Final Report
for
Capital Program Assessment System

Prepared for
New Jersey Department of Transportation

by
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I. EXECUTIVE SUMMARY

A. Summary

The Capital Program Assessment System (CAPAS) is a database management system that allows users to enter, update, and review budget, cost, and status information on capital projects within New Jersey Department of Transportation (NJDOT).

Currently, an Executive Information System (EIS) provides summary status information for the department's capital program elements. This system integrates schedule and progress information, financial and budget allocations, and cost data through direct and indirect links to four other systems. Of the four systems supporting EIS, the PM+ system provides a DOS-based window environment for entering project budget information and is the backbone for integrating the cost data from the Workhorse Financial Management Information System (FMIS).

CAPAS is developed with the intention to provide an efficient and user-friendly on-line transaction processing (OLTP) budget system to replace the PM+ system currently in use. The CAPAS management system provides a true MS-windows environment for data entry, analyses, and reporting, including the use of graphical displays where appropriate. There are four major functional groups in the system: 1) Data input including budget input, cost upload, and administrative; 2) Data review including budget review, budget change, FMIS, cost summary, and performance; 3) Project report; 4) Data retrieval scope selection.

In addition, CAPAS contains a comment-input field with which users can input comments on selected subjects to communicate with the system administrator as well as among all relevant users. The details of these functional groups and the operational methods are discussed in the following sections.

B. Background

The New Jersey Department of Transportation (NJDOT) has taken a leadership role in developing new approaches to manage the capital improvement program. Structural reorganization of NJDOT has resulted in a focus on project management, with a shift to the use of project managers as the new paradigm. Recognizing the need to provide these new project managers with the tools necessary to effectively manage the projects and to concomitant with the structural changes, PC workstation applications have been developed to build on and supplement cost data are available through the mainframe Workhorse Financial Management Information System (FMIS).

Currently, an Executive Information System (EIS) provides summary status information for the department's capital program elements. This system integrates schedule and progress information, financial and budget allocations, and cost data through direct and indirect links to four other systems. The cost data come from Financial Management Information System (FMIS) and PM+. Schedule information is obtained from project
models based on Primavera (P3) and general project information of description and location is available through the Project Reporting System (PRS). Budget allocations are then established within the PM+ system.

Of the four systems supporting EIS, the PM+ system is the most recent to come on-line. This application provides a DOS-based window environment for entering project budget information and is the backbone for integrating the cost data from the FMIS. Users of this system, according to personnel from the Department’s Program Support Services, have identified a number of shortcomings of the system as well as some enhancements that would improve the overall effectiveness and utilization of the PM+ system. While this is not unusual for any new system coming on-line, such user comments must be addressed to encourage the acceptance of the system.

C. Project Objective

NJIT proposes to assist the NJDOT in achieving the objective of an efficient and user-friendly project management system through short-term enhancements to the PM+ system. The result will be a Capital Program Assessment System (CAPAS) which will:

1. Provide an MS Windows environment with the use of graphical displays where appropriate for data entry, analysis, and reporting.

2. Address the needs of users.

3. Establish a framework for user defined and implemented enhancements.

4. Expand the basic financial control features available to include more flexibility in budget allocations, earned value computations, and alternatives for estimation cost at completion and percent complete.

5. Based on dollars, work hours, or both.

6. Enhance reporting flexibility.
II. CAPAS SYSTEM DESIGN

A. CAPAS Data Structure Design

1. Budget Data

Figure 1 illustrates the budget data structure used by the CAPAS system. As shown in the diagram, in-house budgets are initially input at Activity level based on Murt_Code (equivalent to Payroll Unit code).

These activity budgets are then rolled up to Budget Item level, where budgets of Consultants by Contract ID, Undistributed, Expense, Right-Of-Way, Utility, and Data Processing as well as Estimate are entered. A predefined percentage of the approved in-
house budgets under Murt Code will be automatically contributed to Management Reserve accounts at Job Number and Phase levels respectively. Subsequently, the project’s Management Reserve will equal to the summation of management reserves of all phases.

