

Car Parking System Project

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By

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Submitted to

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Assignment Two

In COMP.6209

System Analysis and Design

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1. Business Requirement Identification

Document all the requirements for the system by studying the scenario and make required assumptions.

PROCESS	Functional Requirements	Non-Functional Requirements
Entry System	The entry gate and machine are placed in front of the carpark to cut off entrance to the carpark before ticket release.	The entry machine should be placed far enough away from the entry gate so clientele in large vehicles can pull up and request a ticket before entry into the carpark.
	The entry machine must include a screen to display messages and prompts to the customer.	<p>The screen must be bright enough to see messages and prompts during the night-time and daytime.</p> <p>The screen must have a high enough pixel count to read messages and prompts displayed on it.</p> <p>The screen's messages and prompts must be displayed in human readable text.</p> <p>The screen must be viewable from vehicles of all sizes i.e., jeep, hatchback etc.</p>
	The entry machine must provide a card scanner for government services and staff (access card members) to access the parking complex.	<p>The access card scanner must be reachable from vehicles of all sizes i.e., jeep, hatchback etc.</p> <p>The access card scanner must be clearly labelled with human readable text.</p>
	The entry machine must provide a pre-paid ticket scanner for clientele who have purchased a ticket before arriving at the parking complex.	<p>The ticket scanner must be reachable from vehicles of all sizes i.e., jeep, hatchback etc.</p> <p>The ticket scanner must be labelled with human readable text alongside an icon showing how to scan the card i.e., what position to insert the ticket.</p>
	The entry machine must include a button to press for clientele to get a ticket for	The button must be reachable from vehicles of all sizes i.e., jeep, hatchback etc.

	entrance into the parking complex.	
	Produce/Print a ticket	<p>The ticket produced must be human and machine readable (i.e., it must include a barcode and data readable by the customer).</p> <p>Must be able to print a ticket within a reasonable time frame i.e., 10 – 25 seconds.</p> <p>Printed tickets must be accessible from vehicles of all sizes i.e., jeep, hatchback etc.</p>
	An intercom system on the entry machine for customers to alert staff of problems.	<p>The intercom system includes a microphone, speakers, and a button for clientele to converse with staff.</p> <p>The intercom system is reachable from vehicles of all sizes i.e., jeep, hatchback etc.</p> <p>The intercom system is easily operated by clientele.</p> <p>The intercom system is labelled with human readable text.</p>
	Operational staff members must be notified by the car parking system if a problem arises such as a car not driving into the car park upon ticket release.	
	The entry gate must only respond (open or close) to signals sent by the car parking system from the entry machine.	The entry gate must open or close vertically within 20 – 30 seconds of the signal being sent.
	If the car park is completely occupied, display a sign to inform possible clientele that there are no more spaces available.	<p>The sign should be bright enough to see at night-time and during the daytime.</p> <p>The sign should be easily read and understood by clientele driving on the road.</p>

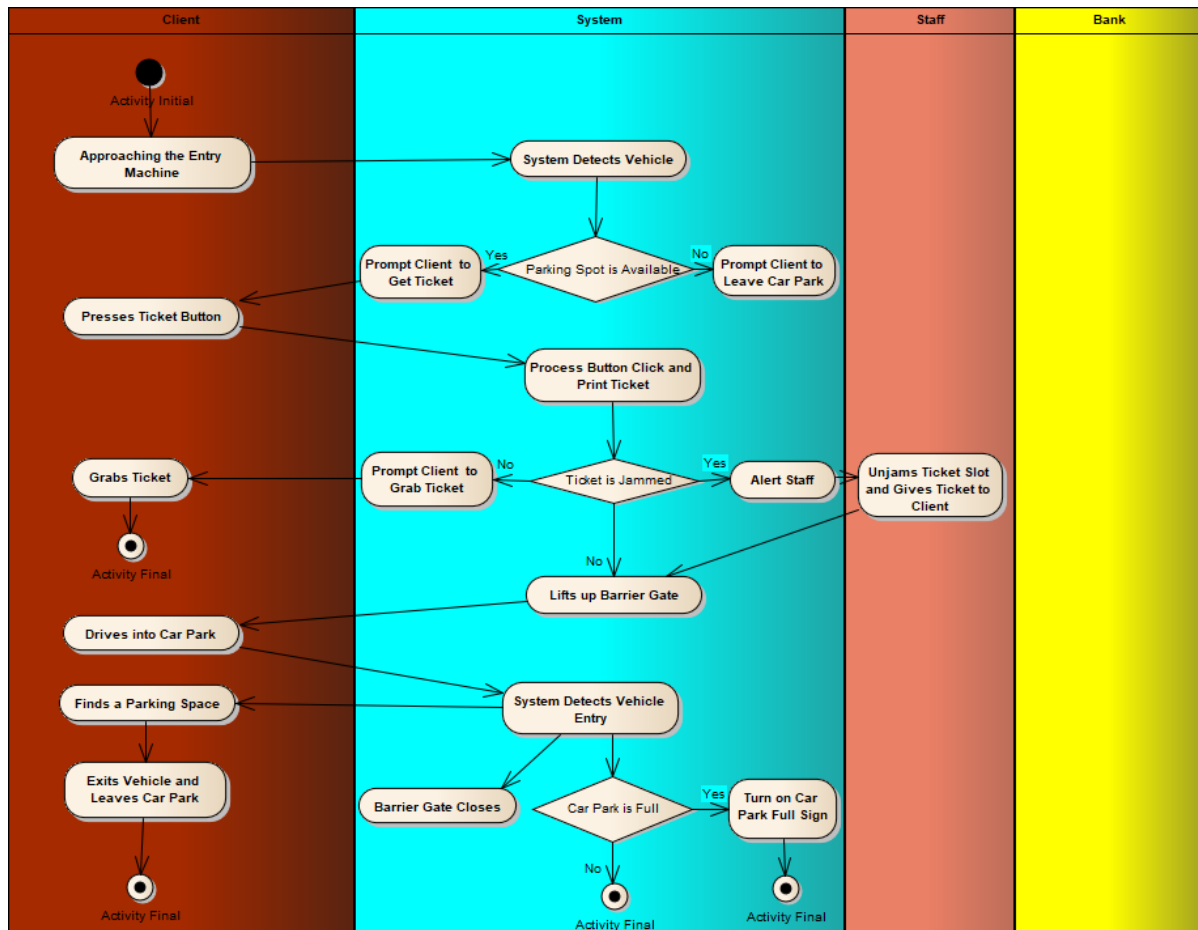
		The sign should be placed on the street corner of the car park to avoid congestion and inconvenience.
Payment System	Tickets are accurately read by the pay-station to properly calculate the entry and exit time to ensure the correct charge is given to clientele.	The pay-station performs this operation in a timely fashion i.e., 5 seconds.
	The pay-station provides clientele with a screen and buttons to interact it.	<p>The screen and buttons are easily accessible and visible to clientele.</p> <p>The screen is large enough to be viewable by clientele.</p> <p>The screen has a good enough resolution to display human readable information.</p> <p>The screen's brightness is decent enough to see information during the daytime and night-time.</p> <p>The buttons are clearly labelled with human readable text i.e., help, pre-pay, receipt, lost ticket, and cancel.</p>
	The pay-station provides a slot for a ticket to be scanned and read.	<p>The slot for the ticket to be scanned is conveniently placed and seen.</p> <p>The slot for the ticket to be scanned is labelled with human readable text alongside an icon clearly displaying what position to insert the ticket.</p>
	The pay-station provides a range of payment options including pay-wave, cash, eftpos and credit card.	<p>The payment options are easily accessible and visible to clientele.</p> <p>The payment options are labelled with human readable text alongside icons to show how to work them.</p> <p>The payment transactions are performed in a timely fashion i.e., 30 seconds to a minute to avoid customer congestion on any given pay-station.</p>
	The pay-station provides/prints a receipt once a ticket is scanned and paid.	The printed receipt contains human readable data about the transaction such as ticket number/id, payment cost etc.
	Releases change once the payment exchange is	

