "not acceptable" (Figure 9). We design the questionnaire so that respondents can decide to accept a proposal by themselves for "surely acceptable" (grade A). Respondents can accept a proposal after requesting one section of information for "acceptable" (grade B); respondents can accept a proposal after requesting more than one section of information for "may be accept" (grade C); respondents need support from leaders to accept proposal for "need support from leaders" (grade D), and respondents cannot accept proposal for "not acceptable" (grade E). See detail in Table 5. The complete questionnaire is shown in Appendix D.

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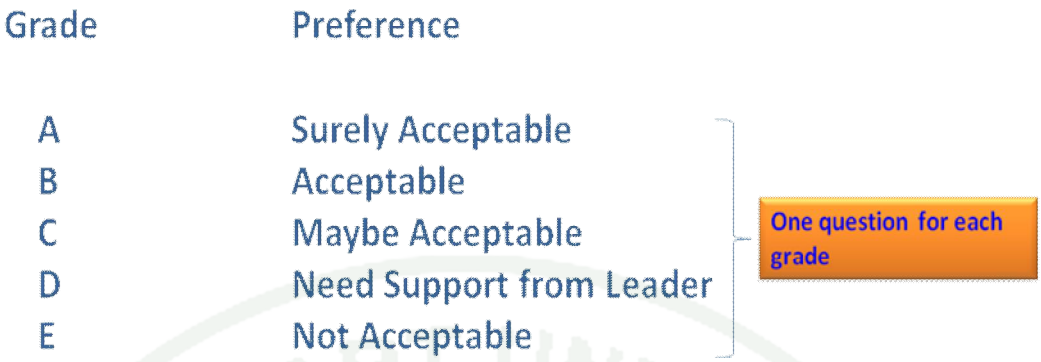

Figure 9 Grade of supplier in the other criteria.

Table 5 Wording on questionnaires for the other criteria.

Grade	Wording
Surely Acceptable (A)	Can accept the proposal immediately
Acceptable (B)	Need to receive one more piece of information to accept
Maybe Acceptable (C)	Need to receive more than one piece of information to accept
Need Support From Leader (D)	Need a leader's support to accept
Not Acceptable (E)	Cannot be accepted

Five questions are asked for each criterion: benefits, defect ratio, customer complaint records, and claimed part data. However, the choices are designed specifically for each criterion. Some criteria need to collect historical data: customer complained records, and claimed part records for designing choices. On the other hand, some criteria are just information; benefits and defect ratio.

The automobile company set the target of cost down in this activity at least 250,000 Baht per year. Therefore we design the questionnaire in percentage of cost down target per year. For example, supplier presents cost down per year 200,000 baht

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that is eighty percentage of the cost down target. The questionnaire on benefit criteria consists of five questions with nine choices. See in Table 7. The wording of questionnaire is shown in Table 6.

Table 6 Wording on questionnaire for the benefit criteria.

Wording	Grade
Surely Acceptable (A)	What the best minimum number percentage of cost down target that you can decide to accept condition by yourself immediately?
Acceptable (B)	What the minimum number percentage of cost down target that you can accept a condition after requesting one section of information?
Maybe Acceptable (C)	What the minimum number percentage of cost down target that you can accept a condition after requesting more than one section of information?
Need Support from Leader (D)	What the minimum number percentage of cost down target that you need support from leaders to accept conditions?
Not Acceptable (E)	What the number percentage of cost down target that you cannot accept conditions?

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Table 7 Choices of benefit and defect ratio criteria questions.

Choices	Content
A	0% - 10%
B	11% - 20%
C	21% - 30%
D	31% - 40%
E	41% - 50%
F	51% - 60%
G	61% - 70%
H	71 % - 80%
I	80% up

The defect ratio shows fraction of defective parts of reviewing proposal in suppliers' process. More defects occur in suppliers' process mean more opportunity defect outflow to the automobile company. The wording of questions and choice design are shown in Table 8 and Table 7.

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Table 8 Wording on questionnaire for the defect ratio criteria.

Grade	Wording
Surely Acceptable (A)	What the best minimum number percentage of defect ratio that you can decide to accept condition by yourself immediately?
Acceptable (B)	What the minimum number percentage of defect ratio that you can accept a condition after requesting one section of information?
Maybe Acceptable (C)	What the minimum number percentage of defect ratio that you can accept a condition after requesting more than one section of information?
Need Support from Leader (D)	What the minimum number percentage of defect ratio that you need support from leaders to accept conditions?
Not Acceptable (E)	What the number percentage of defect ratio that you cannot accept conditions?

The customer complaint data shows how many cases of supplier outflow defect to customers. It is used to guarantee suppliers' capability. Fewer the number of cases of customer complaints, more respect for approving the boundary sample. In this study, we collect the customer complaint data from January to August 2010 (see Appendix E). The questionnaire consists of six multiple choices. Each choice is designed from historical records that show that the maximum customer complaint cases in eight months is seven cases; almost all suppliers have one case of customer complaints in eight months (Table 10). The wording of questionnaire design of customer complaint criteria is shown in Table 9.

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Table 9 Wording on questionnaire for the customer complaint criteria.

Grade	Wording
Surely Acceptable (A)	How many customer complaint cases in eight months of a supplier needed for you to decide to accept a proposal by yourself?
Acceptable (B)	How many customer complained cases in eight months of a supplier needed for you to decide to accept a proposal after requesting one section of information?
Maybe Acceptable (C)	How many customer complaint cases in eight months of a supplier needed for you to decide to accept a proposal after requesting more than one section of information?
Need Support from Leader (D)	How many customer complaint cases in eight months of a supplier needed for you to decide to accept a proposal after support from leaders?
Not Acceptable (E)	How many customer complaint cases in eight months of a supplier needed for you to decide to not accept a proposal?

Table 10 Choices of customer complaint records criteria questionnaire**.**

Choices	Cases
A	0 case
B	1 case
C	2-3 cases
D	4-5 cases
E	6-7 cases
F	7 cases up

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The claimed records show how many cases supplier outflow defects occur at the automobile company. Fewer the number of cases claimed, greater respect for approval boundary samples. In this study, we collect the claimed records in January to August 2010 (see Appendix F). The questionnaire design of claimed records criteria consists of nine multiple choices. Each choice is designed from records that show the top five claimed case in eight months (Table 11). We design choice dividing by ten and the last choice is eighty cases up (Table 13). The wording of questionnaire design of defect ratio criteria is shown in Table 12.

Table11 Claimed case records in eight months.

Supplier	The number of claimed cases in eight months
Supplier A	161 cases
Supplier B	96 cases
Supplier C	89 cases
Supplier D	80 cases
Supplier E	49 cases

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Table 12 Wording on questionnaire for the claimed records criteria.

Grade	Wording
Surely Acceptable (A)	How many claimed cases in eight months needed for you to decide to accept a proposal by yourself?
Acceptable (B)	How many claimed cases in eight months needed for you to decide to accept a proposal after requesting one section of information?
Maybe Acceptable (C)	How many claimed cases in eight months needed for you to decide to accept a proposal after requesting more than one section of information?
Need Support from Leader (D)	How many claimed cases in eight months needed for you to decide to accept a proposal after support from leaders?
Not Acceptable (E)	How many customer claimed cases in eight months needed for you to decide to not accept a proposal?

Table 13 Choices of claimed record criteria questionnaire.

Choices	Cases
A	0 case
B	1-10 cases
C	11-20 cases
D	21-30 cases
E	31-40 cases
F	41-50 cases
G	51-60 cases
H	61-70 cases
I	71-80 cases
J	80 cases up

2.4 The criterion weights pairwise comparisons questionnaire design

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The pairwise criterion weight is designed to find weight scores each criterion by using AHP framework (Figure 5). The questionnaire consists of twenty questions: ten questions for pairwise comparisons, and ten questions for pairwise weight. Table 14 shows the question wording.

Table 14 Wording on questionnaire for the criterion weights pairwise comparisons.

Grade	Wording
No grade	What do you prefer criteria 1 over criteria 2 for approval of boundary samples?
No grade	What is the preferred scoring?

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RESULTS AND DISCUSSTION

Results

1. AHP Scoring

This section explains about the AHP scoring process after distributing questionnaires to respondents and receiving the result of grade each alternative in each criterion and the AHP scores on each criterion. The grades of alternative are applied for AHP scoring by using pairwise comparison scales (Table 15) together with differences of alternatives' grade. A pairwise comparison in AHP uses scales of 1, 3, 5, 7 and 9, representing "equally preferred" that means two alternatives present their grades are given the same grade of alternative; "moderately preferred" represents the difference of 1 grade, "strongly preferred" 2 grades, "very strongly preferred" 3 grades and "extremely preferred" 4 grades (Table 16). For example, the supplier K presents the extent of defects and results in grade A, whereas the supplier L presents his and receives grade E. Therefore, the AHP score is "9" because they differ by 4 grades.

Table 15 Score of pairwise comparisons.

Value	Preference
1	Equally Preferred
3	Moderately Preferred
5	Strongly Preferred
7	Very Strongly Preferred
9	Extremely Preferred

Table 16 shows that the same grade comparison is equal to "1" in AHP scoring; the difference of one grade is equal to "3" in AHP scoring; the difference of two grades is equal to "5" in AHP scoring; the difference three grades is equal to "7"

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in AHP scoring, and the difference of four grades is equal to “9” in AHP scoring. The AHP scoring process is separated by questionnaire types: the extent of defect (Section 3.1), and the other criteria (Section 3.2).

Table 16 Pairwise comparisons in AHP**.**

	Grade A	Grade B	Grade C	Grade D	Grade E
Grade A	1	3	5	7	9
Grade B	-	1	3	5	7
Grade C	-	-	1	3	5
Grade D	-	-	-	1	3
Grade E	-	-	-	-	1

1.1 AHP scoring for the extent of defect

The extent-of-defect questionnaires is distributed to eighteen quality control engineers to verify if they understand the questionnaires and obtain their questionnaire back. The extent-of-defect questionnaires is separated to two categories: “Surely Acceptable” questionnaire and “Not Acceptable” questionnaire. The “Surely Acceptable” questionnaire is designed for minimum extent of defect; the “Not Acceptable” questionnaire is designed for maximum extent of defect. We obtain eighteen the returned questionnaires. The empirical results of minimum and maximum dimension of defect questionnaire are shown in Figures 10 and 11.

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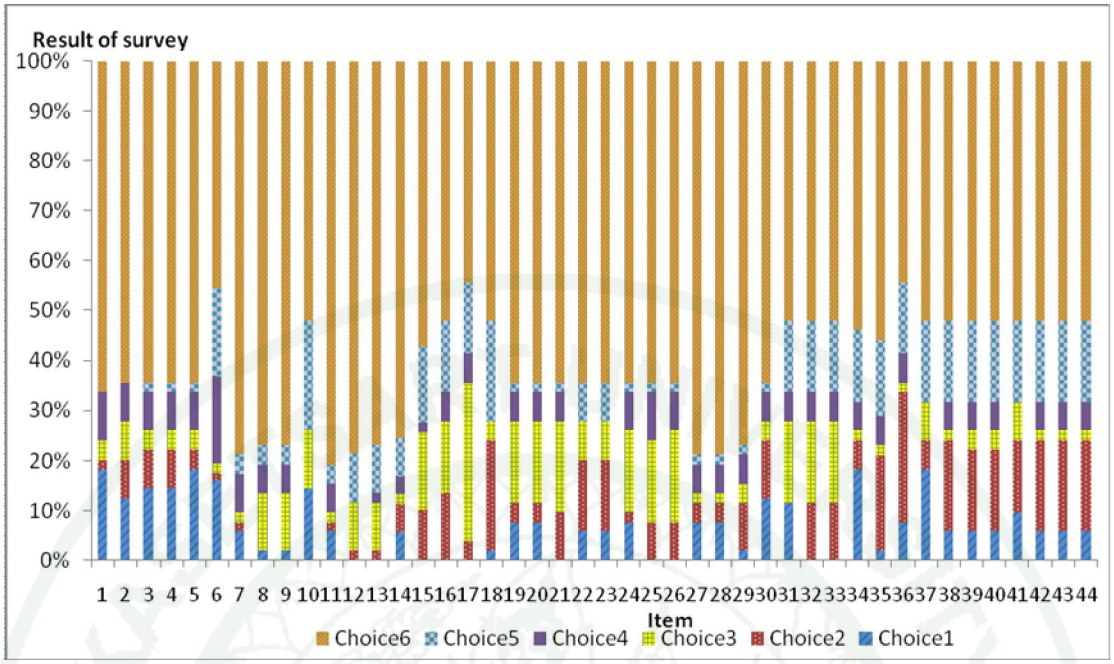

Figure 10 Result of the survey in "surely acceptable" questionnaire (minimum dimension of defect).

In Figure 10, the result of the survey in "surely acceptable" questionnaire shows pattern in that the minimum dimension of defect for each section is chosen to be the sixth choice (orange tab), which means the defects would not be accepted or 0 (zero). Almost all of respondents show in the same opinion the zone of defects and types of parts. The detailed result of survey is shown in Appendix G.

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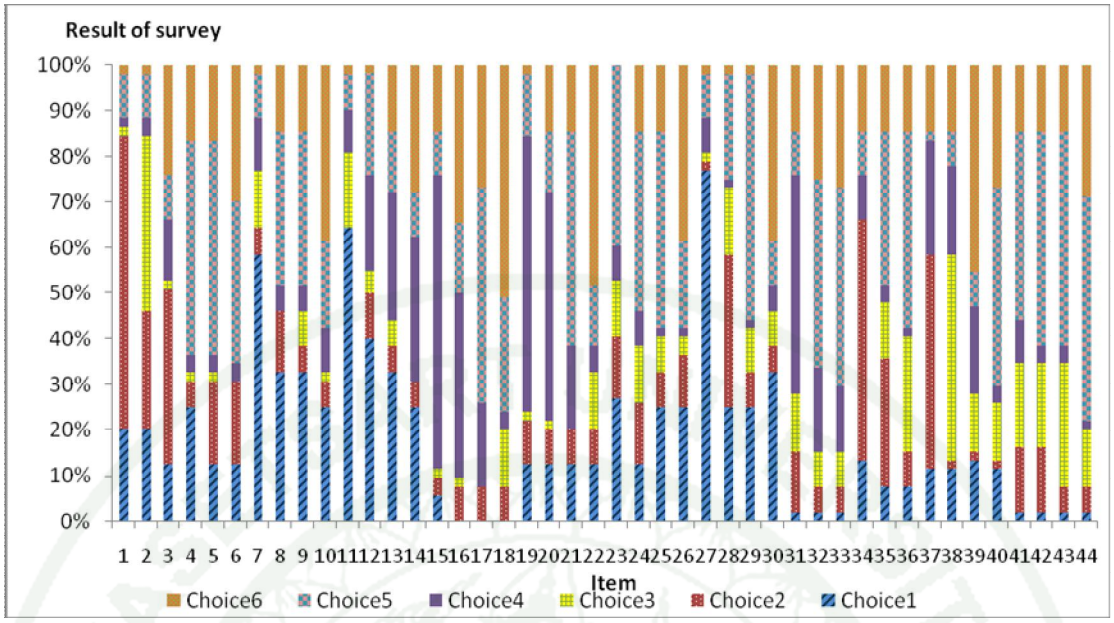

Figure 11 Result of the survey in "not acceptable" questionnaire (maximum dimension of defect).

The result of the survey in "not acceptable" questionnaire shows that the maximum extent of defect depends on the zone of defects and the type of parts. Some zones of defects and the type of parts are more critical and visible that small dimension of defects is required. Some zones of defects and types of parts are less critical and less visible that greater dimension of defects is acceptable. The detailed result of survey is shown in Appendix H.

The "Surely Acceptable" questions represent the "A" grade (minimum) of the extent of defect; the "Not Acceptable" questions represent the "E" grade (maximum) of the extent of defect (Figure 8). Each section in questionnaire is separated by the zone of defect and the type of parts as explained in the section 2.2. We use minimums and maximums from the questionnaire to calculate the dimension of defects for the remaining grade, see Table 17. The example result of setting grade of the extent of defect is shown in Figure 12. The total result of setting grade of the extent-of – defect criteria in each section is shown in Appendix I.

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Table 17 The calculation of remaining grades of the extent of defect.

Grade	Resource	Formula
A	Surely acceptable questionnaire result	(Min)
B		((Max – Min)/4) + Min = Avg1
C		((Max – Min)/4) + Avg1 = Avg2
D		((Max – Min)/4) + Avg2 = Avg3
E	Not acceptable questionnaire result	(Max)

The AHP scoring process starts at a suppliers' proposal presentation. We check the extent of defect of a proposal to identify a section by zone of defect and type of part and translate into a grade. Then pairwise comparison is applied for decision making system by translating grade of alternative to AHP scores by using pairwise comparison scales (Table 15) together with difference of alternatives' grade as explained in AHP scoring (Section 3). The AHP scoring process is shown in Figure 12.

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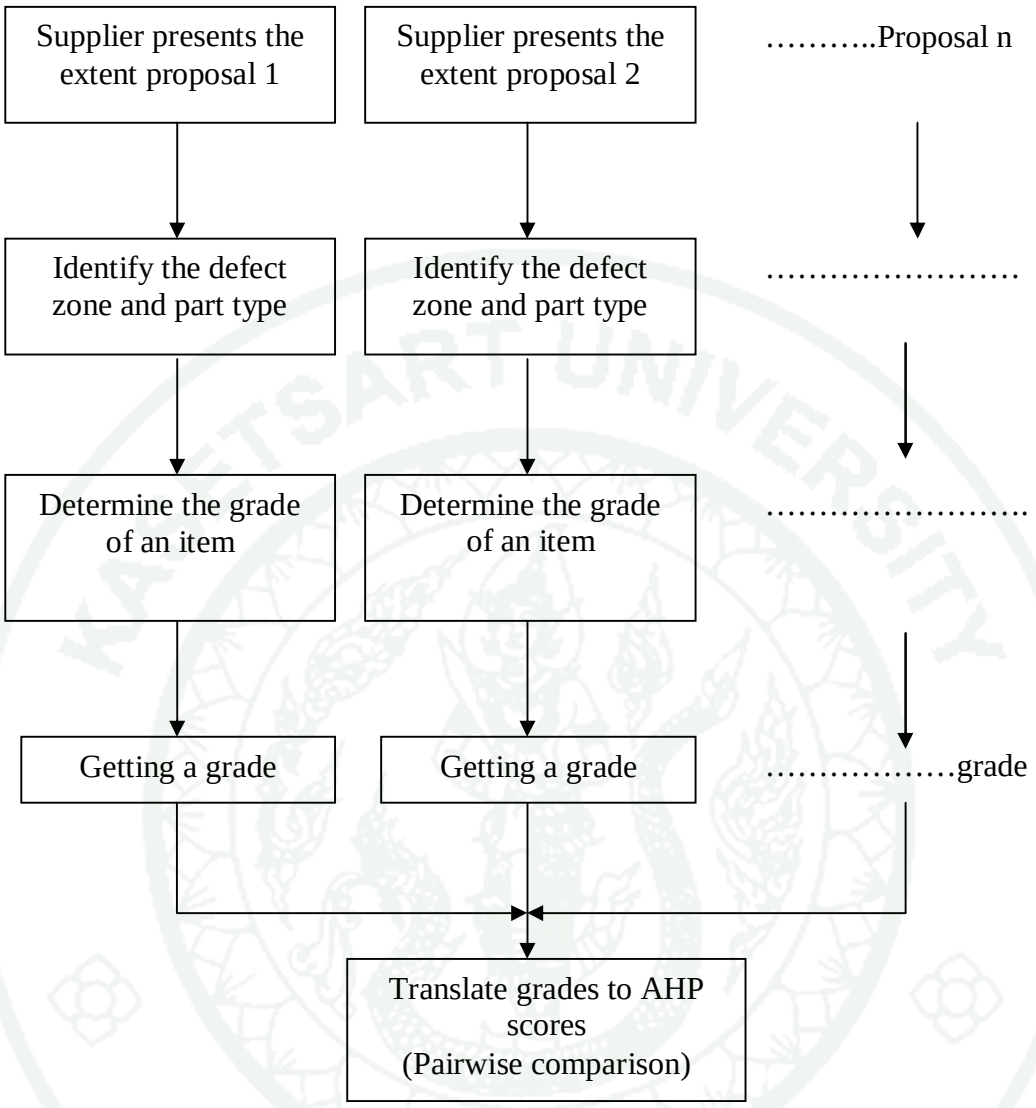

Figure 12 The AHP scoring process in the extent-of-defect criteria**.**

3.2 The other criteria AHP scoring

The other criteria: include benefits, defect ratio, claimed record and customer complaint record to set grade of proposals to make it convenient of respondents. The empirical results of other criteria questionnaires are shown in Tables 18-21.

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Table 18 The result of surveys on benefits.

Grade	Benefits (Percent of cost reduction)	Fraction of respondents
A	80% and up	71%
B	51% – 60%	46%
C	41% – 50%	39%
D	21% – 30%	46%
E	0% – 10%	71%

Table 19 The result of surveys on defect ratio.

Grade	Defect ratio	Fraction of respondents
A	80% and up	64%
B	31% – 40%	46%
C	21% - 30%	46%
D	11% - 20%	54%
E	0% – 10%	89%

Table 20 The result of surveys on the number of customer complaint cases over 8 months.

Grade	# of customer complaint cases	Fraction of respondents
A	0 case	82%
B	1 case	54%
C	2 – 3 cases	64%
D	4 – 5 cases	36%
E	7 cases up	68%

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Table 21 The result of surveys on the number of part claimed cases over 8 months.

Grade	# of part claimed cases	Fraction of respondents
A	1 – 10 cases	54%
B	11 - 20 cases	57%
C	21 - 30 cases	39%
D	31 - 40 cases	43%
E	80 cases up	61%

The AHP scoring process for other criteria is almost similar to the extent-of-defect criterion and is shown in Figure 13.

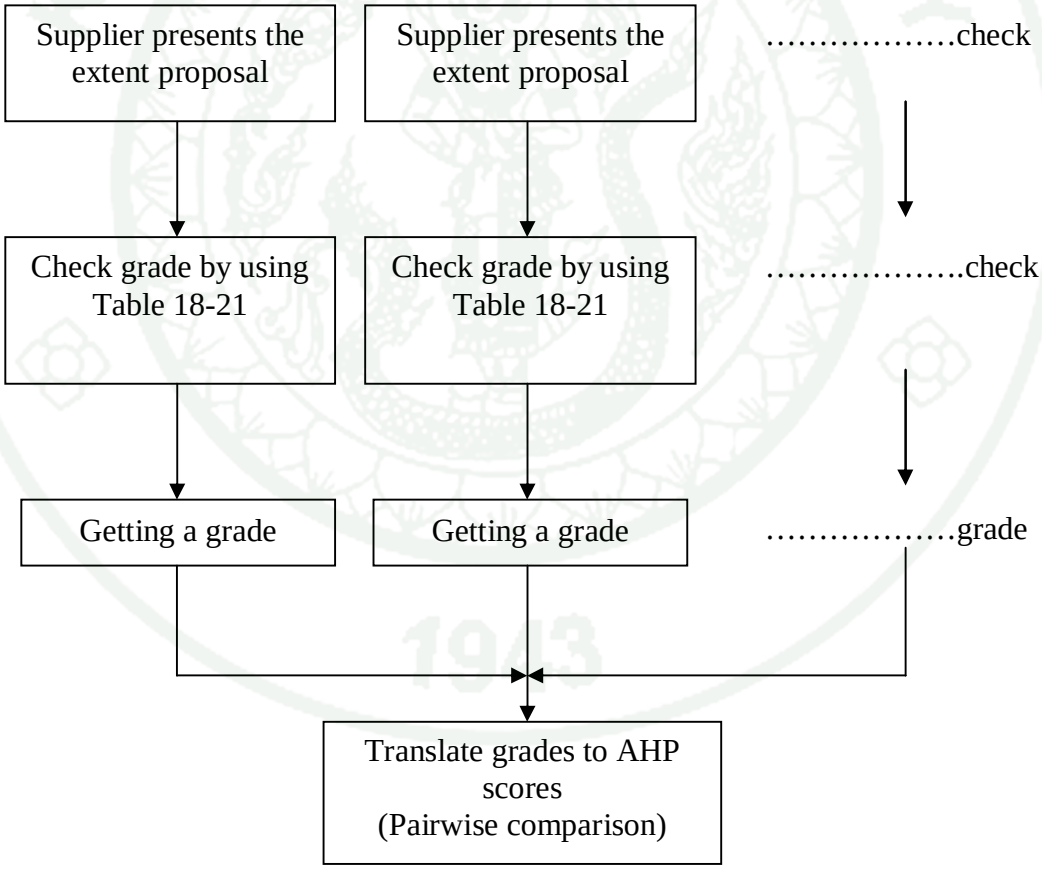

Figure 13 The AHP scoring process on the other criteria**.**

3.3 The criterion weights pairwise comparisons AHP scoring

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The empirical result of other criteria questionnaire is shown in Table 22.

Table 22 The criterion weights for pairwise comparisons questionnaire.

	Extent	Benefits	Defect Ratio	Number of customer complaint cases	Number of claimed parts
Extent	1	5	5	5	5
Benefits	0.2	1	0.17	0.25	0.25
Defect Ratio	0.2	6	1	3	5
Number of customer complained cases	0.2	4	0.33	1	2
Number of claimed parts	0.2	4	0.2	0.5	1

As explained in theory and principle of AHP, we first calculate the sum of each column in the pairwise comparison matrix (Table 23). We then divide each entry in the matrix by its column sum. We will use the average of each row in the normalized matrix as the score for each alternative on the criterion under consideration (Table 24).

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Table 23 The criterion weights for pairwise comparisons.

	Extent	Benefits	Defect Ratio	Number of customer complaint cases	Number of claimed parts
Extent	1	5	5	5	5
Benefits	0.2	1	0.17	0.25	0.25
Defect Ratio	0.2	6	1	3	5
Number of customer complained cases	0.2	4	0.33	1	2
Number of claimed parts	0.2	4	0.2	0.5	1
Sum	1.8	20	6.7	9.75	13.25

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Table 24 The normalized comparisons matrix.

