A detailed explanation regarding all the reports and algorithms of SandMan can be found below

Dashboard

Objective:

The Dashboard provides a quick overview of the state of the foundry in terms of rejections observed. It has filters for

Line
Date (Number/Weight)
Component (Number/Weight)
Pareto Component wise (Number/Weight)
Pareto Defect wise (Number/Weight)

The date-range for which the rejections have to be fetched can be selected using the from and to date fields provided. The default date-range selected is two weeks from the last date of production as in the database. Once the required filter options have been selected, pressing the Filter button presents the results. Several scenarios are possible through various combinations of the filters. The behavior of each of these scenarios are presented below.

Date (Number/Weight)

If the filters Date and Number are used, then the results are presented in three quadrants. The first quadrant displays the top 14 Total Sand Rejection Quantity (number of units rejected) as a percentage of the Total Production Quantity (number of units produced) on a per-day basis ordered highest to lowest from left to right as a column chart. The second quadrant (read clockwise) by default, displays each of the individual rejection types as a percentage of the total production for the day displaying the highest Total Sand Rejection Quantity % in the first quadrant via a pie-chart. The third quadrant by default, displays the contribution of the components which exhibited the largest observed rejection type as in quadrant two. If rejection type distribution for any other day is required, it can be obtained by clicking on the column for the interested day in the first quadrant. This loads the rejection distribution for that particular day in the second quadrant and the component distribution for the highest rejection type in the third quadrant. If for the same day, the component distribution is required for any other rejection type, it can be obtained by clicking on the rejection type of interest in the second quadrant.

If the filters Date and Weight are used, the manner in which the results are presented is the same with the only difference now being that all computations are performed using weight instead of number. This translates to the first quadrant displaying the top 14 Total Sand Rejection Quantity (weight of metal rejected) as a percentage of the Total Production Quantity (weight of metal produced) on a per-day basis and so on.

Component (Number/Weight)

If the filters Component and Number are used, then the results are presented in three quadrants. The first quadrant displays the top 14 Total Sand Rejection Quantity (number of units rejected) as a percentage of the Total Production Quantity (number of units produced) on a per-component basis ordered highest to lowest from left to right as a column chart. The second quadrant (read clockwise) by default, displays each of the individual rejection types as a percentage of the total production for the component displaying the highest Total Sand Rejection Quantity % in the first quadrant via a pie-chart. The third quadrant by default, displays the contribution of the various days on which the component was manufactured which exhibited the largest observed rejection type as in quadrant two. The interactive behavior of the various charts with this filter option is similar to that of the filter Date (Number/Weight)

If the filters Component and Weight are used, the manner in which the results are presented is the same with the only difference now being that all computations are performed using weight instead of number. This translates to the first quadrant displaying the top 14 Total Sand Rejection Quantity (weight of metal rejected) as a percentage of the Total Production Quantity (weight of metal produced) on a per-component basis and so on.

Pareto Component wise (Number/Weight)

If the filters Pareto Component wise and Number are used then the results are displayed in a single chart containing two plots. The column plot shows the contribution of each component in terms of its Total Sand Rejection Quantity (number of units rejected for the component) as a percentage of the Total Sand Rejection Quantity (number of all units rejected) ordered highest to lowest from left to right. The line plot shows the cumulative rejection contribution of the components, starting from the leftmost component which shows the highest rejection percentage. There are also two horizontal dashed lines, at the 50% and 80% mark which are markers to aid in the application of the 80/20 rule.

If the filters Pareto Component wise and Weight are used, the results are displayed in a similar fashion. The only difference being that all computations are performed using weight rather than number. This translates to the column plot showing the contribution of each component in terms of its Total Sand Rejection Quantity (weight of metal rejected for the component) as a percentage of the Total Sand Rejection Quantity (weight of all metal rejected).