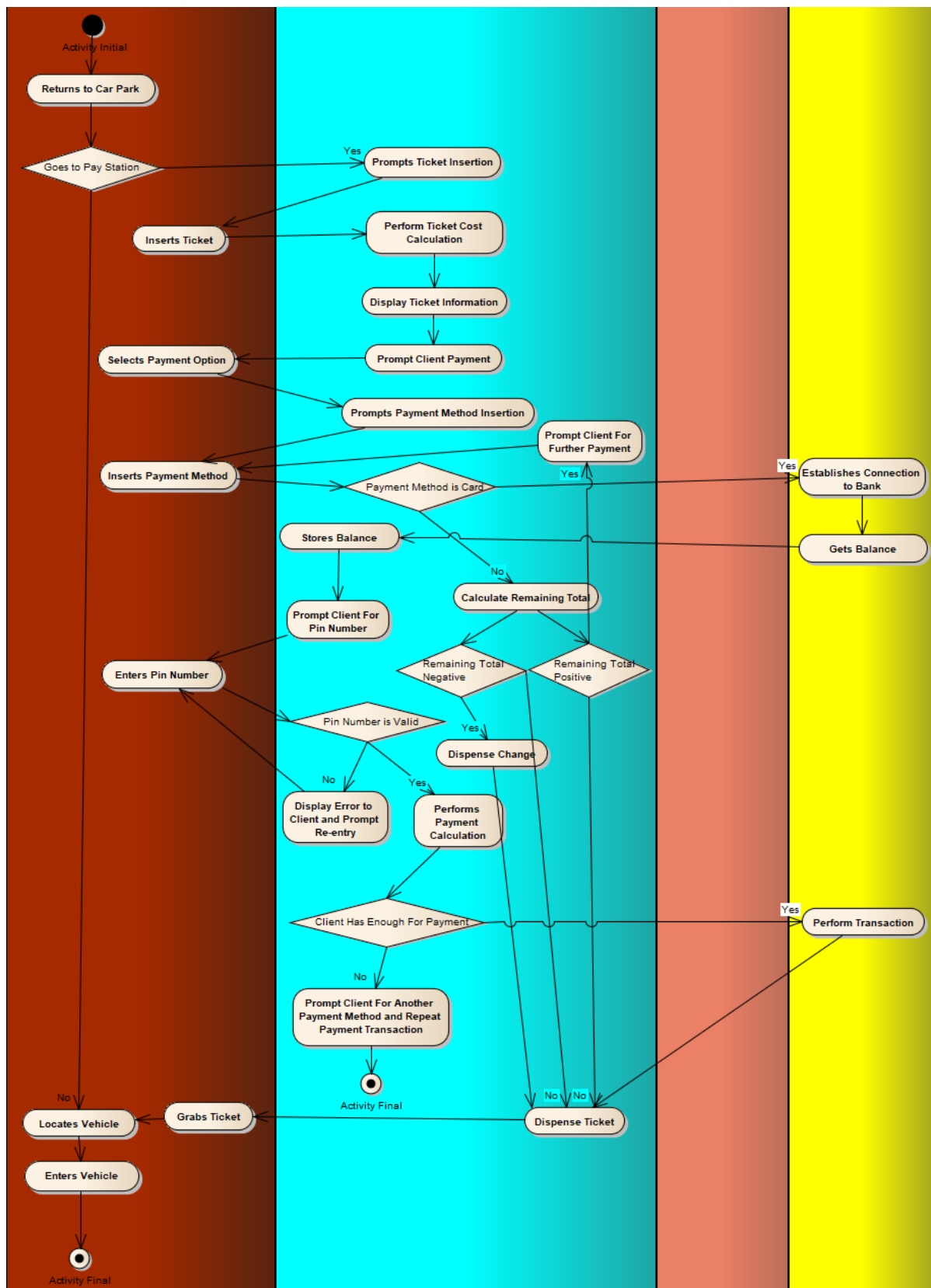
	complete dependent on if cash was used during the exchange.	
	The pay-station provides an intercom system for clientele to talk to staff to resolve possible issues that arise within the parking complex.	<p>The intercom system includes a microphone, speakers, and a button for clientele to converse with staff.</p> <p>The intercom system is easily operated by clientele.</p> <p>The intercom's button is easily seen and accessed.</p> <p>The intercom's button is labelled with human readable text.</p>
Exit System	The exit gate and machine are placed in front of the carpark's exit to cut off departure from the carpark before ticket payment and verification.	
	The exit gate must only respond (open or close) to signals sent by the car parking system from the exit machine.	The exit gate must open or close vertically within 20 – 30 seconds of the signal being sent.
	The exit machine must include a screen to display messages and prompts to the client.	The screen must be easily seen from within vehicles of all sizes i.e., jeep, hatchback etc.
	The exit machine must provide a card scanner for government services and staff (access card members) to access the parking complex.	<p>The access card scanner must be visible and reachable from vehicles.</p> <p>The access card scanner must be clearly labelled with human readable text.</p>
	The exit machine must provide a ticket scanner for clientele to scan their ticket for the machine to calculate and prompt payment.	<p>The ticket scanner must be easily seen and reachable from vehicles.</p> <p>The ticket scanner must be labelled with human readable text alongside an icon showing how to scan the ticket i.e., what position to insert the ticket.</p>
	The exit machine accurately reads tickets to properly calculate the entry and exit	