	Extent	Benefits	Defect Ratio	Number of customer complaint cases	Number of claimed parts	Average Scores
Extent	0.556	0.250	0.746	0.513	0.377	0.488
Benefits	0.111	0.050	0.025	0.026	0.019	0.046
Defect Ratio	0.111	0.300	0.149	0.308	0.377	0.249
Number of customer complained cases	0.111	0.200	0.049	0.103	0.151	0.123
Number of claimed parts	0.111	0.200	0.030	0.051	0.075	0.094

The AHP scoring of criterion weights are implemented on the Excel program.

4. Develop on Excel Program for Users

We implement the AHP frame work on Excel to be the database input for determining the best solution. The Excel program is used because it is easy to collect, manipulate and display data. Users specify: supplier' name, the values for extent of defect, benefits, and defect ratio in the Excel program (See the Appendix J). The process of using the Excel program for decision making is separated to five processes as follows:

4.1 Input the extent of defect

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A user specifies the extent of defect on a blank form that corresponds to the section's zone of defect and type of part as shown in Figure 14. The input data is checked with the maximum values that are stored on the Excel worksheet. The Excel program generates the output. If the extent of defect is less than the maximum value, the program will continue to set a grade based on the extent of defects (Section 3.1). Then pairwise comparison is done by translating a grade of an alternative to AHP scores. On the other hand, if the extent of defect is larger than the maximum data, the program will not approve the proposal and stop the reviewing process.

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Item					Standard				
					Zone s	Zone A	Zone B	Zone C	Zone D
Label	Scratch Chip Tear Cut	Mark, Emblem (mm) Printed letter (mm dia) Strips Label							
Int. and Ext. Painted, Plated, Leather parts	Chip Paint Peeling	Chipping and width is 0.5 mm or more (It is shown with dia.)	Top coat (dia)						
			Reach to under coat	similar color (dia)					
				contrast color (dia)					
			Reach to steel panel (dia)						
Int. and Ext. Painted, Plated, Leather parts	Gash Paint crack Scratch primer which is obvious condition	Linear scratch with catch on finger nail (it is shown in mm)	Top coat (dia),(mm)						
			Reach to under coat	similar color scratch in primer(mm)					
				contrast color (mm)					
			Reach to steel panel (mm)						
Int. and Ext. Painted, Plated, Leather parts	Surface scratch by rubbing (It is shown with mm)		Top coat Similar color (mm)						
			Contrast color (mm)						
Int. and Ext. UnPainted, Pile parts	Gash Paint Crack	Linear scra catch on finger nail (It is shown with mm.)							
Int. and Ext. Unpainted, Pile parts	Surface scratch by rubbing (It is shown with mm)		Top coat Similar color (mm)						

Figure 14 The extent of defect form.

4.2 Input a supplier's name

A user provides a supplier's name to check its record: the customer complained record, and the claimed record. The customer complained record and the

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claimed record are already stored in the Excel program. It generates a grade of an alternative for customer complained record and claimed record criteria (as explained Section 3.2). Then pairwise comparison is done on a decision support system by translating a grade of an alternative to an AHP scores.

4.3 Input a defect ratio

A user puts in the defect ratio that a supplier presents for approval of a boundary sample. The Excel program generates a grade of alternative and an AHP score.

4.4 Input benefits

The suppliers always present benefits in term of cost reduction per year. However, the Excel program translates suppliers' data to percentage of cost down target per year (250,000 Baht) and generates the grade of an alternative in benefits criteria and an AHP score.

4.5 The decision making process

We select the proposal with the largest AHP scores. (See in Appendix J). The user program process is shown in Figure 15.

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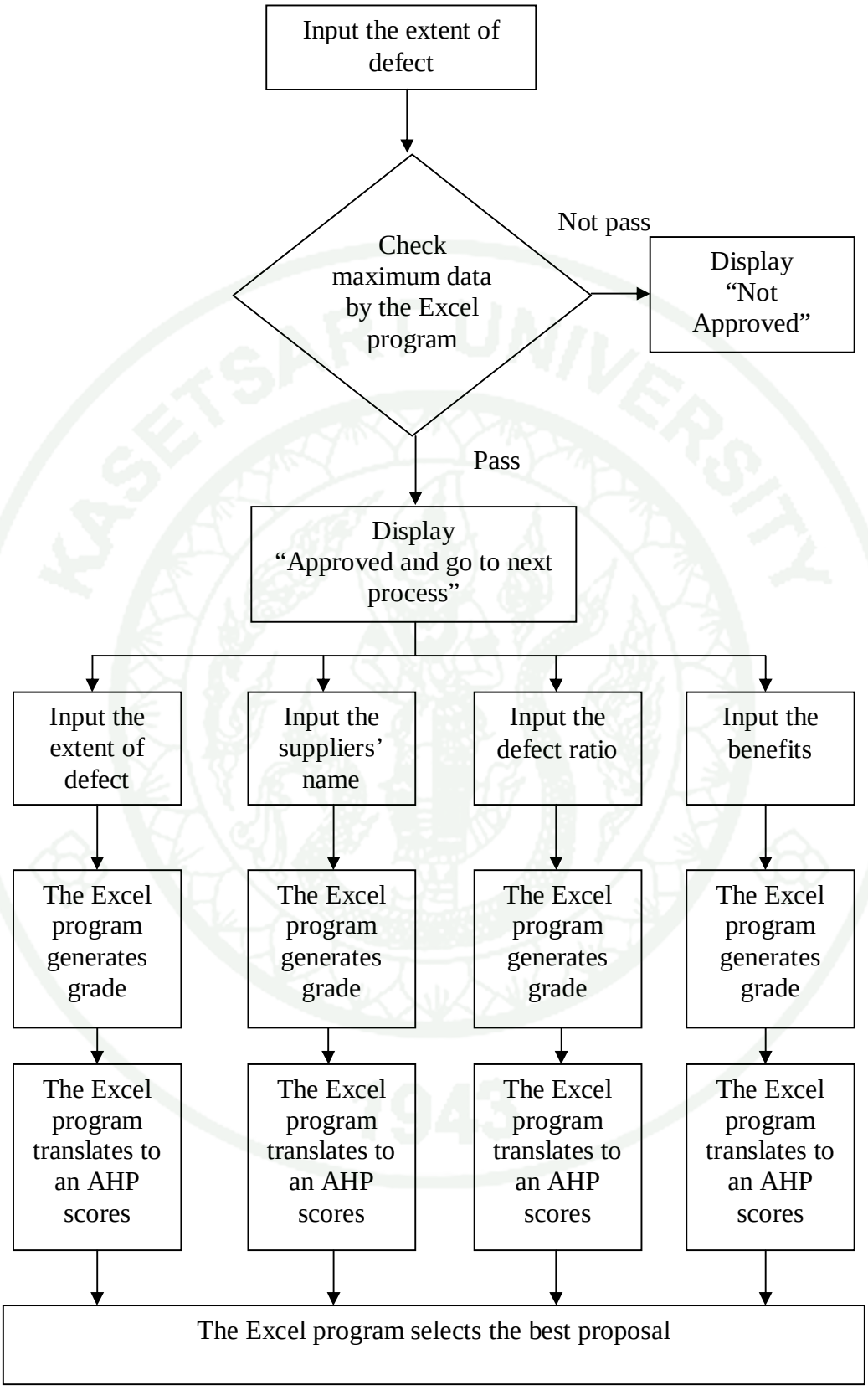

Figure 15 Flowchart of the decision support system.

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5. Evaluate the Excel program

We develop the Excel program for user's convenience. In addition, we evaluate the Excel program by designing the satisfaction survey. The surveys are twenty-eight QC engineers. The wording of questionnaire is shown in Table 23 and Figure 16. The complete questionnaire is shown in Appendix K.

Table 25 Wording on questionnaire for the satisfaction survey.

Wording	Score
Do you think the Excel program support you in saving time for approval boundary sample?	1 - 5
Do you think the Excel program support you for correct decision for approval boundary sample?	1 - 5
Do you think the Excel program support new or inexperienced engineer for approval boundary sample?	1 - 5
Do you think the Excel program support you comfortable for approval boundary sample?	1 - 5
Do you use the Excel program for approval boundary sample?	1 - 5

Choice

1) Extremely disagree
2) Disagree
3) No opinion
4) Agree
5) Extremely agree

Figure 16 Choice of satisfaction survey**.**

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The result of the survey in satisfaction survey shows the same opinion in the Excel program for approval boundary sample (Table 26). Only fifteen QC engineers return the questionnaires to us. The almost of respondents reflect “Agree” or “Extremely agree” in each section in satisfactory user questionnaire. They believe the Excel program for approval boundary sample support them for saving time, correctly decision and helpful for new or inexperience engineer.

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Table 26 The result of the survey in satisfaction survey.

Item	Extremely disagree	Disagree	No opinion	Agree	Extremely agree
Do you think the Excel program support you in saving time for approval boundary sample?				4/15	11/15
Do you think the Excel program support you for correct decision for approval boundary sample?				3/15	12/15
Do you think the Excel program support new or inexperienced engineer for approval boundary sample?				2/15	13/15
Do you think the Excel program support you comfortable for approval boundary sample?				2/15	13/15
Do you use the proposed system program for approval boundary sample?					15/15

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Discussion

In this study, we have considered the multi-criteria decision making alternatives for approval of a boundary sample. We use the AHP framework. The questionnaire design is the one tool for support AHP method and evaluates the Excel program for approval boundary sample. The results of questionnaires are applied in AHP scoring.

1. The criterion weights pairwise comparisons

The result of the criterion weights pairwise comparisons show that the extent of defect is the most important criterion for approval a boundary sample. On the other hand, the benefit is the least essential criteria for acceptance. The defect ratio is the second main criteria for judgment this several criterion problems. The customer complained records is more important than claimed part records because it may cause the loss of reputation.

2. The result of the users' satisfaction survey

Almost all of QC engineers think that the Excel program for approving a boundary sample is useful. It reduces decision making time from two – three days per proposal to 5 minutes per proposal. It is helpful for new or inexperienced engineers.

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CONCLUSION AND RECOMMENDATIONS

Conclusion

Because an automobile manufacturer needs to maintain a goal of "Customers Come First," it must ensure that its suppliers provide products with the highest quality. However, the manufacturer does not have explicit knowledge of suppliers' capability; suppliers cannot control the quality of parts or defect outflow to the manufacturer. Some suppliers resort to scrapping and repairing part in order to deliver parts in good conditions to the manufacturer; this scrapping may result in higher costs to suppliers, even though the parts may not be unacceptably defective.

For this situation, an automobile manufacturer arranges the review boundary sample activity for reducing cost and maintaining the best quality for customers. The essential criteria needed to apply for approval of a boundary sample are: the extent of defect, the benefit, the defect ratio, the customer complained records, and claimed records. We construct the decision making system by using AHP and develop the Excel program to support this system.

The decision making system is evaluated by twenty-eight QC engineers. The result of evaluation shows that this system can support them for reviewing a boundary sample. It reduces decision making time. It is helpful for new or inexperienced engineers.

However, they have some suggestions. The program is too complex because users need to click many buttons. In addition, users are concerned about the data base: the customer complained records, and claimed part records. If they are not updated, it will make the wrong decisions.

QC engineers think that the extent-of-defect questionnaire contains too many sections and that makes it impractical for new or inexperienced engineers to

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understand. The wordings of questionnaire confuse the respondents. If we provide drawings or pictures, it should be better for understanding.

Recommendations

In this study, we are reflected about the questionnaire design and the Excel program for approval boundary sample evaluation by Quality Control engineers who are surveyors and program user. The recommendation can be found in the following.

1. Questionnaire design

The almost of Quality Control engineers reflect the extent-of-defect questionnaire contain overabundance items that make impractical for survey takers and difficult for new or inexperience engineers to understand. It effected to spend more time to answer. The wordings of questionnaire make the confusion with surveyors. If we illustrate for imagine, it should be better for understanding.

2. The Excel program for approval boundary sample

The almost of users have the same opinion that program is useful for them to approve boundary sample. This Excel program can reduction time, more accuracy, comfortable and easily for new or inexperience engineers. However they have some suggestions for this program. The Excel program for approval boundary sample is too complex for using because it needs to click many buttons for operating. In addition, users are concerned about data base: the customer complained history data, and historical claim data. If they are not update, it will make the wrong decision making.

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APPENDICES

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Appendix A
SQA Information

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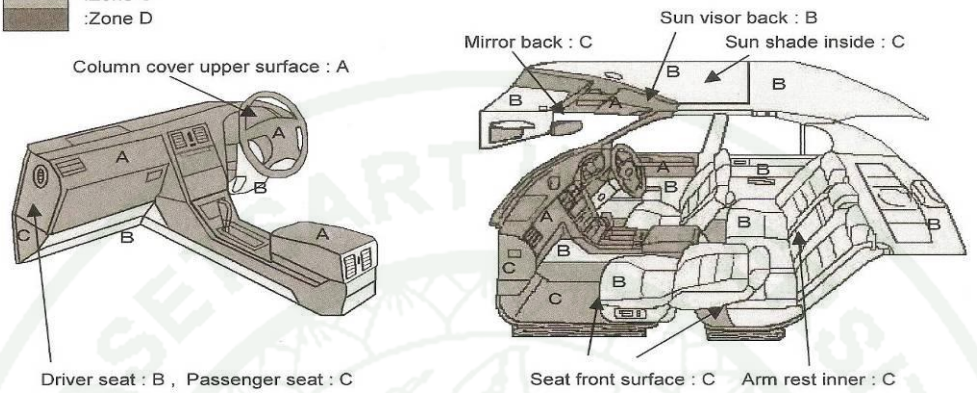
[Zone classification (2/21)]

Zone classification of interior parts [Passenger car]

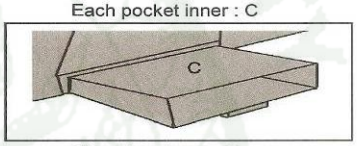
:Zone S
:Zone A
:Zone B
:Zone C
:Zone D

* The zone can be lowered by one rank for defect portion which is hard to see.
* The portion which is not clear decide the zone classification by definition of bottom list.

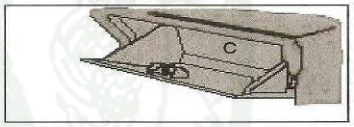


Zone	Main portion	Definition
Zone A	Around instrument panel Around steering wheel Fr. pillar garnish Around sun-visor Fr. console upper surface Fr. door trim upper surface	Area which can be seen Easily from front seat while sitting.
Zone B	Fr.,Rr. door trim Around seat Around roof Center pillar garnish Quarter pillar garnish Package tray	Area which can be seen easily from each seat while sitting, and when getting in / out of vehicle.
Zone C	Around Fr. floor Around Rr. floor Scuff plate Around back door Luggage inner Back of box door, pocket Cowl side trim ENG room design cover	Area which can be seen when loading or unloading baggage. Area which can be seen with bending down except for the zone "B"
Zone D	ENG room Spare tire Other	Other

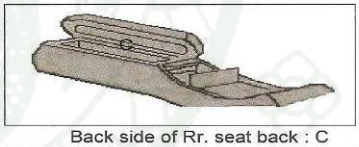
Each pocket inner : C



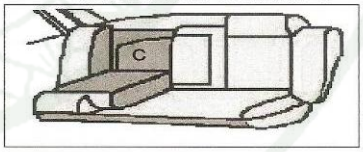
Glove box inner : C



Console inner : C



Back side of Rr. seat back : C



[Zone classification (2/21)] — 89 — 2009/10/1

Appendix Figure A1 SQA information.

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Appendix B

Standard SQA

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Item					Standard				
					Zone s	Zone A	Zone B	Zone C	Zone D
Label	Scratch Chip Tear Cut	Mark, Emblem(mm) Printed letter (mm dia) Strips Label				5 3	10 6	10 6	10 6
Int. and Ext. Painted, Plated, Leather parts	Chip Paint Peeling	Chipping and width is 0.5 mm or more (It is shown with dia.)	Top coat (dia)		0.5	1.5	2	3	5
			Reach to under coat	similar color (dia)	1	1.5	2	3	5
				contrast color (dia)	1	1	1.5	2	3
			Reach to steel panel (dia)		exists	1	1.5	2	4
Int. and Ext. Painted, Plated, Leather parts	Gash Paint crack Scratch primer which is obvious condition	Linear scratch with catch on finger nail (it is shown in mm)	Top coat (dia),(mm)		1	4	6	8	20
			Reach to under coat	similar color scratch in primer(mm)	1.5	3	4	5	12
				contrast color(mm)	1.5	2	3	3.5	6
			Reach to steel panel (mm)		exists	2	3	3.5	6
Int. and Ext. Painted, Plated, Leather parts	Surface scratch by rubbing (It is shown with mm)		Top coat Similar color (mm)		50	100	150	200	
			Contrast color (mm)			70	100	150	
Int. and Ext. UnPainted, Pile parts	Gash Paint Crack	Linear scra catch on finger nail (It is shown with mm.)			6	6	10	40	60
Int. and Ext. Unpainted, Pile parts	Surface scratch by rubbing (It is shown with mm)		Top coat Similar color (mm)		100	100	150	250	500

Appendix Figure B1 SQA Standard.

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Appendix C

The questionnaire of the extent of defect

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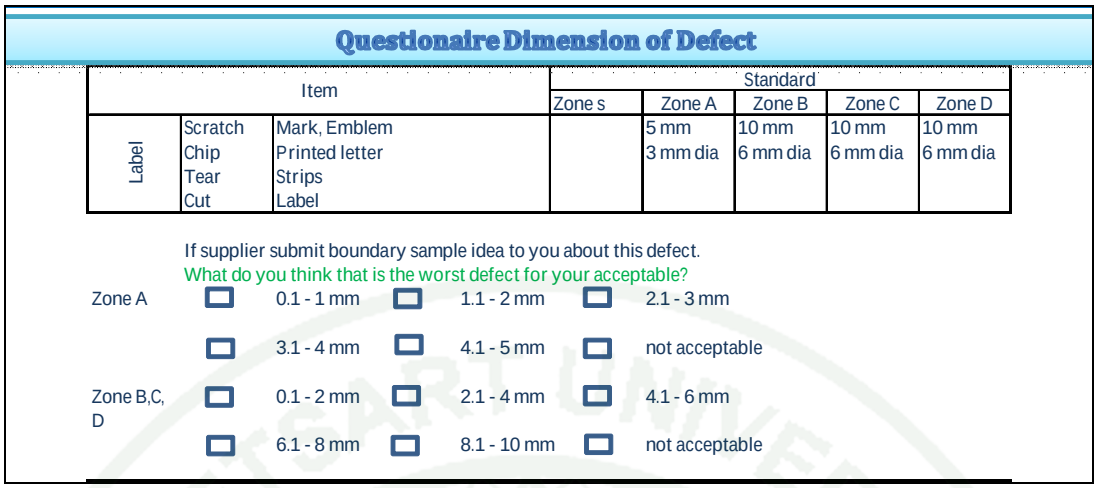

Questionaire Dimension of Defect

Item			Standard				
			Zone s	Zone A	Zone B	Zone C	Zone D
Label	Scratch Chip Tear Cut	Mark, Emblem Printed letter Strips Label		5 mm 3 mm dia	10 mm 6 mm dia	10 mm 6 mm dia	10 mm 6 mm dia

If supplier submit boundary sample idea to you about this defect.
What do you think that is the worst defect for your acceptable?

Zone A	☐	0.1 - 1 mm	☐	1.1 - 2 mm	☐	2.1 - 3 mm		
	☐	3.1 - 4 mm	☐	4.1 - 5 mm	☐	not acceptable		
Zone B,C, D	☐	0.1 - 2 mm	☐	2.1 - 4 mm	☐	4.1 - 6 mm		
	☐	6.1 - 8 mm	☐	8.1 - 10 mm	☐	not acceptable		

Appendix Figure C1 The surely acceptable extent-of-defect questionnaire (Label).

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Item					Standard				
					Zone s	Zone A	Zone B	Zone C	Zone D
Int. and Ext. Painted, Plated, Leather parts	Chip Paint Peeling	Chipping and width is 0.5 mm or more (It is shown with dia.)	Top coat		0.5 dia	1.5 dia	2.0 dia	3.0 dia	5.0 dia
			Reach to under coat	similar color	1.0 dia	1.5 dia	2.0 dia	3.0 dia	5.0 dia
				contrast color	1.0 dia	1.0 dia	1.5 dia	2.0 dia	3.0 dia
			Reach to steel panel		exists	1.0 dia	1.5 dia	2.0 dia	4.0 dia

Chipping and paint peeling at Topcoat and reach to undercoat similar color
If supplier submit boundary sample idea to you about this defect
What do you think that is the worst defect for your acceptable?

Zone S Top coat	☐ 0.1 - 0.1 mm	☐ 0.11 - 0.2 mm	☐ 0.21 -0.3 mm
	☐ 0.31 - 0.4 mm	☐ 0.41 -0. 5 mm	☐ not acceptable
Zone S Reach to undercoat	☐ 0.1 - 0.2 mm	☐ 0.21 - 0.4 mm	☐ 0.41 -0.6 mm
	☐ 0.61 - 0.8 mm	☐ 0.81 - 1 mm	☐ not acceptable
Zone A	☐ 0.1 - 0.1 mm	☐ 0.11 - 0.2 mm	☐ 0.61 - 0.9 mm
	☐ 0.91 - 1.2 mm	☐ 1.21 - 1.5 mm	☐ not acceptable
Zone B	☐ 0.1 - 0.4 mm	☐ 0.41 - 0.8 mm	☐ 0.81 - 1.2 mm
	☐ 1.21 - 1.6 mm	☐ 1.61 - 2.0 mm	☐ not acceptable
Zone C	☐ 0.1 - 0.6 mm	☐ 0.61 - 1.2 mm	☐ 1.21 - 1.8 mm
	☐ 1.81 - 2.4 mm	☐ 2.41 - 3.0 mm	☐ not acceptable
Zone D	☐ 0.1 - 1 mm	☐ 1.1- 2.0 mm	☐ 2.1 - 3 mm
	☐ 3.1 - 4 mm	☐ 4.1 - 5mm	☐ not acceptable

Appendix Figure C2 The surely acceptable extent-of-defect questionnaire (Interior and exterior painted, leather part: chip paint peeling).

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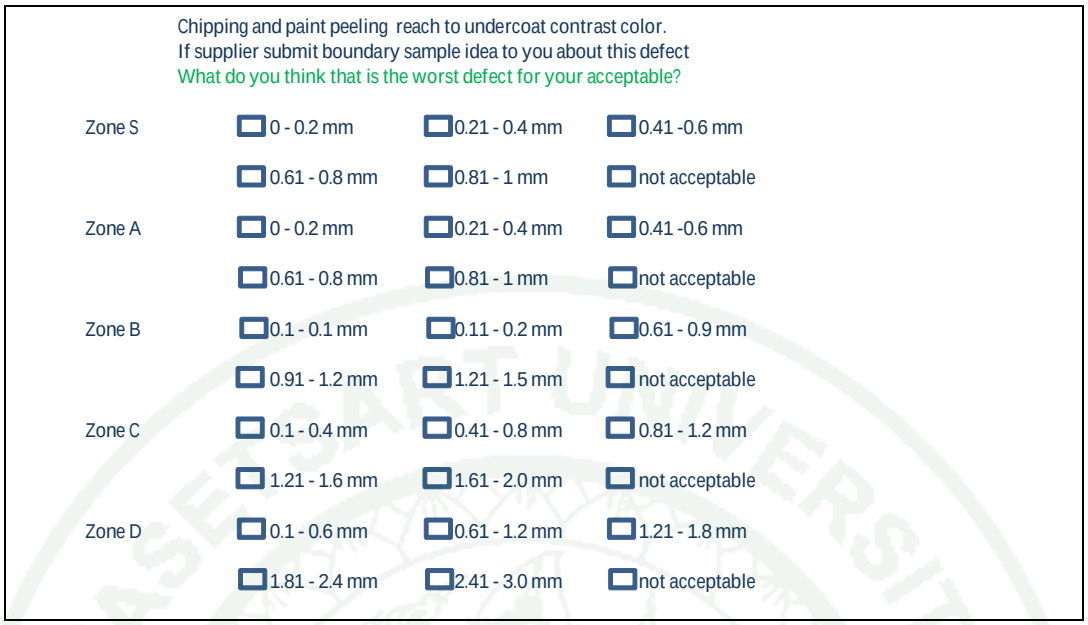
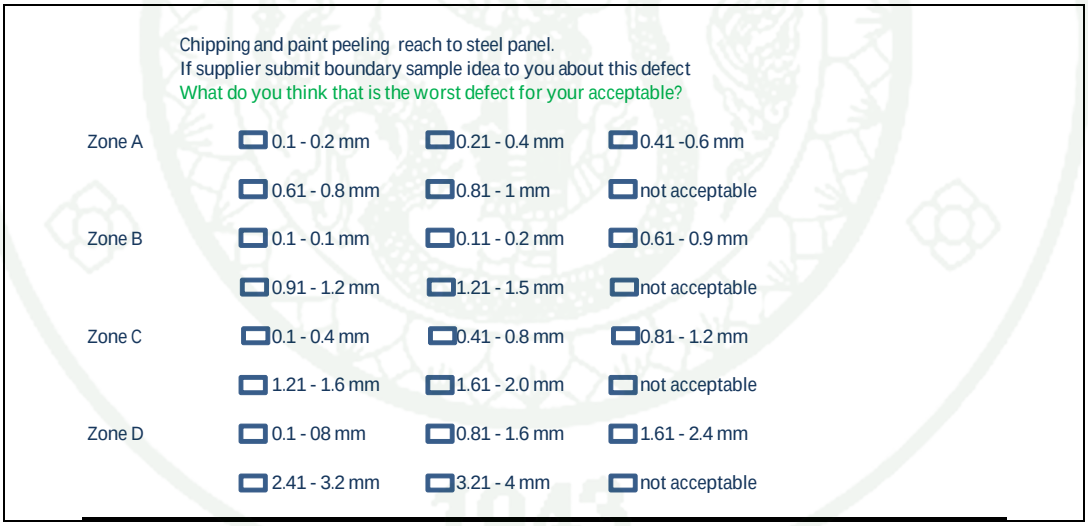


Appendix Figure C2 (Continued)



Appendix Figure C2 (Continued)

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Item					Standard				
					Zone s	Zone A	Zone B	Zone C	Zone D
Int. and Ext. Painted, Plated, Leather parts	Gash Paint crack Scratch primer which is obvious condition	Linear scratch with catch on finger nail (it is shown in mm)	Top coat		1.0 dia	4.0 mm	6.0 mm	8.0 mm	20 mm
			Reach to under coat	similar color scratch in primer	1.5 mm	3.0 mm	4.0 mm	5.0 mm	12 mm
				contrast color	1.5 mm	2.0 mm	3.0 mm	3.5 mm	6.0 mm
			Reach to steel panel		exists	2.0 mm	3.0 mm	3.5 mm	6.0 mm

Gash paint crack scratch in primer which is obvious condition at Top coat.
If supplier submit boundary sample idea to you about this defect
What do you think that is the worst defect for your acceptable?