2. Cost Data

All incurred cost data are stored in the FMIS system on the department's mainframe computer. At the beginning of every month, all cost data for the previous month's Federal Billing Periods are downloaded and saved in the SQL Server Cost200 database on the Bureau's Network File Sever. This process also downloads the latest version of the code tables for UPC Code, Job Numbers, Function Code and other look-up tables used by the PRS.

CAPAS uploads the periodic cost data (both current and cumulative) from the Cost200 database and summarizes the cost information by Job Number and Budget Item. Meanwhile, CAPAS will validate that the incoming cost data are not duplications of cost records already uploaded before.

If any valid cost records have no corresponding budget entries, CAPAS will create empty budget records for them. An Exception Report will also be generated to list these records in order to track their budget entry later.
### B. Data Form Structure Design

There are four levels of data form structure for CAPAS system from top level to detail level. At Project level, users can view the total budget, cost, and performance information for each phase, but they can not change or append any data. At Phase level, users can view budget/cost summary for each budget item which rolls up to phase totals, and input budget data for each phase. At Budget Item (BI) level, users can view the detail budget/cost information for each activity, and input budget data for each budget item. At Activity level, users can input budget data for each activity.

1. **Project level**

   **Budget summary**

<table>
<thead>
<tr>
<th>UPC</th>
<th>Phase</th>
<th>Estimate</th>
<th>Original Baseline</th>
<th>Current Baseline</th>
<th>Current Budget</th>
<th>PE_Date</th>
</tr>
</thead>
</table>

   **Performance**

<table>
<thead>
<tr>
<th>UPC</th>
<th>Phase</th>
<th>ACWP</th>
<th>BCWS</th>
<th>BCWP</th>
<th>CV</th>
<th>SV</th>
<th>PE_Date</th>
</tr>
</thead>
</table>

   **Cost Summary**

<table>
<thead>
<tr>
<th>UPC</th>
<th>Phase</th>
<th>BI (Murt, Row, etc)</th>
<th>Hours_Incrd_ThisPeriod</th>
<th>Budget_Incrd_ThisPeriod</th>
<th>Hours_Incrd_UptoDate</th>
<th>Budget_Incrd_UptoDate</th>
<th>PE_Date</th>
</tr>
</thead>
</table>
2. Phase level

Data Review - budget/cost summary

Budget Input at phase level

<table>
<thead>
<tr>
<th>UPC</th>
<th>Phase</th>
<th>Estimate</th>
<th>Management Reserve</th>
<th>Budget Allocated</th>
<th>Current Budget</th>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

BI (Murt, Row, Undistributed, Expense, Contract_ID, Util, DP#)

<table>
<thead>
<tr>
<th>Hours</th>
<th>Amount</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>(Hours_Original)</td>
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<tr>
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<td></td>
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<td></td>
<td>(Hours_ChangeThisPeriod)</td>
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<tr>
<td></td>
<td></td>
<td>(Budget_ChangeThisPeriod)</td>
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<tr>
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<td></td>
<td>(Hours_Forecast_ToComplete)</td>
</tr>
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<td></td>
<td>(Hours_Incrd_ThisPeriod)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(Hours_Incrd_UptoDate)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PE_Date</td>
</tr>
</tbody>
</table>

3. Budget Item level

Data Review – budget/cost at BI level

<table>
<thead>
<tr>
<th>UPC</th>
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<th>Job_No</th>
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</thead>
<tbody>
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<td></td>
</tr>
</tbody>
</table>

BI (Murt, Row, Undistributed, etc.)

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<thead>
<tr>
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<th>Activity Description</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td>Hours_Original</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Budget_Original</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Hours_Approved</td>
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<tr>
<td></td>
<td></td>
<td>Budget_Approved</td>
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<tr>
<td></td>
<td></td>
<td>Hours_Pending</td>
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<td></td>
<td></td>
<td>Budget_Pending</td>
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<td></td>
<td></td>
<td>(Current_Hours)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(Current_Budget)</td>
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<td>(Hours_ChangeThisPeriod)</td>
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<td>(Amount_Incrd_ThisPeriod)</td>
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<td></td>
<td>(Hours_Incrd_UptoDate)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(Amount_Incrd_UptoDate)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>PE_Date</th>
</tr>
</thead>
</table>
**Budget Input**