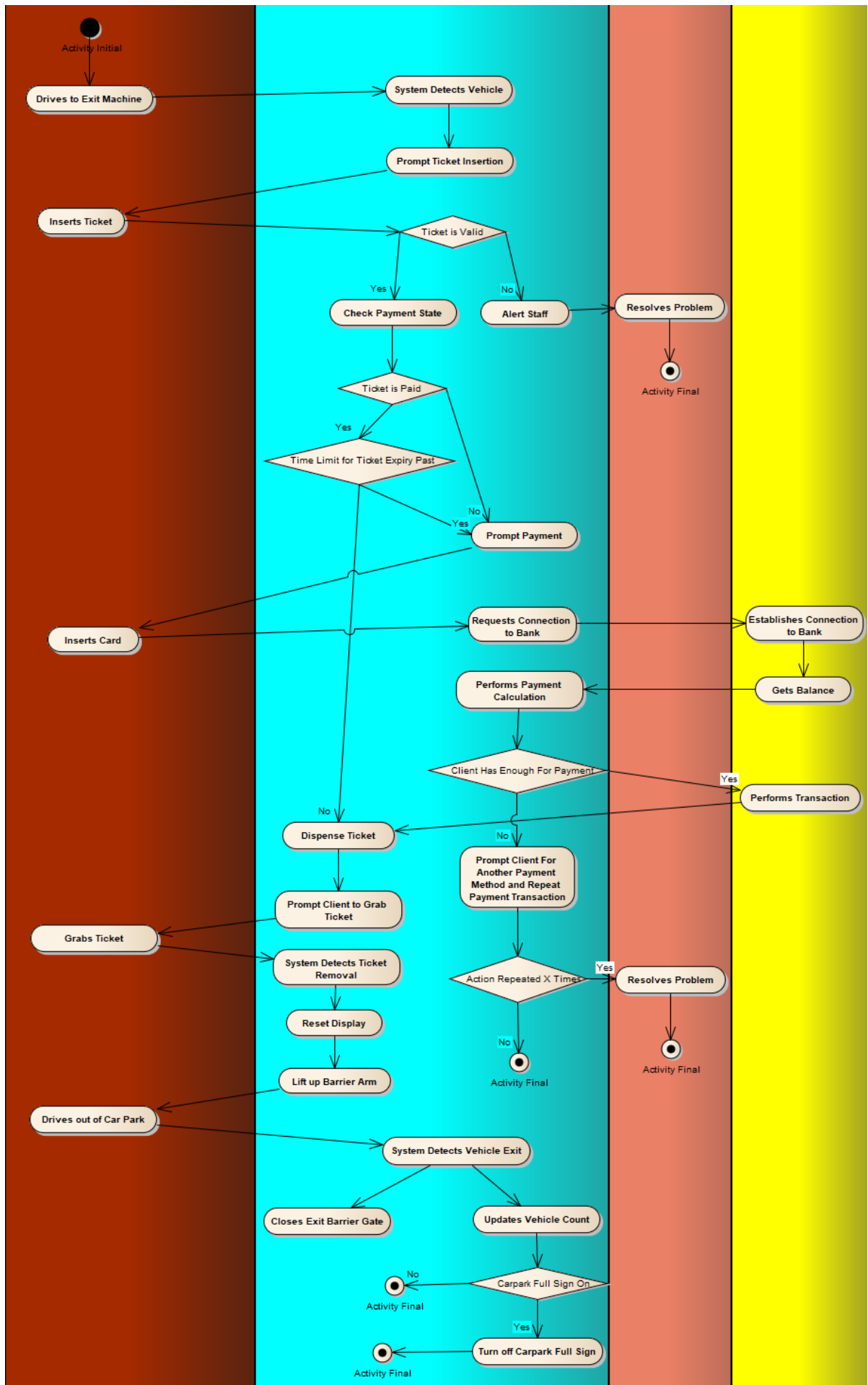
	time to ensure the correct charge is given to clientele.	
	The exit-machine prompt's payment if a time limit of x has been reached since the ticket was last paid.	
	The exit machine provides a range of card-based payment options i.e., visa, master card and credit card.	<p>The payment option slots are clearly labelled with human readable text alongside icons to show how they function.</p> <p>The payment options are reachable from vehicles of all sizes i.e., hatchback, jeep etc.</p>
	The exit machine must include a cancel button to cancel payments currently in progress.	<p>The cancel button must be easily seen and reachable from vehicles of all sizes i.e., jeep, hatchback etc.</p> <p>The cancel button must be labelled with human readable text to avoid customer confusion.</p>
	The exit machine provides/prints a receipt once a ticket is scanned and paid.	The printed receipt contains human readable data about the transaction such as ticket number/id, payment cost etc.
	Operational staff members must be notified by the car parking system if any problems arise such as a car not driving out of the car park upon ticket payment and verification.	
	The exit machine provides an intercom system for clientele to alert staff of problems.	<p>The intercom system includes a microphone, speakers, and a button for clientele to converse with staff.</p> <p>The intercom system is reachable from vehicles of all sizes i.e., hatchback, jeep etc.</p> <p>The intercom system is easily operated by clientele.</p> <p>The intercom system is labelled with human readable text.</p>

2. Activity Diagram For Whole Assumed System (Full System Process Modelling)

Produce an activity diagram for the whole required system including swim-lanes, objects and actors involved in the system operations. This activity diagram is being used as a process modelling to understand the whole operational processes within car parking system.







3. Actor Glossary / Use Case Glossary

A. Actor Glossary

Actor Glossary (A list of actors [rules] related to the system).

Actor Name	Synonym	Description
Client	Customer, Clientele, User	An individual with a vehicle who utilizes the car parking service.
Staff – Operations	Operational Staff, Operational Staff Members, Car Park Staff, Staff Workers	An individual who is actively working for the car parking complex.
Staff – Vehicle	Staff Member in a Vehicle, Car Park Staff, Staff Workers	An individual who works for the car parking complex but is currently in a vehicle.
Government Service Member	Government Worker, Emergency Service Member	An individual who works for the government such as a cop, ambulance driver, fire truck driver etc.
Bank	Bank System	An external system linked to the car parking system which allows payment via card services such as PayWave, Credit Card, Mastercard etc.
Parking System	Car Parking System, Car Park System, The System, Operational System	The system that oversees the day-to-day operations for the car parking system such as controlling the gates, issuing tickets, managing payments, and alerting staff of possible problems.

B. Use Case Glossary

Use Case Glossary (A list of all use cases for the system describing what this system is being used for).

