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# Text Summarization System using Fuzzy Logic and Conditional Random Field Algorithm

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***Abstract— Nowadays Legal experts were doing difficult clerical work of Interpreting and summarizing the previous judgments for their case arguments and for the decision making also. Thus NLP based Summarization Techniques fulfil the needs of the Legal Experts in a simple and efficient manner. In this research work, efficient methods like Fuzzy Logic and Conditional Random Field Algorithm were used to produce a Legal Judgment Summary. 11 Feature Extraction techniques were used to find the important sentences and A Fuzzy Logic Technique is implemented to perform the summarization process. A Machine Learning Technique, named, Conditional Random Field, shortly CRF is used to perform the Classification Technique by identifying the Rhetorical Roles present in the legal document. The important Legal key words and data sets were created with the Help of Legal Experts and the Judgments copies from the Legal websites were used as the training data. Hence the proposed system generates the summary in a structured frame work which is divided into seven labelled components and each label symbolizes the proper rhetorical roles.***

***Keywords— Fuzzy Logic, Legal Judgment, Conditional Random Field, Feature Extraction, Text Summarization***

## I. INTRODUCTION

Text Summarization is a process of producing an abstract or a summary by selecting the important portion of the information from one or more documents. In a Text Summarization process, a text is given to the computer and the computer returns a shorter less redundant extract or abstract of the original text(s).

In the Digitized world, due to the increasing amount of digital data, there is an opportunity to do the technological invention in the entire fields. In this research a Legal Domain is selected, where the judgement references were used as a printed copy (i.e., Hard copy) only. Nowadays the judgements were available in the legal websites. But it is hard to read entire digital data for reference, in that situation legal experts need a technological invention to create a summary for the legal document which leads for a quick perusal.

Decisions of the judges are the sources of law. Nowadays Legal experts were doing difficult clerical work of Interpreting and summarizing the previous judgments for their case arguments and for the decision making also. Human Generated summaries need more time, man power and relatively expensive and also its view will vary for person to person. Thus NLP based Summarization Techniques fulfil the needs of the Legal Experts in a simple and efficient manner. Such summary process is called as Head Note Generation, Which is an time consuming process as well as a Systematic process.

In this research work, efficient methods like Fuzzy Logic and Conditional Random Field Algorithm were used to produce a Legal Judgment Summary. After completing the pre-processing process, 11 Feature Extraction techniques were used to find the important sentences that present in the given document. Sentence scoring will be done based on the Feature Extraction Technique. A Fuzzy Logic Technique is implemented to perform the summarization process. Fuzzy logic extracts the important sentences by using Fuzzy Rules and Membership functions based on their sentence features. Instead of giving a document in a paragraph manner, A Structured manner is a preferable one. For that purpose, Classification Technique is implemented here. Discovering the rhetorical roles present in the given legal document is the important text classification process that involved in this paper. A Machine Learning Technique, named, Conditional Random Field, shortly CRF is used to perform the Classification Technique by identifying the Rhetorical Roles present in the legal document.

In this paper, the related works done by the researchers in the legal field as well as the proposed technique were discussed in section (II), and 11 Feature Extraction Techniques were discussed in the section (III). In Section (IV) the Legal Judgment Summarization using Fuzzy Logic were discussed. The Classification technique Conditional Random Field was discussed in

section (V). The Experiments and Results were covered in section (VI). Finally the conclusion and plan for future work is discussed in section (VII).

## II. Related Work

A Hybrid fuzzy system [1] is proposed by the combination of Genetic Algorithm and Genetic Programming to develop an optimal intelligent system (Summarization System) to extract important sentences in the texts by reducing the redundancy of data. The genetic algorithm is used to optimize the membership functions and genetic programming is used to optimize the rule sets. In [2] a new technique is proposed to optimize text summarization based on fuzzy logic by using the factors length and position of sentence, titles and keywords similarity, sentence-to-sentence cohesion and occurrence of proper texts.

In this system [3], Document is segmented into thematic structure based on the words present in the document, after that within the segmented region filtering, selection, and Production is done [4, 5, 6]. In this system [7], a parallel process of identifying the important sentence for categorization is done by using the feature set and CRF model, while important sentences are extracted by using term distribution model. Post mining is done to fit the extracted sentences in the structure [8, 9, 10, 11].