- UPC
- Phase
- Job_No
- BI (Murt, Row, etc.)
  - Undistributed
  - Hours
  - Amount
- Manager Name
- PE_Date
- UserName

**Cost Download**

- UPC
- Phase
- Job_No
- BI (Murt, Row, etc.)
  - Name
  - Activity Code
  - Activity Description
  - Hours_Incrd_ThisPeriod
  - Amount_Incrd_ThisPeriod
  - Hours_Incrd_UptoDate
  - Amount_Incrd_Uptodate
  - Last_UpdateDate
- PE_Date

4. Activity level

**Budget Input**

- UPC
- Phase
- BI (Murt, Row, etc.)
  - Undistributed
  - Activity Code
  - Activity Description
  - Hours
- Budget_Original
- Budget_Approved
- Budget_Pending
- Funding_Source
- Last_UpdateDate
- PE_Date
- UserName

**Cost Download – from FMIS**

- UPC
- Phase
- Job_No
- BI (Murt, Row, etc.)
  - Name
  - Activity Code
  - Activity Description
  - Incrd_Hours
  - Incrd_Baseline
  - Incrd_Fringe
  - Incrd_Leave
  - (Additive_Factor)
  - (Additive_Federal)
  - (Total_Hours_State)
  - (Total_Amt_State)
  - (Total_Hours_Federal)
  - (Total_Amt_Federal)
- PE_Date
C. CAPAS SQL Database Design

CAPAS system is designed to use Microsoft SQL server as the database management system. All access is mandated to be through SQL Server stored procedures. CAPAS database design includes following seven components.

1. Set up SQL server

2. Create Database
   - Create Tables – define defaults, constraints, and permissions.
   - Create Views – define rules, constraints, and permissions.
   - Create SQL scripts – design stored procedures and triggers to connect database. Supporting stored procedures are listed in Attachment 1.

3. User groups
   - CAPAS_Administrative – includes updating monthly cost; processing budget batch updates; adding new UPC (project number), Job Numbers, ROW (Right of Way), Utility, DP# and Contract_ID, and maintaining security issues.
   - CAPAS_Update – includes inputting normal data and updating budgets and comments.
   - SQLUsers – read only group for budget and cost review.

4. Working tables
   - Periodic cost table downloaded from FMIS.
   - Historical data table for input project budgets and incurred costs under different levels.
   - List tables of project number and description, project and program managers, Job Number, Sub_Job number, Murt_Code, DP#, ROW, contract number and the description, Reserve Rate, State and Federal Factors.
   - Alert table of stored messages.

The CAPAS tables are listed in Attachment 2.
D. CAPAS Interface Design

One of the purposes of CAPAS system is to design a user-friendly interface to improve efficiency of the system. CAPAS provides an MS Windows environment with the use of graphical displays where appropriate for data entry, analysis, and reporting.

CAPAS provides clear and useful processing and warning messages during data input and update to help users’ operation. In addition, users can use help file displayed on the screen to check all the contents related to CAPAS system at any time.

Some main interface designs are shown on following figures.

1) The start-up frame for CAPAS

![Figure 2. CAPAS Start Up Interface](image-url)
2) Budget Input by Budget Item

![Budget Input by Budget Item](image1)

**Figure 3. Budget Input by Budget Item**

3) Budget Input by Activity

![Budget Input by Activity](image2)

**Figure 4. Budget Input by Activity**
4) Budget Review at Phase Level

**Figure 5.** Budget Review at Phase Level
III. CAPAS SYSTEM ANALYSIS

A. Terminology for CAPAS System

1. Management Reserve: Portion of the overall established project budgets that is used by the project manager during the execution of the work. This account can be used to cover minor revisions and unexpected work.

2. Undistributed Budget: Portion of the overall project total that has not yet been refined into activities or budget detailed accounts by the project manager.

3. Budget Cost of Work Scheduled (BCWS): Spread budget to be earned by period and cumulative over entire design duration.