ID	Use Case Name	Use Case Description	Participating Actors
1A	Request Access Card Entry	This use case describes the necessary steps and conditions that allow entry of an access card member into the car parking complex.	Government Service Member Staff – Vehicle Parking System Staff – Operations
2A	Request Pre- Paid Ticket Entry	This use case describes the necessary steps and conditions that allow a pre-paid ticket client into the car parking complex.	Client Parking System Staff – Operations

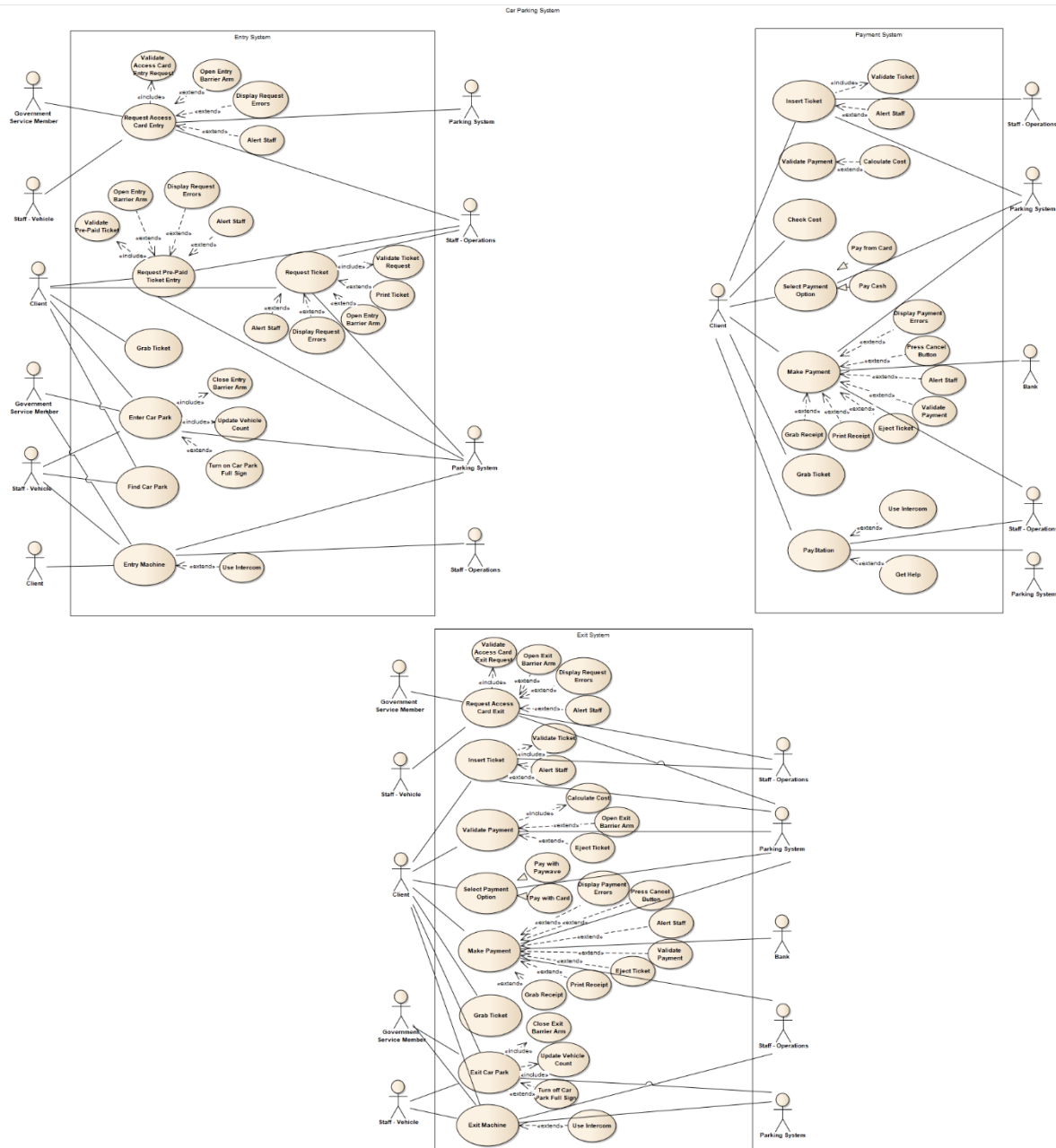
3A	Request Ticket	This use case describes the necessary steps and conditions for a client to request a ticket for entry into the parking complex.	Client Parking System Staff – Operations
4A	Grab Ticket	This use case describes the step of a client grabbing their ticket.	Client
5A	Enter Car Park	This use case describes the steps and conditions that occur when a client, government service member, or staff member in a vehicle enters the parking complex.	Client Government Service Member Staff - Vehicle Parking System
6A	Find Car Park	This use case describes the step of a client or staff member in a vehicle locating and parking in a parking space.	Client Staff – Vehicle
7A	Entry Machine	This use case describes the extra operational features of the entry machine such as an intercom system for clients, government service members, or staff members in vehicles to alert operational staff of possible issues.	Government Service Member Staff – Vehicle Client Parking System Staff – Operations
1B	Insert Ticket	This use case describes the steps and conditions which occur when a client inserts their ticket into the pay-station or exit machine.	Client Staff – Operations Parking System
2B	Validate Payment	This use case describes the steps which occur when a ticket is validated by the pay-station or exit machine, and in the case of the exit machine, if a ticket is paid, it is swiftly followed by the exit barrier gate opening, and the ticket being ejected.	Client Staff – Operations Parking System
3B	Check Cost	This use case describes the step of a client checking the cost of their ticket and coming to a conclusion about which payment method they are going to use.	Client

4B	Select Payment Option	This use case describes the step of the client selecting a payment option.	Client Parking System
5B	Make Payment	This use case describes the necessary steps and conditions of the client making a ticket payment.	Client Parking System Bank Staff – Operations
6B	Pay-Station	This use case describes the extra operational functionality of the pay-station, such as an intercom system for clients to alert operational staff members of possible issues, alongside a help button for information of how to perform payments of a ticket.	Client Staff – Operations Parking System
1C	Request Access Card Exit	This use case describes the necessary steps and conditions that allow an access card member to exit the parking complex.	Government Service Member Staff – Vehicle Staff – Operations Parking System
2C	Exit Car Park	This use case describes the necessary steps and conditions which occur when a vehicle exits the parking complex.	Client Government Service Member Staff – Vehicle Parking System
3C	Exit Machine	This use case describes the extra operational functionality of the exit machine such as an intercom system which allows clients, government service members, and staff members in vehicles to communicating with operational staff members to alert them of possible issues that arise.	Client Government Service Member Staff – Vehicle Staff – Operations Parking System

4. Use Case Diagrams / Use Case Narratives

A. Use Case Diagram

Use Case Model Diagram for the whole system including defined system boundaries. AT least three boundaries are expected (sample of possible boundaries: Entry, Payments, Leaving etc.).



B. Use Case Narratives

Use Case Narratives for major use cases within each chosen boundary. (At least one for each boundary, minimum 3 narratives).

I. Use Case Narrative 1

Use Case Name	Request Access Card Entry	Use Case Type
Use Case ID	1A	Business Requirements
Priority	High	System Analysis
Source	Entry System	✓ System Design
Primary Business Actor	Staff – Vehicle	
Primary System Actor	Parking System	
Other Participating Actors	Government Service Member, Staff – Operations	
Other Interested Stakeholders		
Description	This use case describes the necessary steps and conditions that allow entry of an access card member into the car parking complex.	
Pre-Condition	The access card member must have a vehicle, alongside an access card.	
Trigger	This use case is initialized when a government service member or a staff member in a vehicle scans their access card.	
Typical Course	Actor Action	System Response
	Step 1: The actor scans their access card.	Step 2: The system validates the access card.
		Step 3: The system opens the entry barrier arm.
Alternate Courses	Alt-Step 3: The system displays the access card request errors.	
	Alt-Step 4: The system alerts operational staff members of suspicious activity.	
Conclusion	This use case completes when an actor has been allowed entry to the parking complex.	
Post-Condition	The staff member in a vehicle can locate a staff allocated parking space, or the government service member can head to the emergency.	