[12] It is a Topic Based Summarization Model, in this LDA algorithm identifies the important topics in the Legal Documents. Categorization is done based on the topics identified in the sentence and important sentences are extracted based on the sentence scoring and the topics identified in the legal documents [13]. Variety of Linguistic feature is used in [14] the linguistic analysis to implement Shallow Linguistic summary which can be easily ported to a different domain [15, 16, 17, 18]. In this method [12], Categorization is done first to structure the case document and then, the important or relevant content of the case and the opinion of the court are extracted [7, 8, 9, 10, 11, 25, 26].

## III. Feature Extraction Techniques

### *A. Pre-Processing*

The pre- processing step involves of spring-cleaning the noisy text consists of grammatical and typographical errors. In this paper, below mentioned pre-processing methods were applied, namely, Case Folding, Stop Word Removal, Punctuation Removal, White Space Removal, Word Stemming, Key Phrase Identification, Sentence Segmentation and Tokenization.

A process of translating all the characters to the small characters is called Case Folding. The process of removing the insignificant words which appears repeatedly in the document and provides not as much of meaning in the text processing is called Stop Word Removal. The process of removing the all undesirable punctuations from the document except dot (.) operator, which act as a sentence separator, is called Punctuation Removal. In Legal Document, the extra white space is inserted for some formatting purpose, which occupy more spaces, Removal of Extra White spaces is the process of eliminating the additional white spaces, which cuts the size of the document. A method is proposed for Word Stemming, which is the process of producing the root word, by removing the suffixes and prefixes of each word in the document. Identification of important phrases using relative frequency approach, by finding the occurrence of the word pairs is called Key Phrase Identification. The process of identifying and separating the paragraph into sentence is called Sentence Segmentation. The process of splitting the Sentence into individual words is called Tokenization.

### *B. Sentence Feature Extraction*

Title After completing the Pre- processing step, by using feature extraction technique, each sentence in the document is denoted by a vector point. In this paper 11 feature extraction techniques were used, which gives a value stuck between "0" to "1". The 11 features were as follows:

- **Sentence Position**

  In a Legal Document, the Sentences occurring in the first paragraph as well as sentences occurring in the last paragraph may contain important information's. The following formula is used in order to give high score to those sentences.

$$f_1 = \begin{cases} 1 & for \quad 1^{st} \text{ and } n^{th} \text{ Line} \\ 0.8 & for \quad 2^{nd} \text{ and } n-1^{th} \text{ Line} \\ 0.6 & for \quad 3^{rd} \text{ and } n-2^{th} \text{ Line} \\ 0.4 & for \quad 4^{th} \text{ and } n-3^{th} \text{ Line} \\ 0.2 & for \quad 5^{th} \text{ and } n-4^{th} \text{ Line} \\ 0 & Otherwise \end{cases} \qquad \ldots\ldots equ\ (1)$$

❖ **Proper Noun**

The sentence, which contains more Named Entity called as Proper Noun, which is the important sentence that should be included in the Document Summary. A Named Entity should be started with a Capital Letter only, based on this we can find the Proper Noun in a sentence.

$$f_2 = \frac{No.of\ Proper\ Noun\ in\ a\ Sentence(S_i)}{Sentence\ Length\ (S_i)} \qquad \ldots\ldots\ equ(2)$$

❖ **Sentence Length**

Sentence Length is a measure which is used in identifying the best sentences for summary. The number of words in a sentence is counted, first and then it is normailized to get the Length of the sentence.

$$f_3 = \frac{No.\ of\ Words\ Occuring\ in\ a\ Sentence(S_i)}{No.\ of\ Words\ Occuring\ in\ the\ Longest\ Sentence} \qquad \ldots\ldots equ(3)$$

❖ **Tf * isf ( Term Frequency – Inverse Sentence Frequency)**

Term Weight is used to calculate the importance of sentence by finding the frequency of occurrences of the term within a document, which is also called as raw term frequency. But it is not the case, because importance does not increase proportionately with raw term frequency. So, there is a need in the inverse sentence frequency, which filter the important word that occurring in the sentences.