Zone S	0.1 - 0.2 mm	0.21 - 0.4 mm	0.41 -0.6 mm
	0.61 - 0.8 mm	0.81 - 1 mm	not acceptable
Zone A	0.1 - 08 mm	0.81 - 1.6 mm	1.61 - 2.4 mm
	2.41 - 3.2 mm	3.21 - 4 mm	not acceptable
Zone B	0.1 - 1.2 mm	1.21 - 2.4 mm	2.41 - 3.6 mm
	3.61 - 4.8 mm	4.81 - 6.0 mm	not acceptable
Zone C	0.1 - 1.6 mm	1.61 - 2.4 mm	2.41 - 4.8 mm
	4.81 - 6.4 mm	6.51 - 8 mm	not acceptable
Zone D	0 - 4 mm	4.1 - 8 mm	8.1 - 12 mm
	12.1 - 16 mm	16.1 - 20 mm	not acceptable

Appendix Figure C3 The surely acceptable extent-of-defect questionnaire (Interior and exterior painted, leather part: Gash paint).

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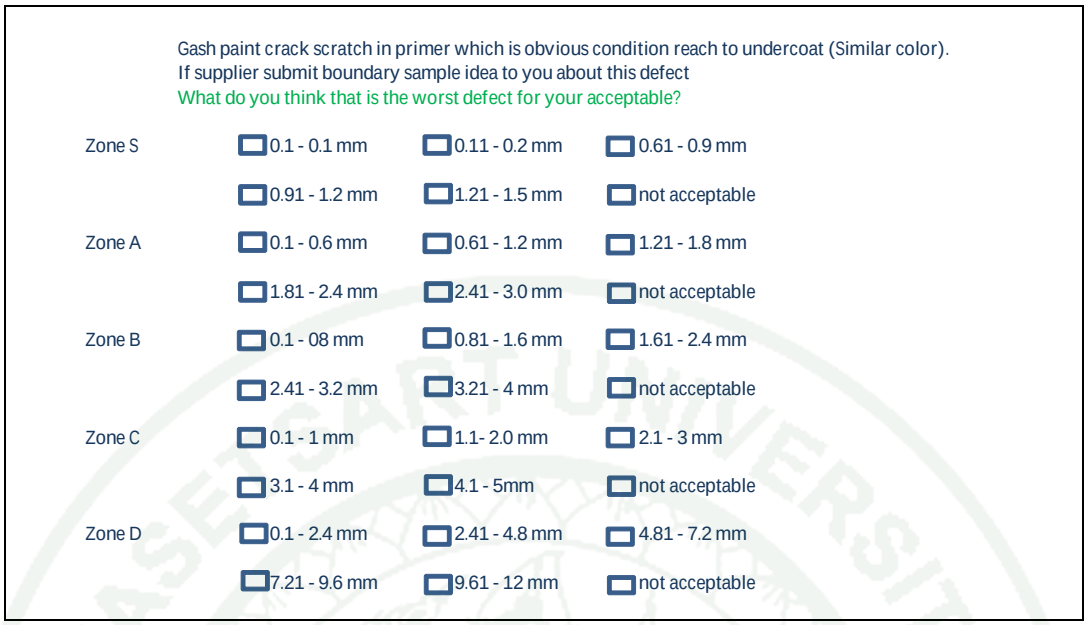
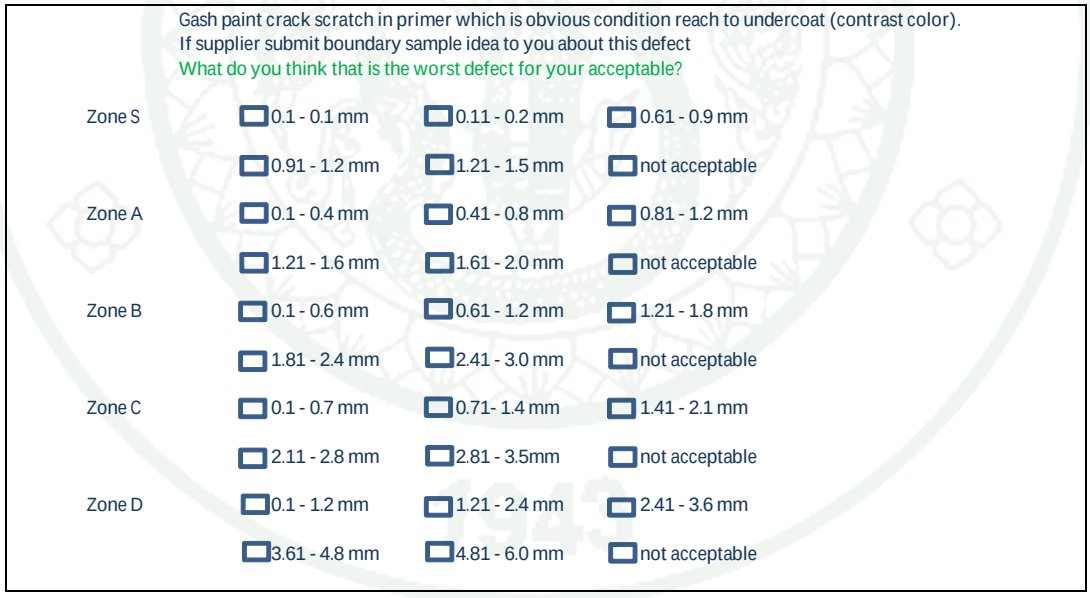


Appendix Figure C3 (Continued)



Appendix Figure C3 (Continued)

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Gash paint crack scratch in primer which is obvious condition reach to steel panel.
If supplier submit boundary sample idea to you about this defect
What do you think that is the worst defect for your acceptable?

Zone A	0.1 - 0.4 mm	0.41 - 0.8 mm	0.81 - 1.2 mm
	1.21 - 1.6 mm	1.61 - 2.0 mm	not acceptable
Zone B	0.1 - 0.6 mm	0.61 - 1.2 mm	1.21 - 1.8 mm
	1.81 - 2.4 mm	2.41 - 3.0 mm	not acceptable
Zone C	0.1 - 0.7 mm	0.71- 1.4 mm	1.41 - 2.1 mm
	2.11 - 2.8 mm	2.81 - 3.5mm	not acceptable
Zone D	0.1 - 1.2 mm	1.21 - 2.4 mm	2.41 - 3.6 mm
	3.61 - 4.8 mm	4.81 - 6.0 mm	not acceptable

Appendix Figure C3 (Continued)

Item			Standard				
			Zone s	Zone A	Zone B	Zone C	Zone D
Int. and Ext. Painted, Plated, Leather parts	Surface scratch by rubbing (It is shown with mm)	Top coat Similar color	50 mm	100 mm	150 mm	200mm	
		Contrast color		70 mm	100 mm	150 mm	

Graze mark surface scratch by rubbing at top coat similar color.
If supplier submit boundary sample idea to you about this defect
What do you think that is the worst defect for your acceptable?

Zone S	0.1 - 10 mm	10.1 - 20 mm	20.1 - 30 mm
	30.1 - 40 mm	40.1 - 50 mm	not acceptable
Zone A	0.1 - 20 mm	20.1 - 40 mm	40.1 - 60 mm
	60.1 - 80 mm	80.1 - 100 mm	not acceptable
Zone B	0.1 - 30 mm	30.1- 60mm	60.1 - 90 mm
	90.1 - 120 mm	120.1 - 150 mm	not acceptable
Zone C	0.1 - 40 mm	40.1 - 80 mm	80.1 - 120 mm
	120.1 - 160 mm	160.1 - 200 mm	not acceptable

Appendix Figure C4 The surely acceptable extent-of-defect questionnaire (Interior and exterior painted, leather part: Surface scratch by rubbing).

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Graze mark surface scratch by rubbing at top coat contrast color
If supplier submit boundary sample idea to you about this defect
What do you think that is the worst defect for your acceptable?

Zone A	0.1 - 14 mm	14.1 - 28 mm	28.1 - 52 mm
	42.1 - 56 mm	56.1 - 70 mm	not acceptable
Zone B	0.1 - 20 mm	20.1 - 40 mm	40.1 - 60 mm
	60.1 - 80 mm	80.1 - 100 mm	not acceptable
Zone C	0.1 - 30 mm	30.1 - 60 mm	60.1 - 90 mm
	90.1 - 120 mm	120.1 - 150 mm	not acceptable

Appendix Figure C4 (Continued)

Item			Standard				
			Zone s	Zone A	Zone B	Zone C	Zone D
Int. and Ext. UnPainted, Pile parts	Gash Paint Crack	Linear scra catch on finger nail (It is shown with mm.)	6 mm	6 mm	10 mm	40 mm	60 mm

Gash paint crack linear scratch which catch on finger nail.
If supplier submit boundary sample idea to you about this defect
What do you think that is the worst defect for your acceptable?

Zone S	0.1 - 1.2 mm	1.21 - 2.4 mm	2.41 - 3.6 mm
	3.61 -4.8 mm	4.81 - 6 mm	not acceptable
Zone A	0.1 - 1.2 mm	1.21 - 2.4 mm	2.41 - 3.6 mm
	3.61 -4.8 mm	4.81 - 6 mm	not acceptable
Zone B	0.1 - 2 mm	2.1 - 4 mm	4.1 - 6 mm
	6.1 - 8 mm	8.1 -10 mm	not acceptable
Zone C	0.1 - 8 mm	8.1 - 16 mm	16.1 - 24 mm
	24.1 - 32 mm	32.1 - 40 mm	not acceptable
Zone D	0.1 - 12 mm	12.1 - 24 mm	24.1 - 36 mm
	36.1 - 48 mm	48.1 - 60 mm	not acceptable

Appendix Figure C5 The surely acceptable extent-of-defect questionnaire (Interior and exterior unpainted, pile part: Gash paint crack).

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Item			Standard				
			Zones	Zone A	Zone B	Zone C	Zone D
Int. and Ext. Unpainted, Pile parts	Surface scratch by rubbing (It is shown with mm)	Top coat Similar color	100 mm	100 mm	150 mm	250mm	500 mm

Graze mark surface scratch by rubbing at top coat similar color.
If supplier submit boundary sample idea to you about this defect
What do you think that is the worst defect for your acceptable?

Zone S	☐ 0.1 - 20 mm	☐ 20.1 - 40 mm	☐ 40.1 - 60 mm
	☐ 60.1 - 80 mm	☐ 80.1 - 100 mm	☐ not acceptable
Zone A	☐ 0.1 - 20 mm	☐ 20.1 - 40 mm	☐ 40.1 - 60 mm
	☐ 60.1 - 80 mm	☐ 80.1 - 100 mm	☐ not acceptable
Zone B	☐ 0.1 - 30 mm	☐ 30.1- 60mm	☐ 60.1 - 90 mm
	☐ 90.1 - 120 mm	☐ 120.1 - 150 mm	☐ not acceptable
Zone C	☐ 0.1 - 50 mm	☐ 50.1 - 100 mm	☐ 100.1 - 150 mm
	☐ 150.1 - 200 mm	☐ 200.1 - 250 mm	☐ not acceptable
Zone D	☐ 0.1 - 100 mm	☐ 100.1 - 200 mm	☐ 200.1 - 300 mm
	☐ 300.1 - 400 mm	☐ 400.1 - 500 mm	☐ not acceptable

Appendix Figure C6 The surely acceptable extent-of-defect questionnaire (Interior and exterior unpainted, pile part: Surface scratch by rubbing).

Item			Standard				
			Zones	Zone A	Zone B	Zone C	Zone D
Label	Scratch Chip Tear Cut	Mark, Emblem Printed letter Strips Label		5 mm 3 mm dia	10 mm 6 mm dia	10 mm 6 mm dia	10 mm 6 mm dia

If supplier submit boundary sample idea to you about this defect.
What do you think that is the beginning dimension of defect for your not acceptable?

Zone A	☐ 0.1 - 1 mm	☐ 1.1 - 2 mm	☐ 2.1 - 3 mm
	☐ 3.1 - 4 mm	☐ 4.1 - 5 mm	☐ over than standard
Zone B,C, D	☐ 0.1 - 2 mm	☐ 2.1 - 4 mm	☐ 4.1 - 6 mm
	☐ 6.1 - 8 mm	☐ 8.1 - 10 mm	☐ over than standard

Appendix Figure C7 The not acceptable extent-of-defect questionnaire (Label).

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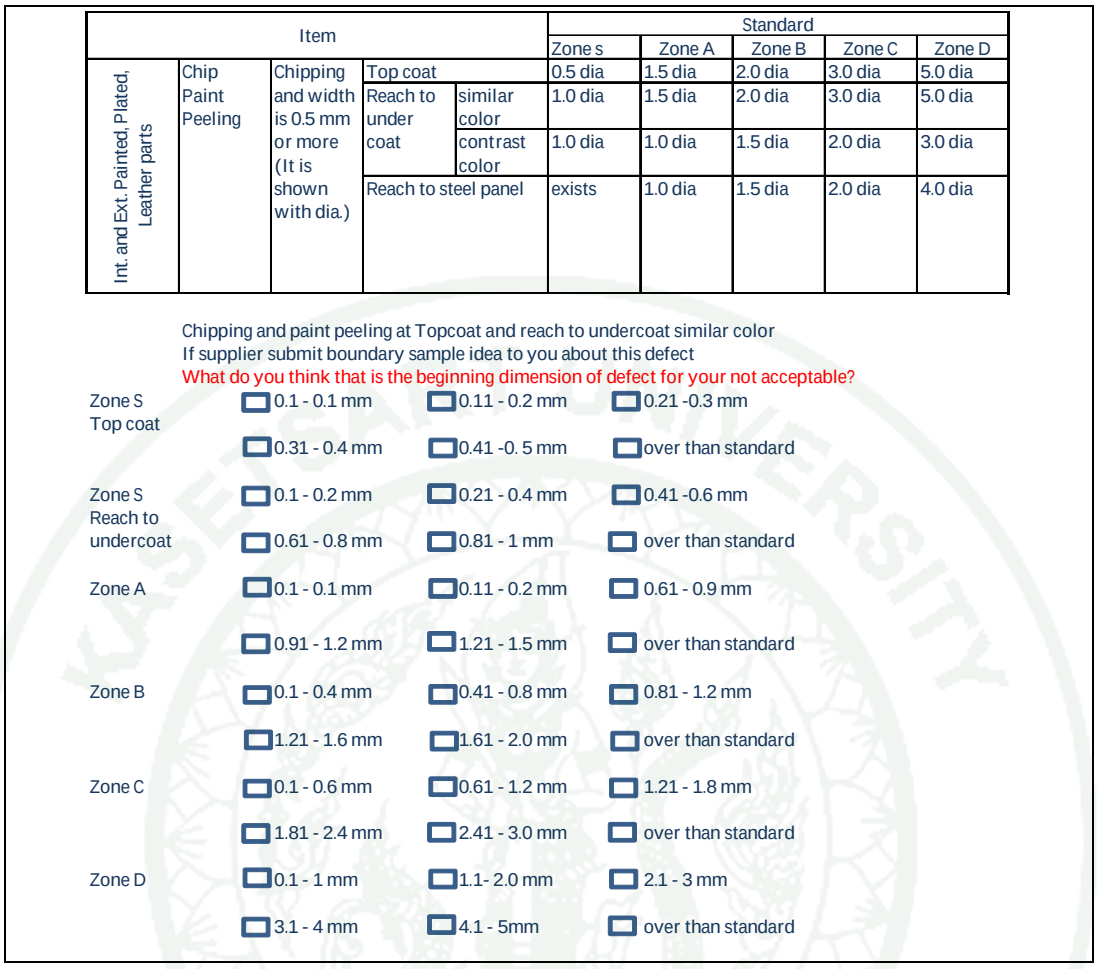

Item					Standard				
					Zone s	Zone A	Zone B	Zone C	Zone D
Int. and Ext. Painted, Plated, Leather parts	Chip Paint Peeling	Chipping and width is 0.5 mm or more (It is shown with dia.)	Top coat		0.5 dia	1.5 dia	2.0 dia	3.0 dia	5.0 dia
			Reach to under coat	similar color	1.0 dia	1.5 dia	2.0 dia	3.0 dia	5.0 dia
				contrast color	1.0 dia	1.0 dia	1.5 dia	2.0 dia	3.0 dia
			Reach to steel panel		exists	1.0 dia	1.5 dia	2.0 dia	4.0 dia

Chipping and paint peeling at Topcoat and reach to undercoat similar color
If supplier submit boundary sample idea to you about this defect
What do you think that is the beginning dimension of defect for your not acceptable?

Zone S Top coat	☐ 0.1 - 0.1 mm	☐ 0.11 - 0.2 mm	☐ 0.21 -0.3 mm
	☐ 0.31 - 0.4 mm	☐ 0.41 -0. 5 mm	☐ over than standard
Zone S Reach to undercoat	☐ 0.1 - 0.2 mm	☐ 0.21 - 0.4 mm	☐ 0.41 -0.6 mm
	☐ 0.61 - 0.8 mm	☐ 0.81 - 1 mm	☐ over than standard
Zone A	☐ 0.1 - 0.1 mm	☐ 0.11 - 0.2 mm	☐ 0.61 - 0.9 mm
	☐ 0.91 - 1.2 mm	☐ 1.21 - 1.5 mm	☐ over than standard
Zone B	☐ 0.1 - 0.4 mm	☐ 0.41 - 0.8 mm	☐ 0.81 - 1.2 mm
	☐ 1.21 - 1.6 mm	☐ 1.61 - 2.0 mm	☐ over than standard
Zone C	☐ 0.1 - 0.6 mm	☐ 0.61 - 1.2 mm	☐ 1.21 - 1.8 mm
	☐ 1.81 - 2.4 mm	☐ 2.41 - 3.0 mm	☐ over than standard
Zone D	☐ 0.1 - 1 mm	☐ 1.1- 2.0 mm	☐ 2.1 - 3 mm
	☐ 3.1 - 4 mm	☐ 4.1 - 5mm	☐ over than standard

Appendix Figure C8 The not acceptable extent-of-defect questionnaire (Interior and exterior painted, leather part: chip paint peeling).

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Chipping and paint peeling reach to undercoat contrast color.
If supplier submit boundary sample idea to you about this defect
What do you think that is the beginning dimension of defect for your not acceptable?

Zone S	0 - 0.2 mm	0.21 - 0.4 mm	0.41 -0.6 mm
	0.61 - 0.8 mm	0.81 - 1 mm	over than standard
Zone A	0 - 0.2 mm	0.21 - 0.4 mm	0.41 -0.6 mm
	0.61 - 0.8 mm	0.81 - 1 mm	over than standard
Zone B	0.1 - 0.1 mm	0.11 - 0.2 mm	0.61 - 0.9 mm
	0.91 - 1.2 mm	1.21 - 1.5 mm	over than standard
Zone C	0.1 - 0.4 mm	0.41 - 0.8 mm	0.81 - 1.2 mm
	1.21 - 1.6 mm	1.61 - 2.0 mm	over than standard
Zone D	0.1 - 0.6 mm	0.61 - 1.2 mm	1.21 - 1.8 mm
	1.81 - 2.4 mm	2.41 - 3.0 mm	over than standard

Appendix Figure C8 (Continued)

Chipping and paint peeling reach to steel panel.
If supplier submit boundary sample idea to you about this defect
What do you think that is the beginning dimension of defect for your not acceptable?

Zone A	0.1 - 0.2 mm	0.21 - 0.4 mm	0.41 -0.6 mm
	0.61 - 0.8 mm	0.81 - 1 mm	over than standard
Zone B	0.1 - 0.1 mm	0.11 - 0.2 mm	0.61 - 0.9 mm
	0.91 - 1.2 mm	1.21 - 1.5 mm	over than standard
Zone C	0.1 - 0.4 mm	0.41 - 0.8 mm	0.81 - 1.2 mm
	1.21 - 1.6 mm	1.61 - 2.0 mm	over than standard
Zone D	0.1 - 08 mm	0.81 - 1.6 mm	1.61 - 2.4 mm
	2.41 - 3.2 mm	3.21 - 4 mm	over than standard

Appendix Figure C8 (Continued)

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Item					Standard				
					Zone s	Zone A	Zone B	Zone C	Zone D
Int. and Ext. Painted, Plated, Leather parts	Gash Paint crack Scratch primer which is obvious condition	Linear scratch with catch on finger nail (it is shown in mm)	Top coat		1.0 dia	4.0 mm	6.0 mm	8.0 mm	20 mm
			Reach to under coat	similar color scratch in primer	1.5 mm	3.0 mm	4.0 mm	5.0 mm	12 mm
				contrast color	1.5 mm	2.0 mm	3.0 mm	3.5 mm	6.0 mm
			Reach to steel panel		exists	2.0 mm	3.0 mm	3.5 mm	6.0 mm

Gash paint crack scratch in primer which is obvious condition at Top coat.
If supplier submit boundary sample idea to you about this defect
What do you think that is the beginning dimension of defect for your not acceptable?

Zone S	☐ 0.1 - 0.2 mm	☐ 0.21 - 0.4 mm	☐ 0.41 -0.6 mm
	☐ 0.61 - 0.8 mm	☐ 0.81 - 1 mm	☐ over than standard
Zone A	☐ 0.1 - 08 mm	☐ 0.81 - 1.6 mm	☐ 1.61 - 2.4 mm
	☐ 2.41 - 3.2 mm	☐ 3.21 - 4 mm	☐ over than standard
Zone B	☐ 0.1 - 1.2 mm	☐ 1.21 - 2.4 mm	☐ 2.41 - 3.6 mm
	☐ 3.61 - 4.8 mm	☐ 4.81 - 6.0 mm	☐ over than standard
Zone C	☐ 0.1 - 1.6 mm	☐ 1.61 - 2.4 mm	☐ 2.41 - 4.8 mm
	☐ 4.81 - 6.4 mm	☐ 6.51 - 8 mm	☐ over than standard
Zone D	☐ 0 - 4 mm	☐ 4.1 - 8 mm	☐ 8.1 - 12 mm
	☐ 12.1 - 16 mm	☐ 16.1 - 20 mm	☐ over than standard

Appendix Figure C9 The not acceptable extent-of-defect questionnaire (Interior and exterior painted, leather part: Gash paint).

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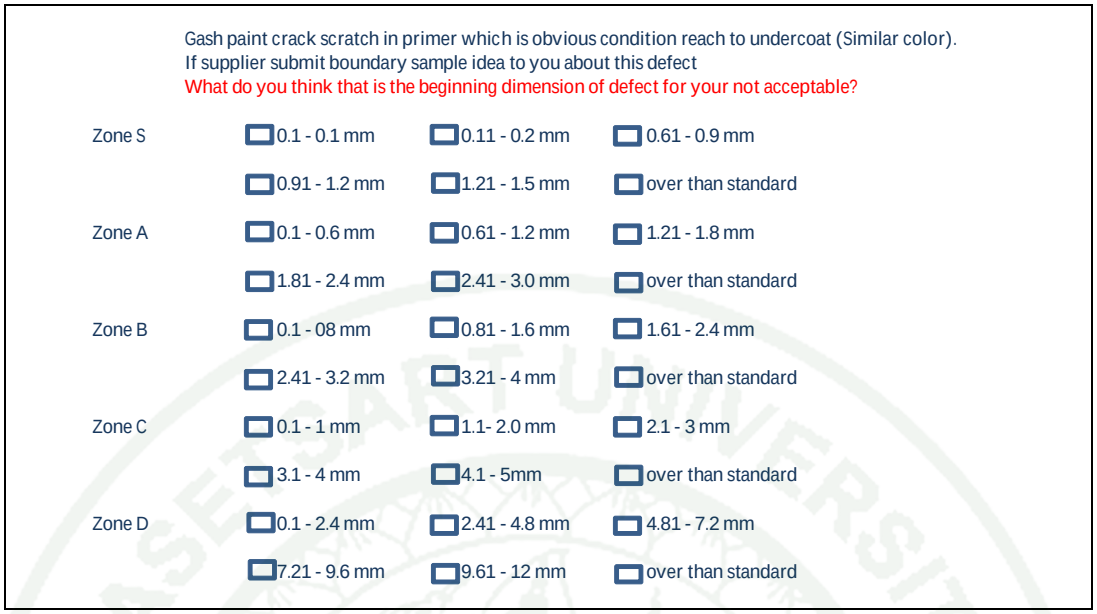
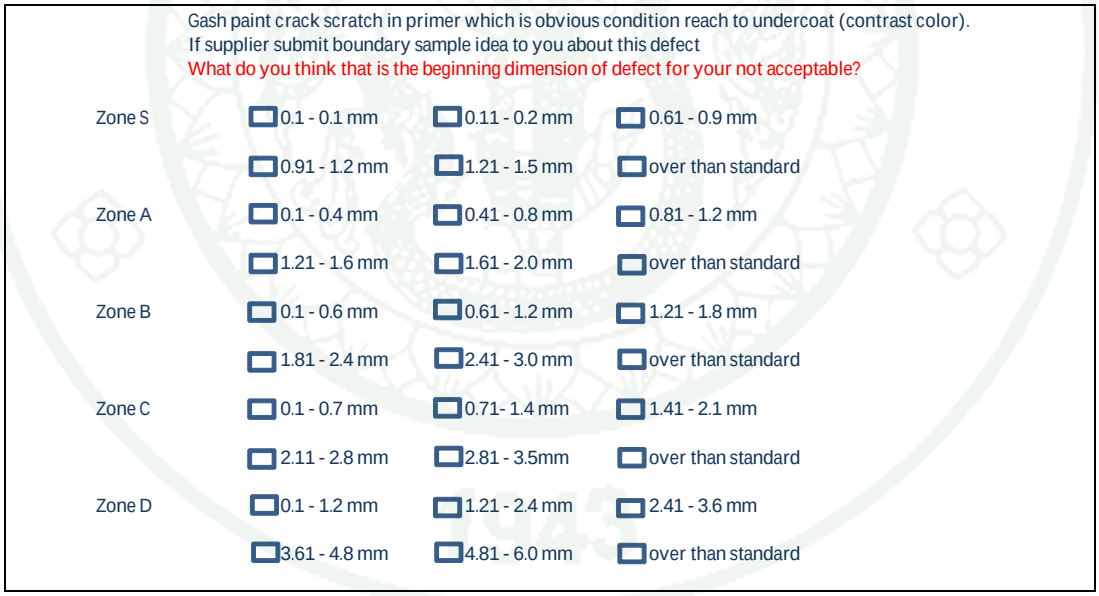


Appendix Figure C9 (Continued)



Appendix Figure C9 (Continued)

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Gash paint crack scratch in primer which is obvious condition reach to steel panel.
If supplier submit boundary sample idea to you about this defect
What do you think that is the beginning dimension of defect for your not acceptable?

