

- Username
- Password
- Use Test Connection to verify the setup

### If Selecting an Existing Database:

The screenshot shows the muDNA interface with the following details:

- Header:** muAoPS Art of Problem Solving, muDNA Problem DNA, Last Modified On: (Draft) Apr 29, 2025 1:59:27 PM by KeerthChandana G.
- Section:** muDNA Linked Artifacts
- Key Questions:**
  - 3 END QUESTIONS: 2 Items
  - Only Key Questions (2)
  - 100% (4)
  - Only linked Data Sources
- Test:** DIPP: Inquisitive, Testability: Yes, Techniques: Data Quality, Data Wrangl..., Status: Completed
- Key Question:** Implementing a unified network optimization tool will enable affiliates to improv... (Low priority, 0%, 0%, 0%)
- Test:** DIPP: Descriptive, Testability: Yes, Techniques: No Technique Selected, Status: Not Started
- Key Question:** Implementing a unified network optimization tool will enable affiliates to improv... (Low priority, 0%, 0%, 0%)

A modal window titled "Add Key Field : 'CustomerRetention' > Map Actual Data Source" is open, showing the following fields:

- Data Source Name: Q\_Airline\_db
- Database Type: MySQL
- Database: airline\_db
- Table Name: Q\_Air\_units\_train
- Column Name: Q\_fc\_name

Buttons in the modal include "Clear", "Back", and "Add".

(Fig 115: Adding Existing Database)

- Choose the existing database from the dropdown
- Select the Table Name and Column Name required for mapping
- Complete the linking by confirming these selections

Once this step is complete, the data source is successfully connected to Key Question.

### 6.muTalos Button Activation and Next Steps

With the test setup and data connection completed:

- The muTalos button remains active next to the Key Question
- Clicking this button now launches the muTalos interface, where the system takes over to automate the reasoning, code generation, and execution process

From this point forward, the AoPS to Code process moves into the muTalos environment, where problem configuration, reasoner setup, and automated testing are executed seamlessly.

Clicking this muTalos button initiates the transition from the hypothesis-building phase to the automated reasoning and code execution phase within muTalos.



The screenshot shows the muDNA interface with the 'PROBLEM STATEMENT' and 'PROBLEM DEFINITION' sections. In the 'PROBLEM DEFINITION' section, there is a 'Key question' card for 'CustomerRetention'. A modal dialog titled 'Add Key Field : 'CustomerRetention' > Map Actual Data Source' is open over the main interface. The dialog has tabs for 'Database Selection' and 'Add New Database'. The 'Add New Database' tab is selected, showing options for MySQL, PostgreSQL, Azure SQL, Databricks SQL, and Snowflake. Buttons for 'Skip and Save' and 'Back' are at the bottom.

(Fig 113: Add Data Source)

## If Adding a New Database:

This screenshot is similar to Fig 113 but focuses on the 'Add New Database' tab of the 'Add Key Field' dialog. It shows the same list of database types: MySQL, PostgreSQL, Azure SQL, Databricks SQL, and Snowflake. Below the list are 'Back' and 'Test Connection' buttons.

(Fig 114: Adding new Database)

- Enter the Data Source Name and Description
- Choose the Database Type (MySQL, PostgreSQL, Azure SQL, Databricks SQL, Snowflake)
- Fill in the connection details:
  - Host
  - Port
  - Database Name

The screenshot shows the muAoPS software interface for a project titled 'DemandPrediction'. The 'PROBLEM STATEMENT' and 'PROBLEM DEFINITION' sections are visible at the top. In the 'PROBLEM STATEMENT' section, there are tabs for 'Situation', 'muSearch', and 'Olivious Gap'. In the 'PROBLEM DEFINITION' section, there are tabs for 'Representations', 'Hypothesis', and 'One Key Questions'. A 'Publish to EndC' button is also present. The main area displays several key questions, each with a status bar indicating progress (e.g., 100%, 9%). One question is highlighted with a green border. A modal dialog box is open in the center, titled 'Add Key Field'. It contains fields for 'Name\*' (CustomerChurn), 'Data Availability' (with a color-coded legend: green for Available inside organization, yellow for Available outside organization, orange for Unavailable, but can be created, red for Unavailable and cannot be created, and grey for Unassigned/Unknown), 'Description' (Enter Description), and 'SME' (Enter SME). Buttons for 'Cancel' and 'Add' are at the bottom right of the dialog.

(Fig 112: Add Key Field)

- Enter the Key Field Name relevant to the test (for example, Customer Churn)
- Define the Data Availability by selecting one of the available statuses:
  - Available inside the organization
  - Available outside the organization
  - Unavailable but can be created
  - Unavailable and cannot be created
  - Unassigned/Unknown
- Provide a brief Description of the data field
- Mention the SME (Subject Matter Expert) responsible for this field

## 5. Connecting to a Database for the Key Field

After defining the key field:

Proceed to map the actual data source by selecting the method of database connection.

The system offers two options:

- Add New Database (for first-time connection setup)
- Select Existing Database (if the database is already available)

- Define Testability by selecting either Yes or No  
This indicates whether the hypothesis can be tested through available data and analytical methods
- Choose the appropriate Techniques from the dropdown list  
Techniques may include Data Quality, Data Wrangling, Statistical Analysis, Predictive Modeling, Segmentation, and several others

#### 4. Enabling Data Source for the Test

After configuring the test:

- Navigate to the Required Data Sources section located next to the test configuration
- Click on the box to enable the data source for the question

The screenshot shows the muAoPS interface for a 'DemandPrediction' project. In the 'PROBLEM DEFINITION' section, under '2 REQUIRED DATA SOURCES', there is a 'CustomerChurn' entry. Below it, a 'Test' section for a question includes a 'DIPP: Inquisitive', 'Testability: Yes', and 'Techniques: Data Quality, Data Wrangl...' dropdown. To the right, there is a 'Network' section labeled 'Enhancing Supply Chain Effic...' with a 'CustomerChurn' entry. A large 'Enable Data Source' button is located in the 'Key Question' row. At the bottom, there is a legend for status indicators: Testable (green), Non-testable (grey), Available inside organization (green), Available outside organization (yellow), Unavailable, but can be created (orange), Unavailable and cannot be created (red), and Unsigned/Unknown (light blue).

(Fig 111: Enable Data Sources)

After enabling the Data source, you need to add a Key Field. To do this, click on the + icon to add it.

