Decision Analysis

Optimizing Raw Material Choices for a Recycled Paper Mill

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Background

The pulp and paper industry is a vast industry that is divided into several segments based on finished products and raw materials. With respect to raw materials, two segments exist: virgin pulp and recycled paper. Virgin pulp is raw material obtained from trees that are broken down mechanically and/or chemically. Recycled paper is raw material obtained from wastepaper, or the paper thrown away by businesses and consumers. Within the recycled paper segment, raw material costs are the largest variable cost in the production of the finished product. Optimizing raw material costs is imperative in the recycled paper segment, as it impacts productivity, quality, and profitability. Finally, given the cyclical nature of wastepaper prices, raw material combinations must constantly be examined in an attempt to optimize productivity, quality, and profitability.

The Republic Group Incorporated is a small company within the industry that uses wastepaper as its primary raw material, no virgin pulp is used in any of its papermills (there are three existing, with one more under construction). Within the industry, Republic is in the gypsum wallboard and paperboard segments. The company is divided into three subsidiary organizations, Republic Gypsum Company, Republic Paperboard Company, and Republic Fibers. Of these three organizations, a decision analysis will be done for raw material combinations to be used in the filler furnish at the Halltown Mill located in Halltown, West Virginia.

Problem to be Analyzed: Best Mix of Raw Material Choices

Problem Definition

Paperboard is made of several different plies of paper bonded together during the sheet-forming portion of the papermaking process. At the Halltown Mill, 90% of the

paperboard is manufactured with liner and filler. Liner is the outer plies of the sheet and comprises 22% to 25% of the total sheet. The remaining 75% to 78% of the sheet is known as the filler and is the inner part of the sheet. Liner is made of more expensive raw material and is designed to meet the appearance and performance needs of the customer. Filler is made of less expensive raw material and is designed to meet the performance needs of the customer and the production parameters of the papermill. As the filler is the largest component of the paperboard sheet and raw material costs are the largest variable cost for any recycled papermill, it is in the best interests of the papermill to optimize the mix of filler raw materials so costs are minimized and customer needs are met. Specifically, the problem to be addressed in this analysis is what mix of raw materials will meet the needs of the customers while realizing the productivity and profitability goals of the papermill.

Importance of Analyzing Raw Material Choices

The need to examine this problem is based on maximizing the productivity and profitability of the Halltown Mill while meeting the needs of the customer in terms of quality and performance of the paperboard. Failure to optimize raw material costs directly impacts the profitability and productivity of the Halltown Mill. Raw material prices are highly volatile (In 1993, one ton of old corrugated containers (OCC) cost $200/ton. Current prices are $35/ton.) If a non-optimal mix of raw materials is chosen, productivity and profits are lost. Also, a non-optimal raw material mix may not meet the needs of the customer, potentially resulting in returned product and eventual loss of the customer. In short, the optimal filler mix of raw materials is a problem that must be addressed to ensure the profitability of the Halltown Mill.

The decision for raw material combinations is made from my perspective, as it is my responsibility to make this decision at the Halltown Mill. However, it should be noted that raw material costs are examined not only by the general manager of the paper mill, but also by the Vice President of Paperboard Operations. As stated earlier, wastepaper is our largest variable cost, and it receives attention on a daily basis. This decision analysis will be conducted monthly, at a minimum. Factors that would cause re-evaluations on a more frequent basis would be changes in availability of certain raw materials and drastic changes in raw material costs.

Methodology Used to Reach Decision

The methodology used to conduct this decision analysis is the use of the decision-making process first introduced by Herbert Simon.[1] The process is broken down into three phases: intelligence, design, and choice. The intelligence phase consists identifying the problem or opportunity. There are several methods to identify problems or opportunities, some of which include listening to people and brainstorming for gaps between current conditions and future conditions.[2] The method used in this decision analysis to identify the problem was to perform an analysis of variable cost opportunities and threats to determine which variable costs presented the greatest opportunities to minimize costs and the greatest threats to profitability and productivity. From the analysis, it was determined raw materials provided the greatest opportunities and posed the greatest threats.

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[1] Ernest H. Forman, *Decision by Objectives (How to convince others that you're right)* (Expert Choice Advanced Decision Support Software, 1998) [CD-ROM]; available from Expert Choice, Inc., Pittsburgh, Pennsylvania.

[2] Ibid.

