**Automated parking solution for a multi-storied office space**

 Our group has chosen to work on a project to develop an automated parking solution for a multi-storied office space. The team has imagined a multi-storied building with each level dedicated to one of the IT solutions offices. The challenge is developing a smart solution to address the parking hassles for the employees of each office. The proposed solution should address the security concerns of the office spaces and also provide the capability to each of the employee to park in their office’s dedicated spaces and control any parking violations.

**Goals of the project:**

The proposed project should resolve the parking issues of the offices with these following goals.

1.       The solution should only allow parking for authorized vehicles

2.       The solution should be able to notify the employees on the available spaces

3.       The solution should automatically find the vehicles/employees who breaches the conditions

**Stakeholders**: This project consists of 6 major stakeholders namely, Companies who have leased out the office spaces, Owner of the building, Security staff, Employees with cars and other four wheelers, Employees with motor bikes, Employees with bikes. Each of the stakeholder’s roles are described below.

1.       Owner of the building: Any physical modifications to the building must be approved by the owner of the building and all the changes must be approved by the council and be completed to the owner’s satisfaction

2.       Companies: Companies are the major stakeholders who are funding the project and will determine deliverables and deadlines of the project.

3.       Security Staff: Security staff is another stakeholder whose role is to determine the proposed solution does not breach any existing security systems and does not account for new vulnerabilities.

4.       Employees with cars: These are the end users of the proposed solution who will get the benefits of the automated parking system and provide the requirements and edge case scenarios.

5.       Employees with Motor bikes: These stakeholder’s equal shares in the parking space and the share the parking space and should not cause any hazards to them.

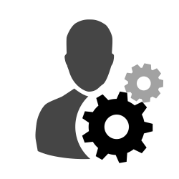
6.       Employees with bikes: The new proposed solution should not affect the bicycle users, and the new solution should not affect their existing rights and spaces.

1. **Functional Requirements**
   1. **The Scope of the Work**

Parking management in multi storied building is always has been confusing and particularly when the parking lots are shared between multiple companies in the building. It will be difficult for everyone, a person who brings a vehicle in for parking will have a tough time in finding the free slot. For the security officers it will be difficult to track the vehicles violating with parking lots such as parking for prolonged duration, entry of unauthorised vehicles and vehicles parked in wrong places. And for the building owners it will be very difficult to have optimised space utilisation. This application will address all the above mentioned scenarios.

The purpose of this project us to develop a centralised parking lot management system that will provide real-time data on the status of each parking slot. The system will monitor inflow and outflow of vehicles. Unauthorised vehicle entry is strictly under control. This will alert the security offers in case of policy / rule violations. This gives the companies to buy and allocate the number of parking lots for their employees which cuts down the prices and make most of the parking area.

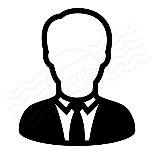
The building manager has to approve architectures changes to parking lots to comply with the designed system, the building should have restricted entries and exists so that the developed application will limit the entry to authorised vehicles only. This also shows the availability of slots in the parking lot and alerts the security officers about vehicles parked for long time. And it is required to install sensors in each parking lot to check the status of parking lot so that the system can update the slot availability. Each individual who uses the parking service will possess a parking card provided by their company. There will be displays in parking lot that shows the information on available parking slots.



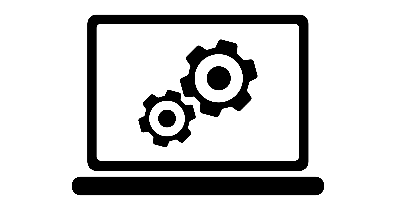
Building Owner



Security Officer



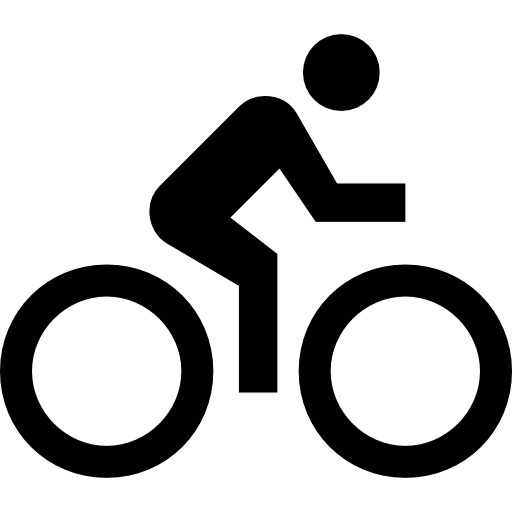
Company Admin



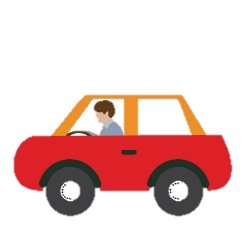
Parking management System



Employee with Motorbike



Employee with Bike



Employee with Car

**Figure.** A context diagram of the scope of the work for the construction of the Petronas Oil Processing Plant. The opposing arrows correspond to the input and output of information between the work and the adjacent external environment.