$$f_4 = \sum_{1}^{n} tf * isf \qquad \ldots\ldots\ldots equ(4)$$

Where n = No. of Words in the Sentence

$$tf = \frac{No.\ of\ times\ term\ t\ appears\ in\ a\ document}{Total\ No.of\ terms\ in\ the\ document} \qquad isf = \log\left(\frac{Total\ No.of\ Sentences\ in\ the\ document}{No.\ of\ Sentence\ in\ which\ term\ t\ occurs}\right)$$

❖ **Sentence to Sentence Similarity**

Similarity to Neighbouring Sentence finds the similarity between each sentence in the document, which is computed by using the cosine similarity measure, which compares all the sentences in the document.

$$f_5 = \cos(\theta) = \frac{A.B}{|A||B|} = \frac{\sum_{i=1}^{n} A_i\ x\ B_i}{\sqrt{\sum_{i=1}^{n}(A_i)^2}\ x\sqrt{\sum_{i=1}^{n}(B_i)^2}} \qquad \ldots\ldots equ(5)$$

❖ **Citation**

Citation Denotes referring someone, which is a needed one in the legal field. Because Indian Legal System follows the Common Law System where, the judgements will referred by some other cases for Arguments and for Judgement. The citation is identified by the keyword v. or vs.

$$f_6 = \begin{cases} 1 & if\ in\ **[\ **\ \ v./vs.\ **\ ]\ or\ **\ v.**\ or\ **vs.** \\ 0 & Otherwise \end{cases} \qquad \ldots\ldots equ\ (6)$$

❖ **Local Features & Layout Features**

Each Legal Document will have a layout structure, from that the data related to the head note can be obtained, like, Judge Name, Court Name, Date, Petitioner & Respondent name etc.. The Local Features & Layout Features will get all the details related to the head note of the Legal Document.

$$f_7 = \begin{cases} 1 & if \quad In\ the\ High\ Court** / Dated / The\ Hon'ble / The\ Honourable \\ & \quad W.P/Writ Petition / Petitioner / Respondent \\ 0 & Otherwise \end{cases} \qquad \ldots\ldots equ\ (7)$$

❖ **Paragraph Structure**

Every Document has a unique internal structure of the Paragraph, which have the high level sum-up in the starting as well as in the ending. Paragraph Structure will assign high score to the first and last paragraph.

$$f_8 = \begin{cases} 1 & if\ \ 2. \quad (Occurs\ after\ the\ heading\ ORDER\ /\ Common\ Order \\ & \quad **.\ \ (Para\ before\ the\ word\ TO\ appears \\ 0 & Otherwise \end{cases} \qquad \ldots\ldots equ\ (8)$$

❖ **Thematic Word**

In Legal Document the final decision is the important one. The word which denotes the main theme of the document is mentioned by the Thematic Word. If the word present in a sentence then that sentence is an important one, it should come in the summary.

$$f_9 = \begin{cases} 1 & if \quad dismiss, dismissed, allowed, Partly\ allowed, disposed\ of, \\ & order\ accordingly, ruled\ discharged, remitted\ back, \\ & reference\ answered\ in\ positive\ /\ negative, no\ costs \\ & no\ merits \\ 0 & Otherwise \end{cases} \quad \ldots\ldots equ\ (9)$$

❖ **Indicators/Cue Phrases**

Cue Phrase denotes frequently used key phrases, which acts as the indicators of expressing the fact finding of the case as well as the judge. The indicators act as an important one in finding the rhetorical roles in the summary.

$$f_{10} = \begin{cases} 1 & if \quad Second\ appearing, Question\ for\ consideration, no\ reason, \\ & points\ to\ be\ considered, pertinent\ to\ note, we\ do\ not\ find, \\ & relied\ on\ the\ decision, counsel\ submitted, appeal, suit, in\ my\ view \\ & we\ therefore\ answer\ the\ question, revision, review, we find \\ & case\ before\ us, impunged, quashed, Bone\ of\ Contention \\ & in\ the\ light\ of, learned\ counsel, Contention\ contends, issue \\ & points\ for\ consideration, we\ found, we\ agree, \\ 0 & Otherwise \end{cases} \quad \ldots\ldots equ\ (10)$$

❖ **Legal Thesaurus**

Legal Thesaurus means words or phrases that include the Legal words of basic vocabularies from a training data.

