SOEN 6461 (Software Design Methodologies)

Concordia University

Department of Computer Science and Software Engineering

Deliverable 1

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Introduction

Ticket vending machines (TVMs) are automated machines used to issue tickets for various modes of transportation or events. They have become increasingly popular in recent years as they provide a convenient and efficient way for customers to purchase tickets without the need for human interaction. This report will provide an overview of TVMs, their benefits, challenges, and their impact on the transportation industry. TVMs offer a number of benefits to both customers and transportation providers. For transportation providers, TVMs offer significant cost savings as they reduce the need for human agents and associated overhead costs. TVMs can also improve customer satisfaction by reducing wait times and providing a more efficient ticketing process.

1.1 Objectives

VMs provide a quick and convenient way to purchase tickets, without the need to interact with a human agent. This can be especially useful during peak travel times when lines at ticket counters can be long. TVMs also offer a level of privacy and security as customers can enter their personal information and payment details without having to share them with another person.

1.2 Challenges

Despite their benefits, TVMs also present a number of challenges. One major challenge is ensuring that the machines are user-friendly and accessible to all customers, including those with disabilities or limited language proficiency. TVMs must be designed with clear and concise instructions, easy-to-use interfaces, and accommodate various payment methods. Another challenge is ensuring that TVMs are reliable and able to handle high volumes of traffic. TVMs must be regularly maintained and updated to prevent breakdowns or malfunctions, which can lead to customer frustration and lost revenue.

1.3 Contributions

Ticket vending machines are a valuable addition to the transportation industry, providing customers with a quick and convenient way to purchase tickets while reducing costs for transportation providers. While there are some challenges associated with TVMs, ongoing advancements in technology and design are helping to address these issues. Overall, TVMs are likely to continue to play an important role in the future of transportation.

Problem 1

2.1 Brief Description

A vending machine is a type of automated machine that provides goods or services to customers after they insert payment, typically in the form of coins, bills, or debit/credit cards. The machine may have an electronic interface or physical buttons that allow the customer to make a selection from a range of products, which can vary from snacks and drinks to personal hygiene products, electronics, and more. After the payment is accepted, the machine dispenses the selected item. Vending machines are commonly found in public places such as schools, airports, hospitals, and workplaces. They are designed to provide convenient access to products or services without the need for direct human interaction. The Ticket Vending Machine (TVM) used by the Société de transport de Montréal (STM) is a device located in metro stations throughout the greater Montreal area that allows commuters to recharge their transit fares and purchase paper tickets or transit passes. These machines accept a range of payment methods, including smart cards, debit/credit cards, as well as cash (coins or bills). travelers can select the type of ticket or pass they need, input the quantity and pay with the appropriate fare.travelers can select the type of ticket or pass they need and pay with any one of these methods. The TVMs also assist with queue management and prioritization of services to improve efficiency of the transit system. This particular TVM was chosen since the project team members were well familiar with its traveler interface and capabilities.

2.2 Assumptions

- The TVM is purposefully positioned, either in the centre of the metro station or near an entrance or exit point, where it is visible easily to the public.
- In order to scan and authenticate the electronic tickets, metro stations and buses possess smart Touchscreen Panel Human Machine Interfaces on which the application will be installed.
- The machine's traveler interface (UI) supports many languages, specifically English and French, so that it may be used lawfully in Canada.
- For blind people who require voice help, tactile marking indented keypads are employed.
- In order to safeguard it against theft and vandalism, the machine's body is built from durable materials.
- The TVM has built-in network security features that guard against fraudulent use and guarantee secure bank transactions.

2.3 Characteristics of the model

1. **A UI that is simple and straightforward :** Our TVM traveler Interface (UI) Design focuses on predicting what travelers may need to do and making sure that the interface has components that are simple to use, access, and comprehend to aid those tasks. Systems operate more effectively when they are kept simple and when extraneous complexities are avoided. We can give the traveler a better experience by simplifying the graphics and eliminating needless details so they can concentrate solely on the important details.The straightforward UI will save traveler's time and effort, thus minimizing the chances of long waiting queues at the TVM.