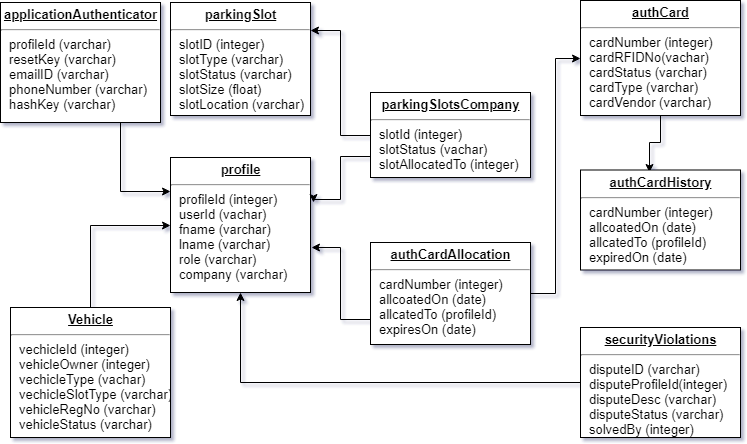
**Table.** This tables gives the description of interactions that can be made by each individual on the application. This also gives the detailed view of work flow by each involving party for the implementation of this project in real time.

|  |  |  |
| --- | --- | --- |
| **Stakeholder** | **INPUT AND OUTPUT** | **SUMMARY OF BUC** |
| Building Manager | > Approves the architecture  changes to the site  > Can view available parking  lots and their status. |  |
| Security Officer | > Create exceptions for the new vehicles  and emergency needs.  > Can view the security breaches and  Policy violations |  |
| Company Admin | > Can manage the number of Parking  slots available.  > Can assign the available parking slots  to the employees.  > In case of paid parking can view the  Billing Information. |  |
| Employee with  Bike | > Can view the available parking slots.  > Can swipe the card to Get authorization. |  |
| Employee with  Motorbike | > Can view the available parking slots.  > Can swipe the card to Get authorization. |  |
| Employee with  Car | > Can view the available parking slots.  > Can swipe the card to Get authorization. |  |

*Note: The* ***blue text*** *shows the* ***inputs*** *while the* ***red text*** *shows the* ***output****.*

* 1. **Business Data Model and Data Dictionary**

The system will have the capacity to trace the engineering and construction changes and queries within the systems as well as cross reference engineering information and materials in the system. It will provide an overall completion status of the entire oil processing plant by system or areas in all stages of the completion and inspection test records to be made available for generating, printing, and recording of the completion activities, acceptance and verification. Figure 4 is the proposed structural model of the computerized turnover completion system that identifies the class entities and their respective tasks. The UML data dictionary is presented in table 4.



**Figure 4.** A class diagram showing the proposed structural model of the computerized turnover completion system. The diagram explicitly describes the relationship between class entities (e.g., actors and the structural hierarchy of the construction) with the corresponding methods.