The design phase consists of identifying alternative solutions to the problem or opportunity.[3] In this case, there are several alternative solutions available. The solutions are derived from both personal experience in the industry and benchmarking our filler raw material mix with other papermills in the industry segment. Our raw material, wastepaper, comes in several different grades. The alternative solutions are based on the use of four different raw materials for the filler. These raw materials are old corrugated containers (OCC), mixed wastepaper (mix), old newsprint (ONP), and box cuttings (box cuts). These raw materials can be used in any combination to make the filler of the sheet. Current alternatives for filler raw material combinations are:

- 33% OCC, 33% mix, 33% box cuts
- 50% OCC, 50% mix – Current mix of raw materials in use
- 33% OCC, 33% mix, 33% ONP
- 50% OCC, 50% ONP
- 33% OCC, 33% ONP, 33% box cuts

The final step in the process is choice. Choice is choosing the best alternative available to meet the stated goal.[4] The goal in this analysis is to optimize the raw material mix for the filler furnish. In achieving the goal, there are certain objectives and sub-objectives to be met. Priorities are assigned to the objectives with respect to the alternatives available to us. In this case, the Analytic Hierarchy Process was used to synthesize the quantitative and qualitative objectives that were the factors in determining the best solution. One quantitative objective was to determine which raw materials would be used to make the filler furnish. It was:

- Cost of the raw material

The qualitative objectives were:

[3] Ibid.
[4] Ibid.

- Effect of the raw material on productivity of the paper machine
- Cleanliness of the raw material and its effect on the equipment used to remove contaminants from the raw material
- Ability of the raw material mix to produce a sheet that will meet the needs of our customers

Each of the qualitative objectives was assigned sub-objectives. Once this was completed, pairwise assessments were conducted to determine importance of each alternative with respect to the objectives. The complete listing of objectives with their derived importance is shown in Appendix A. The results of the assessments for the primary objectives are shown below.

Priorities Table & Graph for Primary Objectives With Respect to the Goal -Table 1

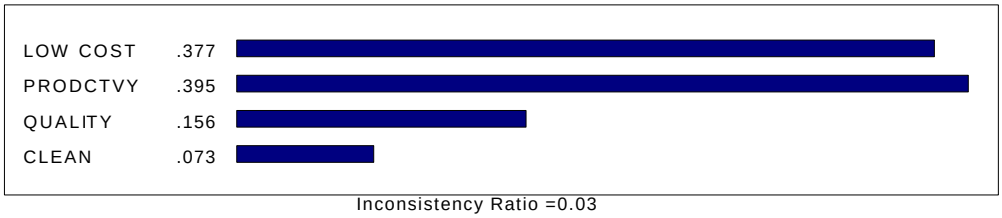
Node: 0

Compare the relative IMPORTANCE with respect to: GOAL

1=EQUAL 3=MODERATE 5=STRONG 7=VERY STRONG 9=EXTREME

1	LOW COST	9	8	7	6	5	4	3	2	**1**	2	3	4	5	6	7	8	9	PRODCTVY
2	LOW COST	9	8	7	6	5	4	3	2	**1**	2	3	4	5	6	7	8	9	QUALITY
3	LOW COST	9	8	7	6	5	4	3	2	**1**	2	3	4	5	6	7	8	9	CLEAN
4	PRODCTVY	9	8	7	6	5	4	3	2	**1**	2	3	4	5	6	7	8	9	QUALITY
5	PRODCTVY	9	8	7	6	5	4	3	2	**1**	2	3	4	5	6	7	8	9	CLEAN
6	QUALITY	9	8	7	6	5	4	3	2	**1**	2	3	4	5	6	7	8	9	CLEAN

Abbreviation	Definition
Goal	Optimize raw material choices for the filler furnish
LOW COST	Low cost of total mix of raw materials
PRODCTVY	Maximize productivity of the paper machine
QUALITY	Maximize quality of the sheet to meet the customers needs
CLEAN	Cleanliness of the furnish chosen