Zone A	☐ 0.1 - 0.4 mm	☐ 0.41 - 0.8 mm	☐ 0.81 - 1.2 mm
	☐ 1.21 - 1.6 mm	☐ 1.61 - 2.0 mm	☐ over than standard
Zone B	☐ 0.1 - 0.6 mm	☐ 0.61 - 1.2 mm	☐ 1.21 - 1.8 mm
	☐ 1.81 - 2.4 mm	☐ 2.41 - 3.0 mm	☐ over than standard
Zone C	☐ 0.1 - 0.7 mm	☐ 0.71- 1.4 mm	☐ 1.41 - 2.1 mm
	☐ 2.11 - 2.8 mm	☐ 2.81 - 3.5mm	☐ over than standard
Zone D	☐ 0.1 - 1.2 mm	☐ 1.21 - 2.4 mm	☐ 2.41 - 3.6 mm
	☐ 3.61 - 4.8 mm	☐ 4.81 - 6.0 mm	☐ over than standard

Appendix Figure C9 (Continued)

Item			Standard				
			Zone s	Zone A	Zone B	Zone C	Zone D
Int. and Ext. Painted, Plated, Leather parts	Surface scratch by rubbing (It is shown with mm)	Top coat Similar color	50 mm	100 mm	150 mm	200mm	
		Contrast color		70 mm	100 mm	150 mm	

Graze mark surface scratch by rubbing at top coat similar color.
If supplier submit boundary sample idea to you about this defect
What do you think that is the beginning dimension of defect for your not acceptable?

Zone S	☐ 0.1 - 10 mm	☐ 10.1 - 20 mm	☐ 20.1 - 30 mm
	☐ 30.1 - 40 mm	☐ 40.1 - 50 mm	☐ over than standard
Zone A	☐ 0.1 - 20 mm	☐ 20.1 - 40 mm	☐ 40.1 - 60 mm
	☐ 60.1 - 80 mm	☐ 80.1 - 100 mm	☐ over than standard
Zone B	☐ 0.1 - 30 mm	☐ 30.1- 60mm	☐ 60.1 - 90 mm
	☐ 90.1 - 120 mm	☐ 120.1 - 150 mm	☐ over than standard
Zone C	☐ 0.1 - 40 mm	☐ 40.1 - 80 mm	☐ 80.1 - 120 mm
	☐ 120.1 - 160 mm	☐ 160.1 - 200 mm	☐ over than standard

Appendix Figure C10 The not acceptable extent-of-defect questionnaire (Interior and exterior painted, leather part: Surface scratch by rubbing).

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Graze mark surface scratch by rubbing at top coat contrast color
If supplier submit boundary sample idea to you about this defect
What do you think that is the beginning dimension of defect for your not acceptable?

Zone A	0.1 - 14 mm	14.1 - 28 mm	28.1 - 52 mm
	42.1 - 56 mm	56.1 - 70 mm	over than standard
Zone B	0.1 - 20 mm	20.1 - 40 mm	40.1 - 60 mm
	60.1 - 80 mm	80.1 - 100 mm	over than standard
Zone C	0.1 - 30 mm	30.1 - 60 mm	60.1 - 90 mm
	90.1 - 120 mm	120.1 - 150 mm	over than standard

Appendix Figure C10 (Continued)

Item			Standard				
			Zone s	Zone A	Zone B	Zone C	Zone D
Int. and Ext. UnPainted, Pile parts	Gash Paint Crack	Linear scra catch on finger nail (It is shown with mm.)	6 mm	6 mm	10 mm	40 mm	60 mm

Gash paint crack linear scratch which catch on finger nail.
If supplier submit boundary sample idea to you about this defect
What do you think that is the beginning dimension of defect for your not acceptable?

Zone S	0.1 - 1.2 mm	1.21 - 2.4 mm	2.41 - 3.6 mm
	3.61 -4.8 mm	4.81 - 6 mm	over than standard
Zone A	0.1 - 1.2 mm	1.21 - 2.4 mm	2.41 - 3.6 mm
	3.61 -4.8 mm	4.81 - 6 mm	over than standard
Zone B	0.1 - 2 mm	2.1 - 4 mm	4.1 - 6 mm
	6.1 - 8 mm	8.1 -10 mm	over than standard
Zone C	0.1 - 8 mm	8.1 - 16 mm	16.1 - 24 mm
	24.1 - 32 mm	32.1 - 40 mm	over than standard
Zone D	0.1 - 12 mm	12.1 - 24 mm	24.1 - 36 mm
	36.1 - 48 mm	48.1 - 60 mm	over than standard

Appendix Figure C11 The not acceptable extent-of-defect questionnaire (Interior and exterior unpainted, pile part: Gash paint crack).

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Item			Standard				
			Zone s	Zone A	Zone B	Zone C	Zone D
Int. and Ext. Unpainted, Pile parts	Surface scratch by rubbing (It is shown with mm)	Top coat Similar color	100 mm	100 mm	150 mm	250mm	500 mm

Graze mark surface scratch by rubbing at top coat similar color.
If supplier submit boundary sample idea to you about this defect
What do you think that is the beginning dimension of defect for your not acceptable?

Zone S	0.1 - 20 mm	20.1 - 40 mm	40.1 - 60 mm
	60.1 - 80 mm	80.1 - 100 mm	over than standard
Zone A	0.1 - 20 mm	20.1 - 40 mm	40.1 - 60 mm
	60.1 - 80 mm	80.1 - 100 mm	over than standard
Zone B	0.1 - 30 mm	30.1- 60mm	60.1 - 90 mm
	90.1 - 120 mm	120.1 - 150 mm	over than standard
Zone C	0.1 - 50 mm	50.1 - 100 mm	100.1 - 150 mm
	150.1 - 200 mm	200.1 - 250 mm	over than standard
Zone D	0.1 - 100 mm	100.1 - 200 mm	200.1 - 300 mm
	300.1 - 400 mm	400.1 - 500 mm	over than standard

Appendix Figure C12 The not acceptable extent-of-defect questionnaire (Interior and exterior unpainted, pile part: Surface scratch by rubbing).

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Appendix D

The questionnaire of the other criteria

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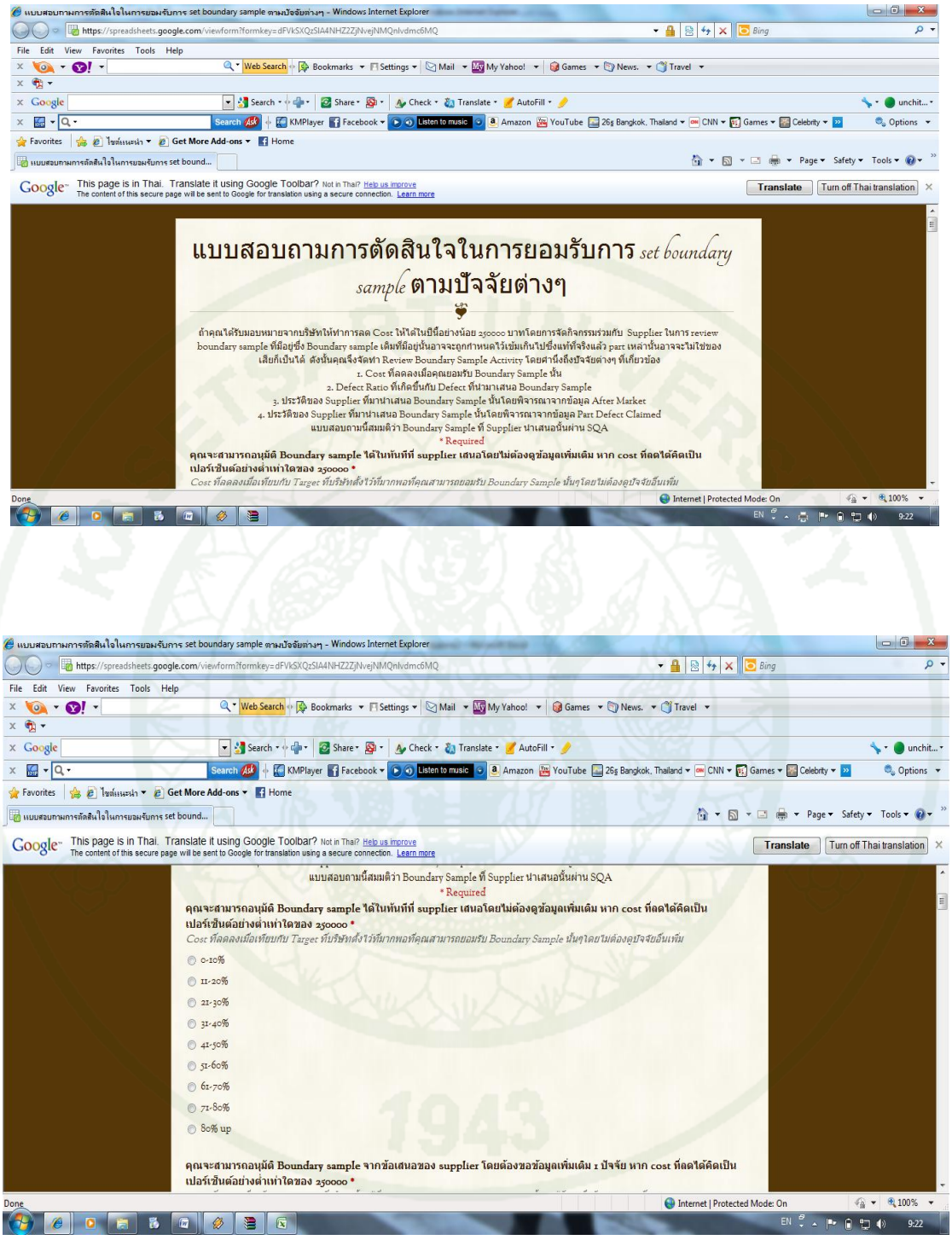

Appendix Figure D1 The other criteria questionnaire.

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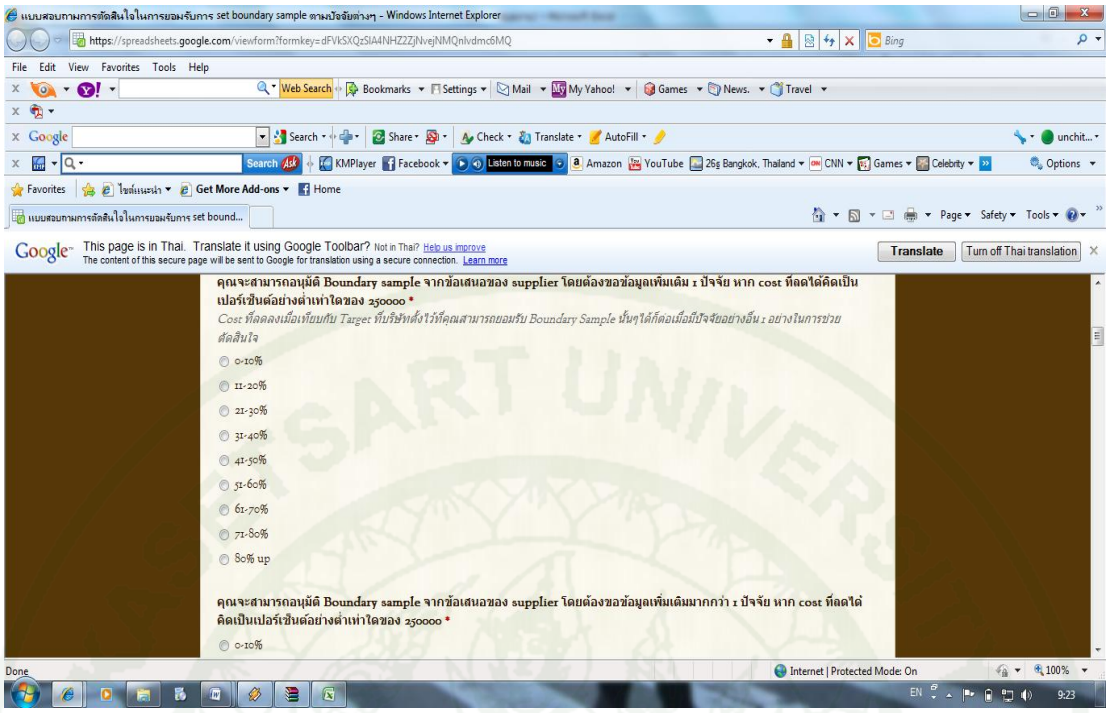

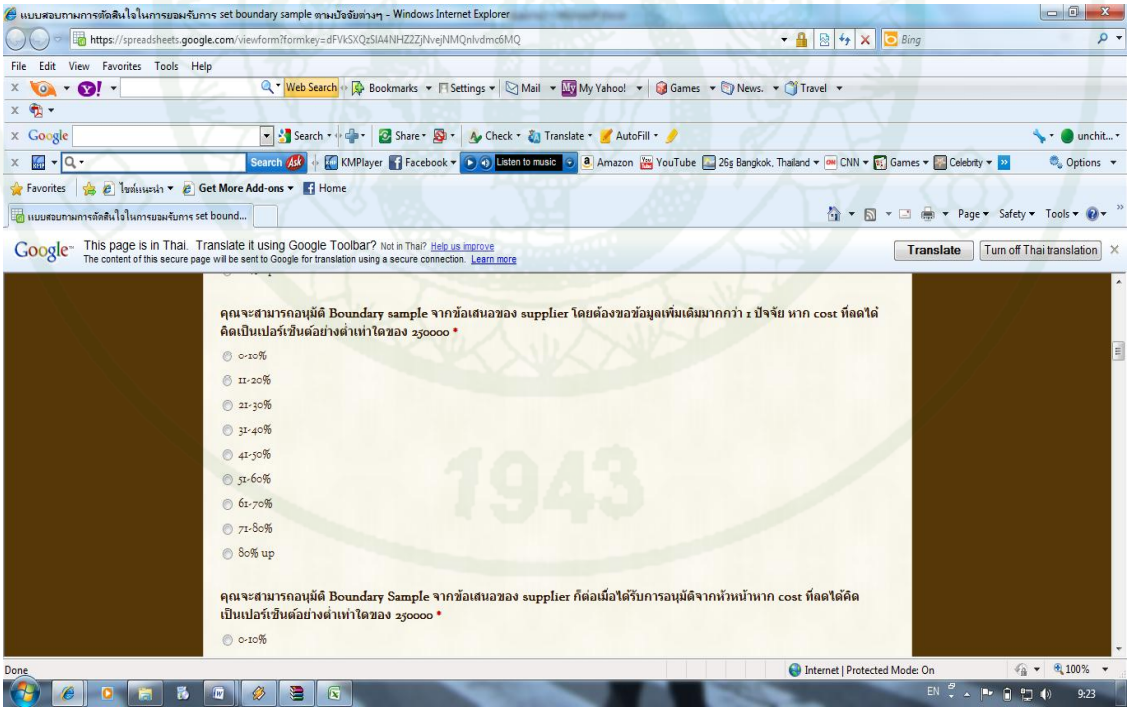

Appendix Figure D1 (Continued)

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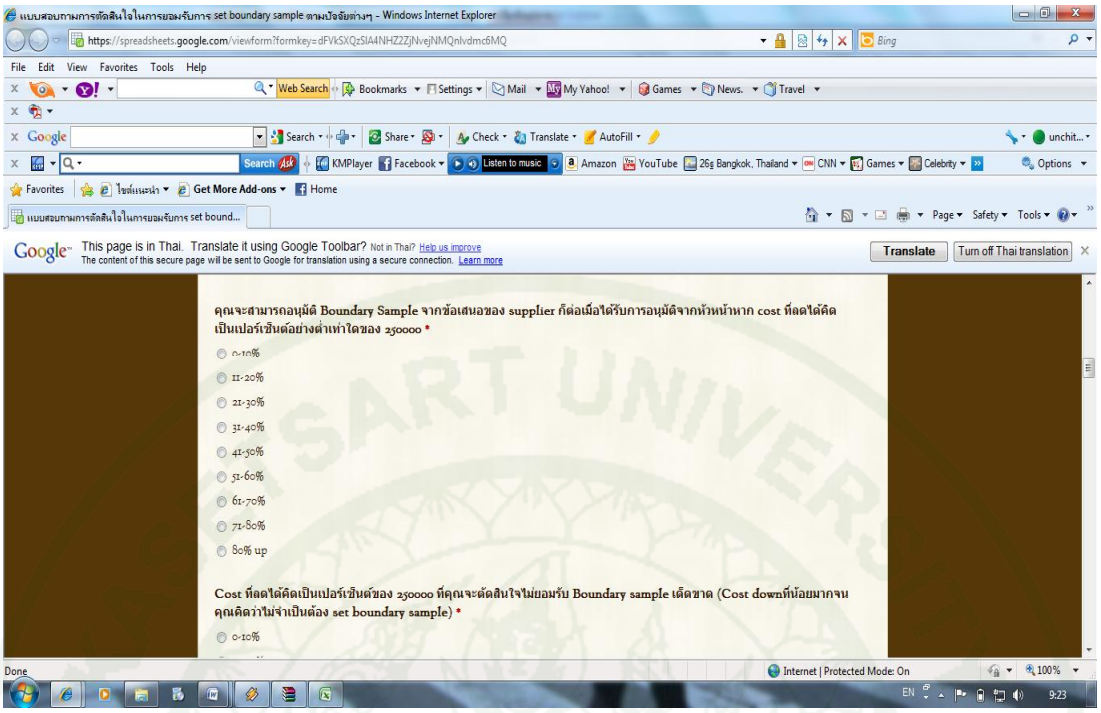

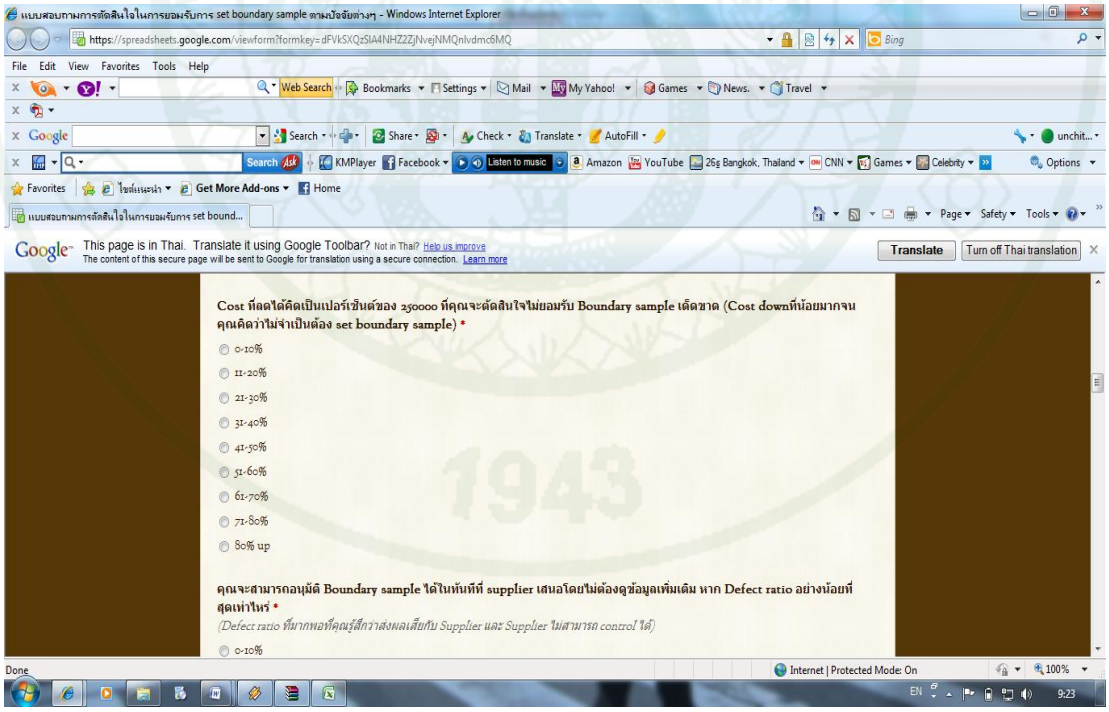

Appendix Figure D1 (Continued)

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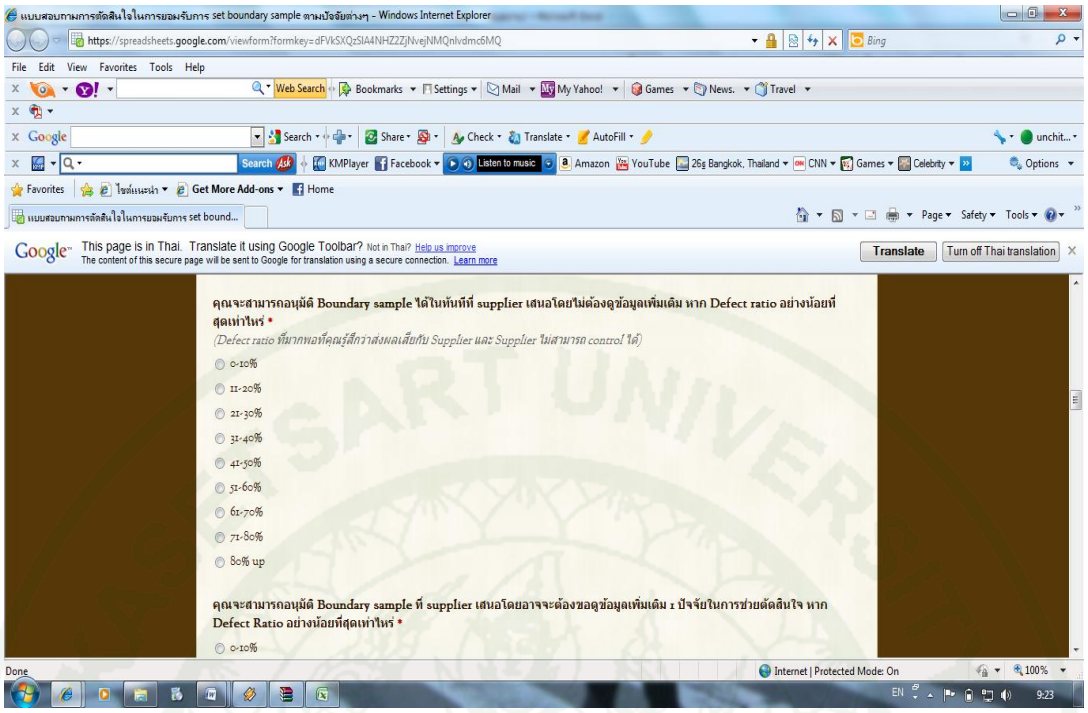

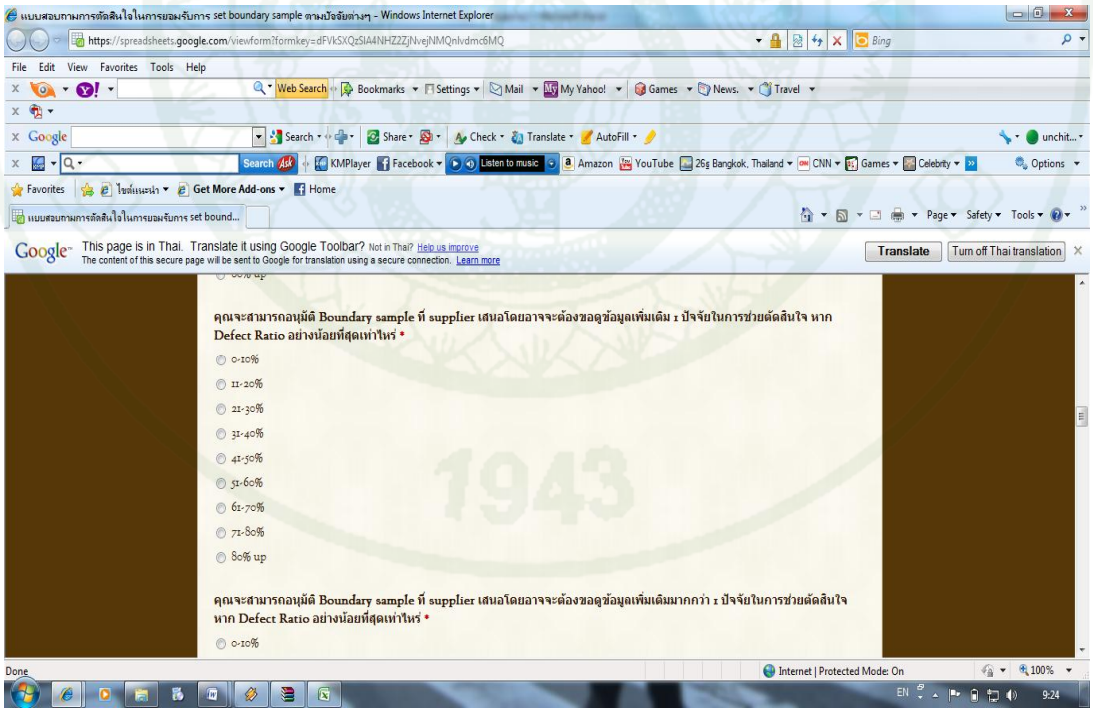

Appendix Figure D1 (Continued)