Business Rules	The actor must be in a vehicle.
	The actor's access card must be valid.
Implementation Constraints and Specifications	
Assumptions	It is assumed, in cases of possible issues arising such as malfunctions of the entry machine or invalid access cards, operational staff members will resolve the situation.
Open Issues	

II. Use Case Narrative 2

Use Case Name	Request Ticket	Use Case Type
Use Case ID	3A	Business Requirements
Priority	High	System Analysis
Source	Entry System	✓ System Design
Primary Business Actor	Client	
Primary System Actor	Parking System	
Other Participating Actors	Staff – Operations	
Other Interested Stakeholders		
Description	This use case describes the necessary steps and conditions for a client to request a ticket for entry into the parking complex.	
Pre-Condition	The client must have a vehicle to utilize the car parking complex.	
Trigger	This use case is triggered when the client presses the request ticket button.	
Typical Course	Actor Action	System Response
of Events	Step 1: The client presses the request ticket button.	Step 2: The system validates the request i.e., checks if the system has the required resources to print a ticket.
		Step 3: The system prints a ticket.

		Step 4: The system prompts the client to grab the ticket.
		Step 5: The system opens the barrier arm.
Alternate Courses	Alt-Step 3: The system displays the request errors.	
	Alt-Step 4: The system alerts the operational staff members of the system malfunction.	
	Alt-Step 5: The operational staff members resolve the malfunction.	
Conclusion	This use case completes when the system opens the entry barrier arm.	
Post-Condition	The client can drive into the car parking complex.	
Business Rules	The client must have a vehicle to utilize the car parking complex.	
Implementation Constraints and Specifications		
Assumptions	It is assumed, in cases of possible issues arising such as malfunctions of the entry machine, operational staff members will be equipped to easily deal with the situation.	
Open Issues		

III. Use Case Narrative 3

Use Case Name	Enter Car Park	Use Case Type
Use Case ID	5A	Business Requirements
Priority	High	System Analysis
Source	Entry System	✓ System Design
Primary Business Actor	Client	
Primary System Actor	Parking System	
Other Participating Actors	Government Service Member, Staff – Vehicle	
Other Interested Stakeholders		

Description	This use case describes the steps and conditions that occur when a client, government service member, or staff member in a vehicle enters the parking complex.	
Pre-Condition	The client, government service member, or staff member must have been allowed entry into the parking complex.	
Trigger	This use case begins when the entry barrier arm is raised.	
Typical Course	Actor Action	System Response
of Events	Step 1: The actor drives into the parking complex.	Step 2: The system closes the entry barrier arm.
		Step 3: The system updates the vehicle count.
Alternate Courses	Alt-Step 4: The system turns on the car park full sign.	
Conclusion	This use case is concluded when an actor within a vehicle enters the parking complex, and the barrier arm closes.	
Post-Condition	The client can locate a parking space, The government service member can head to the emergency, or the staff member can locate a staff allocated parking space.	
Business Rules		
Implementation Constraints and Specifications		
Assumptions	It is assumed that if any malfunctions of the entry system occur, operational staff members will have the capacity to quickly and efficiently resolve any issues that arise such as the entry barrier arm not closing.	
Open Issues		

IV. Use Case Narrative 4

Use Case Name	Make Payment	Use Case Type
Use Case ID	5B	Business Requirements
Priority	High	System Analysis
Source	Payment System	✓ System Design
Primary Business Actor	Client	
Primary System Actor	Parking System	

Other Participating Actors	Bank, Staff – Operations	
Other Interested Stakeholders		
Description	This use case describes the necessary steps and conditions of the client making a ticket payment.	
Pre-Condition	The client enters the parking complex utilizing a ticket.	
Trigger	The client selects a payment option at the pay-station or exit machine.	
Typical Course	Actor Action	System Response
of Events		Step 1: The system connects to the bank.
		Step 2: The system prompts the client to swipe their card.
	Step 3: The client swipes their card.	Step 4: The system validates the card swipe.
		Step 5: The system prompts the client to select their account type.
	Step 6: The client selects their account type.	Step 7: The system validates the account type.
		Step 8: The system prompts the client to enter their pin number.
	Step 9: The client enters their pin number.	Step 10: The system validates the pin number.
		Step 12: The system grabs the account balance.
		Step 13: The system performs the payment calculation.
		Step 14: The system performs the transaction.
		Step 15: The system displays a message to the

		client saying, "Payment Successful".
	Step 16: The client reads the message.	Step 17: The system prints the receipt.
	Step 18: The client grabs their receipt.	Step 19: The system ejects the ticket.
		Step 20: The system checks the resources required for printing a receipt.
Alternate Courses	Alt-1-Step 5: The system displays an error message and re-prompts the client to swipe their card.	
	Alt-2-Step 8: The system displays an error message and re-prompts the client to select their account type.	
	Alt-3-Step 12: The system displays an error message and re-prompts the client to enter their pin number.	
	Alt-4-Step 14: The system displays an error message informing the client that they have insufficient funds to perform the payment transaction and prompts them to select another payment option.	
	Alt-5-Step 21: The system alerts operational staff members of insufficient machine resources.	
	Alt-6-Step 1: The system prompts the client to insert their cash payment.	
	Alt-6-Step 2: The client inserts a percent of their cash payment.	
	Alt-6-Step 3: The system deducts the inserted amount off the top of the remaining total.	
	Alt-6-Step 4: The system validates the payment and detects a positive remaining total.	
	Alt-6-Step 5: The system displays the remaining total to the screen.	
	Alt-6-Step 6: The client inserts an amount over the remaining total.	
	Alt-6-Step 7: The system deducts the inserted amount off the top of the remaining total.	