Pareto Defect wise (Number/Weight)

If the filters Pareto Defect wise and Number are used then the results are displayed as a chart containing two plots and a table. The column plot shows the contribution of each rejection type to the Total Rejection Quantity (number of units rejected). The line plot as before displays the cumulative rejection contribution of the various rejection types, starting from the leftmost rejection type. The table provides easy access to the individual and cumulative percentages used in the plots. Clicking on any of the rejection types, results in a drill-down with the resultant plot showing the corresponding component wise pareto for the selected rejection type.

If the filters Pareto Defect wise and Weight are used then the results are displayed in a similar fashion. The only difference being that all computations are performed using weight rather than number. This translates to the column plot showing the contribution of each rejection type to the Total Rejection Quantity (weight of units rejected).

In addition to the above filters the dashboard charts in the second and third quadrant have an implementation of the High-Influence algorithm during the use of filter Date and Number. If a model has been built, then clicking on either the rejection type in the second quadrant or the component in the third quadrant produces line charts for a 1 month period of the top 2 most influencing properties for either the rejection type or component respectively for the selected day.

The columns/bars which are colored red in the first quadrant represent those dates which are orphan entries. Orphan entries are those records for which rejection data exists but not prepared sand data and vice-versa.

Data Upload

Objective:

The Data Upload module allows users to feed data into the system in the form of excel files for use in the reporting and analytics modules.

Steps for using the module:

The following information has to be provided for the upload:

Line Name: The manufacturing line to which the data corresponds

Category: The category of the data file i.e. PreparedSand, Rejections etc.

The excel file itself. Users can upload a file from their system using the Browse button. The module only accepts files which conform to the pre-defined format. A sample of the pre-defined format files can be downloaded by clicking on the Download Sample File link

Once the above information is provided, users have to press the Upload button to upload the file. This results in the data in the excel sheet being displayed in a grid. If there are any errors associated with the data in a particular row, that row is highlighted pink. Clicking on the highlighted row displays the error associated with the row as a message at the top of the page.

Users can cancel the upload operation by clicking on the Cancel button. Clicking on the Save button attempts to save the data into the database. If duplicate entries are found, a message is provided prompting the user to select the overwrite option if desired. Selecting the option and clicking the Save button saves the data to the database.

Data Storage
Objective:
The Data Storage module allows users to edit/update/download data which they have uploaded into the application using the Data Upload module

Steps for using the module:
The following information has to be provided for the module:

Line Name: The manufacturing line to which the data corresponds
Category: The category of the data file i.e. PreparedSand, Rejections etc.
Date Range: The date range for which the data is to be fetched
Once the above information is provided, users have to press the Search button to fetch the data. The results of the search are displayed in the form of a pie-chart with data being categorized as CLEAN or one of the error types. Clicking on any slice of the pie displays the data associated with the data category in a grid. If there are any errors associated with the data in a particular row, that row is highlighted pink. Clicking on the highlighted row displays the error associated with the row as a message at the top of the page.

Users can edit the data and update it via the Edit button. Clicking on the Edit button makes the cells of the grid editable like in that of an excel sheet. Once satisfied, pressing the Update button updates the values in the database. Users can also download data-pertaining to a specific data category by clicking on the download button. This creates an excel file in the application's pre-defined format and provides it to the user.

If the users wish to download the excel file which was originally uploaded into the system, it is possible by clicking on the View Uploaded Files button. This opens up a grid displaying the various excel files uploaded along with their categories. Clicking on the download button allows them to download the file.

Annotations
Objective:
The Annotations module allows users to record/annotate any changes made to the sand system

Steps for using the module:
The following information has to be provided for the module:

Line Name: The manufacturing line to which the data corresponds
Date of Change: The date on which the change was made
Enter details: The details of the change as a short message
Once the above details have been provided, clicking on the Add button adds the annotation to the database. These annotations will show up on the SPC reports and the Comparative reports if the appropriate date-range is selected. The annotations can also be viewed/edited/deleted by clicking on the View Annotations button and selecting the appropriate option.

System Changes
Objective:
The System Changes module allows users to select from a pre-defined list of sand-system related changes and record it.