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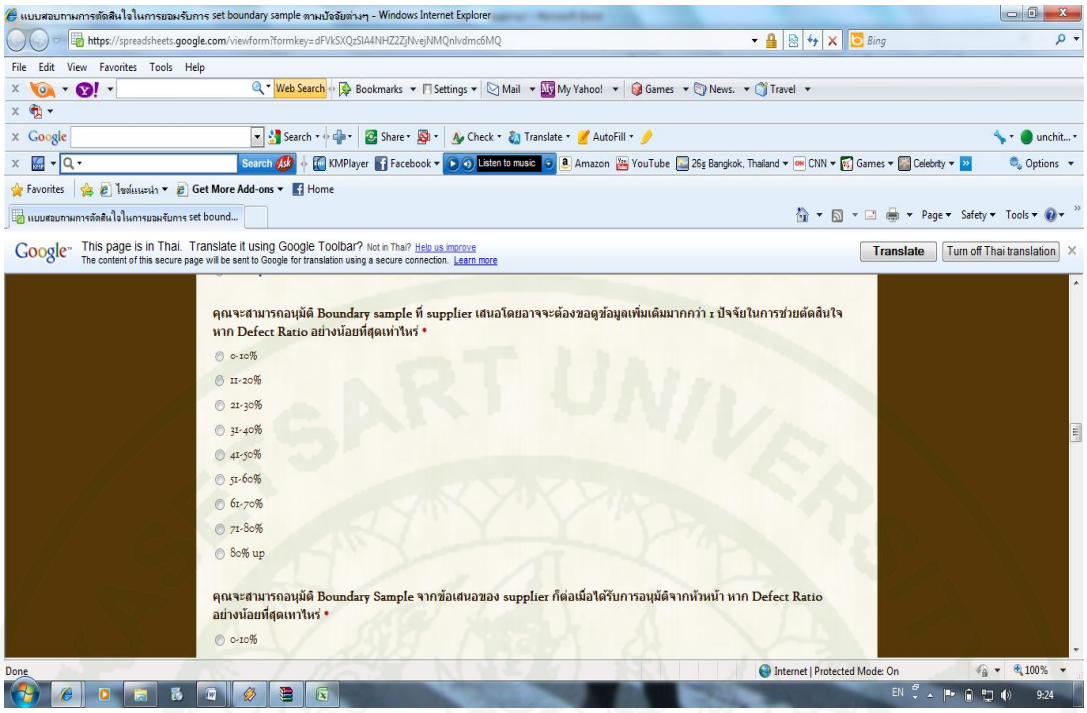

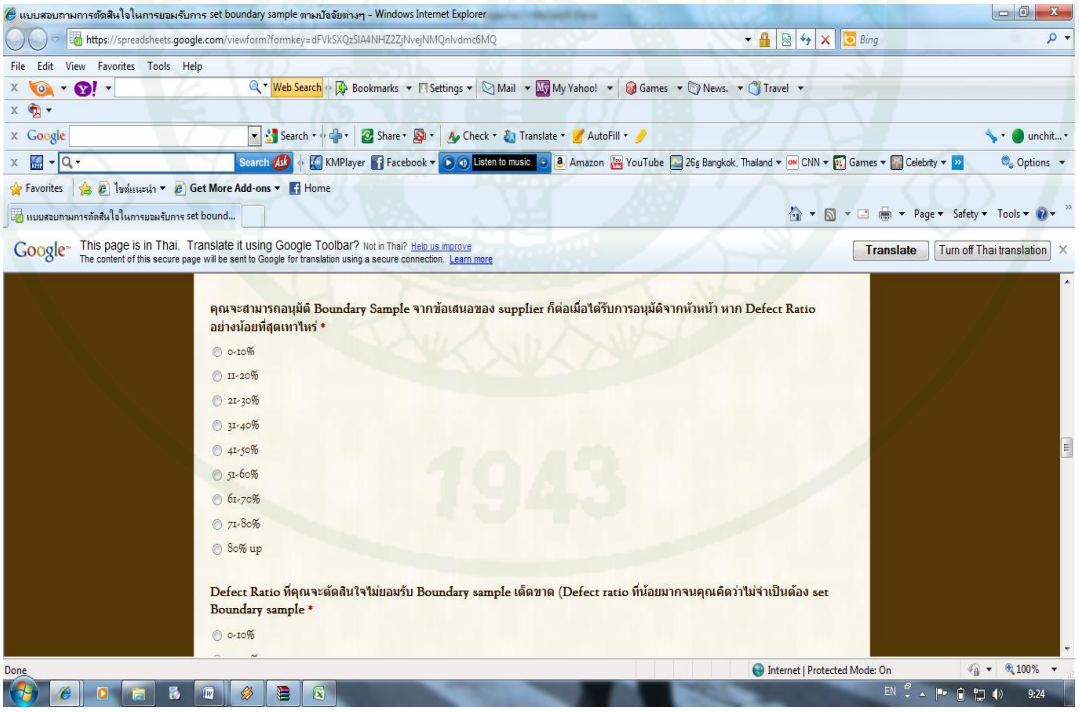

Appendix Figure D1 (Continued)

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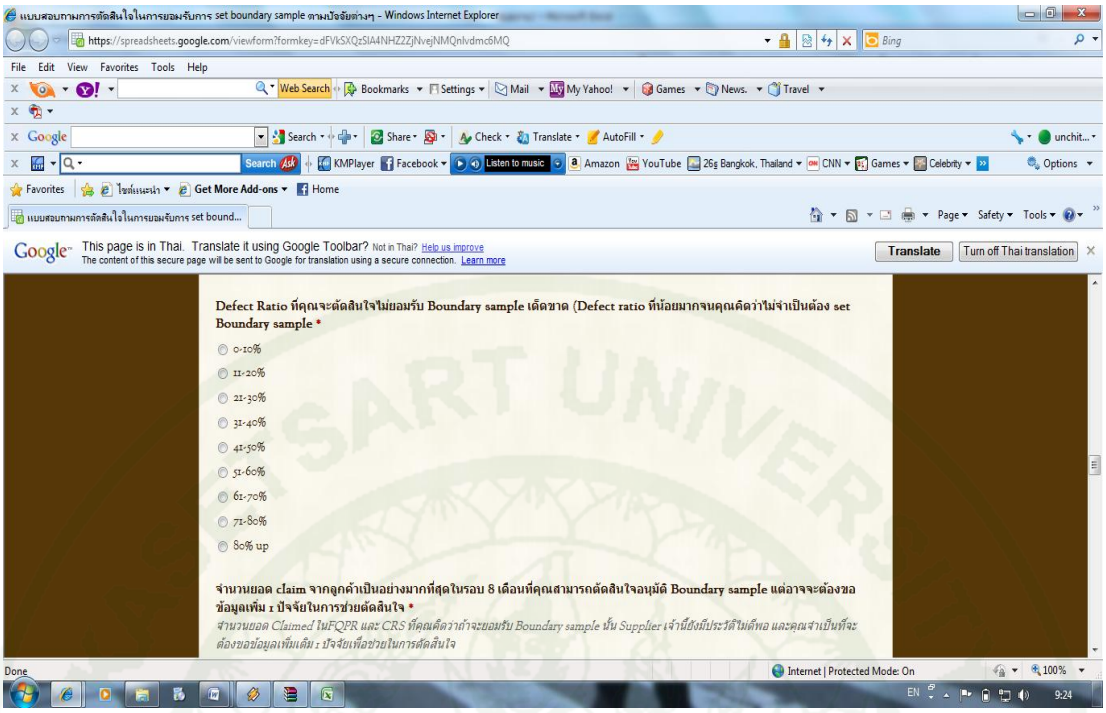

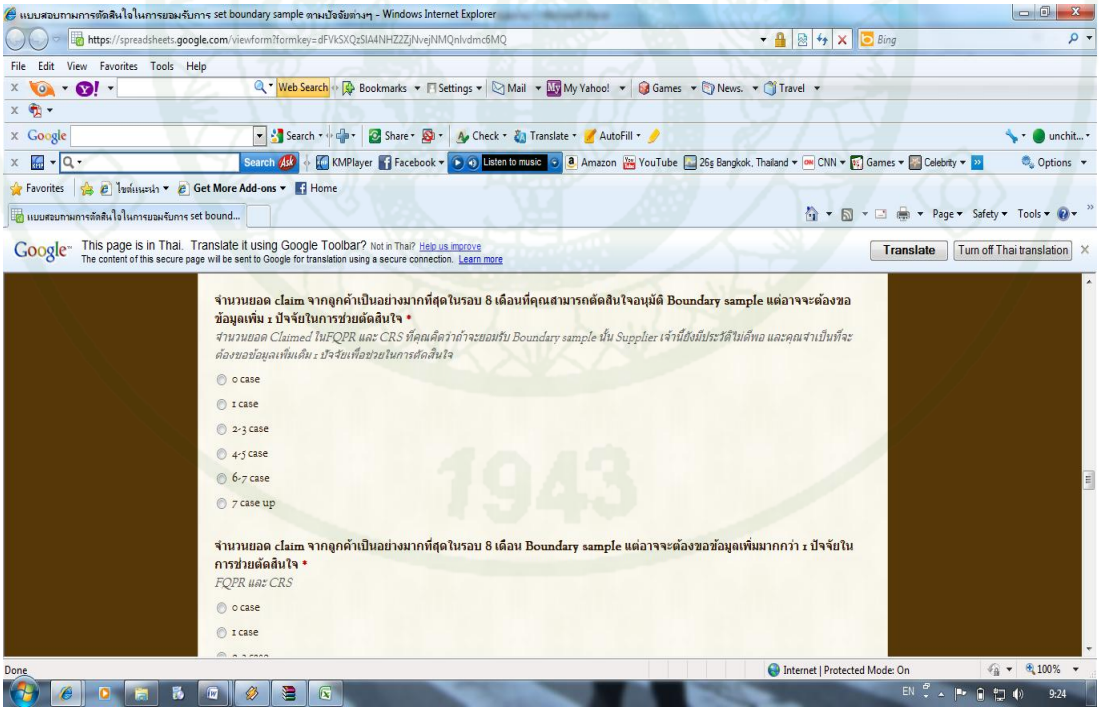

Appendix Figure D1 (Continued)

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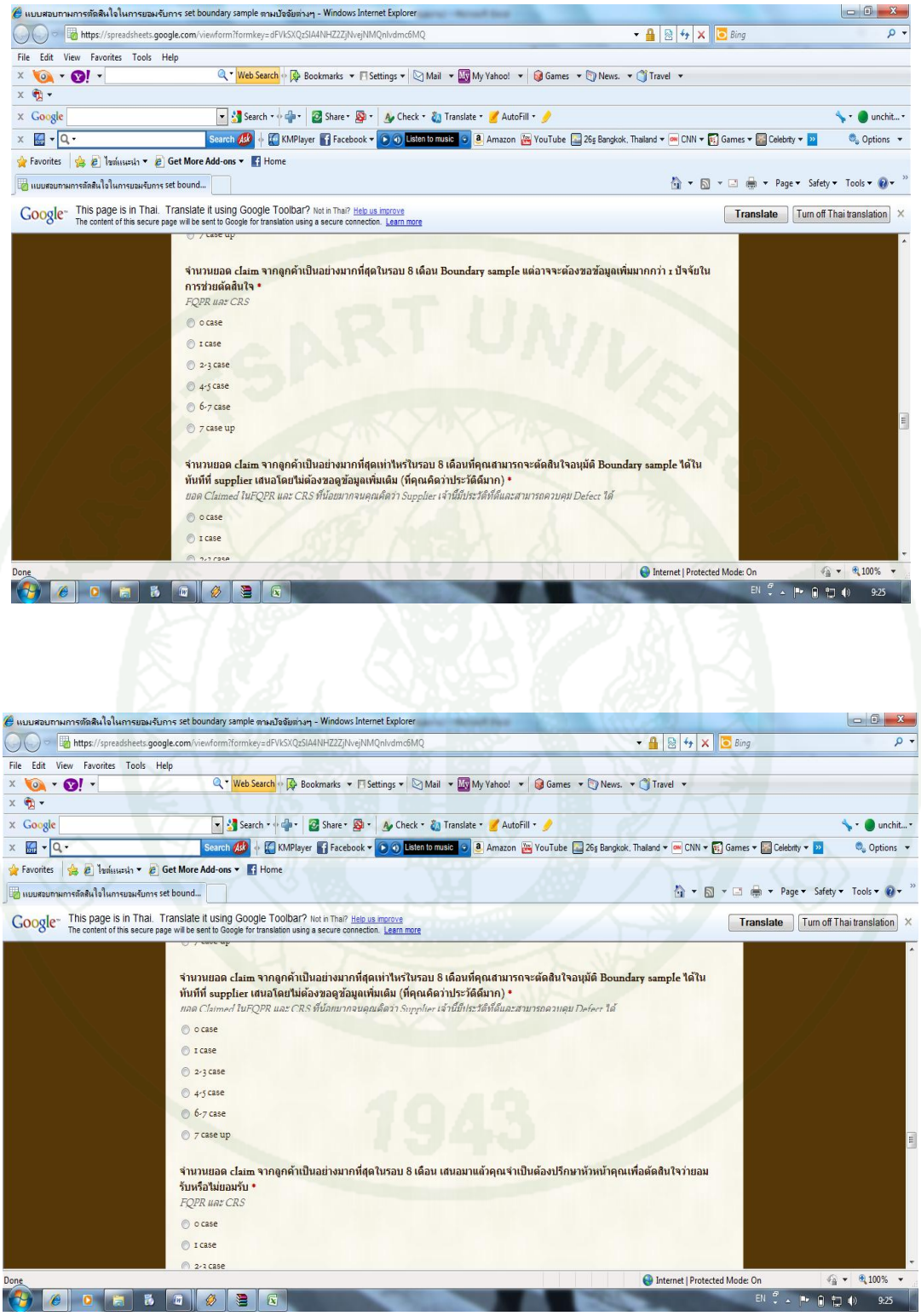

Appendix Figure D1 (Continued)

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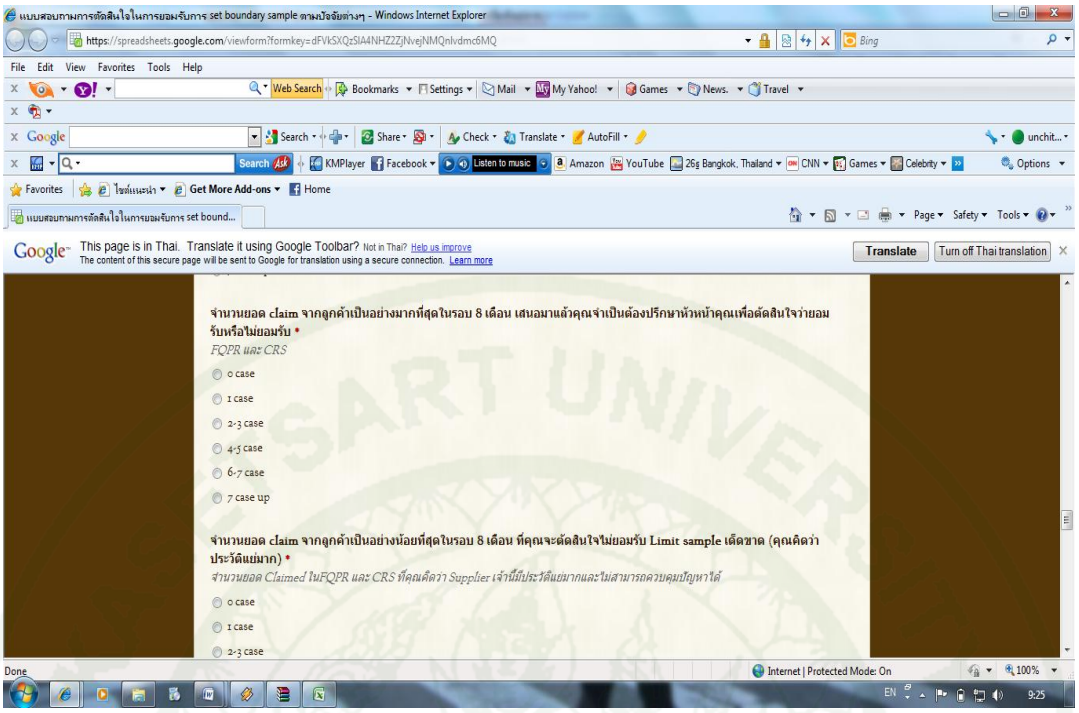

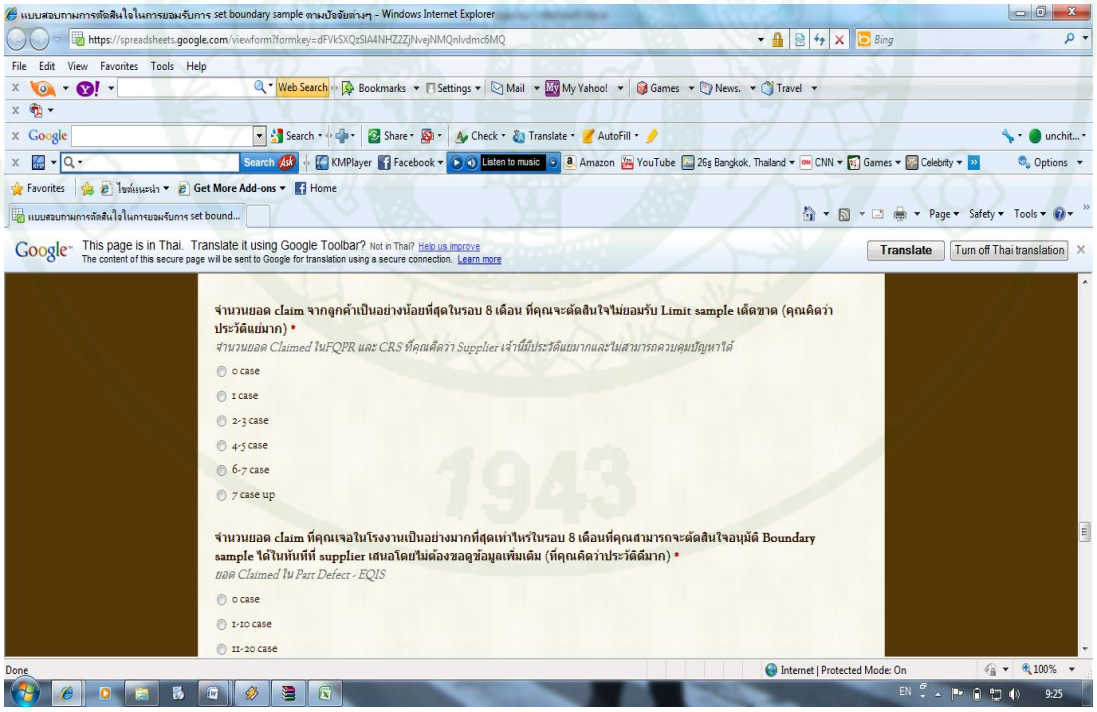

Appendix Figure D1 (Continued)

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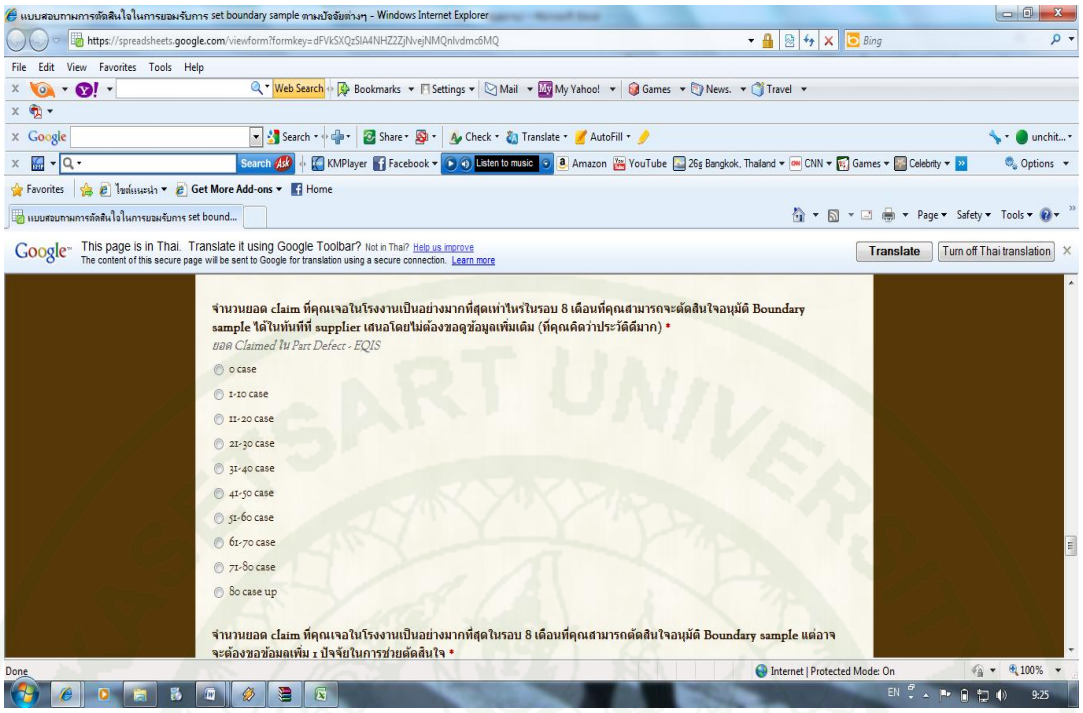

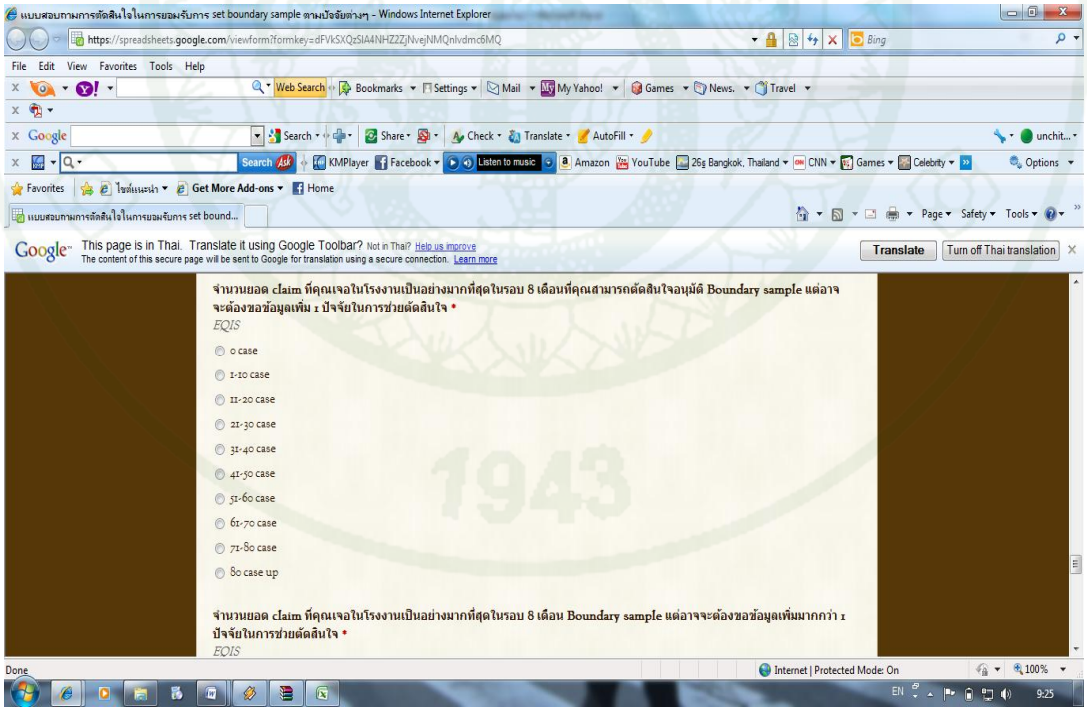

Appendix Figure D1 (Continued)

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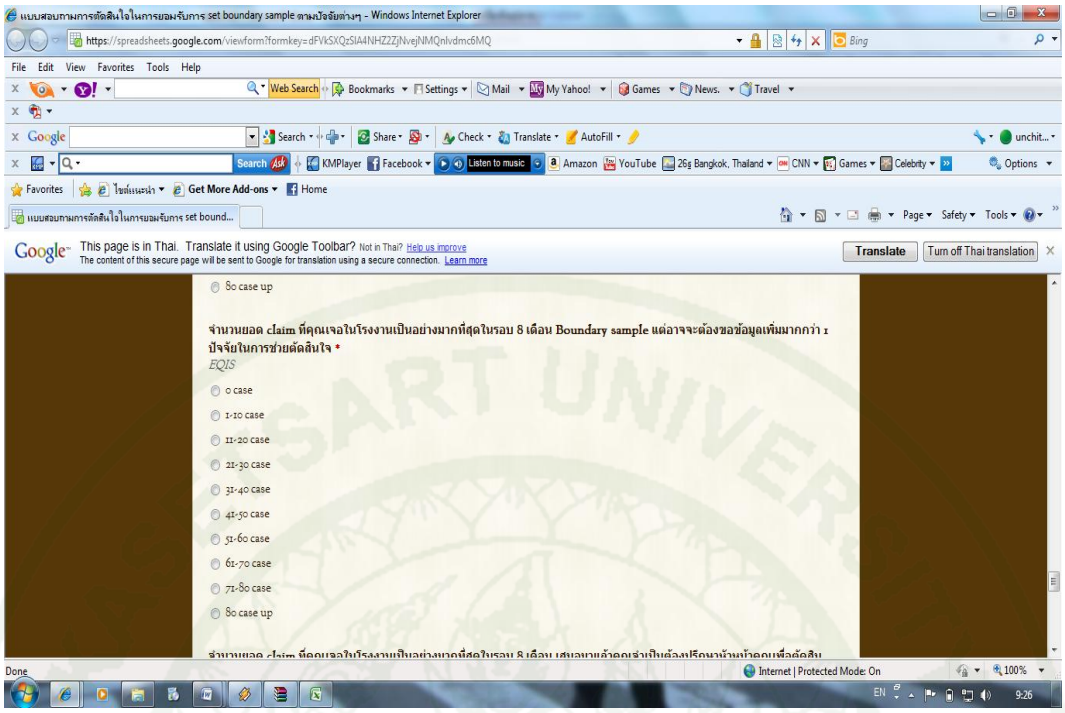