A pop-up titled “Add Key Field” will appear. In this window:



The screenshot shows the muAoPS interface for a problem statement titled "Strategies for Acquiring New Customers". The "Hypothesis" tab is active. Key questions listed include:

- Q1 Which income bracket of customer positively affect the acquisition rate? (Low priority, 0%, 0% complete)
- Q2 Which geographical area of customer positively affects the acquisition rate? (High priority, 100%, 100% complete)
- Q3 Customers of which profession have the most positive effect on the acquisition ra... (Low priority, 0%, 0% complete)

Below each question are test details such as DIPP, Testability, Techniques, and Status. The right side of the screen shows required data sources and their fields.

(Fig 109: Hypothesis)

### 3.Adding Tests for Key Questions in the Hypothesis Section

Once the Key Question is visible in the Hypothesis section with the muTalos button enabled, the next step is to configure Tests for that question.

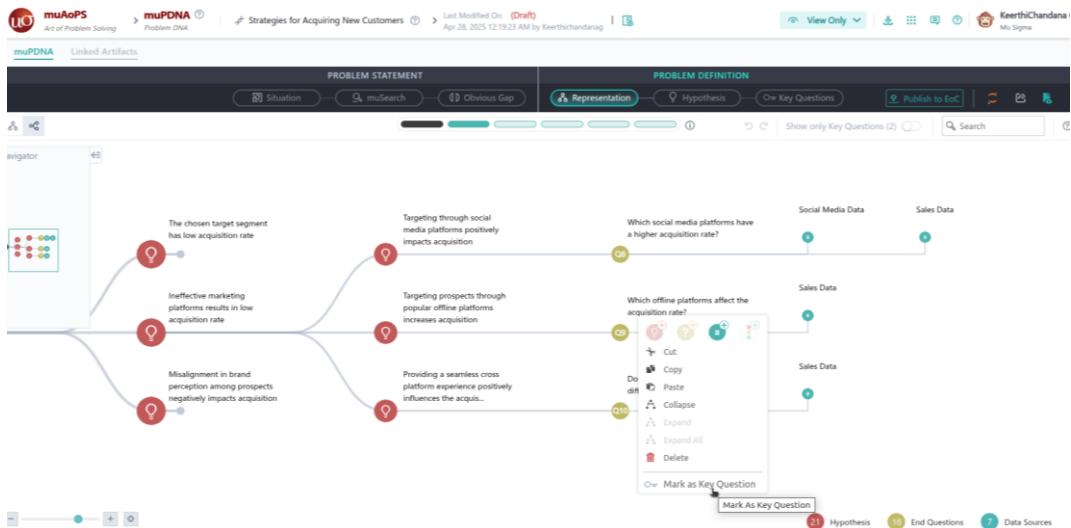
The screenshot shows the muAoPS interface for a problem statement titled "DemandPrediction". A new test is being added for a key question:

**Test:**  
DIPP: Inquisitive, Testability: Yes, Techniques: Data Quality, Data Wrangl..., Status: Completed

The right side of the screen shows the "Enhancing Supply Chain Effic..." section with a "CustomerChurn" key field.

(Fig 110: Adding Test)

- Click on Add Test below the Key Question
- Select the DIPP category, choosing one of the following:



(Fig 108: Mark as Key Question)

In the Representation screen:

- Go to the list of questions under the problem breakdown.
- Find the question that is important for analysis and validation.
- Right-click on that question to open the menu.
- Select “Mark as Key Question” from the options.

## 2.Key Question Flow to Hypothesis Section

Once you do this, the question is marked as a Key Question, meaning it becomes critical for testing, finding data, and validating hypotheses.

After marking a question as a Key Question in the Representation screen:

- This Key Question will automatically appear in the Hypothesis section.
- In the Hypothesis section, each Key Question is displayed along with options to configure tests, link data sources, and set up validation logic.

### Important Note:

When a question is marked as a Key Question, the system immediately activates the muTalos button beside that question in the Hypothesis screen. This button is essential for launching the automated code execution process after test setup.

The presence of the muTalos button confirms that the question is ready for testing and aligned with the AOPS to Code workflow.

- Option to Add Tests and Key Fields: Users can add test cases or key field names to validate their hypotheses
- Only Linked DataSources: Displays only the datasources that are linked to the test

The screenshot shows the muAoPS interface for the muPDNA framework. The top navigation bar includes the muAoPS logo, the project name 'muPDNA', and a status indicator 'Demand Availability [Draft]'. The main content area is divided into two sections: 'PROBLEM STATEMENT' and 'PROBLEM DEFINITION'. In the 'PROBLEM STATEMENT' section, there are five hypothesis questions listed under 'END QUESTIONS'. Each question includes a priority indicator (Low priority), a progress bar (0%), and an 'Add link' button. In the 'PROBLEM DEFINITION' section, there is a summary of '47 REQUIRED DATA SOURCES'. A tooltip explains that 'Data Sources' are from where data is ingested (Ex: Databases, APIs, Files, Streaming data etc.) and that 'Key Field Names' are column names required for analysis. Below this, there is a table for adding key field names, with columns for 'Add a test to add Key Field Name' and 'Key Field Name'. The table includes rows for each of the five hypothesis questions, with the last row being a placeholder. At the bottom of the table, there are color-coded status indicators: green for 'Available inside organization', yellow for 'Available outside organization', orange for 'Unavailable, but can be created', red for 'Unavailable and cannot be created', and grey for 'Unassigned/Unknown'.

(Fig 107: Data Sources)

## C. List of Hypothesis Questions

Each question is displayed with:

- Priority Indicator: Marks whether the question is of low, medium, or high importance
- Answer Link Field: Provides an option to attach answers
- Progress Indicator: Shows the percentage of work completed for each question
- Assigned User: Displays the person responsible for answering the question
- muTalos: The muTalos button is used for the AoPS to Code process, transforming problem representations into automated tests.

Below is the detailed process for AoPS to code:

### AoPS to Code:

#### 1. Starting from the Representation Screen

The process starts in the Problem Definition phase, under the Representation screen of the muPDNA framework. Here, you focus on breaking the main problem into smaller, measurable sub-questions.

- Available outside organization: Filters hypotheses requiring external data sources
- Unavailable but can be created: Data that does not currently exist but can be generated through surveys, experiments, or other methods
- Unavailable and cannot be created: Data that is impossible to obtain or generate
- Unassigned/Unknown: Data availability is not yet determined

## Hypothesis Tab

The screenshot shows the muAoPS Hypothesis tab interface. At the top, there are tabs for 'PROBLEM STATEMENT' and 'PROBLEM DEFINITION'. Under 'PROBLEM DEFINITION', the 'Hypothesis' tab is selected. On the left, it displays '50 END QUESTIONS' and '0 Test'. On the right, it shows '47 REQUIRED DATA SOURCES' and '0 Unique Key Field'. Below these counts, there is a table with six rows, each representing a hypothesis question. Each row includes a question number, a question text, a priority dropdown (set to 'Low priority'), a completion percentage (0%), and a link to add a test. To the right of the table, there is a placeholder text 'Add a test to add Key Field Name'. At the bottom of the table, there are several status indicators: 'Testable' (blue), 'Non-testable' (grey), 'Available inside organization' (green), 'Low priority' (green), 'Available outside organization' (yellow), 'Unavailable, but can be created' (orange), 'Unavailable and cannot be created' (red), and 'Unassigned/Unknown' (light grey). A legend at the bottom right maps colors to these categories.