The following information has to be provided for the module:

Line Name: The manufacturing line to which the data corresponds
System Change Type: The type of the system change
Date of Change: The date on which the change was made
Enter details: The details of the change as a short message
Once the above details have been provided, clicking on the Add button adds the system change to the database. These system changes will show up on the SPC reports and the Comparative reports if the appropriate date-range is selected.
The system changes can also be viewed/edited/deleted by clicking on the View System Changes button and selecting the appropriate option.

General Files
Objective:
The General Files module allows users to save various files into the database for archival purposes

The following information has to be provided for the module:

Line Name: The manufacturing line to which the file corresponds
The file itself. Users can upload a file from their system using the Browse button.
Once the above information is provided, users can click on the Upload button and the file is saved to the database. Users can retrieve the file via the View files button and clicking on Download against the required file.

Statistical Process Control
Objective:
The Statistical Process Control (SPC) report is useful in obtaining/studying the

Uni-variate Cp and Cpk values for any property belonging to either sand properties or rejection types.
Increasing / Decreasing trend in any property
Variations of any property on a daily/monthly/ yearly basis
Annotations / Red herrings in the foundry
Steps for running the report:
The following information has to be provided for the report:

Line Name : The manufacturing line on which the current report has to be generated
Date Range : Starting and end dates of the time period
Select Parameters : Among the Prepared Sand / Rejection properties, the user can select/tick the parameters that are to be studied in the current report
After the above information is provided, the report will be generated, in the same page, once the "Generate Report" button is clicked.

Interpreting the result
SPC Report
In this chart, the historical data of the selected properties will be displayed in line graphs for the time period selected by the user. By default, the line graph of only one selected prepared sand property and one rejection type will be displayed.

The line graphs are useful in studying the variations of any property
The "Show Trendlines" chart option is useful in observing the increasing / decreasing trend in any property. If the trend line of any property is going down with time, then it can be interpreted that the values of the property are decreasing with time. Similarly, for a trend line that is going up with time, it can be interpreted that the values of the property are increasing with time.
All the annotations that belong to the selected time-period will be displayed as "blue asterisk-marks" on the line graph.
Similarly, all the system changes are displayed as "red asterisk-marks" on the graph.

Process Control Charts
In this section, a mean and a range process control chart is displayed for each of the sand properties selected for report generation. The granularity of the subgroup is 3 production days.The mean chart helps users in identifying changes in the process mean, while the range chart helps users in identifying changes in the process variability. The general rules of thumb often used while reading such charts to identify special causes for process instability are listed below :

One point outside the control limits UCL or LCL
Nine points in a row above or below the center line
Six points in a row steadily increasing or decreasing
Fourteen points in a row alternating up and down
Data Distribution Graphs
In this section, a histogram for each property along with its' box plot is displayed. This histogram is helpful in studying the distribution of the property data. The box plot of each property, provides the minimum and maximum values of the property, the first and third quartiles of the property and the median value.

Process Capability Indices (Cp and Cpk)
Cp and Cpk are the process capability indices that measure the capability of a process in producing the outputs within the specified limits.

Cp: Cp compares spread between the process specifications against the spread of the process values, as measured by 6 process standard deviation units. Higher the value of Cp, lesser is the variation in the process compared to the difference of specified limits.
Cpk: Cpk is a measure of how well a process is maintained within the specified limits. Generally, a Cpk value greater than 1.33 is considered as good while, a Cpk value of 2 indicates that our process mean is at least six (6) standard deviations away from the specified limits.
Different Cpk formula for Sand Properties and rejection types
For Prepared sand properties, the quality of the process can be measured through how well the property is centered within the specified limits whereas for rejection properties, the quality of the process should be measured through how close it is to the lower specified limit (which generally is equal to 0%). So, for computing the Cpk value for rejections, a one-sided Cpk formula is being used.