**Table 4.** The entity classes with their corresponding attributes and functions:

|  |  |  |
| --- | --- | --- |
| **ENTITY CLASS** | **ATTRIBUTE** | **FUNCTION** |
| **Construction Coordinator**   * Plan the whole schedule for Mechanical Completion | * Employee ID   + A unique identifier * First name * The given name of the engineer * Family name * The surname of the engineer | * Perform Status Report Monitoring |
| **Commissioning Coordinator**   * Plan the whole schedule for Commissioning | * Employee ID   + A unique identifier * First name * The given name of the engineer * Family name * The surname of the engineer | * Perform Status Report Monitoring |
| **Field engineer**   * Prepares the team for Construction and monitors the progress on site | * Employee ID   + A unique identifier * First name * The given name of the engineer * Family name * The surname of the engineer | * Perform Status Report Monitoring |
| **Commissioning Team**   * Review Engineering Data and monitor Commissioning on site | * Employee ID   + A unique identifier * First name * The given name of the engineer * Family name * The surname of the engineer | * Perform Status Report Monitoring |
| **System Completion Team**   * Review Engineering Data and monitor Commissioning on site | * Employee ID   + A unique identifier * First name * The given name of the engineer * Family name * The surname of the engineer | * Perform Status Report Monitoring * Populate Engineering data in the System |
| **Discipline Engineer**   * Review Engineering Data and monitor Commissioning on site | * Employee ID   + A unique identifier * First name * The given name of the engineer * Family name   The surname of the engineer | * Perform Status Report Monitoring |
| **Vendor, Contractor, Fabricator**   * Provide Equipment Package and services in the Project. Does the installation and testing of the facilitiy | * Employee ID   + A unique identifier * First name * The given name of the engineer * Family name   The surname of the engineer | * Perform Status Report Monitoring |
| **Quality Control Engineer**   * The person responsible for the approval of the installed equipment | * Employee ID   + A unique identifier * First name * The given name of the engineer * Family name * The surname of the engineer | * Approve equipment as installed |
| **Commissioning Technician**   * The person responsible for inspecting the equipment if it is functioning or not | * Employee ID   + A unique identifier * First name * The given name of the engineer * Family name * The surname of the engineer | * Inspect equipment as functioning |
| **Area**   * The highest in the structural hierarchy of the construction * Compose of many systems | * Area number   + A unique identifier * Description * A brief description of the area | * Track installation by area * Track inspection by area * Generate mechanical completion certificate * Generate ready for commissioning certificate * Generate ready for start-up certificate |
| **System**   * The 2nd level in the structural hierarchy of the construction * It is what the area is made of * Compose of maximum of 3 subsystems | * System number   + A unique identifier * Name * The name of the system * Description * A brief description of the system | * Track installation by system * Track inspection by system * Generate system mechanical completion certificate |
| **Subsystem**   * The 3rd level in the structural hierarchy of the construction * It is what the system is made of * Compose of maximum of 3 subsystems | * Type * The specific classification of the subsystem * Subsystem Description * A brief description of the subsystem |  |
| **Electrical circuit/Equipment**   * A type of subsystem made up of electrical circuits | * Electronic circuit number   + A unique identifier for an electrical circuit * Date installed * The date of installation in DDMMYYYY * Date inspected * The date of inspection in DDMMYYYY | * Track installation by circuit * Track inspection by circuit * Generate inspection test result |
| **Telecom circuit**   * A type of subsystem made up of telecommunication circuits | * Electronic circuit number   + A unique identifier for a telecom circuit * Date installed * The date of installation in DDMMYYYY * Date inspected * The date of inspection in DDMMYYYY | * Track installation by circuit * Track inspection by circuit * Generate inspection test result |
| **Instrument loop/Equipment**   * A type of subsystem made up of instrumentations other than electrical and telecommunication | * Electronic circuit number   + A unique identifier for an instrumentation loop * Date installed * The date of installation in DDMMYYYY * Date inspected * The date of inspection in DDMMYYYY | * Track installation by loop * Track inspection by loop * Generate inspection test result |

* 1. **The Scope of the Product**

The computerized turnover completion system will incorporate information of all activities from all construction sites that are within the scope of the work. It will have the capability to detail, maintain records of, and report all activities necessary to achieve successful completion of the project. Specifically, the system will control, track and report the completion status of all sites for inspection such as mechanical completion, equipment function testing for commissioning, and start up. Figure 5 describes the actors and their interaction with the computerized turnover completion system. Moreover, the system will contain, but not limited to, the following records that will be collated by the system management team to populate system:

|  |  |
| --- | --- |
| Drawings | Loop check detail |
| Engineering data and specification sheets | Cable test detail |
| Function code list | Baseline survey |
| Location list | System hand-over approval |
| Discipline list | Commissioning checks |
| Equipment list | System completion approval |
| Line list | Ready for start-up status |
| Cable schedules | Flushing and pressure testing records |
| Instrument index |  |

In addition, the computerized turnover completion system will have the functional feature of generating daily progress report either by system, discipline or area. Table 5 identifies the specific reports that that can be generated out of the system.

**Table 5**. Types of electronic reports that can be generated by the computerized completion system classified by category with corresponding report types.

|  |  |
| --- | --- |
| **CATEGORY** | **TYPE OF REPORT** |
| By system | * Percentage completion * Outstanding items * All items * Discipline breakdown within the system |
| By discipline | * Percentage completion * Outstanding items * All items |
| By Area | * Percentage completion * Outstanding items * All items |
| Others | * Items due at a certain period (e.g., day, week, month or certain date) |



**Figure 5.** The use-case diagram summarizes the product use case with actors and their interaction with the computerized turnover completion system. The role of the system management team is critical in maintaining the system for the entire duration of the project.