	Alt-6-Step 8: The system validates the payment and detects a negative remaining total.
	Alt-6-Step 9: The system displays a remaining total of 0 to the screen.
	Alt-6-Step 10: The system dispenses the change.
	Alt-6-Step 11: The client grabs their change.
	Alt-6-Step 12: The system prints a receipt.
	Alt-6-Step 13: The client grabs their receipt.
	Alt-6-Step 14: The system ejects the client's ticket.
	Alt-6-Step 15: The system checks the resources required for printing a receipt.
Conclusion	This use case is concluded when the system checks the system resources required for printing a receipt.
Post-Condition	The client can now grab their ticket and exit the parking complex in their vehicle within 15 minutes to avoid another ticket payment.
Business Rules	The ticket must be valid.
	Ticket payment must be concluded before clientele are allowed to exit in their vehicle.
Implementation Constraints and Specifications	
Assumptions	This use case assumes the pay-station or exit machine are in fully working order.
Open Issues	

V. Use Case Narrative 5

Use Case Name	Exit Car Park	Use Case Type
Use Case ID	2C	Business Requirements
Priority	High	System Analysis
Source	Exit System	✓ System Design
Primary Business Actor	Client	
Primary System Actor	Parking System	

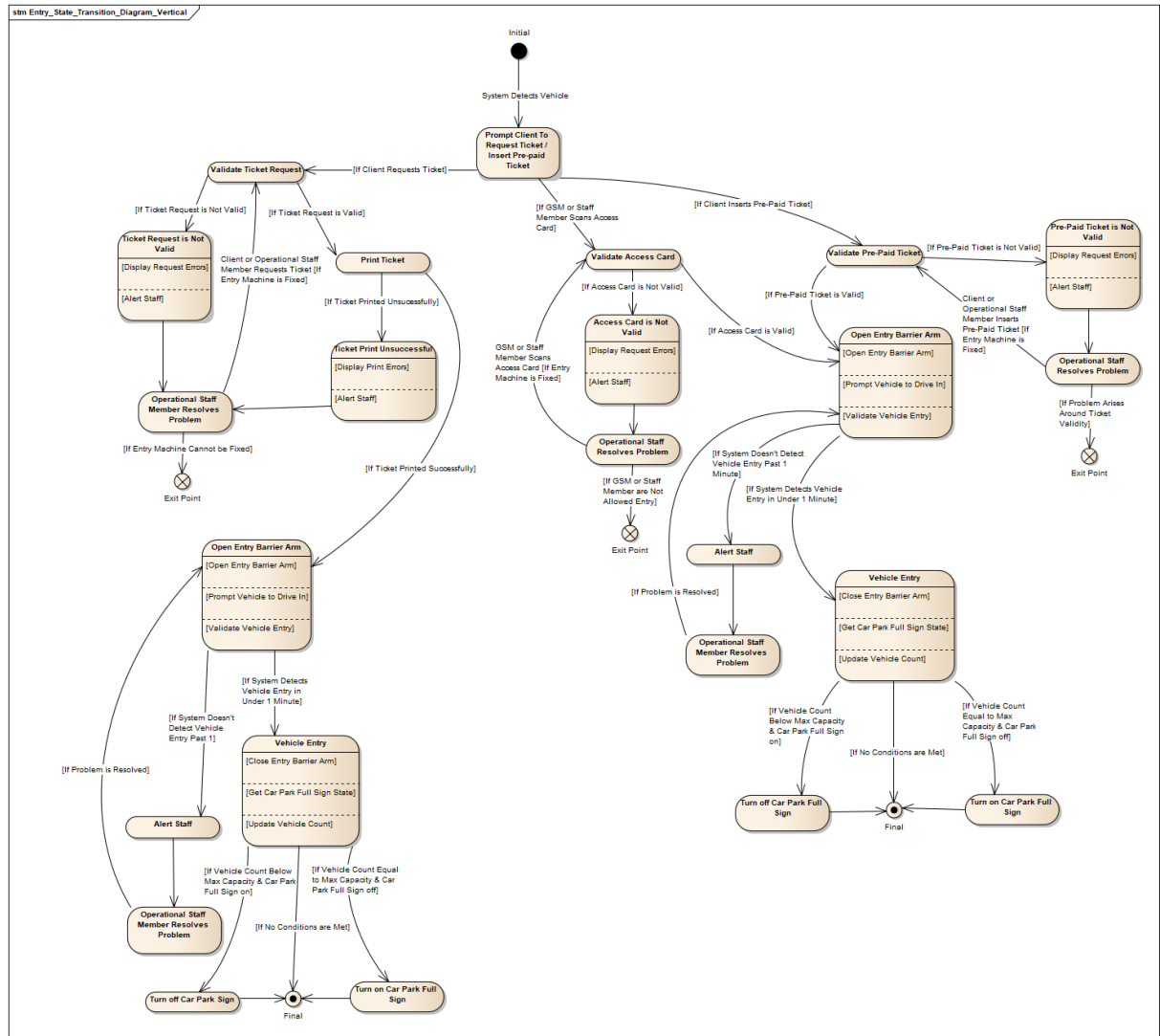
Other Participating Actors	Government Service Member, Staff – Vehicle	
Other Interested Stakeholders		
Description	This use case describes the necessary steps and conditions which occur when a vehicle exits the parking complex.	
Pre-Condition	The client, government service member or staff member in a vehicle must have completed the preceding use cases for the exit system.	
Trigger	This use case initiates when a vehicle begins to exit the parking complex.	
Typical Course	Actor Action	System Response
of Events	Step 1: The actor drives out of the parking complex.	Step 2: The system detects a vehicle has exited the parking complex.
		Step 3: The system closes the exit barrier arm.
		Step 4: The system updates the parking complexes vehicle count.
		Step 5: The system validates the parking complexes vehicle count.
Alternate Courses	Alt-Step 6: The system turns off the car park full sign.	
Conclusion	This use case is concluded when the system validates the parking complexes vehicle count.	
Post-Condition		
Business Rules	The client, government service member, or staff member must be in a vehicle.	
Implementation Constraints and Specifications		
Assumptions	This use case assumes all vehicles exiting the parking complex are counted on entry.	
Open Issues		

5. State Transition Diagrams

Select 2 objects within your system design. Explain the complexity of each object and draw 2 state transition diagrams for selected objects. State transition diagram is to identify all state changes of an object.