2. **Payment Options :** TVMs usually accept various payment methods, including cash, credit cards, debit cards, and mobile payments. Only Canadian dollars are shown for prices (CAD). Along with coins worth 1,2, and 25 cents, the machine also accepts Canadian dollar bills in denominations of 5, 10, 20, 50 and 100 dollars.

3. **Ticket Types :** The chosen TVM can issue end customers tickets/transit passes and top off their transport smart cards. The passes can be purchased in increments of five, ten, or more passes, or they can be purchased for a specific period of time, such as daily, weekly, or monthly.

4. **Receipt Type :** For blind people who require voice help, tactile marking indented keypads are employed.

5. **Accessibility :** TVMs are designed to be accessible to all travelers, including those with disabilities, by providing audio instructions and tactile features.

6. **Security :** TVMs are equipped with security features such as video surveillance, alarms, and tamper-proof design to prevent fraud and vandalism.

7. **Maintenance :** TVMs require regular maintenance and updates to ensure they are functioning properly and providing accurate information.

Problem 2

A problem domain model is a representation of the key concepts and relationships within a specific area of knowledge or expertise. It defines the scope of the problem and helps to identify the relevant entities, their attributes, and the relationships between them. The model is typically created during the analysis phase of a software development project to help clarify requirements and ensure that all stakeholders have a common understanding of the problem domain. The problem domain model is typically represented using diagrams such as class diagrams, entity-relationship diagrams, or data flow diagrams. It is an important tool for software developers, as it helps to ensure that the software system being developed accurately reflects the requirements and constraints of the problem domain.
Defining Class, attributes and their relationships of our TVM model as follows:

1. **TVM :** The purpose of a ticket vending machine (TVM) is to give customers a way to reload their metro cards and purchase tickets. In the problem domain model, it serves as both the primary element and the key idea. Language and address are the two characteristics of this class. Language is equivalent to the two languages that our TVM iGo supports: French and English. The address corresponds to the spot where our TVM is. This class is highly important for our TVM because it is situated at locations other than metro stations, such as important bus stops and the city's core. TVM has the following relationships with other entities in the domain, as indicated in the domain model diagram:

    - TVM is used by one-to-many traveler(s).
    - Zero-to-many Ticket(s) are dispensed by one to many TVM(s).
    - One TVM has only one Payment Gateway
    - The zero to many Metro Card(s) can be recharged using one-to-many TVM(s).
    - One-to-many Receipt(s) can be generated by one to many TVM(s).

2. **traveler :** The end traveler of the TVM. traveler has the following relationships with other entities in the domain, as indicated in the domain model diagram:

    - One-to-many traveler(s) can use one-to-many TVM(s).
    - One-to-many ticket(s) can be purchased by one-to-many traveler(s).
    - One traveler can have zero or one metro card.

3. **Ticket :** Paper made tickets can be purchased from any of the TVM. These tickets are made for the limited usage based on the option selected while purchasing.Ticket has the following relationships with other entities in the domain, as indicated in the domain model diagram:

    - Zero-to-many ticket(s) can be dispensed by one-to-many TVM(s).
    - One-to-many traveler(s) can purchase one-to-many ticket(s).

4. **Metro card :** A Metro card is a type of smart card used for transportation in certain cities around the world. These cards are typically used for public transit systems such as subways, buses, and trains. It is a plastic card which consists of a magnetic chip that can be recharged at all TVMs. Metro card has the following relationships with other entities in the domain, as indicated in the domain model diagram:

- One traveler can own zero or one metro card.
- One-to-many Metro Card(s) can be recharged by one-to-many TVM(s).

5. **Payment Gateway :** Every TVM has a specific payment gateway that handles daily payments made by travelers when they purchase tickets or recharge their metro cards. Customers have the option of inserting cash or coins for their transactions, as well as using a debit or credit card.
   Payment Gateway has the following relationships with other entities in the domain, as indicated in the domain model diagram:

   - There is one Payment Gateway per TVM.
   - To process transactions, every payment gateway is linked to all of the main national banks.
   - One Payment Component is used by one-to-many traveler(s).