5. Actual Cost of Work Performed (ACWP): Incurred cost charged by period and cumulative.

6. Funding Source: Source of the budget including Reserved, Undistributed, Scope Change, Original, and Budget Change.

7. Funding Status: Pending or Approved for the budget.
B. Data Relationship for CAPAS System

1. General Current Budget

   • Current Budget for the Project = Budget Allocated (including Undistributed) + Reserve at Project level
   • Current Budget for the Phase = Budget Allocated (including Undistributed) + Reserve at Phase level

2. Original Budget, Budget Baseline, and Current Budget for project summary report

   • Baseline Original = Original Budget Allocated + Original Management Reserved
   • Baseline Budget = Baseline Original + Scope Change Approved
   • Current Budget = Baseline Original + Scope Change Approved + Budget Change Approved

3. Performance Measures

   • Earned Value [BCWP] = Percent to Complete * Current Budget
   • Forecast_To_Complete = Current Budget – Earned Value [BCWP]
   • Budget Forecast_Final = Current Budget + Actual Cost of Work Performed [ACWP] – Earned Value [BCWP]
   • Cost Variance = Earned Value [BCWP] – Actual Cost of Work Performed [ACWP]
   • Schedule Variance = Earned Value [BCWP] – Budget Cost of Work Scheduled [BCWS]
C. Data Processing Logic

After the SQL server periodically downloads the budget and incurred cost data from the mainframe, CAPAS cost system can be used to input, retrieve, and restore current and cumulative budget/cost information randomly between the SQL server and PCs on the network. The following data processing logic chart shows the basic information flow paths used in the system development.

![Data Processing Logic Chart](image-url)

**Figure 7.** Data Processing Logic Chart
IV. CAPAS SYSTEM OPERATIONAL FUNCTION

There are four main functional groups in CAPAS, including data input, data review, report review, and comments as shown on Figure 8. Before entering any functional group, the system prompts users to choose UPC (project) codes to limit the amount of data retrieved.

Figure 8. CAPAS Function Chart
A. Data Input Function

Data input is the largest functional group in CAPAS and is classified into three smaller parts of budget input, cost upload, and administrative. Budget input provides the function to input and edit budget information; cost upload provides the function to download up-to-date cost data from FMIS to CAPAS; and administrative provides the function to perform administrative tasks.

1. Budget Input

Budget Input provides two data entry levels: budget input by budget item and budget input by activity. At each level, users can select one of the six project phases (Scoping, Design, ROW, Utility, Construction Engineering, and Construction) currently used by NJDOT and update information for the selected phase.

Under budget input by budget item level (see Figure 3), users can select the appropriate Job Number, Sub_Job Number, Funding Source, Funding Status, Log_ID, DP#, and Contract_ID if necessary. Then users can input budget amount for the selected budget item, such as Undistributed, Expense, Contract, ROW, Utility, etc.

For Phase Scoping, Design, ROW, and Construction Engineering, users can also input budget information by activity (see Figure 4). Under this level, users first select the appropriate Murt_Code and reserve rate, then input the budgeted hours for the activities one by one. Before users input any budgets for the selected phase, they can input the total estimated amount for this phase under the Budget Item level.

Users can not only input new budget for a budget item or an activity, but also update the existing budget amount or hours by simply entering the updated data under the selected item or activity.
Figure 9. Budget Operational Process
The information of current budget, allocated, reserved, and undistributed budget at phase level and at project level is also provided on each screen for users’ convenience. This information is updated automatically every time users input new data.

During budget input processing, users can reset the current data entries at any time before saving data to database. In addition, the system provides many comprehensive process and warning messages to help users’ operation.

Figure 9 displays the budget-input operational process for CAPAS.

2. Cost Upload

The cost upload function executes the following tasks through a Transaction batch file:

- Checking duplication on current period costs downloaded from mainframe.
- Appending new cost records into Cost_History table.
- Appending/merging new cost records into Cost_FMIS table.
- Appending/merging new cost records into Cost_Summary table.
- Generating Exceptional List for new cost records with no corresponding budget entry in the database.
- Updating the calculations for Percentage_To_Complete coefficients at Phase level.

The transactions will rollback if any task fails during the cost upload process. Only database administrator has the permission to carry on this operation and it should be done only once in every downloading period.

3. Administrative

Administrative tasks consist of six connected functions including adding UPC, Job_No, Sub_Job, Activity, Murt_Code, Contract_ID, and DP#; assigning responsibility; editing Excel spreadsheet (for in-house budget inputs); updating additives (Federal and State, respectively); editing salaries (by UPC and Murt_Code); and updating reserve rate list table.