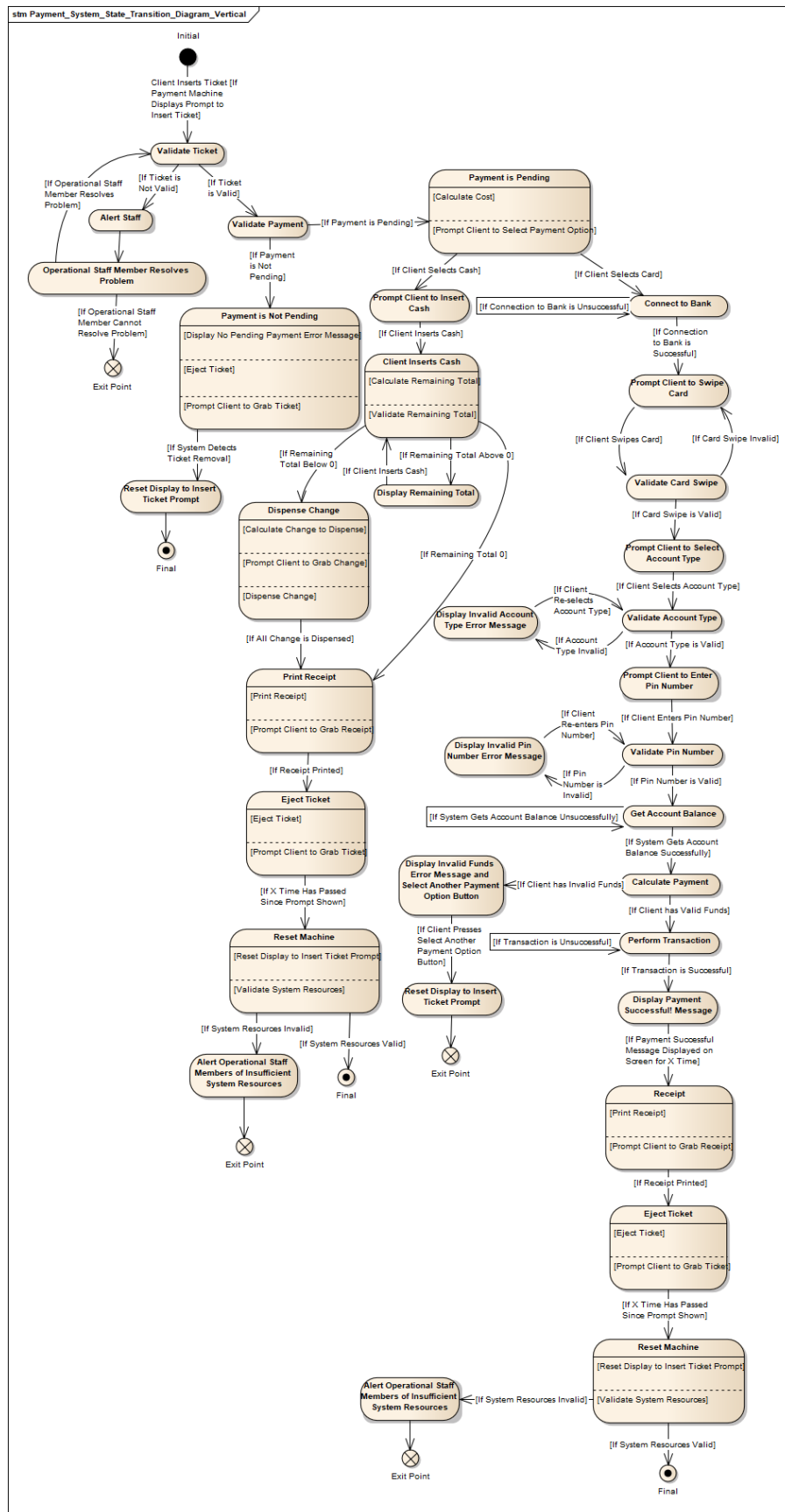
A. Entry System

This state transition diagram is for the entire entry system of the car parking complex.



B. Payment System

This state transition diagram is for the entire payment system of the car parking complex.

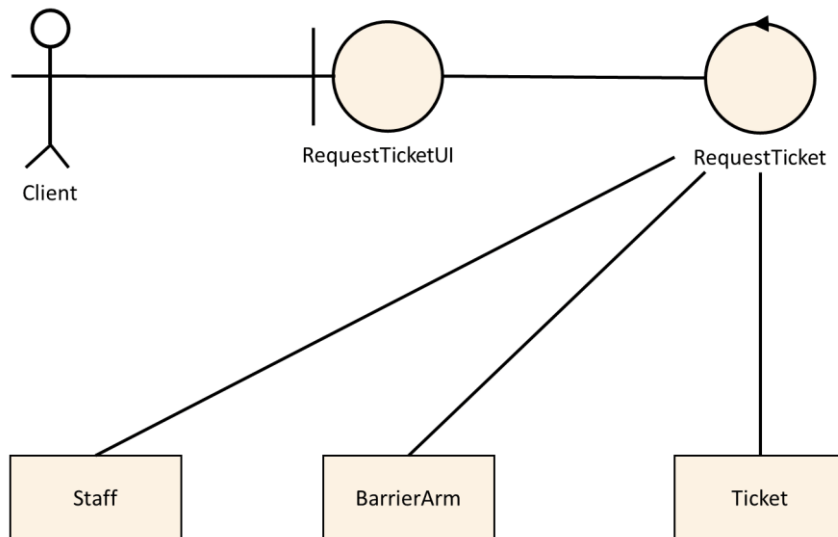


6. Communication Diagrams

A. Request Ticket Communication Diagram

I. Identification and Sketch

Identify and sketch “Interface”, “controller” and “entity” objects for 2 major use cases you identified in task 4 (this can be done in MS Word, as EA does not support this action directly, you draw the refined version of this as communication diagram).



II. Description

You need to explain briefly how you decided to draw each diagram and what was your logic behind decisions you made.

In my research on communication diagrams, I gathered that communication diagrams are developed from use case narratives and are comprised of four primary components. These four primary components are an actor element, a user interface element, a control element, and object elements, otherwise known as domain classes (Master2Teach, 2020; Sparx Systems, 2022).

The standard for control elements is to label them the name of the utilized use case narrative, using pascal case (the compounding of words and capitalization of each first letter) (Master2Teach, 2022).

The standard for user interface elements is similar to control elements as you label them the pascal cased version of the utilized use case narrative, with the difference of the addition of the abbreviation UI ending the word combination (Master2Teach, 2022).

Taking a glance at my communication diagram sketch for the request ticket use case narrative, you can immediately tell that it is comprised of an actor named Client, with the three domain classes of Staff, BarrierArm, and Ticket.

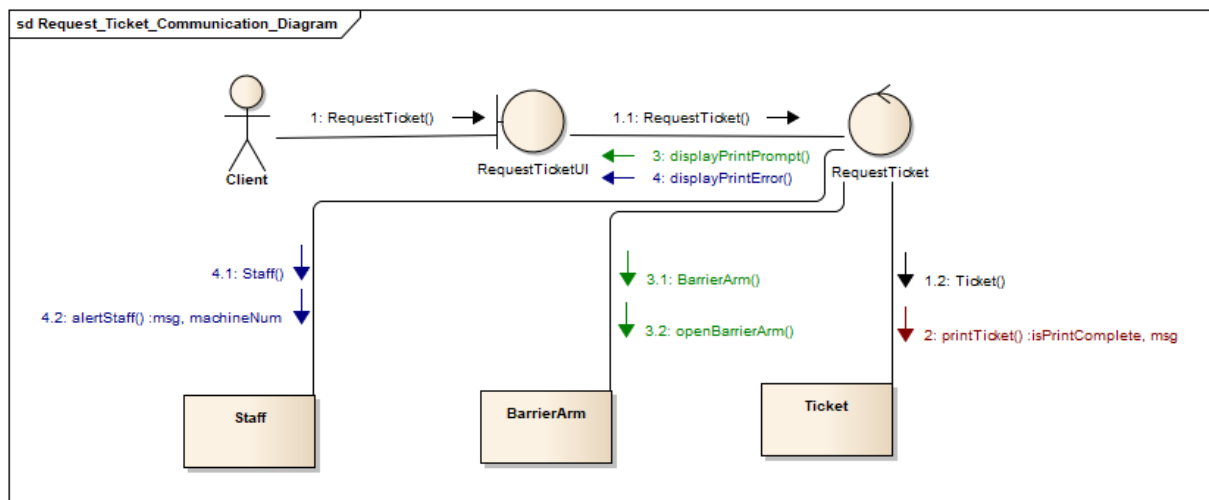
The actor of client was utilized for this communication diagram as clients are the primary participant who can activate the use case. Following on from this, during the development of this communication diagram I viewed the control element as a base class controlling

subclasses or child classes. Utilizing this method of thinking, I believe the best domain classes for this particular diagram are Staff, BarrierArm, and Ticket.