Inconsistency Ratio =0.03

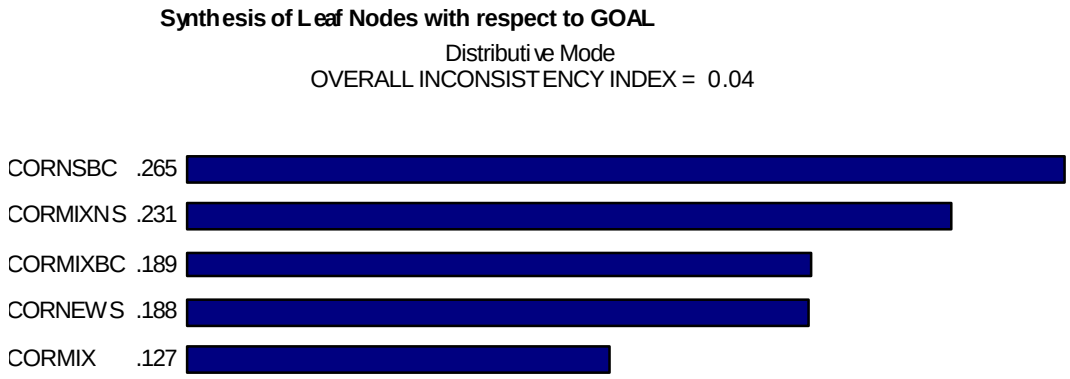
The primary point to be highlighted from this portion of the analysis is the priority assigned to each primary objective. Productivity and low cost are approximately 2.5 times more important than quality and approximately 5.5 times more important than

cleanliness of the furnish chosen. The primary reason quality is ranked as low as it is stems from most of the quality issues being determined by the liner of the sheet. As this analysis is for the filler, quality is not as important. Cleanliness also ranks low because the equipment used to clean the furnish is quite resistant to overall wear and tear due to contaminants in the raw material. Also, the liner plays a major part in covering the filler and any imperfections that show up in the sheet due to the use of less clean furnishes. Once any portion of the synthesis is completed, it may be wise to review the priority assigned to each objective to ensure it is consistent with the assessments. Similar assessments conducted for each primary objective are shown in Appendices B through E. Once all the assessments are conducted for the objectives and sub-objectives with respect to the alternatives, a final assessment is done for the goal. The results of this decision synthesis are reviewed in the next section.

Results and Conclusions

The final results of the synthesis with respect to the goal are shown in Table 2.

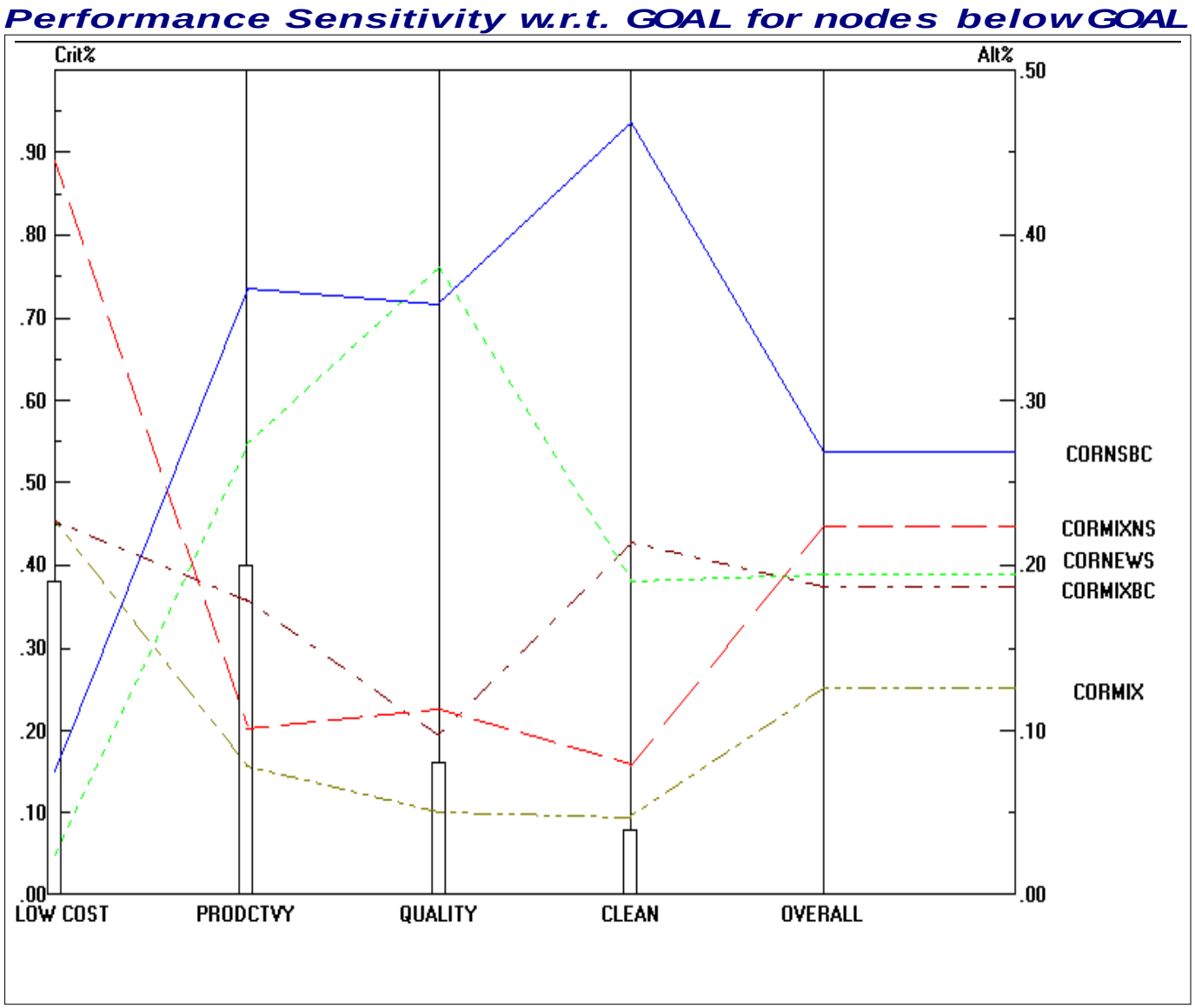
Final Synthesis of Alternatives with Respect to the Goal - Table 2