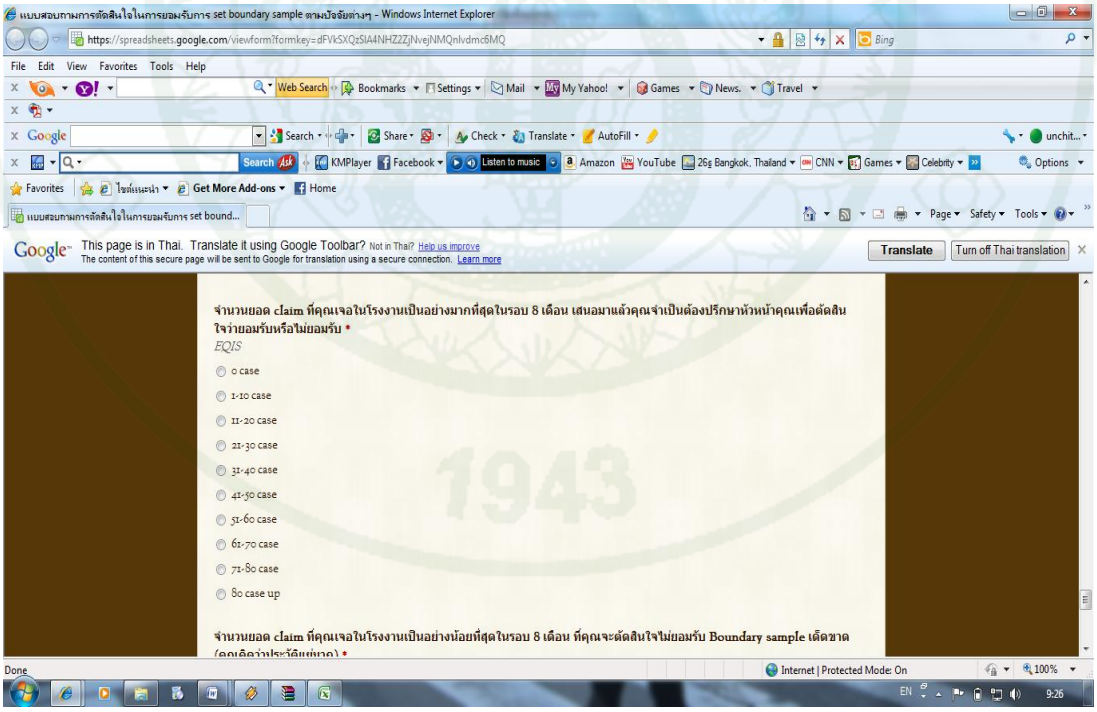

Appendix Figure D1 (Continued)

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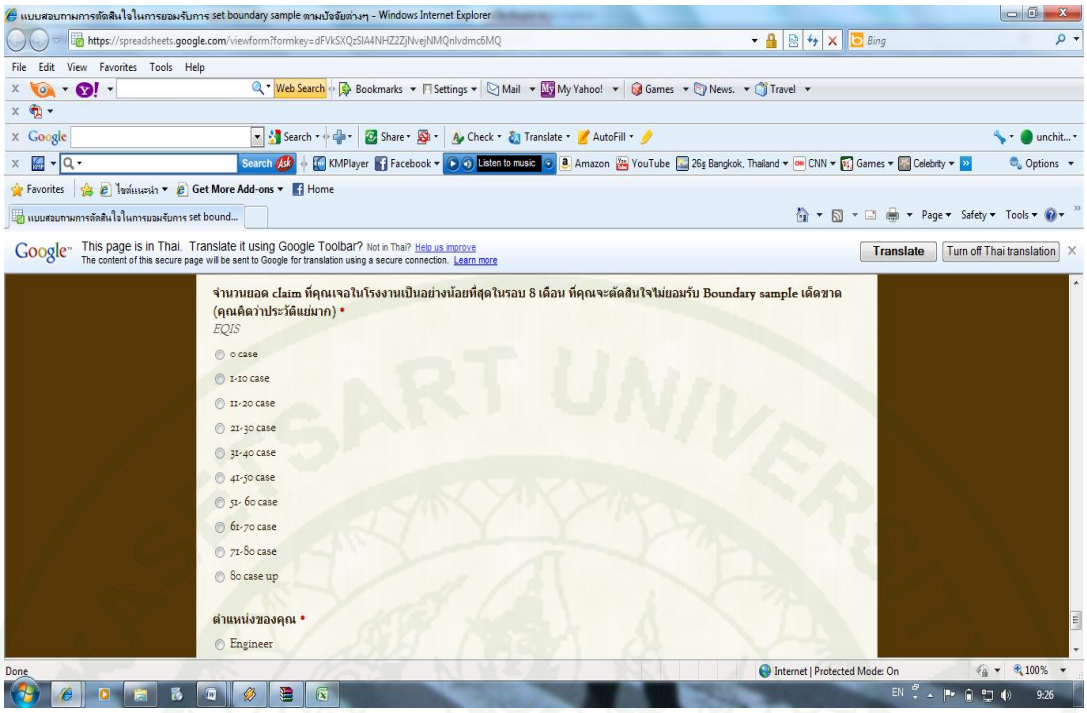

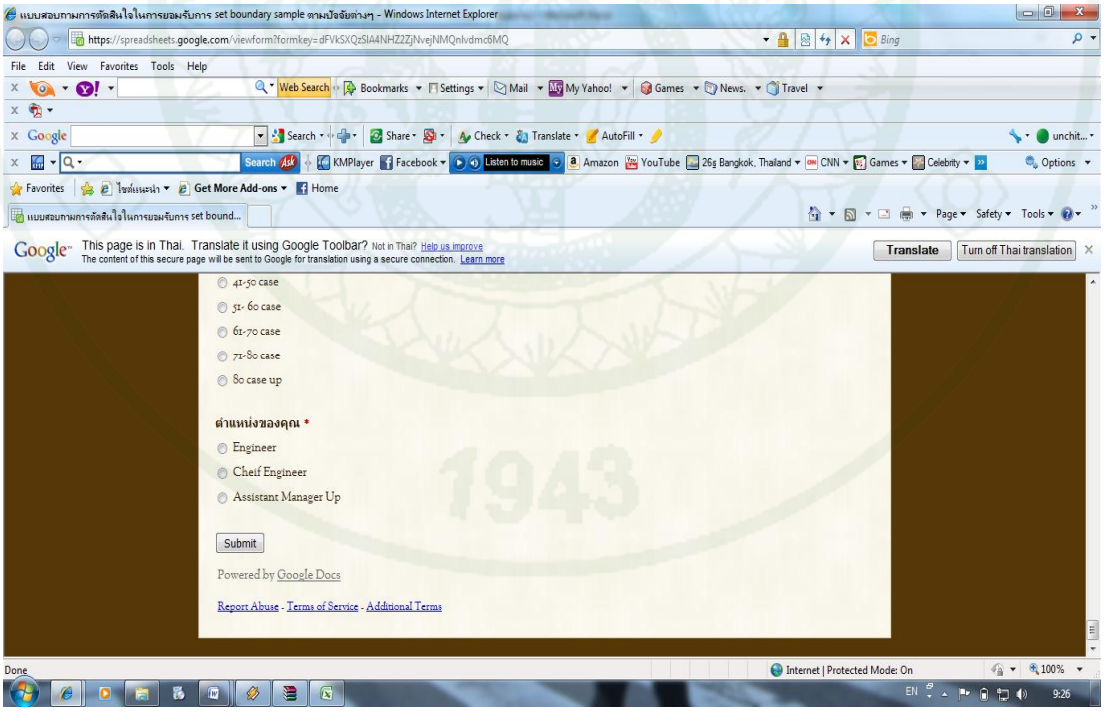

Appendix Figure D1 (Continued)

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Appendix E

The customer complained records

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CRS No.	Maker	Year
S2TMT63D1	SGP	2010
S2TMTA4A0	TRT	2010
S2TMTBWY0	YSP	2010
S2TMT95L1	SGP	2010
S2TMTH8E0	SGP	2010
S2TMTM8Q2	DITH	2010
S2TMTNM80	SGP	2010
S2TMTQ2V1	SA	2010
S2TMTLKE0	DITH	2010
S2TMTFXE0	DITH	2010
S2TMTSBN0	TBGT	2010
S2TMTKTN0	TKC	2010
S2TMT5H20	TBGT	2010
S2TMTEBS0	TRW	2010
S2TMT8P90	TRT	2010
S2TMTEE60	ADVICS	2010
S2TMTPBU0	JTEKT	2010
S2TMTEGV0	SGP	2010
S2TMTZRK0	SGP	2010
S2TMT7WD0	DITH	2010
S2TMTXNA0	AHT	2010
S2TMTCRY0	TBAS(TGT)	2010
S2TMTG641	SEWT	2010
S2TMTF7H0	TAP	2010
S2TMT8SP0	YSP	2010
S2TMTR8V0	SGP	2010
S2TMTA730	TGT	2010
S2TMTW6U0	ADVICS	2010
S2TMT4NT0	ADVICS	2010

Appendix Figure E1 The customer complained records.

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Appendix F

The claimed records

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Supplier	Defect
ATH	2
DAIW	23
GKN	22
IAT	17
IRC	11
MCT	6
SAB	14
SATI	28
SMM	6
SRCT	5
STT	9
TBAS	24
TF	7
TGRT	9
TGT	41
TSLA	10
TTL	18
UP	7
YNP	17
AHT	20
NMT	2
TKO	10
APC	33
BSNC	2
DITH	9
HTT	2
SLC	2
SNSS	2
SPF	3
TAI	3
TER	4
TKC	2
TOC	46
TRW	8
TSC	2
TSG	1
OTC	2
VCS	4
ATC	1
CTC	7
EKT	1

Appendix Figure F1 The claimed records.

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MTAT	4
NHK	1
SKYB	6
TKI	1
TRT	8
TSA	11
TSE	5
SAS	8
SEWT	1
HMT	1
ITTC	4
KHIN	1
SSGT	1
TDC	49
TTC	1
BS	1
DSC	32
EAT	1
GY	3
JTC	2
SRT	1
TSB	2
GS	2
MS	1
YTC	2
SGP	161
YSP	96
SA	89
ADVS	80
CAP	47

Appendix Figure F1 (Continued)

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Appendix G

The result of surely acceptable questionnaire

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Item			Standard				
			Zones	Zone A	Zone B	Zone C	Zone D
Label	Scratch Chip Tear Cut	Mark, Emblem Printed letter Strips Label		5 mm 3 mm dia	10 mm 6 mm dia	10 mm 6 mm dia	10 mm 6 mm dia

If supplier submit boundary sample idea to you about this defect.
What do you think that is the worst defect for your acceptable?(Minimum)

Zone A	☐ 0.1 - 1 mm	☐ 1.1 - 2 mm	☐ 2.1 - 3 mm
	☐ 3.1 - 4 mm	☐ 4.1 - 5 mm	■ not acceptable
Zone B,C, D	☐ 0.1 - 2 mm	☐ 2.1 - 4 mm	☐ 4.1 - 6 mm
	☐ 6.1 - 8 mm	☐ 8.1 - 10 mm	■ not acceptable

Appendix Figure G1 The result of surely acceptable questionnaire (Label).

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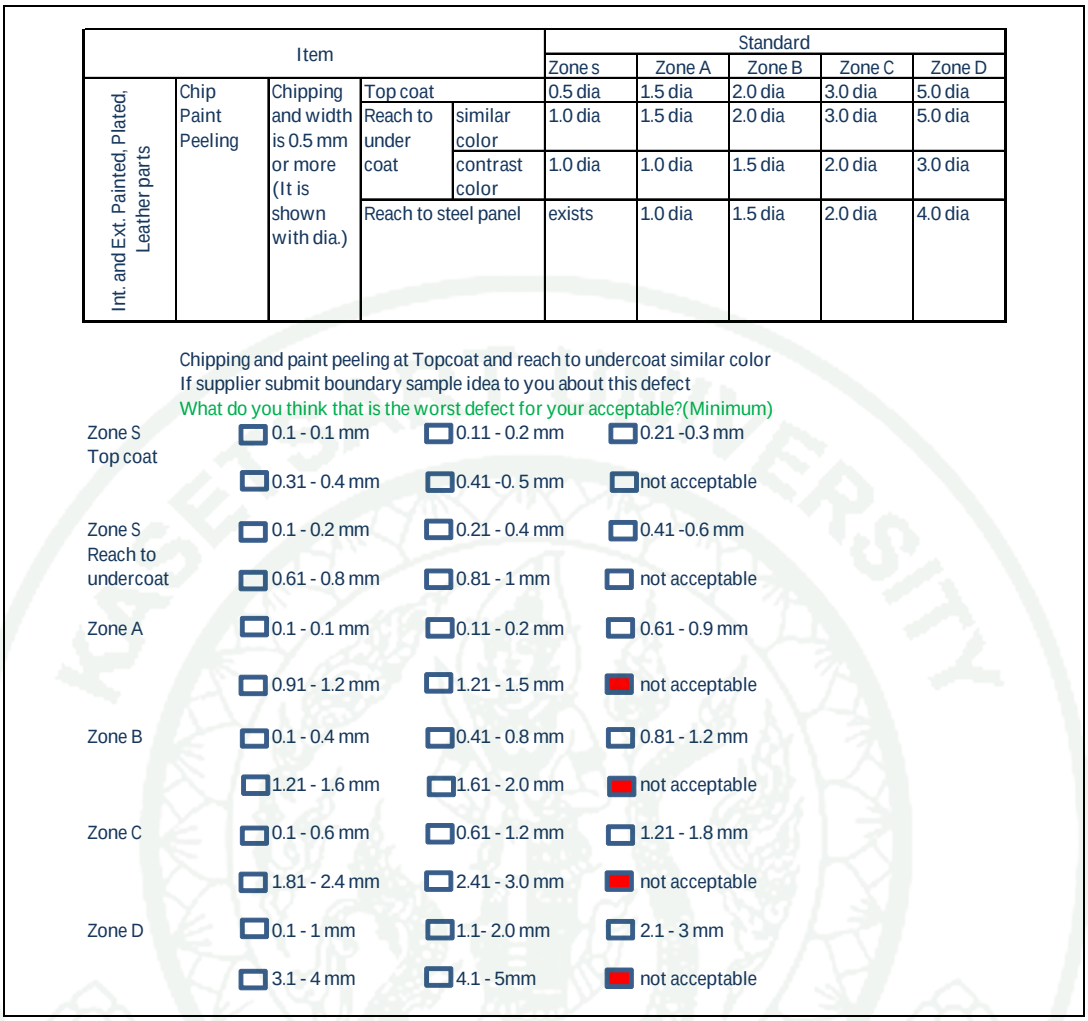

Item					Standard				
					Zone s	Zone A	Zone B	Zone C	Zone D
Int. and Ext. Painted, Plated, Leather parts	Chip Paint Peeling	Chipping and width is 0.5 mm or more (It is shown with dia.)	Top coat		0.5 dia	1.5 dia	2.0 dia	3.0 dia	5.0 dia
			Reach to under coat	similar color	1.0 dia	1.5 dia	2.0 dia	3.0 dia	5.0 dia
				contrast color	1.0 dia	1.0 dia	1.5 dia	2.0 dia	3.0 dia
			Reach to steel panel		exists	1.0 dia	1.5 dia	2.0 dia	4.0 dia

Appendix Figure G2 The result of surely acceptable questionnaire (Interior and exterior painted, leather part: chip paint peeling).

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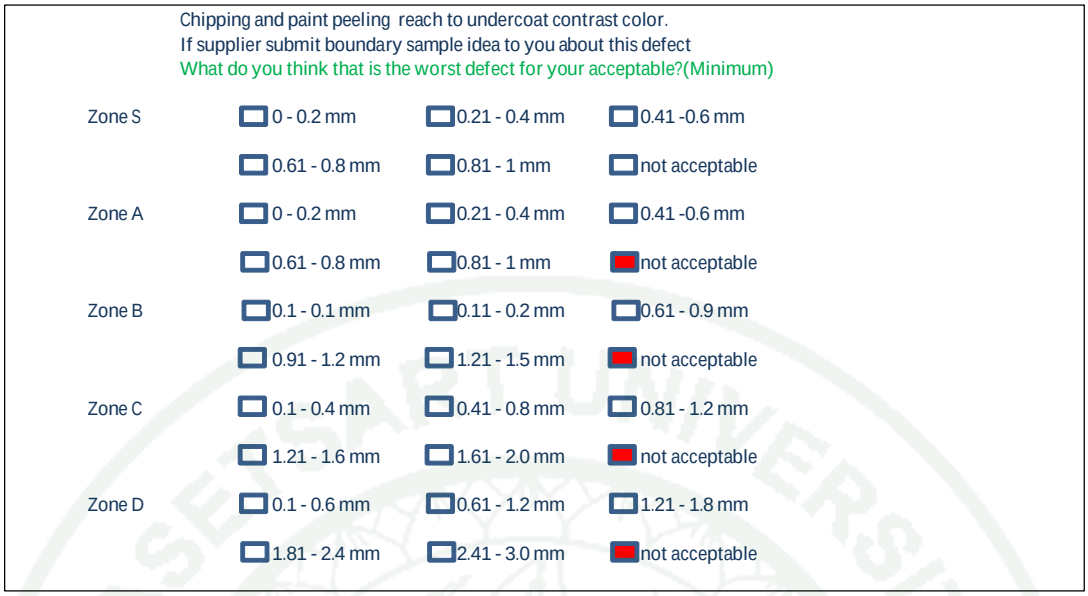
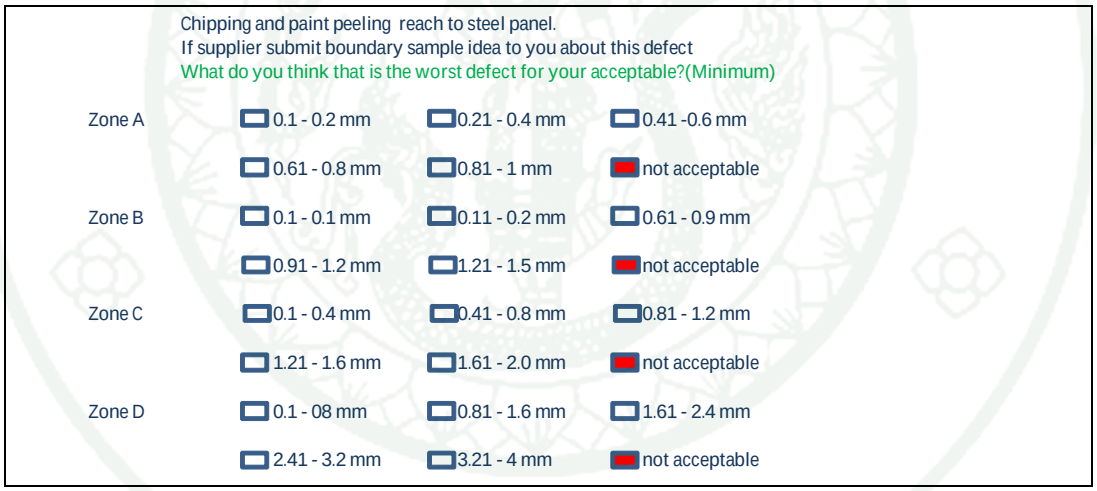


Appendix Figure G2 (Continued)



Appendix Figure G2 (Continued)

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Item					Standard				
					Zone s	Zone A	Zone B	Zone C	Zone D
Int. and Ext. Painted, Plated, Leather parts	Gash Paint crack Scratch primer which is obvious condition	Linear scratch with catch on finger nail (it is shown in mm)	Top coat		1.0 dia	4.0 mm	6.0 mm	8.0 mm	20 mm
			Reach to under coat	similar color scratch in primer	1.5 mm	3.0 mm	4.0 mm	5.0 mm	12 mm
				contrast color	1.5 mm	2.0 mm	3.0 mm	3.5 mm	6.0 mm
			Reach to steel panel		exists	2.0 mm	3.0 mm	3.5 mm	6.0 mm

Gash paint crack scratch in primer which is obvious condition at Top coat.
If supplier submit boundary sample idea to you about this defect
What do you think that is the worst defect for your acceptable?(Minimum)

Zone S	0.1 - 0.2 mm	0.21 - 0.4 mm	0.41 -0.6 mm
	0.61 - 0.8 mm	0.81 - 1 mm	not acceptable
Zone A	0.1 - 08 mm	0.81 - 1.6 mm	1.61 - 2.4 mm
	2.41 - 3.2 mm	3.21 - 4 mm	not acceptable
Zone B	0.1 - 1.2 mm	1.21 - 2.4 mm	2.41 - 3.6 mm
	3.61 - 4.8 mm	4.81 - 6.0 mm	not acceptable
Zone C	0.1 - 1.6 mm	1.61 - 2.4 mm	2.41 - 4.8 mm
	4.81 - 6.4 mm	6.51 - 8 mm	not acceptable
Zone D	0 - 4 mm	4.1 - 8 mm	8.1 - 12 mm
	12.1 - 16 mm	16.1 - 20 mm	not acceptable

Appendix Figure G3 The result of surely acceptable questionnaire (Interior and exterior painted, leather part: Gash paint).

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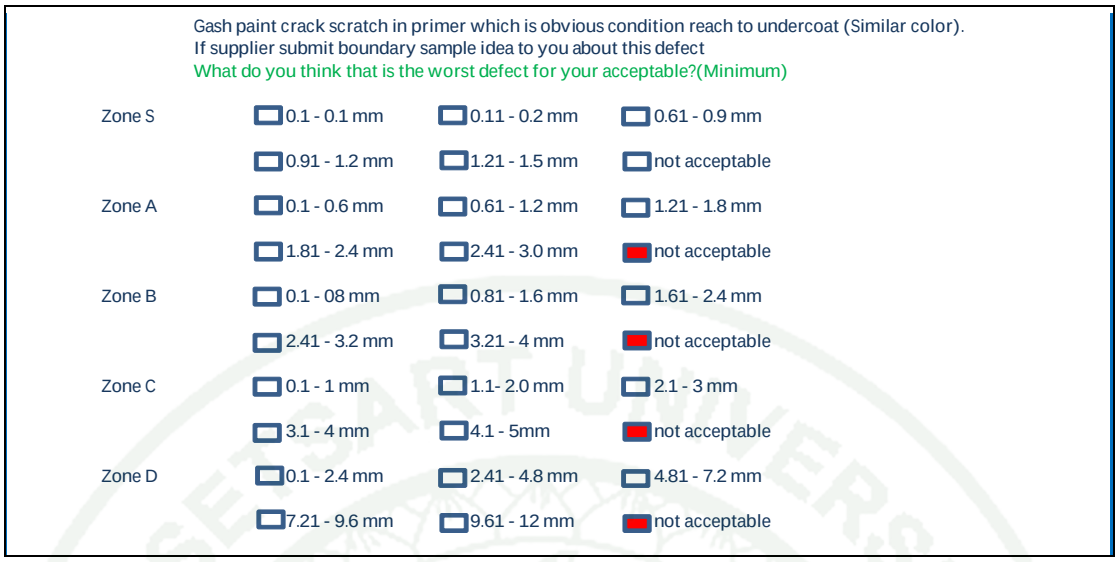
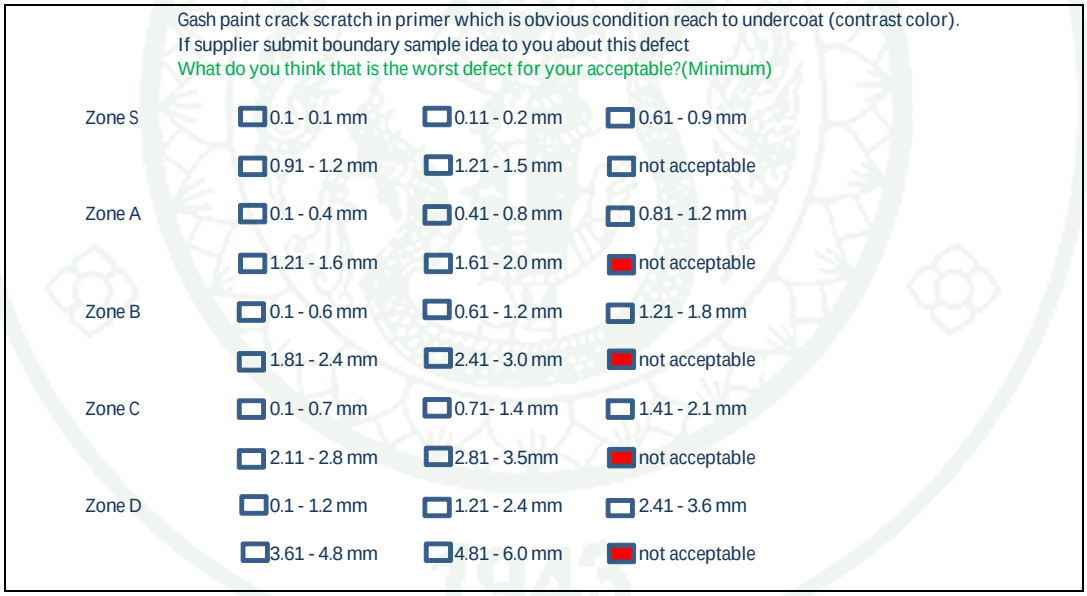


Appendix Figure G3 (Continued)



Appendix Figure G3 (Continued)