(Fig 106: Hypothesis)

The main section of the Hypothesis tab displays a list of key questions that help validate different hypotheses.

### A. Header Section

- Total End Questions Count: Displays the total number of hypothesis-related questions
- Completion Progress: A tracker showing how many questions have been completed
- Only Key Questions Toggle: Allows users to filter and view only the most important questions

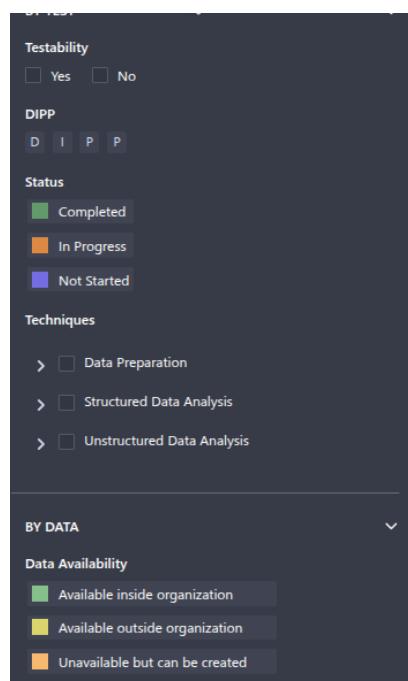
### B. Required Data Sources

- Total Data Sources Count: Indicates how many data sources are required for hypothesis validation

### 3.By Test

This filter is useful for tracking which hypotheses have been tested and which ones require validation.

- Testability (Yes/No): Filters whether a hypothesis can be tested with available data
- DIPP (Descriptive, Inquisitive, Predictive, Prescriptive): Filters tests based on their purpose
- Status (Completed, In Progress, Not Started): Helps track the stage of each hypothesis test
- Techniques Used: Filters based on the type of data analysis used:
  - Data Preparation: Cleaning and organizing data before analysis
  - Structured Data Analysis: Analyzing data in structured formats like tables
  - Unstructured Data Analysis: Processing text, images, or other unstructured data



(Fig 105: By Test, By Data)

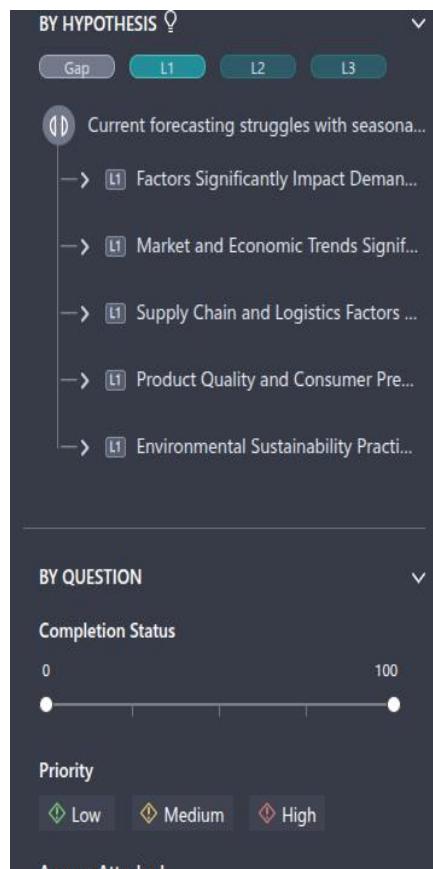
### 4.By Data

This filter helps users check the availability of required data for hypothesis validation.

- Available inside organization: Filters hypotheses based on data that are available internally

- **L1, L2, L3 Levels:** Represent different depths of hypotheses, with L1 being broad categories and L3 being more specific

Example: Filtering for "Supply Chain and Logistics Factors" will show only the hypotheses related to that aspect of the problem



(Fig 104: By Hypothesis, By Questions)

## 2.By Questions

This filter helps in focusing on specific key questions related to the problem. Key questions help in understanding the root cause of an issue.

- Completion Status Slider: Allows users to filter questions based on their progress (0-100%)
- Priority Levels: Questions can be categorized as Low, Medium, or High priority
- Answer Attached: Users can filter based on whether an answer has already been attached



### Step 1: Understanding the Problem Statement

- Start with a well-defined problem statement that highlights the key challenge
- Example: Forecasting struggles with seasonal and regional demand shifts, causing stockouts and excess inventory

### Step 2: Breaking Down into Hypotheses

- Identify key factors influencing the problem
- Each hypothesis represents a potential cause of the issue

### Step 3: Adding Key Questions

- Key questions help in validating or rejecting the hypotheses
- These questions should be specific and linked to data sources

### Step 4: Assigning Data Sources

- Identify relevant data sources to support the key questions
- Data sources should provide measurable insights

### Step 5: Marking Key Questions

- Highlight the most important key questions
- This ensures focus on the most critical aspects of the problem

### Step 6: Managing the Structure

- Use options like cut, copy, paste, collapse, and expand to refine the representation
- Ensure a logical flow from the problem statement to hypotheses, key questions, and data sources

## 3.9 Hypothesis

The Hypothesis tab in muPDNA helps in structuring and validating problem statements by organizing key questions and tracking progress.

### Left Panel – Filters

Filters help users narrow down and focus on specific hypotheses, questions, tests, and data sources

#### 1.By Hypothesis

This filter allows users to organize and filter hypotheses based on different levels (L1, L2, L3) and categories. Hypotheses represent assumptions or potential causes of a problem, and filtering by hypothesis helps focus on a particular set of related assumptions

## Why is it Important?

- It helps identify the key challenge
- It shows what needs to be fixed
- It helps businesses focus on solutions

### Example of an Obvious Gap

If a company struggles with demand forecasting, an obvious gap could be:

"The company cannot accurately predict demand changes, leading to stock shortages or excess stock."