Abbreviation	Definition
CORNSBC	33% OCC/33% ONP/33% Box Cuts filler furnish
CORMIXNS	33% OCC/33% Mix/33% ONP furnish mix
CORMIXBC	33% OCC/33% Mix/33% Box Cuts furnish mix
CORNEWS	50% OCC/50% ONP filler furnish mix
CORMIX	50% OCC/50% Mix filler furnish mix

The results show two alternatives are within 0.034 of each other. Those two alternatives are the corrugated/news/boxcuts furnish and the corrugated/mix/news furnish. Of the two, the corrugated/news/boxcuts filler furnish mix is the overall best choice. The final result to be examined is the performance graph for the decision alternatives shown in Table 3.

Performance Graph for the Decision Alternatives - Table 3



The item of interest from the performance graph stems from the ratings of the top two choices with respect to the four primary objectives. The cor/news/boxcuts combination places first or second in 3 out of 4 primary objectives and places next to last in cost. The cor/mix/news combination places first with respect to cost and last or second to last as the best alternative with respect to productivity, quality and cleanliness. The analysis indicates optimizing all four primary objectives with the current alternatives is an either/or choice. Either productivity, quality and cleanliness are optimized at the expense of low cost or low cost is optimized as the expense of productivity, quality and cleanliness. If cost were to become a more important objective; i.e., the cost of news and box cuts goes up while mix does not, a re-evaluation needs to be performed to see what effect changing costs has on the optimal filler furnish mix.

Referring back to the opportunities and threat analysis, it appears a tradeoff is being made with respect to low cost and productivity, quality, and cleanliness. The decision analysis reveals the top choice is very good at meeting threats associated with productivity and profitability (profitability from staying in business by selling quality products and keeping customers) but is not the best alternative for taking advantage of the low cost opportunity. The opposite is true of the second best alternative, which is a very good alternative at meeting low raw material costs, but poor in meeting productivity, quality, and cleanliness objectives.

Based on the results of this decision analysis, the current filler furnish in use is the least desirable alternative. In order to optimize the filler furnish mix with respect to the stated objectives, the best alternative is the filler furnish mix of 33% OCC/33% ONP/33% box cuts. Even though this furnish mix will cost more, its qualitative benefits