* 1. **Functional Requirements**

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| **Requirement No:** 1 | **Requirement Type:** 9 (Functional) | **Event in PUC:** 1,2,3 |
| **Description:** | The system shall attach and display with degree of efficiency the intended check sheets for installation, inspection, and commissioning of equipment’s. | |
| **Rationale:** | The Equipment installed and inspected on site requires a specific check sheets to fill up and record the results and values attained during the check. | |
| **Originator:** | System Management Team | |
| **Fit Criterion:** | The system shall display and made available the appropriate Check sheets in hierarchical order starting from Area, Systems, Subsystems, Loop drawings and tags, within a second per hierarchy. It may have one or more check sheets assigned to tags depending on its type. | |
| **Customer Satisfaction:** 5 (5 Highest; 1 Lowest)  **Customer Dissatisfaction:** 1 (5 Highest; 1 Lowest) | | |
| **Dependencies:** None  **Conflict: None:** None | | |
| **Supporting materials:** | Project Execution Plan Manual – Functional Requirements Section | |
| **History:** | Project Execution Plan Manual (Version 2), July 2017 | |

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| --- | --- | --- |
| **Requirement No:** 2 | **Requirement Type:** 9 (Functional) | **Event in PUC:** 3,4,5 |
| **Description:** | The system shall display the intended Certificate for handover of system from one phase to the next | |
| **Rationale:** | For the discipline lead and Supervisors to certify that the system is Mechanically Complete and/ or Ready for Commissioning | |
| **Originator:** | System Management Team | |
| **Fit Criterion:** | The system shall display and made available the appropriate certificates in hierarchical order starting from Area, Systems and Subsystems. One certificate to attach for each stage completed. | |
| **Customer Satisfaction:** 5 (5 Highest; 1 Lowest)  **Customer Dissatisfaction:** 1 (5 Highest; 1 Lowest) | | |
| **Dependencies:** None  **Conflict: None:** None | | |
| **Supporting materials:** | Project Execution Plan Manual – Functional Requirements Section | |
| **History:** | Project Execution Plan Manual (Version 2), July 2017 | |

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| --- | --- | --- | --- |
| **Requirement No:** 3 | **Requirement Type:** 9 (Functional) | **Event in PUC:** 3 | |
| **Description:** | The system shall generate the necessary forms and records (e. g. ITRs) for recording completion activities and acceptance and verification. | |
| **Rationale:** | The check sheets ITR (Inspection Test Record) and FTR (Function Test Record) are used to record the completion of installation and testing of equipment. Responsible Inspectors records the values attained during the walkthrough. | |
| **Source:** | Joint Application Development (JAD) with the stakeholders conducted 15th of July 2017. | |
| **Fit Criterion:** | The check sheet forms are generated by the system per equipment. Tablet or mobile is configured to access the system and the forms so responsible Inspectors can bring this on site and record the actual inspection. It is mandatory that inspectors close at least 50 forms within the day. | |
| **Customer Satisfaction:** 5 (5 Highest; 1 Lowest)  **Customer Dissatisfaction:** 1 (5 Highest; 1 Lowest) | | |
| **Dependencies:** None  **Conflict: None:** None | | |
| **Supporting materials:** | Minutes of the meeting prepared by the System Management Team dated July 16, 2017 from JAD. | |
| **History:** | Project Execution Plan Manual (Version 2), July 2017 | |

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| --- | --- | --- |
| **Requirement No:** 4 | **Requirement Type:** 9 (Functional) | **Event in PUC:** 3 |
| **Description:** | The system can link all equipment tag numbers, system, sub-system numbers with key engineering documents such as P&ID’s, SLD’s, Loop Drawings, Data Sheets, commissioning procedures, FAT, and similar aspects with Vendor engineering data to effectively execute on-site inspection and test scope. | | |
| **Rationale:** | To make the Engineering Documents available for all users to use for reference and review. | | |
| **Source:** | System Management Team | | |
| **Fit Criterion:** | System can show in hierarchy the Engineering documents under Tags, subsystem and System for quick access and referencing of Engineers during their inspection and Function testing. The attachment can be limited to its size and there are no number of attachment can be saved as long as it is relevant to the equipment. | | |
| **Customer Satisfaction:** 5 (5 Highest; 1 Lowest)  **Customer Dissatisfaction:** 1 (5 Highest; 1 Lowest) | | | |
| **Dependencies:** None  **Conflict: None:** None | | | |
| **Supporting materials:** | Project Execution Plan Manual – Functional Requirements Section | | |
| **History:** | Project Execution Plan Manual (Version 2), July 2017 | | |