The Staff domain class will be utilized for such tasks as alerting staff of possible issues. Alongside this, the BarrierArm domain class will be utilized to control the opening and closing of all entry and exit barrier arms, while the Ticket domain class will be utilized to perform such tasks as printing and validation of tickets.

III. Diagram

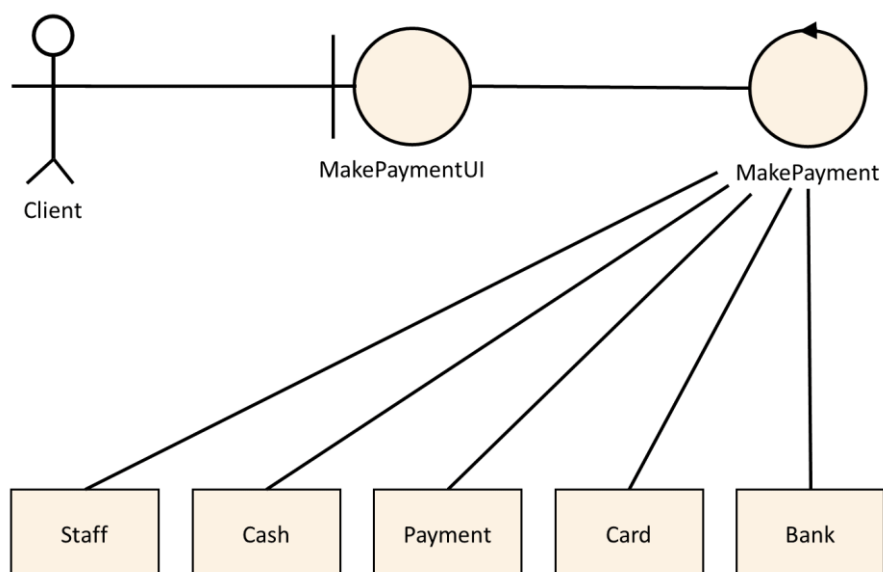
Transfer all drawn use case objects /relations above to proper communication diagrams and identify /add all relevant messages between each object (all messages must be named, numbered, and include directions between each object).



B. Make Payment Communication Diagram

I. Identification and Sketch

Identify and sketch "Interface", "controller" and "entity" objects for 2 major use cases you identified in task 4 (this can be done in MS Word, as EA does not support this action directly, you draw the refined version of this as communication diagram).



II. Description

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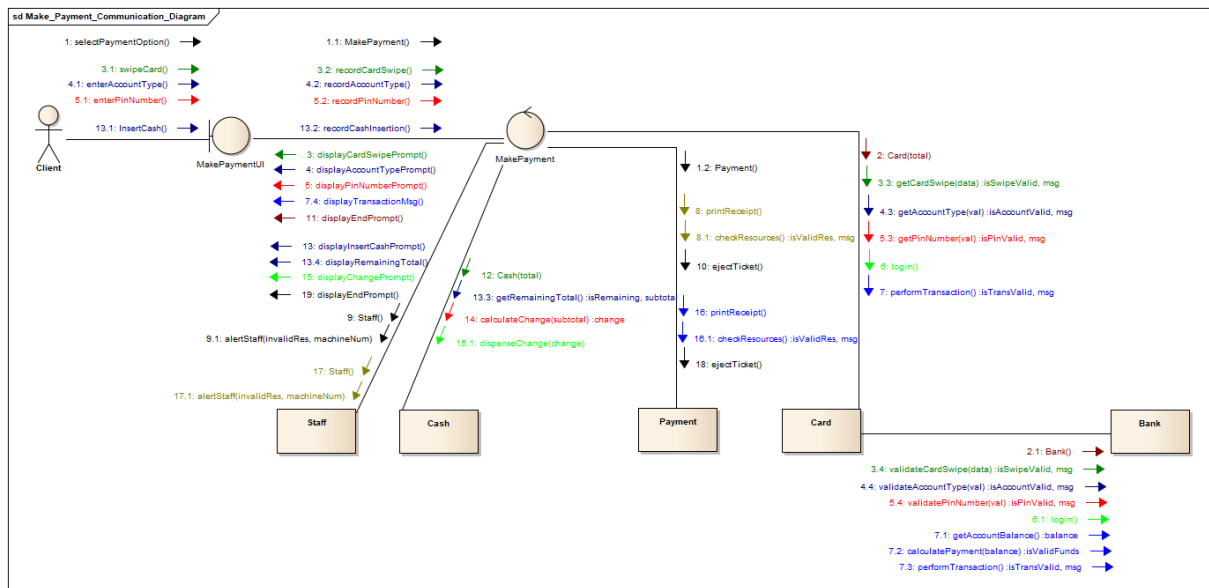
Observing the communication diagram sketch for the make payment use case narrative, you can instantly tell that the diagram is comprised of an actor labelled Client, with the five domain classes of Staff, Cash, Payment, Card, and Bank.

The actor of client was utilized for this communication diagram as clients are the only participant who can activate this use case. Succeeding this, during the development of this communication diagram, I viewed the control element as a base class controlling child classes (domain classes). Taking this understanding, I believe the best domain classes for this particular use case are Staff, Cash, Payment, Card, and Bank.

The Staff domain class will be utilized for such tasks as alerting staff members of possible issues. The Payment domain class will be utilized for the required standard tasks of payment transactions such as printing receipts, ejecting tickets, and checking system resources. Alongside this, the Cash and Card domain classes will be utilized for each of their respective tasks, i.e., cash payments, and card payments. However, unlike the Cash domain class, the Bank domain class will be used in conjunction with the Card domain class for connection to bank services, alongside performing card validation and payment transactions.

III. Diagram

Transfer all drawn use case objects /relations above to proper communication diagrams and identify /add all relevant messages between each object (all messages must be named, numbered, and include directions between each object).



References

Master2Teach. (2020, April 2). *Communication – Collaboration Diagram – Step by Step Guide* [Video]. YouTube. https://www.youtube.com/watch?v=Z_KPh5K_cC0&ab_channel=Master2Teach

Sparx Systems. (2022). *Communication Diagram*.
https://sparxsystems.com/enterprise_architect_user_guide/14.0/model_domains/communicationdiagram.html