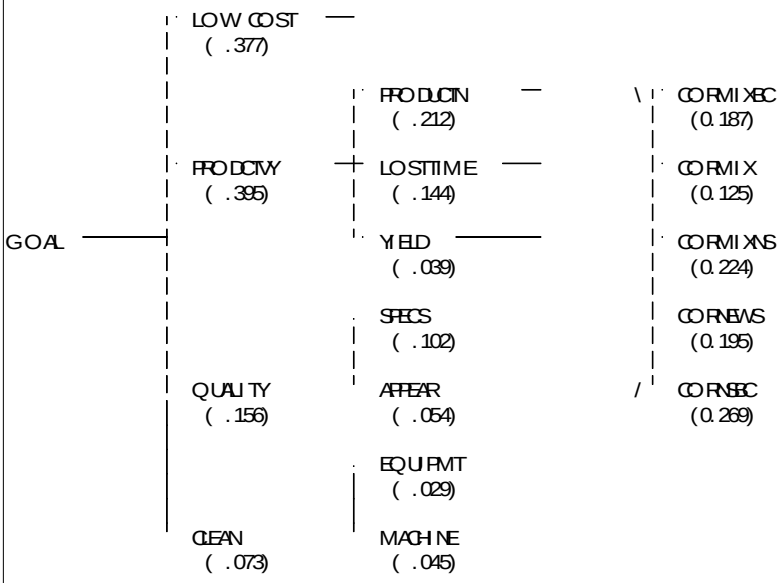
of better productivity, quality, and cleanliness compensate for its quantitative higher cost. The benefits of changing to this filler furnish should materialize in the form of higher tons per day of paper manufactured, higher tons per day of first-line quality paper produced, less production lost time due to paper machine cleanliness and runnability issues and less production lost time due to paper machine shutdowns for maintenance and cleaning.

Bibliography

Forman, Ernest H. *Decision by Objectives (How to convince others that you're right).* Expert Choice Advanced Decision Support Software, 1998. CD-ROM. Available from Expert Choice, Inc., Pittsburgh, Pennsylvania.

Appendix A

Optimize raw material choices for the filler furnish



Abbreviation	Definition
GOAL	
APPEAR	Ability of the furnish to meet customer appearance needs
CLEAN	Cleanliness of the furnish chosen
CORMIX	50% OCC/50% Mix filler furnish mix
CORMIXBC	33% OCC/33% Mix/33% Box Cuts furnish mix
CORMIXNS	33% OCC/33% Mix/33% ONP furnish mix
CORNEWS	50% OCC/50% ONP filler furnish mix
CORNSBC	33% OCC/33% ONP/33% Box Cuts filler furnish
EQUIPMT	Effect on equipment used to remove contaminants from furnish
LOSTTIME	Lost time incurred on the paper machine due to furnish problems
LOW COST	Low cost of total mix of raw materials
MACHINE	Effect of furnish on the cleanliness of the wet end of the PM
PRODCTVY	Maximize productivity of the paper machine
PRODUCTN	Production rate of the paper machine
QUALITY	Maximize quality of the sheet to meet the customers needs
SPECS	Ability of the furnish to meet customer specifications
YIELD	Furnish mix delivering the greatest yield per ton of material

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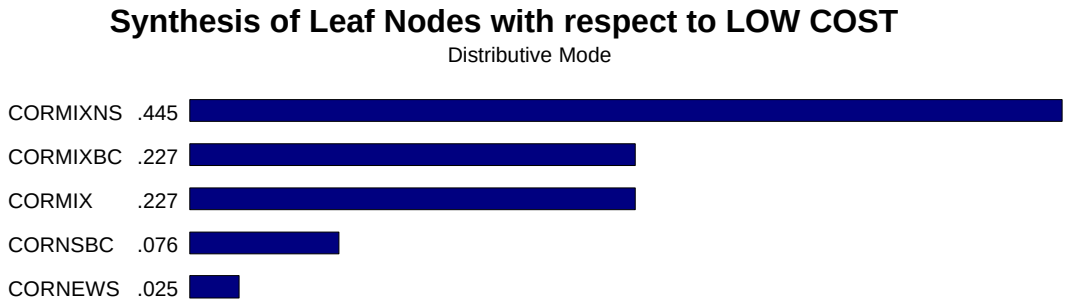
Appendix B

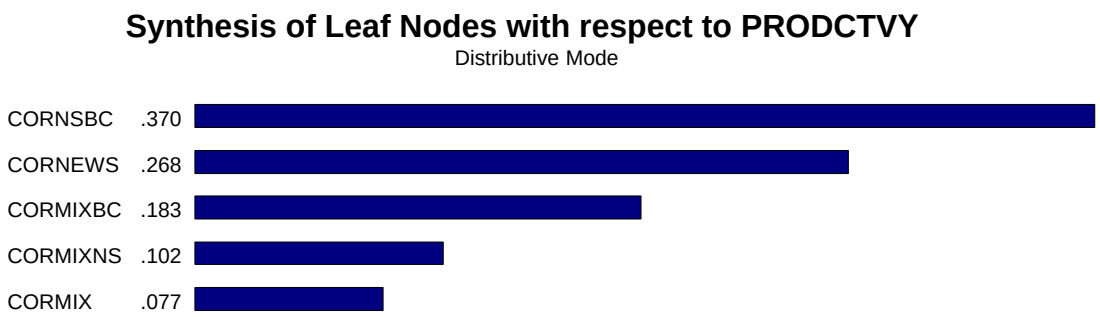
Importance of Alternatives with Respect to Low Cost