6. **Bank :** Bank depicts a regulatory body related to the banking industry, which authenticates and verifies payments while purchasing tickets and recharging metro cards using credit/debit cards.
   Bank has the following relationships with other entities in the domain, as indicated in the domain model diagram:

   - One Payment Gateway of TVM is connected to one-to-many Bank(s).
   - Bank and payment are linked with one-to-one since multiple banks cannot authenticate the same payment.

7. **Payment :** A payment comprises details about the chosen transaction. The traveler has the option of paying with cash or a card (debit/credit). Per session, only one payment is permitted.
   Payment has the following relationships with other entities in the domain, as indicated in the domain model diagram:

   - One bank will authenticate one payment during a single session set up through the payment gateway.
   - There will be one receipt for each payment.

8. **Receipt :** The receipt is evidence of the transaction and includes the date, time, and price. It can be printed or emailed.
   Receipt has the following relationships with other entities in the domain, as indicated in the domain model diagram:

   - One-to-many receipt(s) can be generated by one-to-many TVM(s).
   - One receipt only contains details about one payment.

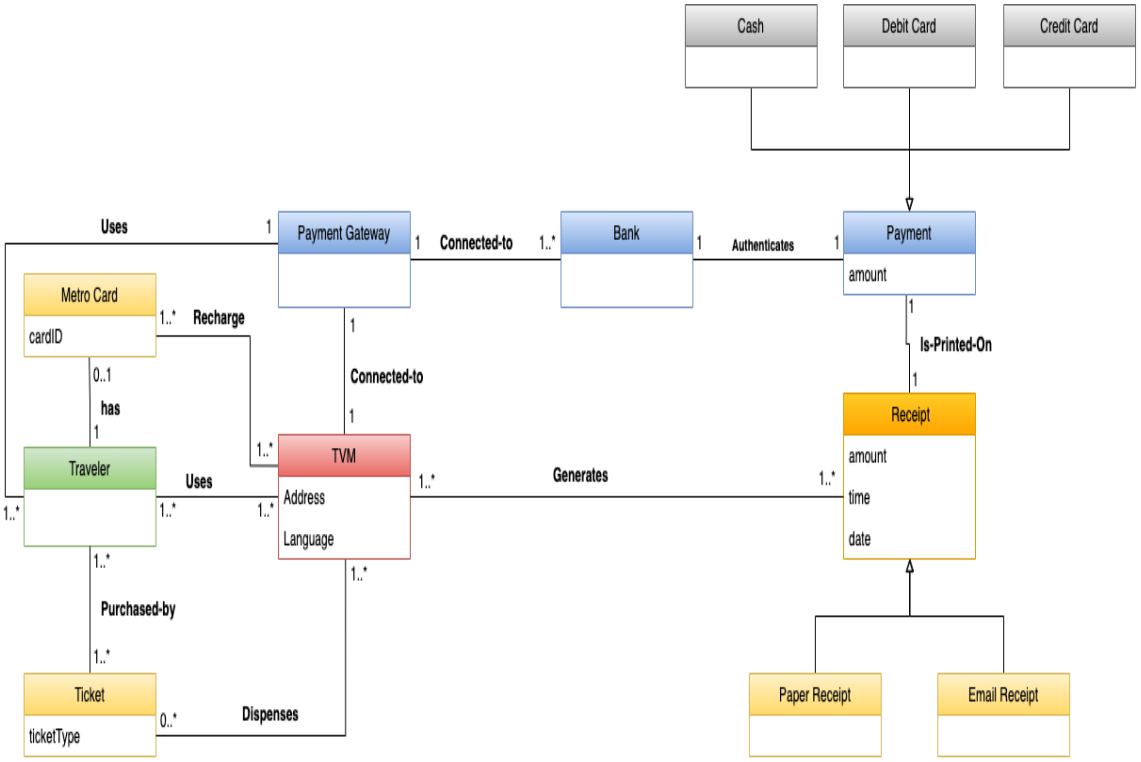

Figure 3.1: Domain model

Problem 3

4.1 Mind Map

A mind map is a diagram used to visually organize information and ideas around a central theme or topic. The central idea is placed at the center of the map, and other ideas and information are added in a branching, hierarchical structure. Mind maps are often used to help brainstorm, plan, or organize information for writing, presentations, or other projects.The structure of a mind map can be customized depending on the user's preferences and the complexity of the topic. Key points, ideas, and supporting details can be represented using different colors, symbols, images, and text. Mind maps are often used as a creative and effective way to summarize, analyze, and communicate information in a more engaging and memorable way.