Process Control Metrics
Here we use the entire data of the selected time period in the computation, and the following are displayed

Property Name
User LSL
User USL
Cp(User)
Cpk(User)
Sys.LSL
Sys.USL
Cp(Sys)
Cpk(Sys)
Âµ
Ïƒ
Please note that the LSL and USL values that were provided at the "Foundry line Parameters page" are used here in the calculations of Cp(User) and Cpk(User).As stated earlier, Cp and Cpk values greater than 1.33 are considered good. Âµ represents the mean (average) value of the property and Ïƒ represents the variation (standard-deviation) of the process. For any property, a higher value of Ïƒ indicates that the average difference between Âµ and the data is high.

Sys.LSL and Sys.USL refer to the system/software identified limits for a target rejection value displayed in the slider, while Cp(Sys) and Cpk(Sys) refer to the process capability and process capability index computed using these limits. Users can change the target rejection they want to achieve on the slider and press the "Calculate Limits" button to obtain the new system limits of the properties

When the user clicks on a rejection-type in the table, the top 3 "most impacting" prepared sand properties for the selected rejection-type, based on the data of the selected time period, are highlighted. A color gradient based "Impact Map" legend is also provided. Here, "impact" of each prepared sand property on a rejection type is computed based on the change in the rejection % obtained with a unit change in the sand property.

Comparative Report
Objective:
The Comparative Report is useful in obtaining

The most influencing Prepared Sand properties which affect Total Sand Rejection Quantity across two different periods for a given foundry line or two different foundry lines
The values of the above mentioned properties when the Total Sand Rejection Quantity was the highest and the lowest in each of the respective periods
The performance of the foundry line(s) in terms of the process consistency through the Cpk values of the above mentioned properties
A general trend of the above mentioned properties through graphs for each of the respective periods
Steps for running the report:
The following information has to be provided for the report:

Line Name : The manufacturing line on which the current report has to be generated
Date Range : Starting and end dates of the time periods of interest
After the above information is provided, the report will be generated, in the same page, once the "Compare" button is clicked.Please note that the report requires selection of time-periods such that, each of the time periods have a minimum of 30 unique data points

Interpreting the result
The results in the table "Top 3 highest Rejections with Highest Influencing Sand Properties" show the three dates corresponding to the highest rejection values observed during each period along with the values of the top two most influencing Prepared Sand properties of periods A and B on these dates.The properties marked with an asterisk in this table are those which were found to be the highest influencers of Total Sand Rejection Quantity for Period B

The results in the table "Top 3 lowest Rejections with Highest Influencing Sand Properties" show the three dates corresponding to the lowest rejection values observed during each period along with the values of the top two most influencing Prepared Sand properties of periods A and B on these dates.The properties marked with an asterisk in this table are those which were found to be the highest influencers of Total Sand Rejection Quantity for Period B

The results in the table "Cpk Table for the Highest Influencing Parameters" show the Cp,Cpk,Î¼ and Ïƒ values of the highest influencing properties of periods A and B along with Total Sand Rejection Quantity, computed on a per-period basis.

The graphs titled "Period A" and "Period B" show a general trend of the influencing properties for Periods A and B respectively. These graphs also have special markers which indicate any annotations or system changes made during each period if any, to aid users in drawing inferences

The input field "Remarks" has been provided for users to enter any interesting inferences which they were able to draw from the report. The input field "Report Name" has been provided for the users to enter a name for the report for easy identification. Once the above two fields have been filled, the entire report can be saved and retrieved on call at a later point in time using the "View Report Archive" feature present on the page

Model Building Module
Objective:
This module will be useful in building the mathematical models between the input parameters (prepared san properties) and output parameters (rejection types). For each foundry line and component, a model can be built relating the prepared sand properties with various rejection types.