1) Adding UPC, Job_No, Sub_Job, Activity, Murt_Code, Contract_ID, and DP#:

- Adding a new non-duplicated project (UPC) code, project title, project category and manager name.
- Adding a valid Job_No for the selected project and project phase.
- Adding a valid Sub_Job for the selected project and job number.
- Adding a new activity number and description for the selected project phase.
- Adding a valid Murt_Code for the selected project manager.
- Adding a valid Contract_No for the selected project, phase, Job_No, and Sub_Job.
- Adding a valid DP# for the selected project and job.
2) Assigning responsibility:

- Adding a new project manager name and ID for a project.
- Changing the project manager for a project.

3) Editing Excel spreadsheet (for in-house budget inputs):

Excel spreadsheet function allows user to enter in-house budget hours with Excel spreadsheets by transferring system control to Excel window. The application automatically checks the average salary for each valid Murt_Code on the template sheet. If no valid average salary exists, the corresponding column of the Murt_Code is temporarily deleted. In addition, the system will delete all the Murt_Codes from the budget-input sheet. Users can choose to either exit Excel application to edit relevant average salaries or continue to work on the budget input process. Before saving the Murt_Code budgets, users need to enter valid UPC Code, Job_No, and Sub_Job at the specified locations of the budget sheet.

While finishing the original budget entry, "Save to Excel" command will open a data input interface for users to provide information about Funding Source, Funding Status, LOD_ID, LOG_Date, and Reserved Rate. After saving the budget entries successfully into Excel workbooks, "Save to CAPAS" command will automatically transfer budget data into CAPAS SQL database.

4) Updating additives (Federal and State, respectively):

- Changing state factor by entering a valid numeric value.
- Changing federal factor by entering a valid numeric value.

5) Editing salaries (by UPC and Murt_Code):

Users can edit the average salaries for the desired project and Murt_Code.

6) Updating reserve rate list table:

Users can update budget reserve rate for the selected project and job.
B. Data Review Function

Data Review consists of four sub functions including budget review, FMIS review, cost summary, and performance.

1. Budget Review

Budget review allows users to view the summarized budget data at project level, phase level, and activity level.

- **Budget review by project level**
  The system displays the summarized Original Budget, Baseline Budget, and Current Budget (State) for each phase of the selected project. It also provides some general project information, such as project category, PM_Name, and PM_ID.

- **Budget review by phase level**
  The system displays the summarized current and history budget information under user’s selection. Users can freely select the desired project, phase, Job_No, Sub_Job, Contract_ID, and Murt_Code to view different information.

- **Budget review by activity level**
  The system displays the detail budget information at activity level for selected project number (UPC), Job_No, Sub_Job, and Murt_Code.

2. FMIS Review

The system displays the cumulative incurred cost data downloaded from FMIS by budget item. The fields on the screen can be rearranged by drag-and-drop operation for users to view the cost data from different angles.

3. Cost Summary Review

The system provides summary budget/cost information, including current and cumulative as well as forecast to complete data, to give an overview of the current status of the project.

4. Performance Review

The system shows all the key elements for cost management, such as Budgeted Cost of Work Scheduled (BCWS), Budgeted Cost of Work Performed (BCWP), Actual Cost of Work Performed (ACWP), as well as other performance indices used by NJDOT.
C. Report Function

CAPAS provides summarized information on four different reports based on users’ selection of Crystal reports:

- Performance Report by Working Hours
- Performance Report by Dollar Amounts
- Cost_Summary Report by UPC and Phase
- Cost_Summary Report in BI details
V. CONCLUSION FOR CAPAS SYSTEM

To conclude, this project accomplishes the following:

1. Provides a user friendly MS Windows environment with the use of appropriate graphical displays based on users’ requirements for valid data entry, review, analysis, and reporting.

2. Expands the basic financial control features available to include more flexibility in budget allocations, earned value computations and alternatives for final cost estimation and percent complete during the project life.

3. Calculates and displays budget/cost information based on dollars, work-hours, or both. It also provides flexible review and reporting functions.

4. Provides clear on-line help and user manual for the system users.

5. Downloads historical cost data from mainframe and saves the processed information to SQL server.