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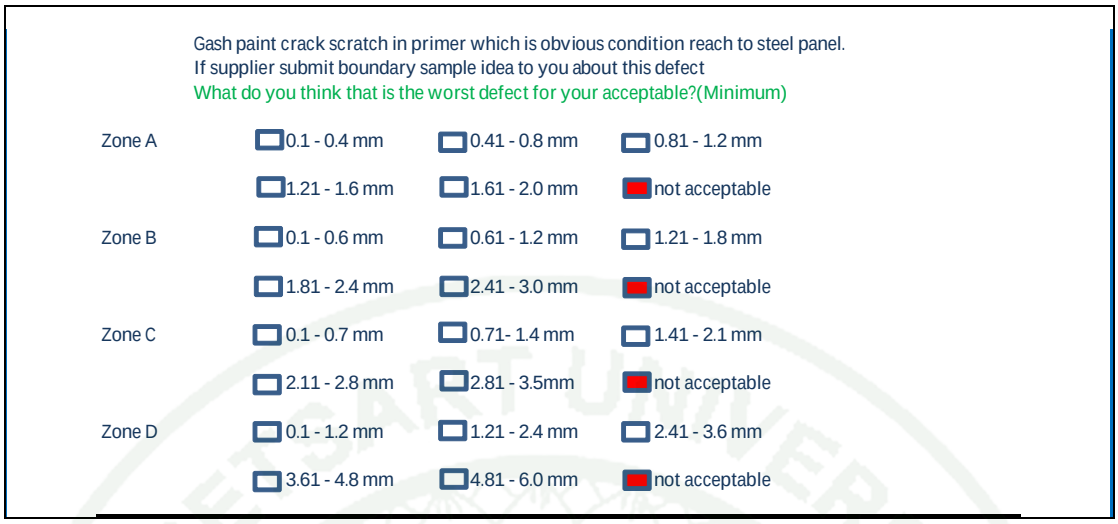
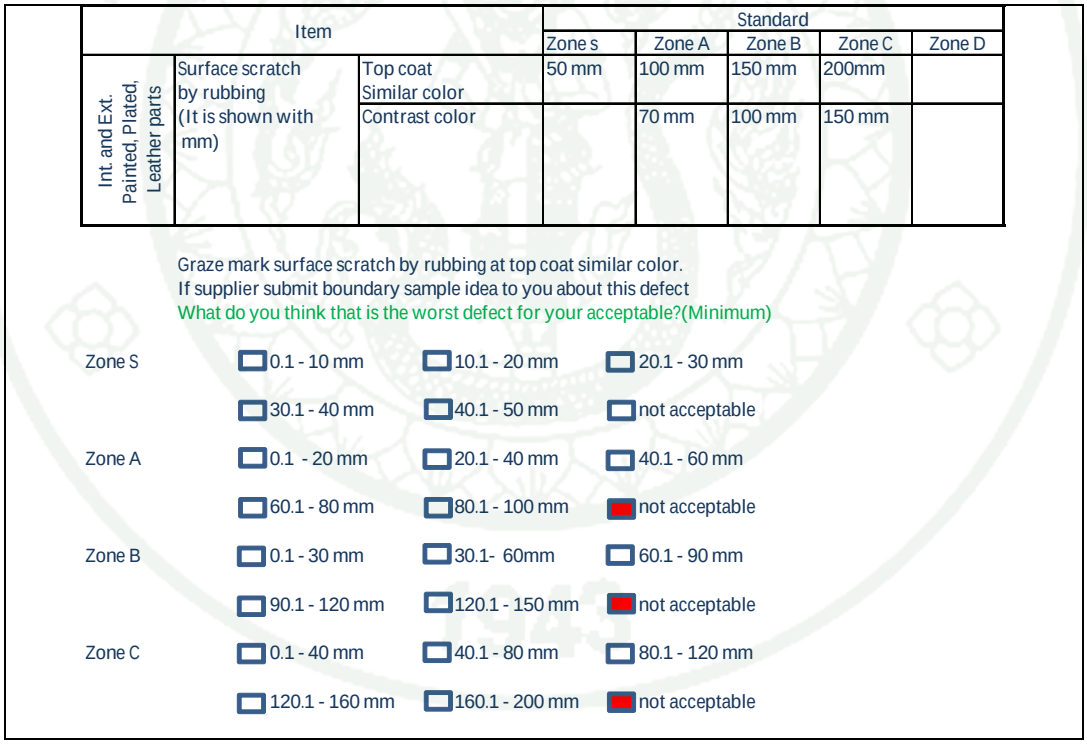


Appendix Figure G3 (Continued)



Appendix Figure G4 The result of surely acceptable questionnaire (Interior and exterior painted, leather part: Surface scratch by rubbing).

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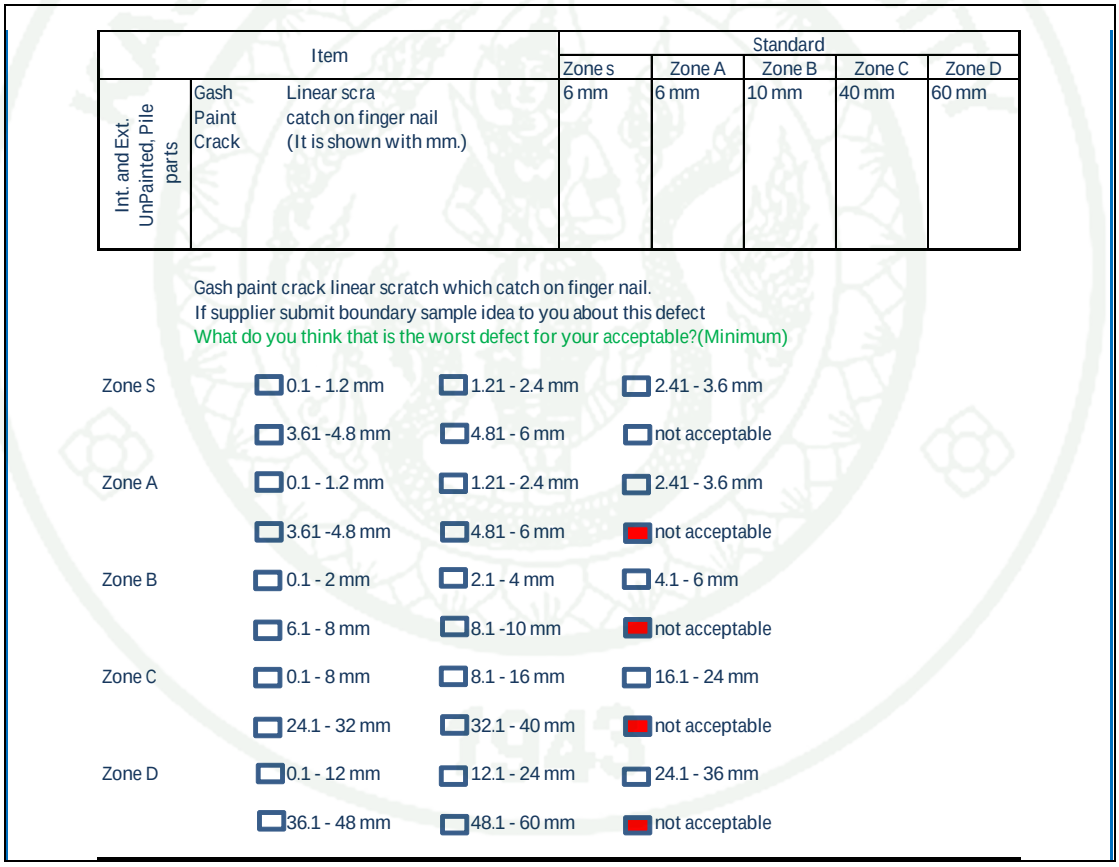
Appendix Figure G4 (Continued)



Appendix Figure G5 The result of surely acceptable questionnaire (Interior and exterior unpainted, pile part: Gash paint crack).

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Item			Standard				
			Zone s	Zone A	Zone B	Zone C	Zone D
Int. and Ext. Unpainted, Pile parts	Surface scratch by rubbing (It is shown with mm)	Top coat Similar color	100 mm	100 mm	150 mm	250mm	500 mm

Graze mark surface scratch by rubbing at top coat similar color.
If supplier submit boundary sample idea to you about this defect
What do you think that is the worst defect for your acceptable?(Minimum)

Zone S	☐ 0.1 - 20 mm	☐ 20.1 - 40 mm	☐ 40.1 - 60 mm
	☐ 60.1 - 80 mm	☐ 80.1 - 100 mm	☐ not acceptable
Zone A	☐ 0.1 - 20 mm	☐ 20.1 - 40 mm	☐ 40.1 - 60 mm
	☐ 60.1 - 80 mm	☐ 80.1 - 100 mm	☐ not acceptable
Zone B	☐ 0.1 - 30 mm	☐ 30.1- 60mm	☐ 60.1 - 90 mm
	☐ 90.1 - 120 mm	☐ 120.1 - 150 mm	☐ not acceptable
Zone C	☐ 0.1 - 50 mm	☐ 50.1 - 100 mm	☐ 100.1 - 150 mm
	☐ 150.1 - 200 mm	☐ 200.1 - 250 mm	☐ not acceptable
Zone D	☐ 0.1 - 100 mm	☐ 100.1 - 200 mm	☐ 200.1 - 300 mm
	☐ 300.1 - 400 mm	☐ 400.1 - 500 mm	☐ not acceptable

Appendix Figure G6 The result of surely acceptable questionnaire (Interior and exterior unpainted, pile part: Surface scratch by rubbing).

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Appendix H

The result of not acceptable questionnaire

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Item			Standard				
			Zones	Zone A	Zone B	Zone C	Zone D
Label	Scratch Chip Tear Cut	Mark, Emblem Printed letter Strips Label		5 mm 3 mm dia	10 mm 6 mm dia	10 mm 6 mm dia	10 mm 6 mm dia

If supplier submit boundary sample idea to you about this defect.
What do you think that is the beginning dimension of defect for your not acceptable?(Maximum)

Zone A	☐	0.1 - 1 mm	■	1.1 - 2 mm	☐	2.1 - 3 mm		
	☐	3.1 - 4 mm	☐	4.1 - 5 mm	☐	over than standard		
Zone B,C, D	☐	0.1 - 2 mm	☐	2.1 - 4 mm	■	4.1 - 6 mm		
	☐	6.1 - 8 mm	☐	8.1 - 10 mm	☐	over than standard		

Appendix Figure H1 The result of not acceptable questionnaire (Label).

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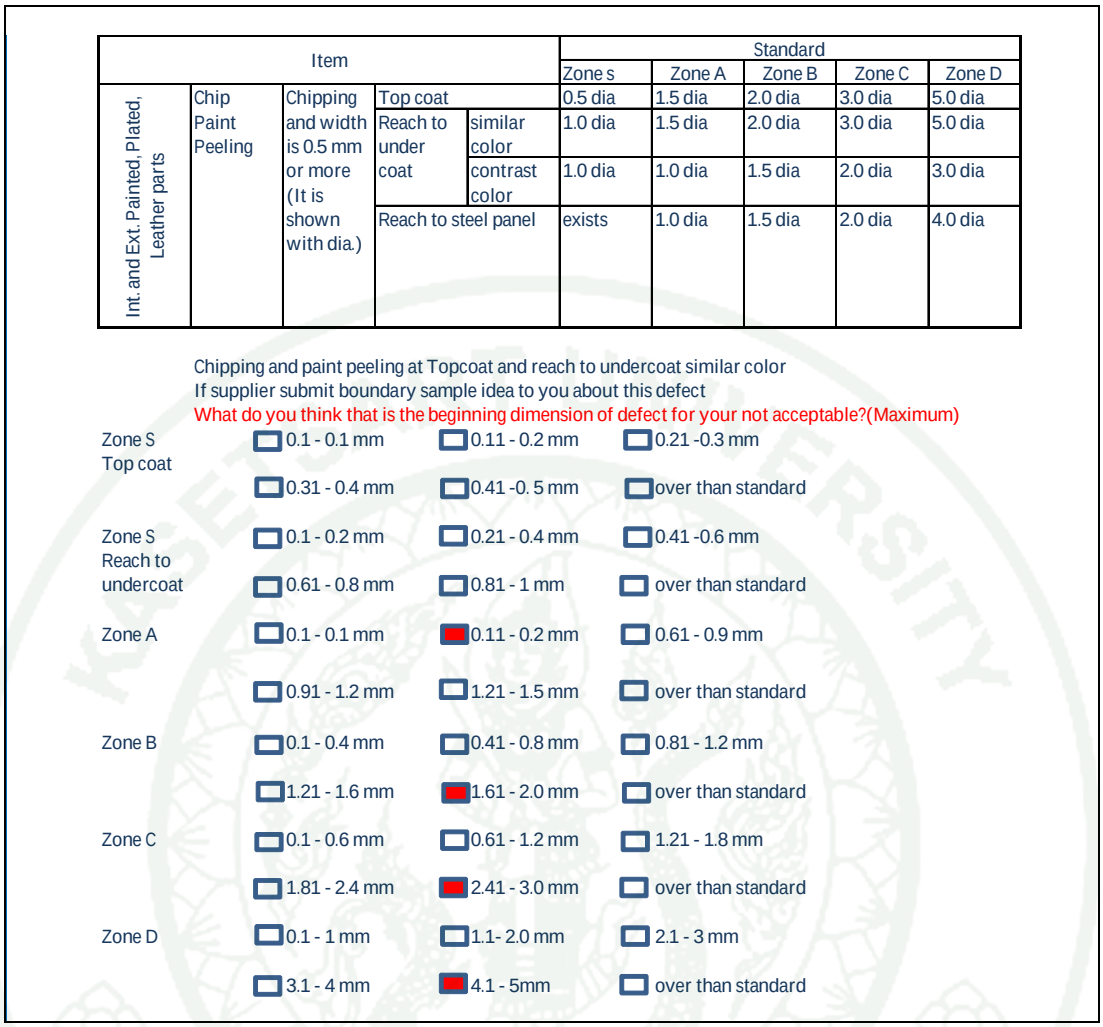

Item					Standard				
					Zone s	Zone A	Zone B	Zone C	Zone D
Int. and Ext. Painted, Plated, Leather parts	Chip Paint Peeling	Chipping and width is 0.5 mm or more (It is shown with dia.)	Top coat		0.5 dia	1.5 dia	2.0 dia	3.0 dia	5.0 dia
			Reach to under coat	similar color	1.0 dia	1.5 dia	2.0 dia	3.0 dia	5.0 dia
				contrast color	1.0 dia	1.0 dia	1.5 dia	2.0 dia	3.0 dia
			Reach to steel panel		exists	1.0 dia	1.5 dia	2.0 dia	4.0 dia

Chipping and paint peeling at Topcoat and reach to undercoat similar color
If supplier submit boundary sample idea to you about this defect
What do you think that is the beginning dimension of defect for your not acceptable?(Maximum)

Zone S Top coat	☐ 0.1 - 0.1 mm	☐ 0.11 - 0.2 mm	☐ 0.21 -0.3 mm
	☐ 0.31 - 0.4 mm	☐ 0.41 -0. 5 mm	☐ over than standard
Zone S Reach to undercoat	☐ 0.1 - 0.2 mm	☐ 0.21 - 0.4 mm	☐ 0.41 -0.6 mm
	☐ 0.61 - 0.8 mm	☐ 0.81 - 1 mm	☐ over than standard
Zone A	☐ 0.1 - 0.1 mm	☐ 0.11 - 0.2 mm	☐ 0.61 - 0.9 mm
	☐ 0.91 - 1.2 mm	☐ 1.21 - 1.5 mm	☐ over than standard
Zone B	☐ 0.1 - 0.4 mm	☐ 0.41 - 0.8 mm	☐ 0.81 - 1.2 mm
	☐ 1.21 - 1.6 mm	☐ 1.61 - 2.0 mm	☐ over than standard
Zone C	☐ 0.1 - 0.6 mm	☐ 0.61 - 1.2 mm	☐ 1.21 - 1.8 mm
	☐ 1.81 - 2.4 mm	☐ 2.41 - 3.0 mm	☐ over than standard
Zone D	☐ 0.1 - 1 mm	☐ 1.1- 2.0 mm	☐ 2.1 - 3 mm
	☐ 3.1 - 4 mm	☐ 4.1 - 5mm	☐ over than standard

Appendix Figure H2 The result of not acceptable questionnaire (Interior and exterior painted, leather part: chip paint peeling).

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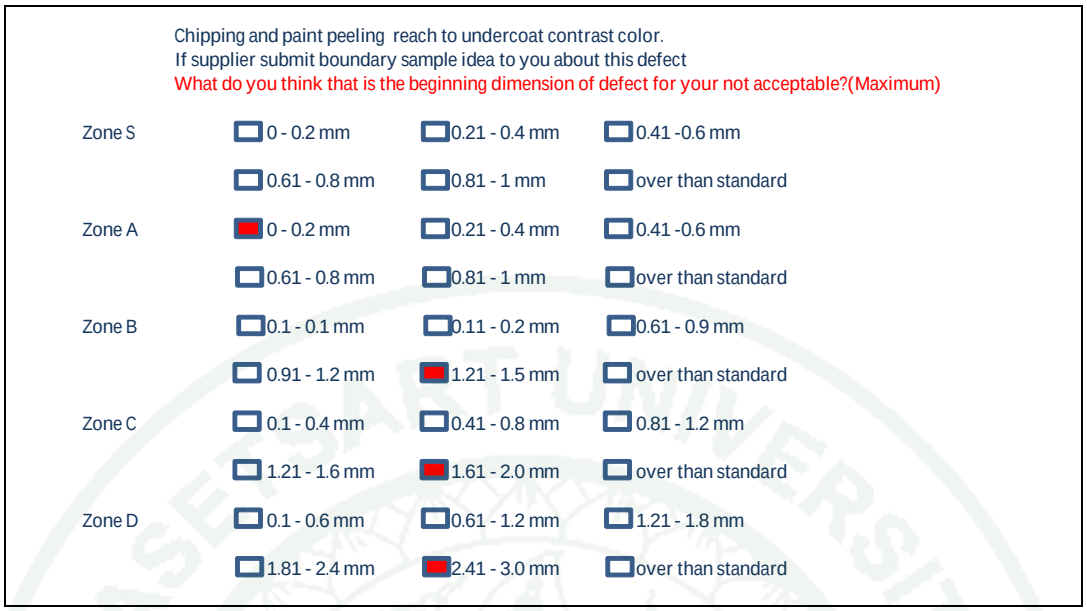
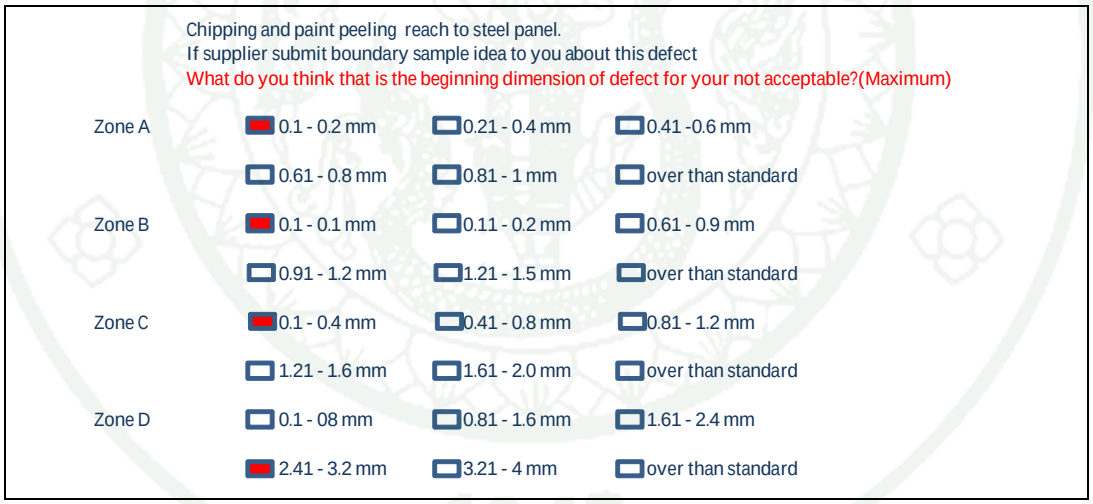


Appendix Figure H2 (Continued)



Appendix Figure H2 (Continued)

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Item					Standard				
					Zone s	Zone A	Zone B	Zone C	Zone D
Int. and Ext. Painted, Plated, Leather parts	Gash Paint crack Scratch primer which is obvious condition	Linear scratch with catch on finger nail (it is shown in mm)	Top coat		1.0 dia	4.0 mm	6.0 mm	8.0 mm	20 mm
			Reach to under coat	similar color scratch in primer	1.5 mm	3.0 mm	4.0 mm	5.0 mm	12 mm
				contrast color	1.5 mm	2.0 mm	3.0 mm	3.5 mm	6.0 mm
			Reach to steel panel		exists	2.0 mm	3.0 mm	3.5 mm	6.0 mm

Gash paint crack scratch in primer which is obvious condition at Top coat.
If supplier submit boundary sample idea to you about this defect
What do you think that is the beginning dimension of defect for your not acceptable?(Maximum)

Zone S	0.1 - 0.2 mm	0.21 - 0.4 mm	0.41 -0.6 mm
	0.61 - 0.8 mm	0.81 - 1 mm	over than standard
Zone A	0.1 - 08 mm	0.81 - 1.6 mm	1.61 - 2.4 mm
	2.41 - 3.2 mm	3.21 - 4 mm	over than standard
Zone B	0.1 - 1.2 mm	1.21 - 2.4 mm	2.41 - 3.6 mm
	3.61 - 4.8 mm	4.81 - 6.0 mm	over than standard
Zone C	0.1 - 1.6 mm	1.61 - 2.4 mm	2.41 - 4.8 mm
	4.81 - 6.4 mm	6.51 - 8 mm	over than standard
Zone D	0 - 4 mm	4.1 - 8 mm	8.1 - 12 mm
	12.1 - 16 mm	16.1 - 20 mm	over than standard

Appendix Figure H3 The not acceptable questionnaire (Interior and exterior painted, leather part: Gash paint).

Gash paint crack scratch in primer which is obvious condition reach to undercoat (Similar color).
If supplier submit boundary sample idea to you about this defect
What do you think that is the beginning dimension of defect for your not acceptable?(Maximum)

Zone S	0.1 - 0.1 mm	0.11 - 0.2 mm	0.61 - 0.9 mm
	0.91 - 1.2 mm	1.21 - 1.5 mm	over than standard
Zone A	0.1 - 0.6 mm	0.61 - 1.2 mm	1.21 - 1.8 mm
	1.81 - 2.4 mm	2.41 - 3.0 mm	over than standard
Zone B	0.1 - 08 mm	0.81 - 1.6 mm	1.61 - 2.4 mm
	2.41 - 3.2 mm	3.21 - 4 mm	over than standard
Zone C	0.1 - 1 mm	1.1- 2.0 mm	2.1 - 3 mm
	3.1 - 4 mm	4.1 - 5mm	over than standard
Zone D	0.1 - 2.4 mm	2.41 - 4.8 mm	4.81 - 7.2 mm
	7.21 - 9.6 mm	9.61 - 12 mm	over than standard

Appendix Figure H3 (Continued)

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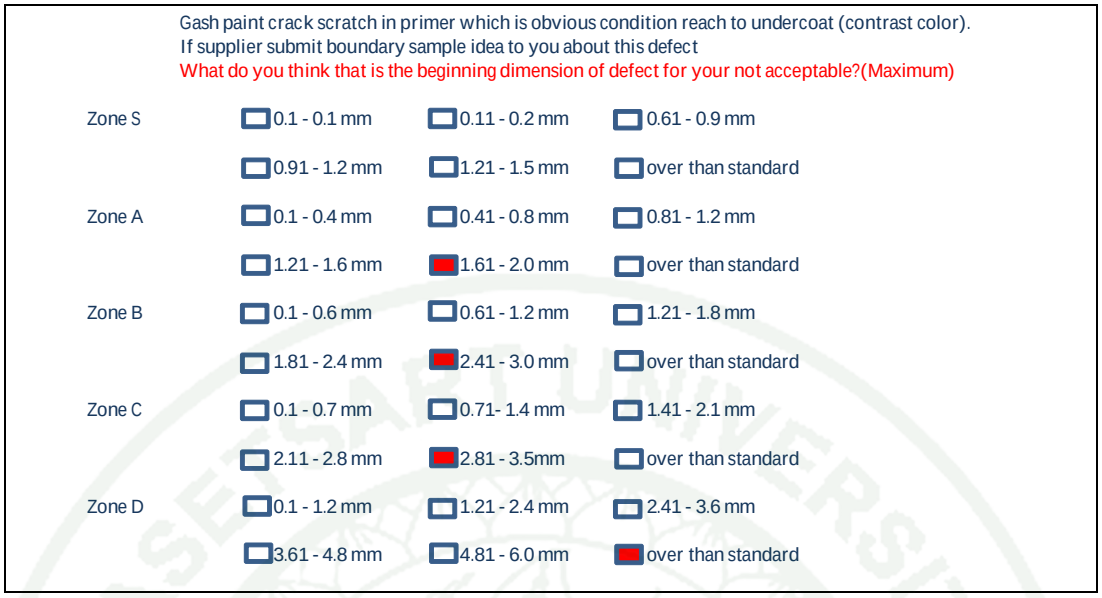
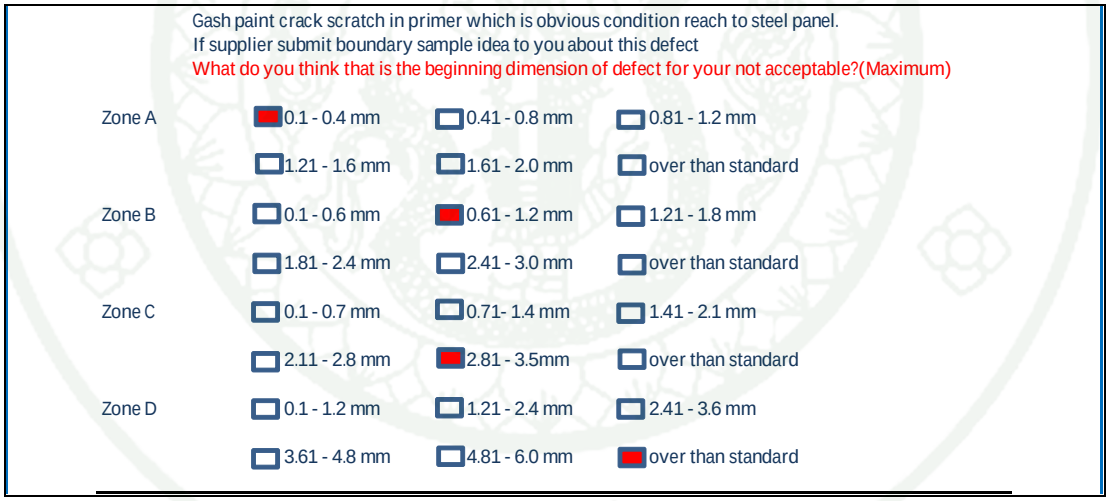


Appendix Figure H3 (Continued)



Appendix Figure H3 (Continued)

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Item			Standard				
			Zone s	Zone A	Zone B	Zone C	Zone D
Int. and Ext. Painted, Plated, Leather parts	Surface scratch by rubbing (It is shown with mm)	Top coat Similar color	50 mm	100 mm	150 mm	200mm	
		Contrast color		70 mm	100 mm	150 mm	

Graze mark surface scratch by rubbing at top coat similar color.
If supplier submit boundary sample idea to you about this defect
What do you think that is the beginning dimension of defect for your not acceptable?(Maximum)

Zone S	☐ 0.1 - 10 mm	☐ 10.1 - 20 mm	☐ 20.1 - 30 mm
	☐ 30.1 - 40 mm	☐ 40.1 - 50 mm	☐ over than standard
Zone A	☐ 0.1 - 20 mm	☐ 20.1 - 40 mm	☐ 40.1 - 60 mm
	■ 60.1 - 80 mm	☐ 80.1 - 100 mm	☐ over than standard
Zone B	☐ 0.1 - 30 mm	☐ 30.1- 60mm	☐ 60.1 - 90 mm
	☐ 90.1 - 120 mm	■ 120.1 - 150 mm	☐ over than standard
Zone C	☐ 0.1 - 40 mm	☐ 40.1 - 80 mm	☐ 80.1 - 120 mm
	☐ 120.1 - 160 mm	■ 160.1 - 200 mm	☐ over than standard

Appendix Figure H4 The result of not acceptable questionnaire (Interior and exterior painted, leather part: Surface scratch by rubbing).