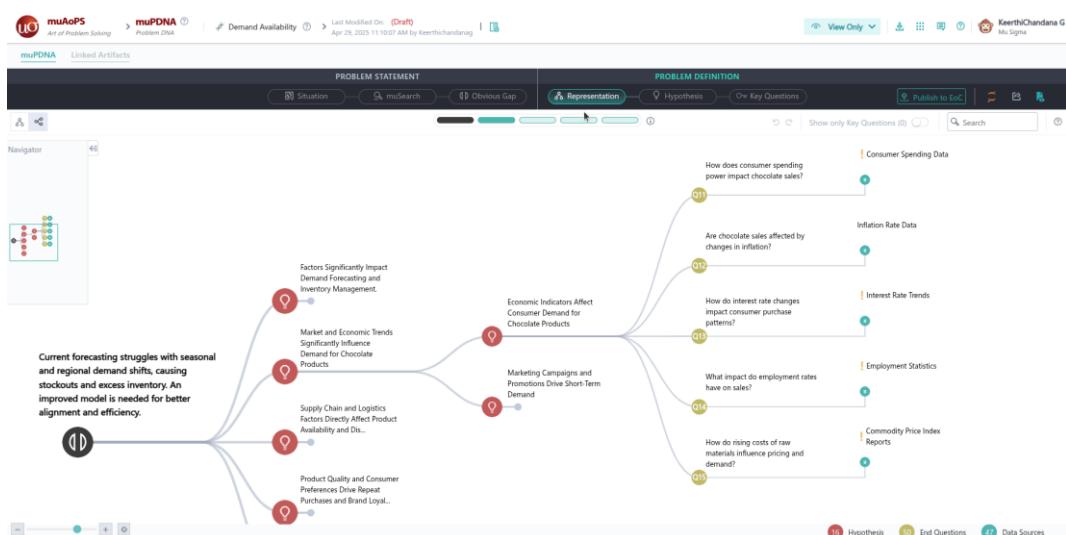
### How to Find an Obvious Gap?

- Look at the Current State: What problem exists now?
- Think about the Future State: What is the goal?
- Find the main issue stopping progress

## 3.8 Representation

The Representation tab helps in structuring the problem by breaking it down into:

- Hypotheses: Possible reasons behind the problem
- Key Questions: Critical questions that need to be answered
- Data Sources: Information required to validate the key questions



(Fig 103: Representation)

complex searches on Google Scholar but also actively finds similar search terms, expanding the scope of exploration and delivering more comprehensive insights. In short, it's not just a responder; it's a dynamic navigator enhancing your search experience.

- **Generating Search Term Details:** The final step involves the synthesis of the obtained information. The AI4NS systematically organizes and presents the details related to the search term. The output is a detailed and well-structured overview.

In essence, AI4NS amalgamates the power of semantic search, advanced embeddings, and a sophisticated language model to streamline the research process. By harnessing the capabilities of Google Scholar, it not only fetches information but transforms raw data into meaningful insights, fostering more efficient and informed research for muPDNA.

### 3.7 Obvious gap

#### What is an Obvious Gap?

An Obvious Gap is the main problem stopping a stakeholder from moving from the Current State (where they are now) to the Desired Future State (where they want to be).

The screenshot shows the muPDNA platform interface. At the top, there are navigation links for 'muAoPS', 'muPDNA', 'Demand Availability', 'Last Modified On: Draft', and 'KeerthChandana G Mu Sigma'. Below the header, the 'PROBLEM STATEMENT' and 'PROBLEM DEFINITION' sections are visible. The 'PROBLEM STATEMENT' section includes tabs for 'Situation', 'muSearch', and 'Obvious Gap'. The 'PROBLEM DEFINITION' section includes tabs for 'Representation', 'Hypothesis', and 'Key Questions'. A 'View Only' dropdown and various sharing icons are on the right.

**Current State:**

- Key Stakeholders and their Responsibilities:** Joe, a Senior Data Engineer, specializes in creating demand forecasting models, analyzing sales and inventory data, and collaborating with business teams to improve supply chain efficiency.
- Current Scenario:** Frequent demand shifts for chocolate products are leading to stockouts, especially for seasonal items. The team needs a model to enhance demand projections, optimize inventory, and plan promotions effectively.
- Purpose:** The client aims to resolve this issue by improving forecasting accuracy, balancing inventory levels, and boosting supply chain efficiency, ultimately reducing stockouts and excess stock for significant cost savings.

**Obvious Gap:**

Current forecasting struggles with seasonal and regional demand shifts, causing stockouts and excess inventory. An improved model is needed for better alignment and efficiency.

**Desired Future State:**

- Analytical Output:** Demand forecasting enables alignment of production schedules with expected demand, optimizing inventory to avoid stockouts and overstocking. It also enhances efficiency by improving sourcing and logistics, while adjusting pricing and promotions based on demand trends.
- Business Actions:** The company can schedule promotions for specific snack varieties based on demand and adjust inventory levels across warehouses and regions.
- Outcomes:** The company can optimize promotional scheduling and inventory levels by accurately forecasting demand fluctuations. This ensures better alignment between supply and demand.

(Fig 102: Obvious Gap)



- All the generated search terms would be added to the muSearch. Users can see all the generated terms with AI4NS symbol at the right side of the muSearch tab

### 3. Working of AI4NS

The screenshot shows the muAoPS user interface for a project titled 'muPDNA'. The main navigation bar includes 'muAoPS', 'muPDNA', 'Demand1111', 'Last Modified On', 'KeerthChandana G', and 'Mu Sigma'. Below the navigation is a toolbar with icons for 'Editing', 'Publish to Eng', and others. The main workspace is divided into sections: 'PROBLEM STATEMENT' (Situation, muSearch, Obvious Gap), 'PROBLEM DEFINITION' (Representation, Hypothesis, Key Questions), and 'SEARCH TERMS' (BIBLIOGRAPHY). A sidebar on the right lists 'ALL TERMS' (Showing 0 of 0) and provides a search input field. At the bottom are 'Back', 'Cancel', and 'Add terms' buttons.