$$f_{11} = \begin{cases} 1 & if \quad Appointment, Recuritment, Suspension, Termination, Misconduct \\ & Disciplanary\ Proceeding, Probation, Service\ Conditions, Super\ Anuation, \\ & Transfer, Reinstatement, Reversion, Allowances, Detuction, Graduity \\ 0 & Otherwise \end{cases} \quad \ldots\ldots equ\ (10)$$

## IV. FEATURE EXTRACTION TECHNIQUES

### A. *Text Summarization Based on Fuzzy Logic*

To Implement the Legal Text Summarization using Fuzzy Logic, First the Feature Extraction process has to complete for all the 11 features. Fuzzy Logic system design involves in selecting membership function and fuzzy rules. The action of the fuzzy logic system will openly affect by the selection of fuzzy rules and membership functions. The four main components of the Fuzzy Logic System were: Fuzzifier, Inference Engine, Defuzzifier, and the Fuzzy Knowledge Base. In the fuzzifier section, the membership function translates the inputs into linguistic values. The inference engine refers the Fuzzy rule base, which contains fuzzy IF THEN rule to derive the linguistic values. At last, the Defuzzifier converts the linguistic variables to the final crisp values from the inference Engine, using output membership function. The final sentence score was derived. In the Defuzzfication step, the output membership function step is divided into three membership functions, namely: Unimportant, Average, Important, Which converts the result of the inference engine into a crisp output to obtain a final sentence score for each sentence.

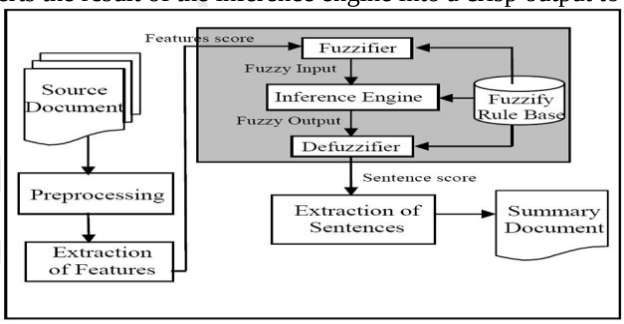


Figure 1: Shows text summarization based on fuzzy logic system architecture.

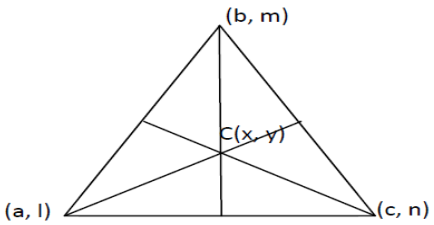


Figure 2: Fuzzy Centroid Calculation

The Membership functions used in the Fuzzy logic was based on the fuzzy centroid method, which calculates the score for the entire sentences present in the legal document. Fuzzy Centroid method used generalized triangular membership function, to

obtain the sentence score, which depends on the three parameters 'a', 'b' and 'c'. In which the position of the parameters 'a' and 'c' are left and right most feet of a triangle and 'b' is the peak of a triangle. The output value was obtained from zero to one for each sentence, based upon the sentence features and knowledge base. The above said value shows the degree of importance of the sentences that present in the final summary. The formula to calculate the fuzzy centroid (1) is given below.

$$C(x,y) = \left(\frac{a+b+c}{3}, \frac{l+m+n}{3}\right) \quad \text{--------- (equ 12)}$$

The values a, b, c were the standard values of Low Medium and High, respectively and the values l, m, n were the calculated values of Low Medium and High, respectively. Defining IF-Then rules is the important one in the Inference Engine. Sample IF – Then rules for our feature extraction measures was mentioned below.

*IF (Sentence Position is VH) and (Proper Noun is H) and (Sentence Length is VH) and (tf*isf is H) and (Sentence to sentence Similarity is VH) and (Citation is H) and (Local & Layout Features is VH) and (Paragraph Structures is H) and (Thematic Word is H) and (Indicators/Cue Phrases is M) and (Legal Thesaurus is H) THEN (Sentence is important)*

## V. TEXT SEGMENTATION USING CRF

Conditional Random Field (CRF) Technique is a probabilistic Framework which has been used for text segmentation problems. Conditional Random Field model is a good one because of its conditional nature, which ensures tractable inference. CRF segmented the given document into no. of segments based on the keywords satisfied by the conditions. The Legal keywords were identified and then the corresponding sentences were segmented based on the rhetorical roles present in the Legal judgement. In an exceptional case in which the output nodes are linked by edges in a linear chain, CRFs make a first-order Markov independence assumption with binary feature functions, and thus can be understood as conditionally-trained finite state machines (FSMs) which are suitable for sequence labeling.