Graze mark surface scratch by rubbing at top coat contrast color
If supplier submit boundary sample idea to you about this defect
What do you think that is the beginning dimension of defect for your not acceptable?(Maximum)

Zone A	☐ 0.1 - 14 mm	■ 14.1 - 28 mm	☐ 28.1 - 52 mm
	☐ 42.1 - 56 mm	☐ 56.1 - 70 mm	☐ over than standard
Zone B	☐ 0.1 - 20 mm	☐ 20.1 - 40 mm	☐ 40.1 - 60 mm
	☐ 60.1 - 80 mm	■ 80.1 - 100 mm	☐ over than standard
Zone C	☐ 0.1 - 30 mm	☐ 30.1 - 60 mm	☐ 60.1 - 90 mm
	☐ 90.1 - 120 mm	■ 120.1 - 150 mm	☐ over than standard

Appendix Figure H4 (Continued)

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Item			Standard				
			Zone s	Zone A	Zone B	Zone C	Zone D
Int. and Ext. UnPainted, Pile parts	Gash Paint Crack	Linear scra catch on finger nail (It is shown with mm.)	6 mm	6 mm	10 mm	40 mm	60 mm

Gash paint crack linear scratch which catch on finger nail.
If supplier submit boundary sample idea to you about this defect
What do you think that is the beginning dimension of defect for your not acceptable?(Maximum)

Zone S	☐ 0.1 - 1.2 mm	☐ 1.21 - 2.4 mm	☐ 2.41 - 3.6 mm
	☐ 3.61 -4.8 mm	☐ 4.81 - 6 mm	☐ over than standard
Zone A	☐ 0.1 - 1.2 mm	■ 1.21 - 2.4 mm	☐ 2.41 - 3.6 mm
	☐ 3.61 -4.8 mm	☐ 4.81 - 6 mm	☐ over than standard
Zone B	☐ 0.1 - 2 mm	☐ 2.1 - 4 mm	■ 4.1 - 6 mm
	☐ 6.1 - 8 mm	☐ 8.1 -10 mm	☐ over than standard
Zone C	☐ 0.1 - 8 mm	☐ 8.1 - 16 mm	☐ 16.1 - 24 mm
	☐ 24.1 - 32 mm	☐ 32.1 - 40 mm	■ over than standard
Zone D	☐ 0.1 - 12 mm	☐ 12.1 - 24 mm	☐ 24.1 - 36 mm
	☐ 36.1 - 48 mm	■ 48.1 - 60 mm	☐ over than standard

Appendix Figure H5 The not acceptable questionnaire (Interior and exterior unpainted, pile part: Gash paint crack).

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Item			Standard				
			Zone s	Zone A	Zone B	Zone C	Zone D
Int. and Ext. Unpainted, Pile parts	Surface scratch by rubbing (It is shown with mm)	Top coat Similar color	100 mm	100 mm	150 mm	250mm	500 mm

Graze mark surface scratch by rubbing at top coat similar color.
If supplier submit boundary sample idea to you about this defect
What do you think that is the beginning dimension of defect for your not acceptable?(Maximum)

Zone S	☐ 0.1 - 20 mm	☐ 20.1 - 40 mm	☐ 40.1 - 60 mm
	☐ 60.1 - 80 mm	☐ 80.1 - 100 mm	☐ over than standard
Zone A	☐ 0.1 - 20 mm	☐ 20.1 - 40 mm	☐ 40.1 - 60 mm
	☐ 60.1 - 80 mm	■ 80.1 - 100 mm	☐ over than standard
Zone B	☐ 0.1 - 30 mm	☐ 30.1- 60mm	☐ 60.1 - 90 mm
	☐ 90.1 - 120 mm	■ 120.1 - 150 mm	☐ over than standard
Zone C	☐ 0.1 - 50 mm	☐ 50.1 - 100 mm	☐ 100.1 - 150 mm
	☐ 150.1 - 200 mm	■ 200.1 - 250 mm	☐ over than standard
Zone D	☐ 0.1 - 100 mm	☐ 100.1 - 200 mm	☐ 200.1 - 300 mm
	☐ 300.1 - 400 mm	■ 400.1 - 500 mm	☐ over than standard

Appendix Figure H6 The result of not acceptable questionnaire (Interior and exterior unpainted, pile part: Surface scratch by rubbing).

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Appendix I

The result of setting grade of the extent-of – defect criteria in each section

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Item			Grade				
			A	B	C	D	E
Label	Scratch Chip Tear Cut	Mark, Emblem Printed letter Strips Label					
Zone A			0	0.5	1	1.5	2
Zone B			0	1.5	3	4.5	6
Zone C			0	1.5	3	4.5	6
Zone D			0	1.5	3	4.5	6

Appendix Figure I1 The grade of extent of defect in Label.

Item					Grade				
					A	B	C	D	E
Int. and Ext. Painted, Plated, Leather parts	Chip paint peeling	Chipping and width is 0.5 mm or more (It is shown in dia.)	Top coat						
			Zone A		0	0.05	0.1	0.15	0.2
			Zone B		0	0.5	1	1.5	2
			Zone C		0	0.75	1.5	2.25	3
			Zone D		0	1.25	2.5	3.75	5
			Reach to under coat	similar color					
				Zone A	0	0.05	0.1	0.15	0.2
				Zone B	0	0.5	1	1.5	2
				Zone C	0	0.75	1.5	2.25	3
				Zone D	0	1.25	2.5	3.75	5
				contrast color					
				Zone A	0	0.05	0.1	0.15	0.2
				Zone B	0	0.375	0.75	1.125	1.5
				Zone C	0	0.5	1	1.5	2
				Zone D	0	0.75	1.5	2.25	3
			Reach to steel panel						
				Zone A	0	0.05	0.1	0.15	0.2
				Zone B	0	0.025	0.05	0.075	0.1
				Zone C	0	0.4	0.8	1.2	1.6
				Zone D	0	0.8	1.6	2.4	3.2

Appendix Figure I2 The grade of extent of defect in Interior and Exterior, painted, plated, leather parts (chip paint peeling).

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					Grade				
					A	B	C	D	E
Int. and Ext. Painted, Plated, Leather parts	Gash Paint crack Scratch primer which is obvious condition	Linear scratch with catch on finger nail (it is shown in mm)	Top coat		1.0 dia	4.0 mm	6.0 mm	8.0 mm	20 mm
			Zone A		0	0.8	1.6	2.4	3.2
			Zone B		0	1.2	2.4	3.6	4.8
			Zone C		4.8	5.6	6.4	7.2	8
			Zone D		0	5	10	15	20
			Reach to under coat	similar color scratch in primer	1.5 mm	3.0 mm	4.0 mm	5.0 mm	12 mm
				Zone A	0	0.6	1.2	1.8	2.4
				Zone B	0	0.8	1.6	2.4	3.2
				Zone C	0	1.25	2.5	3,75	5
				Zone D	0	3	6	9	12
				contrast color	1.5 mm	2.0 mm	3.0 mm	3.5 mm	6.0 mm
				Zone A	0	0.5	1	1.5	2
				Zone B	0	0.75	1.5	2.25	3
				Zone C	0	0.875	1.75	2.625	3.5
				Zone D	0	1.5	3	4.5	6
			Reach to steel panel		exists	2.0 mm	3.0 mm	3.5 mm	6.0 mm
				Zone A	0	0.1	0.2	0.3	0.4
				Zone B	0	0.75	1.5	2.25	3
				Zone C	0	0.875	1.75	2.625	3.5
				Zone D	0	1.5	3	4.5	6

Appendix Figure I3 The grade of extent of defect in Interior and Exterior, painted, plated, leather parts (Gash paint crack scratch).

Item				Grade				
				A	B	C	D	E
Int. and Ext. Painted, Plated, Leather parts	Surface scratch by rubbing (It is shown with mm)	Top coat Similar color		50 mm	100 mm	150 mm	200mm	
			Zone A	0	20	40	60	80
			Zone B	0	37.5	75	112.5	150
			Zone C	0	50	100	150	200
			Zone D					
			Contrast color		70 mm	100 mm	150 mm	
			Zone A	0	7	14	21	28
			Zone B	0	25	50	75	100
			Zone C	0	37.5	75	112.5	150
			Zone D					

Appendix Figure I4 The grade of extent of defect in Interior and Exterior, painted, plated, Leather parts (Surface scratch by rubbing).

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Item			Grade				
			A	B	C	D	E
Int. and Ext. UnPainted, Pile parts	Gash Paint Crack	Linear scra catch on finger nail (It is shown with mm.)	6 mm	6 mm	10 mm	40 mm	60 mm
		Zone A	0	0.6	1.2	1.8	2.4
		Zone B	0	1.5	3	4.5	6
		Zone C	0	10	20	30	40
		Zone D	0	15	30	45	60

Appendix Figure I5 The grade of extent of defect in Interior and Exterior, Unpainted, pile parts (Gash paint crack).

Item			Grade				
			A	B	C	D	E
Int. and Ext. Unpainted, Pile parts	Surface scratch by rubbing (It is shown with mm)	Top coat Similar color	100 mm	100 mm	150 mm	250mm	500 mm
		Zone A	0	25	50	75	100
		Zone B	0	37.5	75	112.5	150
		Zone C	0	62.5	125	187.5	250
		Zone D	0	125	250	375	500

Appendix Figure I6 The grade of extent of defect in Interior and Exterior, Unpainted, pile parts (surface scratch by rubbing).

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Appendix J

Evaluate the Excel program

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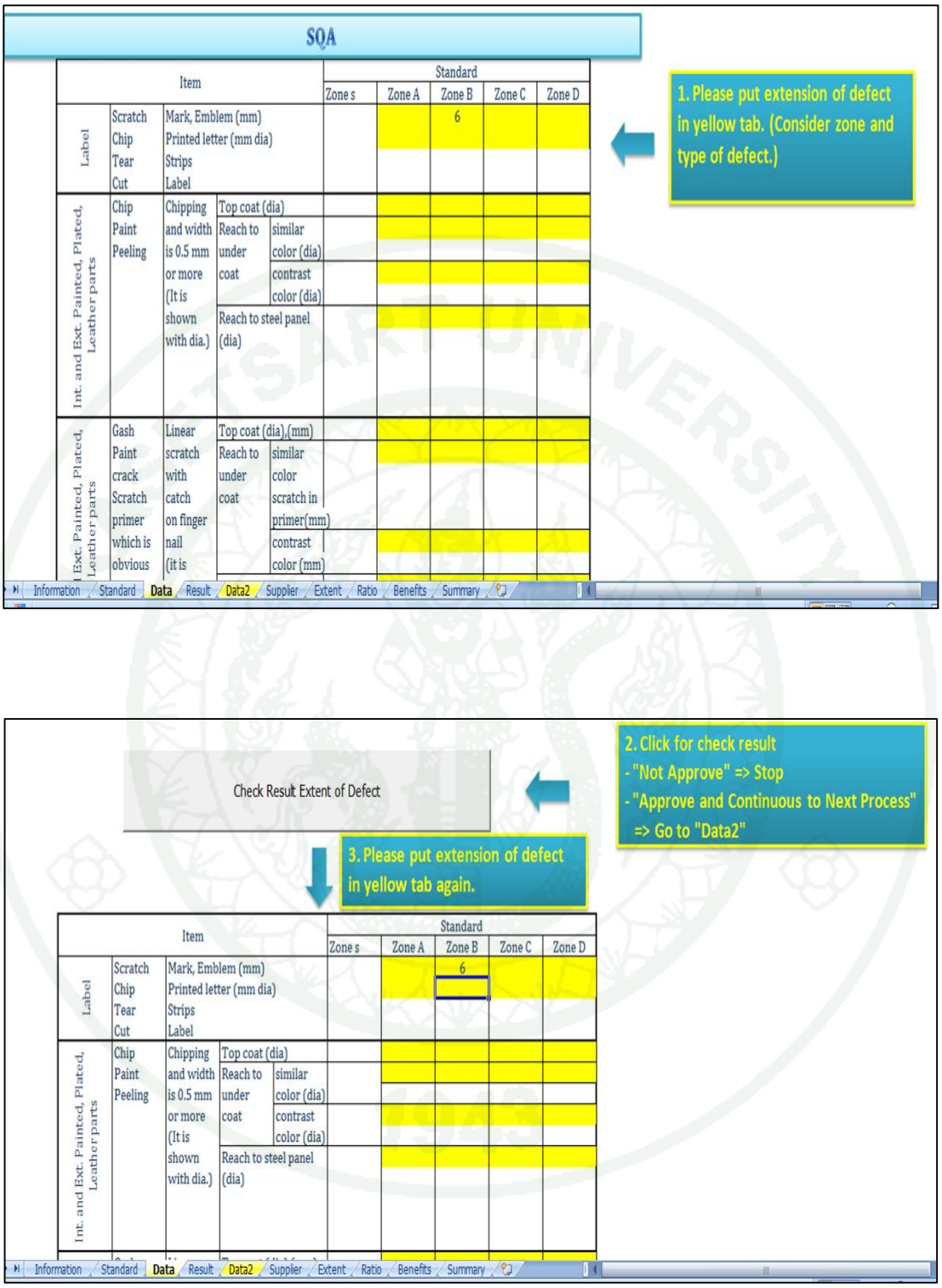

Appendix Figure J1 The Excel program.

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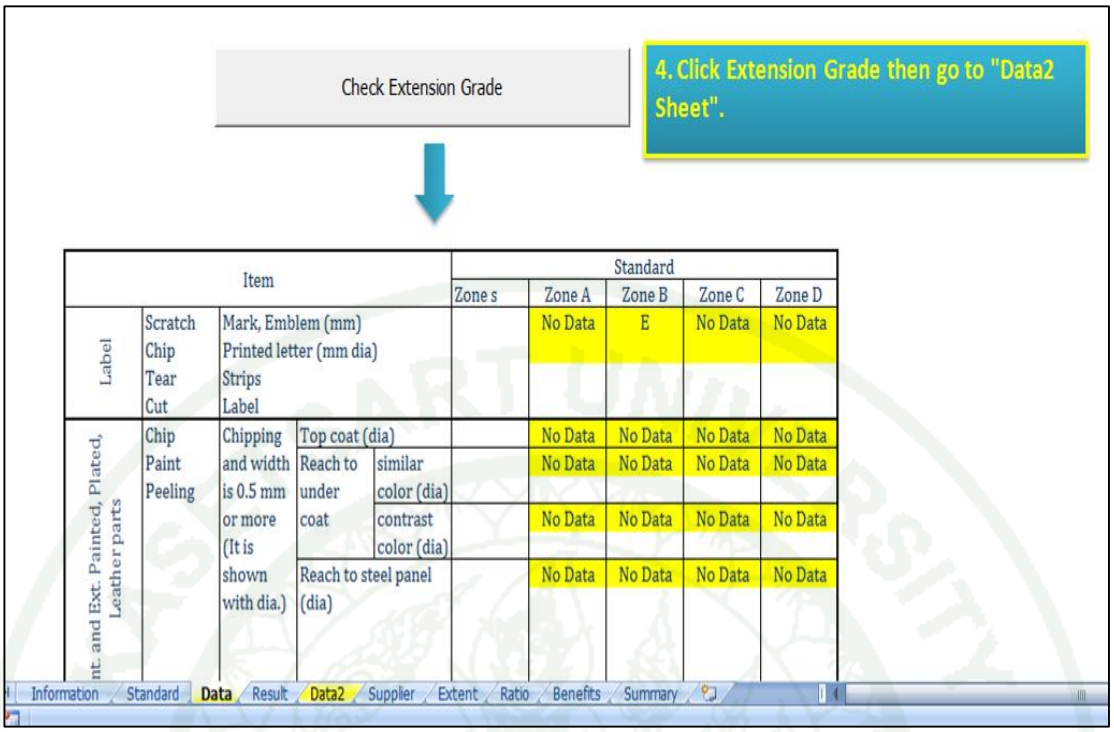

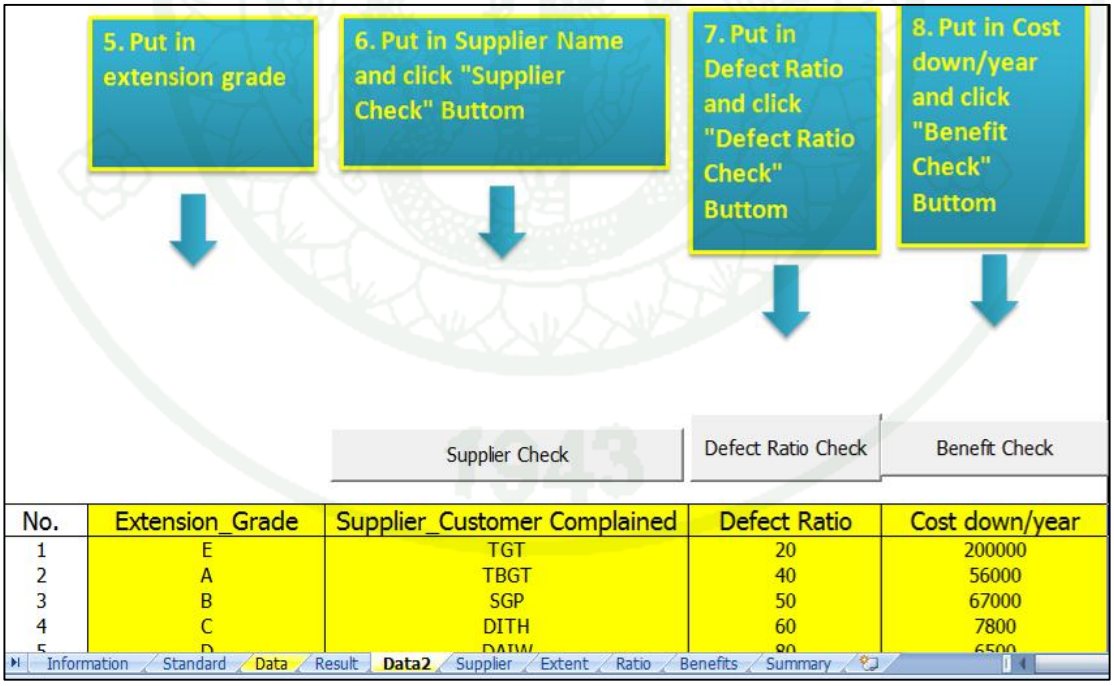

Appendix Figure J1 (Continued)

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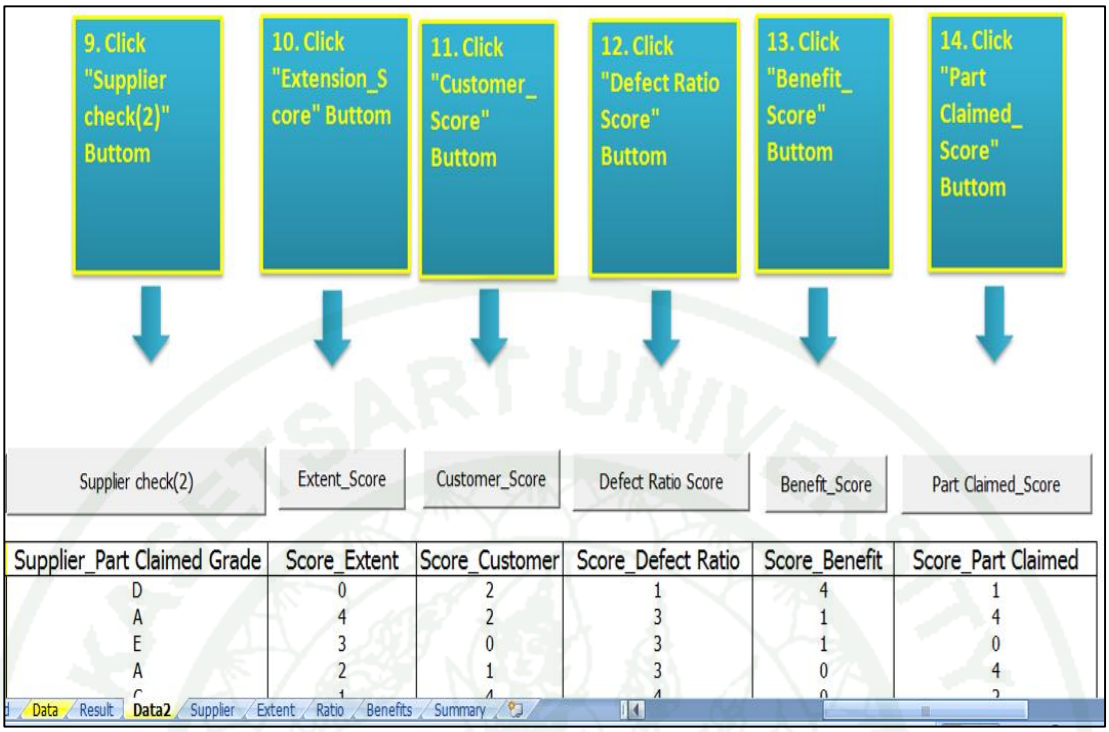

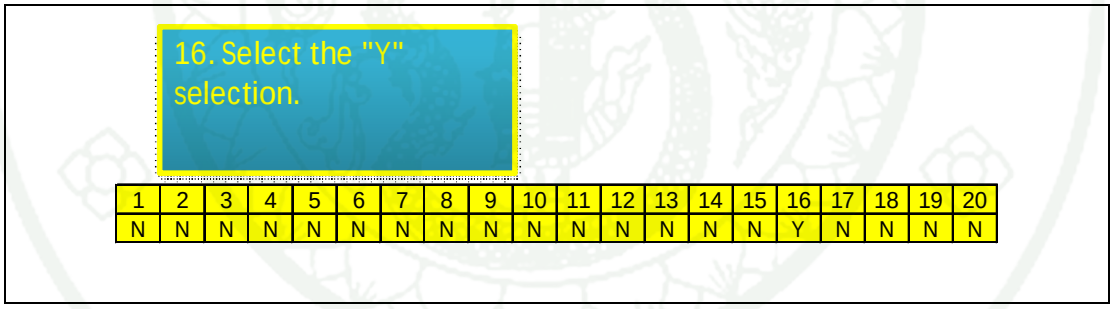

Appendix Figure J1 (Continued)

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Appendix K

Satisfaction survey

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แบบสอบถามความพึงพอใจการใช้โปรแกรม Excel ในการตัดสินใจอนุมัติ Boundary Sample

หัวข้อ	1 ไม่เห็นด้วยอย่างยิ่ง	2 ไม่เห็นด้วย	3 เฉยๆ	4 เห็นด้วย	5 เห็นด้วยอย่างยิ่ง
1. คุณคิดว่าโปรแกรม Excel ในการตัดสินใจอนุมัติ Boundary Sample ช่วยให้คุณใช้เวลาในการตัดใจน้อยกว่าวิธีการเดิม					
2. คุณคิดว่าโปรแกรม Excel ในการตัดสินใจอนุมัติ Boundary Sample ทำให้คุณรู้สึกว่าการตัดสินใจของคุณถูกต้อง แม่นยำมากกว่าวิธีการเดิม					
3. คุณคิดว่าโปรแกรม Excel ในการตัดสินใจอนุมัติ Boundary Sample มีประโยชน์กับ New Engineer หรือ Engineer ที่มีประสบการณ์น้อย					
4. คุณคิดว่าโปรแกรม Excel ในการตัดสินใจอนุมัติ Boundary Sample ช่วยให้คุณทำงานสะดวกขึ้น ง่ายขึ้นกว่าวิธีการเดิม					
5. คุณจะใช้โปรแกรม Excel นี้ในการตัดสินใจอนุมัติ Boundary Sample					

ข้อเสนอแนะ.....
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Appendix Figure K1 Satisfaction survey.

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CURRICULUM VITAE

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WORK PLACE : -

SCHOLARSHIP/AWARDS : -

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