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| **Sets** | |
|  | the set of harvesting nodes as sources of supply |
|  | the set of all potential terminals |
|  | the set of mills (sawmills, papermills and biorefinery) |
|  | the set of business time periods (i.e., yearly base) |
|  | the set of capacity process |
|  | the set of production process at mill |
|  | the set of final products |
|  | the set of intermediate products |
|  | the set of capacity process for terminal locations |
|  | the set of assortments |
|  | the set of sorting process |

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| **Parameters** | |
|  | volume of available timber of assortment *a* at forest *h* |
|  | amount of exported volume |
|  | demand of assortment *a* at mill *j* in period *t* |
|  | demand of product *p* in at mill *j* during time period *t* |
|  | proportion of assortment *a* in sort group *s* |
|  | cost of sorting process of sort process *s* in node *h* |
|  | a small value |
|  | represents period *t* that node *h* is scheduled for harvesting |
|  | proportion of consumed product *p* through planning process *r* |
|  | cost of harvesting at node *h* |

 cost of transportation between node *h* and *j*

 cost of transportation between node *h* and *w*

 cost of transportation between node *w* and *j*

cost of inventory at forest node

 cost of inventory at terminal node

 cost of inventory at mill node

 proportion of produced product *p* through planning process *r*

: demand at mill *j* for final product during time period *t*

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| **Variables** | |
| *Forest* | |
|  | flow of assortment group transported between nodesduring time period | |
|  | flow of assortment group transported between nodesduring time period | |
|  | flow of assortment group transported between nodesduring time period | |
|  | flow of produced products (intermediate products) transported between nodesduring time period | |
|  | volume of sorting process at node *h* using sorting process *s* in time period *t* | |
|  | inventory of assortment *a* at node *h* during time period *t* | |
|  | inventory of assortment *a* at node *W* during time period *t* | |
|  | inventory of assortment *a* at node *J* during time period *t* | |
|  | inventory of by-product *p* at node *J* during time period *t* | |
|  | 0,1 if harvest nodes *h* is harvested during time period *t* | |
|  | quantity of process for intermediate products in mill *j* using planning process *r* during time period | |
|  | quantity of process for final products in mill *j* using planning process *r* during time period | |

The mathematical model is subject to the following set of constraints as formulated as follows:

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The objective function comprise costs for harvesting, transport from forest to mills, transport from forest to terminal, transport from terminal to mill, sorting cost, and inventory cost at forest, terminal and mills.

**Constraints:**

**Harvesting decisions:**

**Cons1:** impose that each harvest site must be harvested exactly once

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**Cons2:** inventory constraints; calculate balance of assortment after sorting and shipping these volumes either to mills or terminals

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**Cons3:** calculate balance constraints for terminal, which guarantee all material should be way out to the mills

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**Cons4:** calculate balance constraints for mills, which guarantee all outgoing assortment from forest and terminal should be entered to the planning process at mills

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**Cons5:** compute the balance of intermediate products (sawdust (swd) and woodchips (wc)) at mills

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**Cons6:** computes the balance of final products at mills and biorefinery and the demand for final products at time period *t*.



**Cons6**: logical constraints that link binary variables with continuous variables for transporting residues, and sorting process for all available residues from a given cut-block.