Steps for running the algorithms:
Model Category (Build Model)
Selected Line Id and Component: This label has to be selected only when one model has to dbe built for a particular foundry line and component.
All Components for the selected Line ID: When models have to be built for all the components that were produced on a particular foundry line, then this label has to be selected.
Line Name: Select the appropriate foundry line on which the model has to be built
Component: Select the appropriate component (produced on the "Line Name" selected in the previous step) on which the model has to be built (similar to Line Name)
"All" as component: this represents a model which combines the input and output data of all components. In simple terms, this model assumes that for different type of castings, a unique set of prepared sand values will result in the same rejection percentage values for all the castings.
Date Range: Select the start and end dates for the period during which the model has to be built.
Prepared Sand: All the prepared sand properties that are being selected in the configuration page will be present here.
Even though total clay is being selected in the configuration page, this property would not appear in this list. (As total clay can be expressed as a summation of active clay and inert fines).
Rejection: All the rejection types that are being selected in the configuration page will be present here.
Interpreting the result
At least, a minimum number of twenty days of data (twenty data points) are required for building a model for a particular combination of foundry line and component.

The combinations of foundry line and component which resulted in a successful model build would be included in a "success" table.
And, those combinations where model was not built successfully would be shown in a "failure" table with a reason for the failure in the third column.
High Influence
Objective: This algorithm returns information about the input parameter values that the foundry floor people could consider while operating their plant in order to decrease their rejection percentages.

Steps for running the Algorithm:
First, the user has to select the line name and the component that will be manufactured on that line.
Then, the user has to provide values for the prepared sand parameters that are measured on that line and select the desired rejection types.
Interpreting the result:
The results in the table "Heat Map (based on a specified input)" show a Heat map which displays the current and optimal values of the input parameters and the corresponding predicted rejection percentage values. The optimal input parameters here correspond to high confidence and least rejection % value. The rejection percentages for both the current and optimal values are obtained by using the predictive model built using the selected foundry line, component and rejection type. The values of the parameters represent the values that the parameters could be moved to achieve optimum rejection. The parameters are arranged by taking into account of the following factors

influence on rejection type and
amount of change between the current and optimal values.
The parameter that is displayed in the first column can bring in the maximum reduction in rejection % of the selected rejection type when compared with other parameters. The foundry floor people could consider changing the input parameters to the values suggested by the optimal point only when the rejection percentage of the optimal value is less than the current value. Optimum here refers to the region where the lowest value rejections were clustered in the historical data.

For some input parameter values, the results table will only contain the current operating values accompanied by a message stating that "User provided values are better than optimal". This may happen only for those input parameter values whose predicted rejection percentages is lesser than that of the optimal point.

Disclaimer:
The accuracy of the predictions are dependent upon:

The accuracy of the historical data that has been entered into the system.
The entered input data being present in the neighborhood of historical data.
No external parameters other than the input parameters influence the rejections.
Neighborhood Locator
Objective: The Neighborhood Locator locates the requested number of points that are in the neighborhood of the input parameter values provided by the user. The located values depend on the historical data that is fed to the system. Based solely on the historical data provided by the foundry, this algorithm will arrive at a range of rejection percentage values that can be observed when the selected foundry line and component is operated with the input parameter values entered by the user.
If FIVE nearest points are to be selected from the neighborhood of input parameter values, then radio button "No. of Nearest predictions" has to be selected and the value of 5 (FIVE) has to be provided in the adjacent box.
And, if all the points, present within a specified distance % from the input parameter values are to be selected, then the radio button " % of closeness" has to be selected and the distance % value has to be provided in the adjacent box.
The distance % value provided by the user helps in limiting the radius of the neighborhood. For a distance % value of 10, the Neighborhood Locator algorithm will first compute the distance between the farthest points (maximum distance) in the historical data set provided by the foundry and uses 10% of this maximum distance as the radius of the neighborhood region.
Steps for running the algorithm
If the neighborhood span has to be limited to a specified time-period, the user can select the corresponding "from date" and "to date" for the time-period of interest.
The user has to select the line name and then the desired component that will be manufactured on that line.
Once input values have been provided for all the selected parameters then select all the rejection types of interest. On clicking the "Predict" button, the algorithm results will be displayed in the same page. The number of neighborhood points that are displayed by the system is based upon either:

The number of points selected by the user
The points in the vicinity of the input point which are present within a selected distance percentage
The neighborhood can be run either by input parameters or by rejections. If any non-zero value is provided in all the selected fields under the "Rejections" tab, this algorithm will search in the neighborhood of rejection types and locates the points that are close to these non-zero values provided by the user.