Abbreviation	Definition
CORMIXN	33% OCC/33% Mix/33% ONP furnish mix
CORMIXB	33% OCC/33% Mix/33% Box Cuts furnish mix
CORMI	50% OCC/50% Mix filler furnish mix
CORNSB	33% OCC/33% ONP/33% Box Cuts filler furnish
CORNEW	50% OCC/50% ONP filler furnish mix

Appendix C

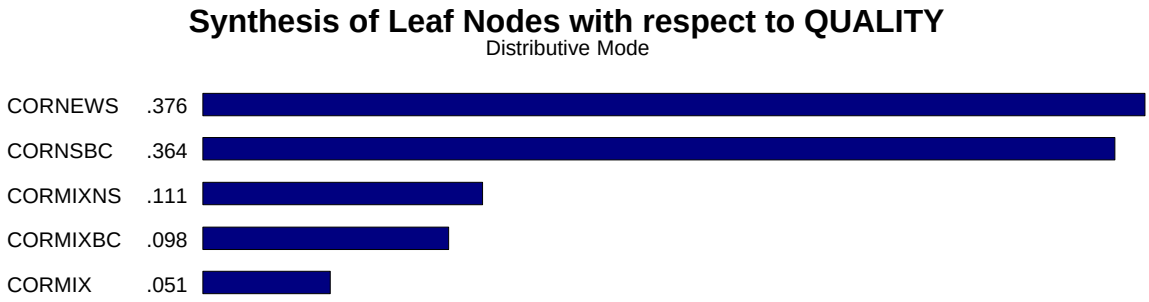
Importance of Alternatives with Respect to Productivity



Abbreviation	Definition
CORNSB	33% OCC/33% ONP/33% Box Cuts filler furnish
CORNEW	50% OCC/50% ONP filler furnish mix
CORMIXB	33% OCC/33% Mix/33% Box Cuts furnish mix
CORMIX	33% OCC/33% Mix/33% ONP furnish mix
CORMI	50% OCC/50% Mix filler furnish mix

Appendix D

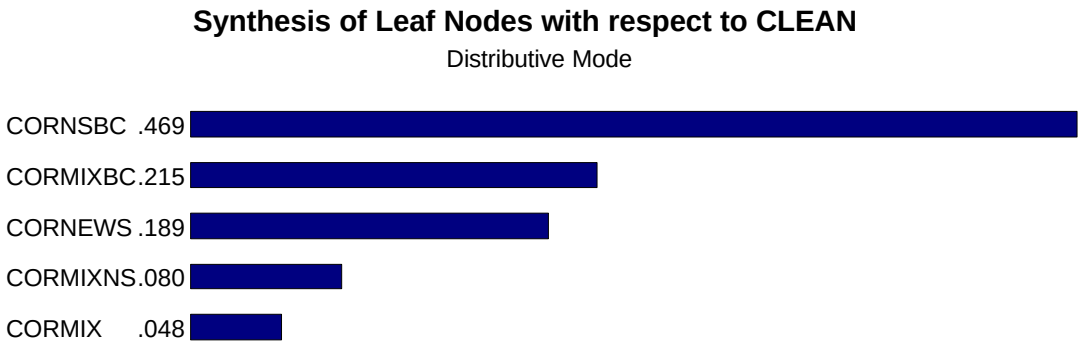
Importance of Alternatives with Respect to Quality



Abbreviation	Definition
CORNEW	50% OCC/50% ONP filler furnish mix
CORNSB	33% OCC/33% ONP/33% Box Cuts filler furnish
CORMIXN	33% OCC/33% Mix/33% ONP furnish mix
CORMIXB	33% OCC/33% Mix/33% Box Cuts furnish mix
CORMIX	50% OCC/50% Mix filler furnish mix

Appendix E

Importance of Alternatives with Respect to Cleanliness



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