(Fig 101: Working of AI4NS)

- **Initiating Google Scholar:** The first step involves AI4NS accessing Google Scholar, a repository of scholarly articles, papers, and publications. This serves as the primary source for gathering relevant information
- **Fetching Links and Synthesis:** Upon initiation, the AI diligently fetches links related to the given search term. Simultaneously, it generates a synthesis, providing a succinct overview of the selected search term. This synthesis acts as a quick reference point, offering an initial understanding of the topic selected
- **Embedding Creation and Semantic Search Execution:** One of the key strengths of this AI lies in its ability to create embeddings for the search terms. Embeddings, in this context, represent a mathematical representation of the semantic meaning of the words. These embeddings facilitate a more nuanced and context-aware search, ensuring that the retrieved information is not only relevant but also semantically connected to the user's query
- **Querying the Large Language Model (LLM):** The LLM is the brain behind our system, trained to understand and respond to natural language queries. It not only executes

- Now the AI4NS will generate details for the selected terms. Users can also cancel by clicking on cancel
- It may take some time to generate details while following all the backend steps

This screenshot shows the muSearch tab within the muDNA interface. The top navigation bar includes 'muDNA' (with a gear icon), 'Demand1111' (with a draft status), 'Last Modified On: Apr 28, 2025 5:01:15 PM by Keerthichandana G', and a 'Keerthichandana G Mu Sigma' profile. The main content area is titled 'SEARCH TERMS' and displays three search terms: 'Demand forecasting techniques', 'Customer expectations and preferences', and 'Strategic actions for growth'. Each term has a detailed description, sources, and tags. A sidebar on the right lists 'ALL TERMS' with 0 items.

(Fig 99: muSearch Tab for generated details for selected search terms)

- Now users can review and edit the generated details for all the search terms
- Click on 'add terms' after reviewing and editing details

This screenshot shows the muSearch tab with updated search terms. The 'Strategic actions for growth' term now includes a note: 'Authorized 2 minutes ago by Keerthichandana G (AI4NS)'. The 'Customer expectations and preferences' term also has an update note. The 'Demand Forecasting Techniques' term is listed under 'ALL TERMS' with a modification timestamp. The sidebar on the right shows a list of terms with their last modified times and AI4NS status.

(Fig 100: muSearch Tab showing all search terms updated by AI4NS)



- Now it will generate search terms over third iteration with creativity parameter 0.5 to 0.75

The screenshot shows the muSearch tab interface. At the top, there's a header with the muAoPS logo, navigation links like 'muPDNA', 'Demand1111', and 'Last Modified On: Apr 28, 2023 5:01:15 PM by KeerthiChandana', and a user profile for 'KeerthiChandana G Mu Sigma'. Below the header, the main area is divided into three columns representing '1ST ITERATION', '2ND ITERATION', and '3RD ITERATION'. Each column lists various search terms with checkboxes. In the 1st iteration, terms like 'Demand forecasting techniques' and 'Customer expectations in market trends' are checked. In the 2nd iteration, terms like 'Strategic actions for growth' and 'Market research and analysis' are checked. In the 3rd iteration, terms like 'Customer expectations and preferences' and 'Future state planning strategies' are checked. To the right of these columns is a sidebar titled 'ALL TERMS' showing 'Showing 0 of 0'. At the bottom, there are buttons for 'Cancel' and 'Generate Details'.

(Fig 97: muSearch Tab for selecting search terms)

- In this iteration, also terms with similarity score greater than or equal to 0.6 will be highlighted for users
- Users can select the search terms that meet their expectations and then click on generating details

The screenshot shows the muSearch tab interface. The main area displays a list of selected search terms with checkboxes. The terms listed are: 'Initiating google scholar', 'Fetching links and generating synthesis', 'Embedding creation and semantic search execution', 'Querying the large language model (LLM)', and 'Generating search term details'. Each term has a small circular icon next to it. At the bottom of the list are buttons for 'Back', 'Cancel', and 'Add terms'.

(Fig 98: muSearch Tab for generating details for selected search terms)



The screenshot shows the muSearch tab interface. At the top, it displays 'AI4NS v24.12.02 (Powered by GPT 3.5 Turbo) Suggested Terms'. Below this, a note says 'Please select terms to generate details'. The interface is divided into three sections: '1ST ITERATION' (left), '2ND ITERATION' (middle), and 'ALL TERMS' (right). The '2ND ITERATION' section is highlighted with a red border. It contains two columns of terms, each with a checkbox. In the first column of the 2nd iteration, the following terms are listed: Demand forecasting techniques, Stakeholder analysis strategies, Scenario planning methodologies, Future state goal setting, Customer expectations in market trends, Outcome measurement metrics, Action plan implementation steps, Market research data analysis, Prior problem-solving case studies, and Solution development best practices. In the second column of the 2nd iteration, the following terms are listed: Demand forecasting techniques, Stakeholder analysis in marketing, Scenario planning for business, Future state goal setting, Customer expectations and satisfaction, Outcome measurement in business, Strategic actions for growth, Market research and analysis, Competitor benchmarking strategies, and Data-driven decision making. A note at the bottom left says 'Note: The highlighted terms are those with similarity score >= 0.6.' At the bottom right are 'Cancel' and 'Generate Details' buttons.

(Fig 95: muSearch Tab for generated search terms over second iteration)

- Terms with similarity score greater than or equal to 0.6 will be highlighted for users aiding them in choosing the most relevant terms
- If the search results still not meet user's expectations again, then can click on "regenerate" to iterate for the third time

The screenshot shows the muSearch tab interface for the third iteration. The layout is identical to Fig 95, with sections for '1ST ITERATION', '2ND ITERATION', and 'ALL TERMS'. The '2ND ITERATION' section is highlighted with a red border. The '3RD ITERATION' section is also visible on the right. The '2ND ITERATION' section contains the same list of terms as in Fig 95. The '3RD ITERATION' section lists the following tasks:

- Changing the creativity parameter (temperature) from 0.5 to 0.75
- Embedding creation and semantic search execution
- Querying the large language model (LLM)
- Generating search terms
- Identifying similar terms across iterations and highlighting those with similarity scores >= 0.6

A note at the bottom left says 'Note: The highlighted terms are those with similarity score >= 0.6.' At the bottom right are 'Cancel' and 'Generate Details' buttons.

(Fig 96: muSearch Tab for generating search term over third iteration)



- Cancel: Stop generating the search terms at any time by clicking on cancel

(Fig 93: muSearch Tab for initially generated search terms)

- Regenerate: If the initial search results do not meet user's expectations, they can click on "regenerate" to iterate again, ensuring that the searches precisely align with their specific needs and preferences

(Fig 94: muSearch Tab for generating search term over second iteration)

- Now it will generate search terms over second iteration with creativity parameter 0.25 to 0.5

## Appending muSearch to an existing muPDNA:

The screenshot shows the muAoPS interface with the muPDNA page open. The top navigation bar includes the muSigma logo, 'muAoPS Art of Problem Solving', 'muPDNA Problem DNA', 'Demand Availability', 'Last Modified On: (Draft) Apr 29, 2025 11:10:07 AM by Keerthchandana G', and user profile 'KeerthChandana G Mu Sigma'. The main content area is divided into 'PROBLEM STATEMENT' and 'PROBLEM DEFINITION' sections. Under 'SEARCH TERMS', there is a list of inventory management terms and their sources. A red box highlights the '+ Add muSearch' button in the top right corner of this section. To the right, a sidebar shows recent documents like 'Efficient Demand Planning Strategies' and 'Optimal Stock Calculation Solution'.