Interpreting the result:
The first section of the report shows the input parameter and rejection ranges of the neighborhood points.
In the second section, the heading "Last production details" displays data from

the last date that was entered into the system.
The rest of the outputs are arranged in the increasing order of their distance from the input point. These data points are also plotted on a chart.
High Influence Diagnostics
Objective: The High Influence Diagnostic Report provides the users with a result summary of iterative High Influence algorithm executions for sand parameters between two production dates using the current active model.

Steps for running the algorithm
The user has to select a foundry line on which the algorithm is to be run
The user has to select the date period for which the report has to be produced
Once the above two inputs have been provided the user can click on the Fetch Diagnostic Report to see the results

Interpreting the result:
The first section of the report shows the result summary in a tabular fashion

This section contains the production date whose sand parameter values were used as the input to the high influence algorithm run
The first and second highest influencing parameters on the corresponding production date along with their observed values and directionality of change to reach their optimum value
The Predicted Rejection % as predicted on the corresponding production date
The Actual Rejection (Raw) % as recorded on the corresponding production date (inclusive of errors in data)
The Actual Rejection (Clean) % as recorded on the corresponding production date (exclusive of errors in data)
The Absolute Error which is the absolute difference between the Predicted Rejection % and Actual Rejection (Clean) %
The RMSE or the root mean square error which indicates in a sense the average error in the predictions
The second section of the report shows a frequency map of the various sand parameters

SandMix Analytics
Objective: The SandMix Analytics provides end users with the quantities in which the additives have to be added to prepare a sand mixture with sand parameters as close to the High Influence optimum

Steps for running the algorithm
The user has to select a foundry line on which the algorithm is to be run
The user has to select the date on which the suggestion is to be made. Upon selection the available shift identifiers are auto populated
The user has to select the shift on which the suggestion is to be made
Once the above two inputs have been provided the user can click on the Predict Additives button to see the results

Interpreting the result:
The first section of the result shows the required quantities in which the additives have to be added if 1kg of Recycle Sand (Return Sand + Core Sand) were to be used in preparation of the mixture

There is an input box provided where users can modify the quantity of Recycle Sand being used to create the mixture. After entering a suitable number, clicking on the calculate button updates the additive quantity values in the table below

Under the heading Predicted Additive Ratios/MT of Prepared Sand are the ratios in which the additives have to be added with reference to a fixed quantity of Prepared Sand

Under the heading Additive Quantities are the quantities in kg in which the additives have to be added to reach as close to the optimum sand parameters as suggested by High Influence algorithm

The second section of the result shows a table displaying the sand parameter values under several headings

Under the heading Current Value are the sand parameter values on the date and shift that was selected in the input section
Under the heading Target Value are the optimum sand parameter values as suggested by the High Influence algorithm
Under the heading Predicted Value are the predicted sand parameter values one might get upon implementation of the additive mix as suggested by the SandMix Analytics for the provided input
In both of the tables light red highlights are provided under the following conditions

If the optimized additive ratios are at the limits as used by the SandMix Analytics
If either the Current or Target or Predicted sand parameter values are either at the limits or outside of the limits as used by the SandMix Analytics
Fishbone Analytics
Objective: The Fishbone Analytics provides user to analyze the causes of unexplained defects on the assumption that defects happen due to the process deviations.

Steps for running the algorithm
The user has to select a foundry line on which the algorithm is to be run
The user has to select the group name followed by component name. The default setting is "All"
The user has to select defect type from the dropdown list for the root cause analysis and submit it
The user has to provide the reference period (minimum rejection period) and the comparison period (period when rejection is high).
Interpreting the result:
The fishbone diagram related to the selected defect will appears with highlighted properties
Every sand property corresponds to three plots.
Box plot: To show the variability of selected parameters over the period
Distribution plot: To show the shift in the property w.r.t reference period
Correlation plot: To show the correlation between defect and the selected property
The summary plots will shows the most deviated properties in descending order