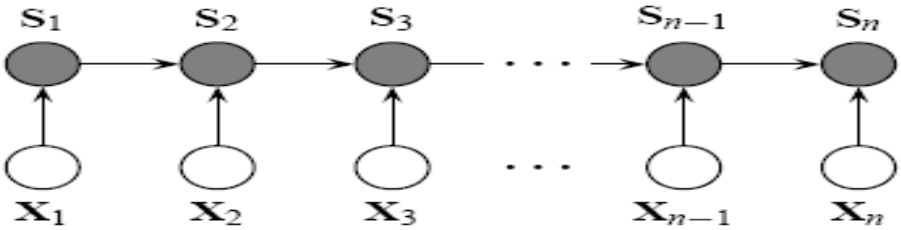


Figure 3 Conditional Random Field

## VI. EXPERIMENTS AND RESULTS

In this paper, the system is developed using Fuzzy Logic Method and implemented using c#. The experimentation is done by taking 30 Legal Documents from the legal website, among that 10 Documents from the Service Law, 10 Documents from Industry Law, and 10 Documents from Constitutional Law. On the given data set, First pre-processing technique is applied, followed by the feature extraction techniques, which obtains the feature Score for the sentences present in the Legal Document.

Table 1 – Precision, Recall & F-Measure Calculation

| | PRECISION $P= (N_o/N_m)$ | RECALL $R=(N_o/N_h)$ | FMEASURE $F=(2((P*R)/(P+R))$ |
|---|---|---|---|
| **Identifying the Case** | 1 | **1** | **1** |
| **Establishing the facts of the Case** | 0.6 | 1 | **0.75** |
| **History of the Case** | 0.78 | 0.95 | **0.85** |
| **Analysis** | 0.28 | 0.25 | **0.26** |
| **Ratio Decidendi** | 0.73 | 0.85 | **0.78** |
| **Final Decision** | 0.54 | 1 | **0.70** |
| **Reference / Citation** | 0.86 | 0.8 | **0.82** |