(Fig 91: muSearch Tab for adding to existing muPDNA)

- Generate a muSearch term through AI4NS by clicking on the plus (+) icon at the top right corner of the muSearch page
- Then click on Generate using AI4NS (Artificial Intelligence for Natural Stupidity). AI4NS will start regenerating search terms

The screenshot shows the muAoPS interface with the muSearch page open. The top navigation bar is similar to Fig 91. The main content area shows the 'muSearch' tab selected. A red box highlights the 'Regenerate' button in the top right corner of the AI4NS dialog box. The dialog box displays 'AI4NS v24.12.02 (Powered by GPT 3.5 Turbo) Suggested Terms' and a note 'Please select terms to generate details'. Below is a list of AI4NS processes: Data retrieval from the situation screen, Embedding creation and semantic search execution, Querying the large language model (LLM), and Generating search terms. At the bottom are 'Cancel' and 'Generate Details' buttons.

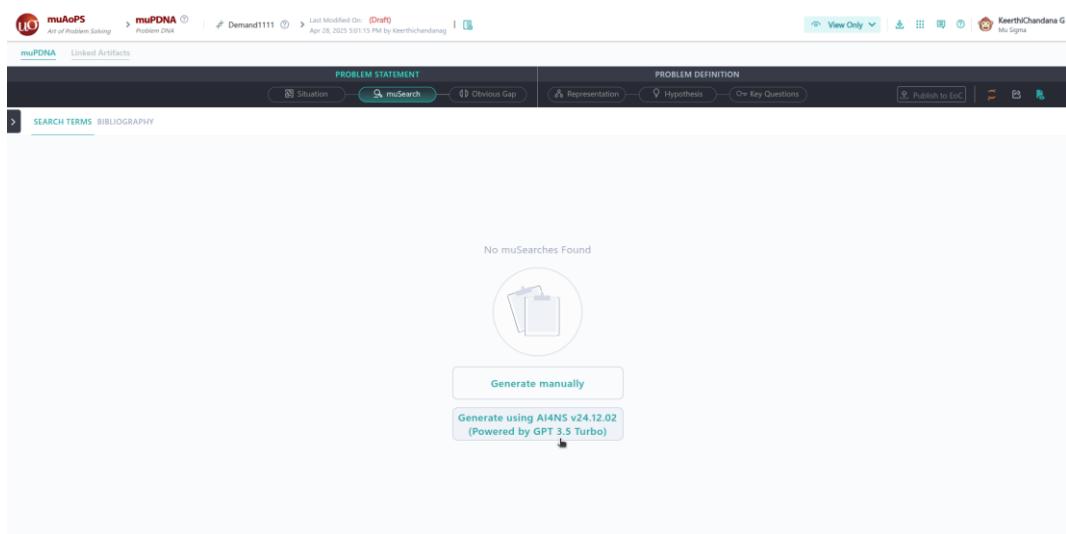
(Fig 92: muSearch Tab for generating search terms initially)

Users can manually input a search term when they already have a specific topic in mind. This is useful for well-defined research areas where users already know what they want to explore

## 2.Creating muSearch through AI4NS

Enable muSearch for both new and existing muPDNAs effortlessly.

### Adding muSearch to a new muPDNA



The screenshot shows the muAoPS interface for creating a muSearch term. At the top, there's a navigation bar with the muAoPS logo, the current page ('muPDNA'), and user information ('Demand1111', 'Last Modified On: Apr 28, 2023 5:01:15 PM by KeerthiChandana'). Below the navigation is a toolbar with various icons and a 'View Only' dropdown. The main content area has tabs for 'muPDNA' and 'Linked Artifacts'. Under 'muPDNA', there are sections for 'PROBLEM STATEMENT' (with 'Situation' and 'muSearch' fields) and 'PROBLEM DEFINITION' (with 'Representation', 'Hypothesis', and 'Key Questions' fields). A 'SEARCH TERMS' tab is also visible. The central part of the screen displays a message 'No muSearches Found' with a circular icon containing a clipboard. Below this are two buttons: 'Generate manually' and 'Generate using AI4NS v24.12.02 (Powered by GPT 3.5 Turbo)'.

(Fig 90: muSearch Tab for adding to new muPDNA)

To create a muSearch term using AI4NS, select the “Generate using AI4NS” option on the muSearch page. AI4NS will then automatically begin generating search terms for the new muPDNA.

## Main Features:

- List of Sources: Shows books, research papers, and articles related to user topic
- Source Details: Each reference includes the author, title, year, and a link to the original content
- Editing Options:
  - Edit: Modify a reference
  - Delete: Remove an entry
  - Favorite: Save important references
- Other Suggested Links: Get additional related sources for deeper research

## 3.Right-Side Filter Options

The right-side panel in muSearch provides filtering and categorization options for search terms and bibliography entries. Users can:

- View All Search Terms: A list of previously created search terms is displayed
- Sort by Last Modified: Organize search terms based on recent updates
- Add muSearch Term: A "+" button in the top-right corner allows users to create a new search term using two methods: Generating Search Terms: Manual vs AI4NS

## Add muSearch Term:

### 1. Generate Manually

The screenshot shows the muSearch interface for generating a search term. The main area is divided into sections: PROBLEM STATEMENT (Situation, muSearch, Obvious Gap), PROBLEM DEFINITION (Representation, Hypothesis, Key Questions), and SEARCH TERMS (BIBLIOGRAPHY). The BIBLIOGRAPHY section contains a text input field with the word "untitled". Below it are sections for Tags, Sources, Attachments, and Relevance. To the right, a sidebar titled "ALL TERMS" lists several search terms with their last modified dates and counts. At the bottom, there are "Cancel" and "Done" buttons.

(Fig 89: Generating muSearch through manually)

- Actions (Edit, Delete, Favorite): Users can edit, delete, or mark a search term as a favorite using the available icons

**(Fig 87: muSearch)**

## 2.Bibliography

The Bibliography section in muSearch helps users to store and organize research references for easy access.

**(Fig 88: Bibliography)**



## 3.6 muSearch

muSearch is an advanced research and bibliography management tool designed to assist users in efficiently gathering, organizing, and referencing information related to a business problem. It combines primary and secondary research methods, utilizing internal company resources such as the EOC, the vast internet, and AI-driven techniques like AI4NS (Artificial Intelligence for Natural Stupidity) to generate search terms.