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| --- | --- | --- | --- |
| **Requirement No:** 5 | **Requirement Type:** 9 (Functional) | **Event in PUC:** 3 | |
| **Description:** | The system shall have traceability features for engineering and construction changes and project queries with respect to equipment’s under systems, sub-systems and areas such that all changes are implemented, tested, commissioned and certified. | |
| **Rationale:** | The system data should be aligned with the one on site and on new revision drawing. All deleted items on site should be removed in the system and new items are to be added. | |
| **Source:** | System Management Team | |
| **Fit Criterion:** | To trace the engineering and construction changes and queries in systems. These changes will be implemented, tested, commissioned and certified. Within 24 hours the changes must be applied in the system, new tags added, non-existing tags on site to be deleted or updated by the System Administrators. | |
| **Customer Satisfaction:** 5 (5 Highest; 1 Lowest)  **Customer Dissatisfaction:** 1 (5 Highest; 1 Lowest) | | |
| **Dependencies:** None  **Conflict: None:** None | | |
| **Supporting materials:** | Project Execution Plan Manual – Functional Requirements Section | |
| **History:** | Project Execution Plan Manual (Version 2), July 2017 | |

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| **Requirement No:** 6 | **Requirement Type:** 9 (Functional) | **Event in PUC:** 3 | |
| **Description:** | The system shall provide Overall Completion status of all facilities, systems, subsystems and area | |
| **Rationale:** | Stakeholders has planned the Mechanical Completion and Commissioning of the facility. They need to monitor the status and track daily activities. It shows the numbers of completed check sheets and the outstanding. | |
| **Source:** | Joint Application Development (JAD) with the stakeholders conducted 15th of July 2017. | |
| **Fit Criterion:** | System can report the overall status of all equipment installed and commissioned on site per system, per subsystem, discipline, and per check sheet type. In a day, the progress of completed inspection must be more than 50 tags and function tested at least 25. The ITRs/FTR’s closed and signed by construction and commissioning should be uploaded in the system immediately to show the actual status on site. | |
| **Customer Satisfaction:** 5 (5 Highest; 1 Lowest)  **Customer Dissatisfaction:** 1 (5 Highest; 1 Lowest) | | |
| **Dependencies:** None  **Conflict: None:** None | | |
| **Supporting materials:** | Minutes of the meeting prepared by the System Management Team dated July 16, 2017 from JAD. | |
| **History:** | Project Execution Plan Manual (Version 2), July 2017 | |

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| --- | --- | --- | --- |
| **Requirement No:** 7 | **Requirement Type:** 9 (Functional) | **Event in PUC:** 4,5 | |
| **Description:** | The system shall generate Certification report status throughout all project completions stages | |
| **Rationale:** | Stakeholders to know how many systems are Mechanically Complete and Ready to be Commissioned, Certification is necessary to be able to proceed to the next stage. | |
| **Source:** | System Management Team | |
| **Fit Criterion:** | During the peak of the project the target is to make 2-3 system 100% Mechanically Complete to proceed to Commissioning. | |
| **Customer Satisfaction:** 5 (5 Highest; 1 Lowest)  **Customer Dissatisfaction:** 1 (5 Highest; 1 Lowest) | | |
| **Dependencies:** None  **Conflict: None:** None | | |
| **Supporting materials:** | Project Execution Plan Manual – Functional Requirements Section | |
| **History:** | Project Execution Plan Manual (Version 2), July 2017 | |

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| --- | --- | --- | --- |
| **Requirement No:** 8 | **Requirement Type:** 9 (Functional) | **Event in PUC:** 1,2 | |
| **Description:** | The system additional feature allows user to Electronically access the check sheets, fills up the form and close the E-check sheets online. Then turnover system to complete the status of check sheet. | |
| **Rationale:** | Stakeholders can monitor and track the daily progress on site of all Construction and Commissioning works by using the Overall Completion Status report of Check sheets per System. | |
| **Source:** | System Management Team | |
| **Fit Criterion:** | The System can report the check sheets status completed by Construction and Commissioning within the day in just one click. | |
| **Customer Satisfaction:** 5 (5 Highest; 1 Lowest)  **Customer Dissatisfaction:** 1 (5 Highest; 1 Lowest) | | |
| **Dependencies:** None  **Conflict: None:** None | | |
| **Supporting materials:** | Project Execution Plan Manual – Functional Requirements Section | |
| **History:** | Project Execution Plan Manual (Version 2), July 2017 | |