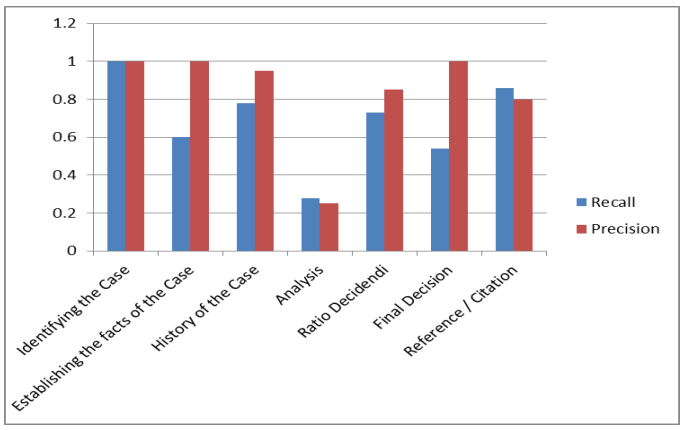


Figure. 4 Precision & Recall graph

IN THE HIGH COURT OF DELHI AT NEW DELHI. 14th December, 2011. ORIENTAL INSURANCE CO. LTD - Appellant. KAUSHALYA DEVI & ORS- Respondents. HON'BLE MR. JUSTICE G.P.MITTAL. The Appellant Oriental Insurance Company Limited is aggrieved by an award dated 27.08.2004 whereby it was made liable to pay the compensation in the seven Claim Petitions decided by a common order with a right of recovery from Vinod Kumar . The Tribunal by the impugned award found that the accident took place on account of rashness and negligence on the part of the tempo driver Ram Pal. It was submitted that the persons were travelling in the tempo in violation of the terms of insurance policy and thus, it is not liable to pay the compensation. New India Insurance Company vs. Asha Rani 2003 ACJ (1) SC. National Insurance Company Ltd. vs. Baljeet Kaur & Others 2004 ACJ 428. It is hereby held that respondent no.3 is liable to pay the compensation to the petitioners. The question which thus, arises is whether the respondent no.3 is entitled to recover the said compensation from the owner of the tempo i.e. respondent no.2. It has been held in the case of Sawaran Singh Vs. National Insurance Company 2004. In Skandla Insurance Company Ltd. Vs. Kokilaben Chandravadan & Ors. 1987. It is not entitled to recover the compensation amount from respondent no.2.". Section 147 of the 1988 Act did not impose any statutory liability on the owner of vehicle to get his vehicle insured for any passengers travelling in a goods vehicle and therefore, the insurers would not be liable. Sections 2(8), 2(25), 2(29) and 2(33) of the 1939 Act . Sections 2(14), 2(35), 2(40) and 2(47) of 1988 Act. Mallawwa (Smt.) and Ors. v. Oriental Insurance Company Ltd. and Ors. (1999) 1 SCC 403. Section 2(35) of 1988 Act does not include passengers in goods carriage whereas Section 2(25). we are of the opinion that as the provisions thereof do not enjoin any statutory liability on the owner of a vehicle to get his vehicle insured for any passenger travelling in a goods vehicle, the insurers would not be liable therefor." in National Insurance Company v. Baljit Kaur & Ors. (2004) 2 SCC 1. New India Assurance Company v. Satpal Singh (2000) 1 SCC 237. in New India Assurance Company Limited v. Asha Rani & Ors.In the case of gratuitous passengers travelling in a goods vehicle, there is no liability of the insurance company at all to pay the compensation. In Padma Sundara Rao & Ors. v. State of T.N. & Ors. (2002) 3 SCC 533. in Herrington v. British Railways Board (1972) 2 WLR 537. It was mentioned in the order that the claimants were very poor man and most of them were daily wage earners. It is the liability of the owner of the tempo i.e. Respondent No.5 (Vinod Kumar) to pay the amount. It is, therefore, directed that the Appellant shall have right to recover the amount of compensation paid to the Respondents (Claimants) in these appeals without having resort to file a civil suit. The Appeals are allowed in above terms.

Figure 5 - Sample Output for Judgment Summarization

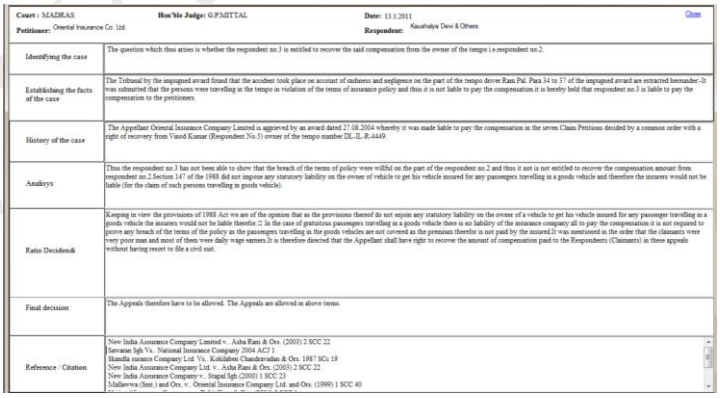


Figure 6 – Sample Output for Structured Judgment Summarization System

The Sample results of precision, recall and F- Measure was shown for a single legal document; the output for the general summary was shown in figure 5 and the segmented summary using conditional random field algorithm was shown in figure 6.

## VII. CONCLUSION AND FUTURE WORK

In this paper, An Automatic Legal Judgement Summarization system is implemented, using Fuzzy Logic Method and Conditional Random field Algorithm. In this paper, 11 Feature Extraction techniques were used to increase the accuracy of the summary. In this paper a Single document summarization technique is applied. The system is tested with the input of 30 Legal Judgements, in which 10 Documents from the Service Law, 10 Documents from Industry Law, and 10 Documents from Constitutional Law, which is collected from the legal website, The Judgement Information System (http://judis.nic.in/). The result shows that the summary produced by the Fuzzy Logic method gives the complete information about the legal Document in a crisp manner. Then the final summary is generated by implementing the classification technique Conditional Random Field, which segments the generated paragraph summary into a structured summary based on the Keywords. Rhetorical Roles were used to classify the summary. Hence the No. of Legal Judgement sheets were summarized and finally shown in a single page.

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