The process of muSearch involves carefully searching for and collecting important ideas, terms, and knowledge that are crucial for solving the targeted business problem. It fosters teamwork and structured exploration to ensure comprehensive understanding and coverage of the problem space.

muSearch is structured into two main sections:

- **Search Terms:** Collect and organize relevant keywords and phrases, either manually or through AI4NS.
- **Bibliography:** Manage and generate bibliographic references for the gathered resources.

There are two ways to add search terms in muSearch:

1. **Generate Manually:** Users independently brainstorm and input relevant search terms.
2. **Generate using AI4NS:** Users leverage AI assistance to automatically generate effective and diverse search terms.

### 1. Search Terms

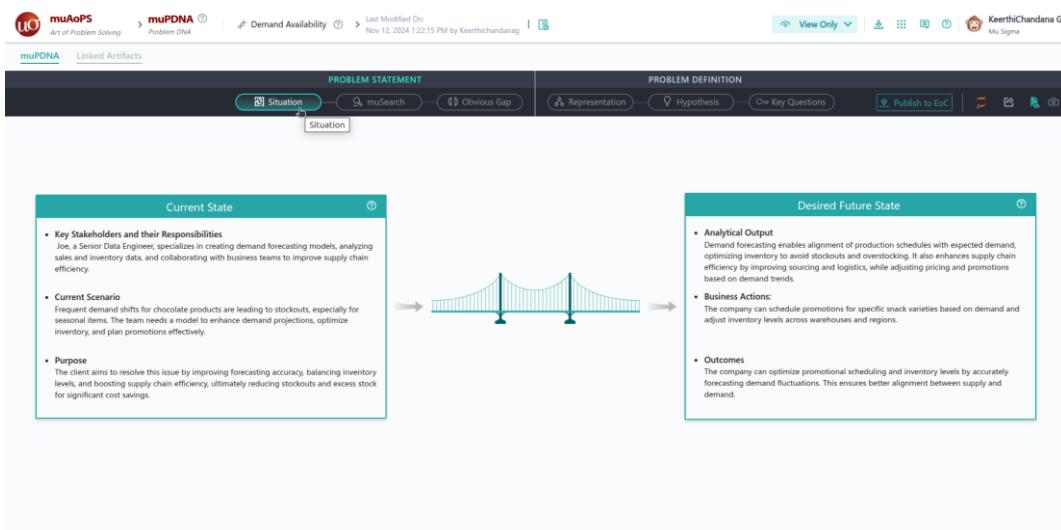
The Search Terms section in muSearch allows users to store, categorize and organize important research topics with related references. Each search term entry includes:

- **Title:** A short and descriptive name for the topic
- **Author & Timestamp:** The name of the user who created the entry and when it was last modified
- **Key Research Insights:** A summary of key points related to the topic
- **Sources:** A list of reference links, including journal articles, case studies, and relevant documents
- **Additional Suggested Links:** Extra reading materials suggested by AI, if available
- **Attachments:** Users can add attachments to support their research

## Purpose

- Defines why the problem needs to be solved
- Highlights business goals and objectives
- Shows how solving the problem will add value to the organization

By structuring the Situation effectively, users can ensure that they are addressing the right problem in a well-defined manner before moving to deeper analysis and solution-building.



(Fig 86: Situation)

## 2.Desired Future State

The Desired Future State represents the ideal outcome after addressing the problem. It ensures that the solution aligns with business goals and is measurable.

### Analytical Output:

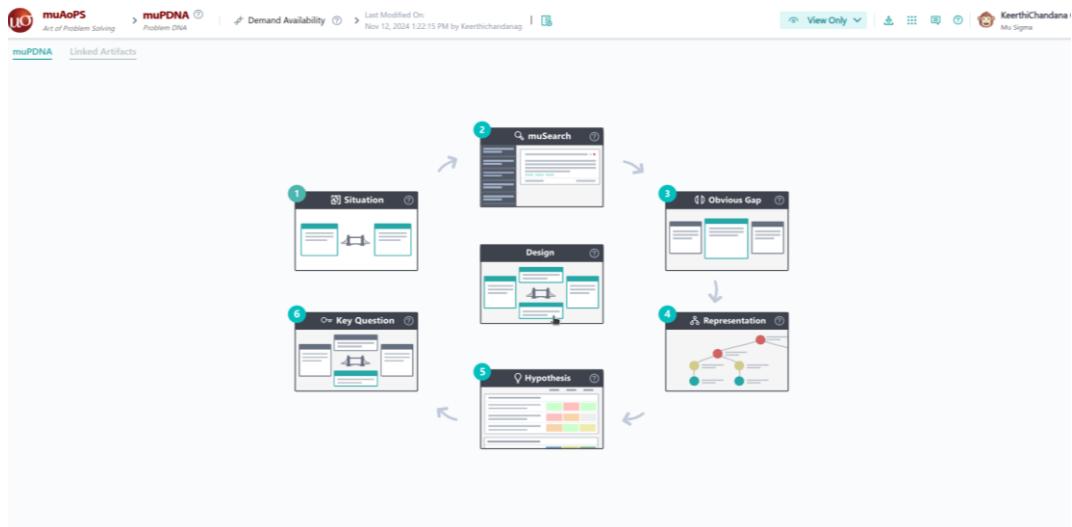
- Defines the specific output expected after solving the problem
- Includes measurable deliverables such as reports, dashboards, insights, or process improvements

### Utilization of Output:

- Explains how businesses will use the outputs to make better decisions
- Ensures that the solution is actionable and relevant to the stakeholders

### Required Input:

- Identifies the necessary data, resources, and tools needed to achieve the desired state



(Fig 85: Steps in muPDNA)

### 3.5 Situation

The Situation is the foundation of problem-solving in muPDNA. It helps in establishing a clear understanding of current challenges and setting the right direction for finding solutions. By defining the Current State and the Desired Future State, all stakeholders can align their understanding before diving into problem-solving techniques.

#### Key Components of a Situation

##### 1. Current State

The Current State helps in understanding the existing problem, the context in which it occurs, and why it is significant. It consists of:

##### Key Stakeholders and Their Responsibilities

- Identify people or teams involved in the problem
- Defines their roles and responsibilities in addressing the issue
- Help in understanding who will be responsible for implementing solutions

##### Current Scenario

- Describes the problem the business is facing
- Identifies the trigger that caused the issue
- Explaining the impact of the problem on business operations



## Updating muPDNA

- Users can modify a muPDNA by switching from View-Only Mode to Editing Mode using the dropdown on the top right
- Changes can be saved by clicking on the 'Save' option in the app header
- Version control helps in tracking modifications, improvements, and key decisions

## Deleting muPDNA

- Users can manage or remove muPDNA if necessary, ensuring only relevant ones are maintained
- By effectively using these CRUD operations, users can create, manage and refine their muPDNA for better problem-solving and decision-making

## 3.4 Explanation of Terminology

- **Situation:** Describe the Current State and Desired Future State
- **muSearch:** Search and understand the context of the problem
- **Obvious Gap:** State the Obvious Gap
- **Representation:** Represent the problem through Hypotheses, End Questions, and Data Sources
- **Hypothesis:** State the tests/data requirements for End Questions and Data Sources
- **Key Questions:** Refine the Gap and define the Key Question based on the current context of the problem
- **Design:** Provides a visual representation of the structured problem, outlining the transition from the Current State to the Desired Future State

**Note:** A tile will become active only after content is entered in the preceding tile. Users can access a tile only if it is active, meaning it contains content.

(Fig 84: muPDNA Artifacts Tab)

### 3.3 CRUD Operations of muPDNA

CRUD operations (Create, Read, Update, Delete) in muPDNA allow users to efficiently manage Problem DNAs. Here's how users can perform these operations:

#### Creating a muPDNA

- To create a muPDNA (Problem DNA) in muAoPS, users can follow the standard artifact creation process:
- To create a muPDNA, start by navigating to the 2. Common Utilities section. From there, access 2.2 Toolbar and refer to 4. Creating a New Artifact to initiate the process creating a new muPDNA
- If the user has an existing muPDNA they want to use, 2. Common Utilities section. From there, access 2.2 Toolbar and refer to section 5, 'Importing Artifact,' for easy import

#### Reading muPDNA

- Users can access different muPDNAs they have created or imported
- Multiple versions of the same muPDNA can be saved and accessed through the dropdown menu, ensuring version control

### Three Principles Behind a Good muPDNA Project

1. The process should be iterative: Representation and Hypotheses should drive the best possible design, requiring refinement over time.
2. Top-down structuring leads to better design: Rather than a scattered approach, slowing down thinking deeply about the problem leads to better solutions.
3. The right question should be challenging yet answerable: The problem should be framed in a way that makes solutions insightful and actionable.

### 3.2 Navigation to muPDNA

To access muPDNA within muAoPS, follow these steps:

- Login to muAoPS: Open muAoPS and enter the Credentials
- Go to the Homepage: After logging in, the homepage will be displayed



(Fig 83: Navigation to muPDNA)

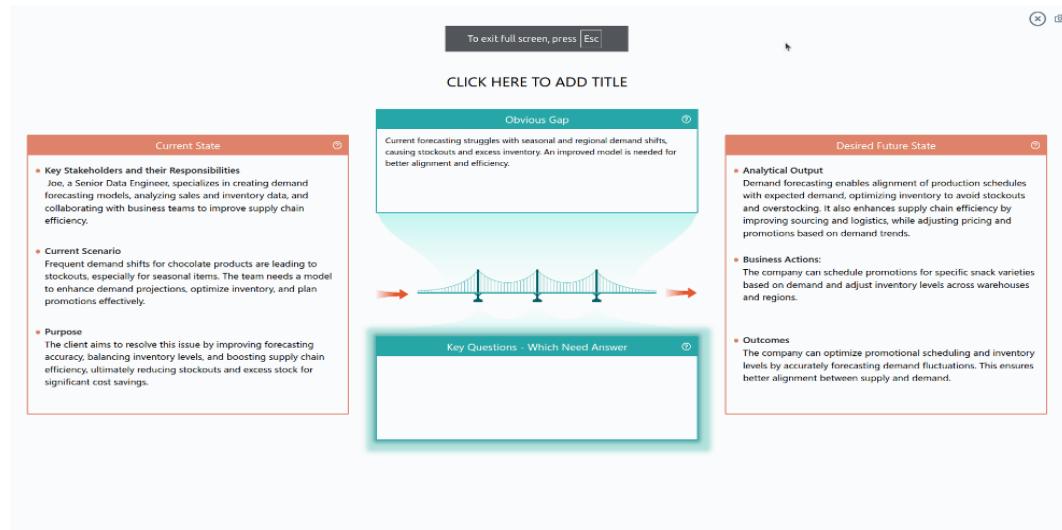
- Click on the muPDNA Icon: click the muPDNA icon to access the muPDNA section. This will take the user to the 'muPDNA' tab where all the artifacts available to the user are listed

### 3.1.2 Why do we need muPDNA

The need for muPDNA arises from the fact that many businesses struggle with defining problems clearly, leading to ineffective solutions. Without a structured approach, companies may jump to conclusions, misinterpret data, or focus on irrelevant issues.

#### Benefits of muPDNA:

- Ensures Clarity in Problem Definition:** Helps teams properly define and structure business problems before jumping into solutions
- Promotes Structured Thinking:** Encourages a top-down approach, ensuring a logical flow from problem identification to solution
- Avoid Premature Solutions:** Focuses on understanding the root cause rather than providing quick fixes
- Enhances Data-Driven Decision Making:** Ensures that hypotheses are tested using appropriate data, leading to reliable and efficient solutions
- Iterative and Adaptive:** The methodology allows for continuous refinement, making it flexible and scalable for different business scenarios



(Fig 82: muPDNA)



## 3.muPDNA

### 3.1 Introduction to muPDNA

muPDNA (Mu Sigma's Problem DNA) is a structured problem-solving framework designed to enable organizations to define and deconstruct complex business challenges. It ensures a systematic approach to problem definition, representation, and hypothesis formation, leading to more effective decision-making.

Much like DNA serves as the fundamental blueprint of life, muPDNA acts as the foundational structure for solving business problems with precision and clarity. It emphasizes structured thinking, hypothesis-driven analysis, and iterative problem refinement, making sure that businesses arrive at data-backed, well-designed solutions rather than jumping to premature conclusions.

#### 3.1.1 muPDNA what and how?

muPDNA provides a step-by-step methodology to define business problems clearly and systematically. It structures problems in a way that promotes the best possible design by focusing on asking the right questions.

It consists of three key strands:

##### 1.Design

- Understand the Current State and Desired Future State
- Identify gaps in business processes based on extensive research
- Define a key contextual question that is challenging yet solvable

##### 2.Representation

- Identify key hypotheses that represent the problem.
- Use a top-down approach to break the problem into structured components
- Avoid premature solutions and focus on understanding the problem first

##### 3.Hypothesis

- Formulate hypotheses to test possible solutions to the problem
- Design structured tests to answer key business questions
- Identify and analyze the data required to execute these tests

By iterating through these steps, muPDNA ensures a well-framed problem statement that leads to the most effective solution.