Figure 4.1: Mind map diagram

4.2 INTERVIEWS

Conducting interviews with users before building a software is a critical step in the software development process. Here are some key reasons why user interviews are important:

- Understanding user needs: User interviews help to understand the needs, goals, and challenges of the target audience for the software. By understanding their needs, software developers can create software that meets the needs of its intended users, increasing user satisfaction and engagement.
- Identifying pain points: User interviews can help identify pain points and areas of frustration that users experience when using similar software or products. This information can be used to design software that addresses those pain points and provides a better user experience.
- Validating assumptions: Conducting user interviews can help validate assumptions made during the software development process. This can help ensure that the software is designed to meet actual user needs rather than assumptions made by the development team.
- Improving usability: User interviews can provide insights into how users expect the software to work, their preferences for user interfaces, and other usability considerations. This information can be used to design software that is intuitive and easy to use.
- Building trust: By involving users in the software development process through interviews, developers can build trust with users and demonstrate a commitment to meeting their needs.

Overall, conducting user interviews before building a software can help ensure that the software meets the needs of its intended users, addresses pain points and frustrations, improves usability, validates assumptions, and builds trust with users.

4.2.1 Salient Conclusions drawn from the interviews.

From the four interviews, the following salient conclusions can be drawn:

1. The existing TVM of STM is user-friendly, but there are areas that need improvement.
2. The TVM should have an option to recharge for 1-day or weekly trips to make it more environmentally friendly.
3. The TVM is not children-friendly or disabled people-friendly, and more TVMs should be added at frequently accessible locations such as bus stops.
4. An online mechanism for recharging OPUS cards via mobile applications or websites would be more convenient and time-saving.
5. The existing TVM can lag while recharging, and an online system would save time, especially for people with busy schedules.
6. Digital receipts are preferred over physical receipts, and smart payment options like scanning QR codes or tapping mobile phones are desired.
7. An option for a break of 15 days for billing the OPUS card is suggested.
8. People prefer the monthly pass as it is more economical for them.
9. Notifications on the phone if there is a limited number of trips remaining on the OPUS card would be helpful.

Note : Please refer this drive link for the conducted interview recordings and its transcripts: SDM D1 Interviews Team A

Problem 4

A use case model is a way of representing the functionality of a system or application in terms of the traveler's goals and tasks. It is a visual representation of the system's behavior that defines the interactions between the system and its travelers or external systems. A use case model can be visualized using a use case diagram, which shows the actors, use cases, and relationships between them.

NAME	Select Language
ID	UC1
DESCRIPTION	The traveler selects either French or English from two language options.
ACTORS	traveler
NORMAL FLOW	System's language changes according to the traveler's preference
PRE-CONDITIONS	traveler starts the interaction with the TVM.
POST-CONDITION	Language of the System changed successfully.
EXCEPTIONS	The desired language other than French and English is not available.

Table 5.1: Use Case 1 - Select Language

NAME	Purchase Ticket
ID	UC2
DESCRIPTION	The traveler wants to purchase a ticket from TVM
ACTORS	traveler
NORMAL FLOW	1.The traveler selects the desired ticket option. 2.The application is redirected to the payment option screen
PRE-CONDITIONS	1.traveler starts the interaction with the TVM. 2.traveler selects the desired language.
POST-CONDITION	After selecting a ticket, the traveler is taken to the payment screen.
EXCEPTIONS	The traveler cancels the session.

Table 5.2: Use Case 2 - Purchase Ticket

NAME	Recharge Metro Card
ID	UC3
DESCRIPTION	The traveler wants to recharge the pre-owned metro card.
ACTORS	traveler
NORMAL FLOW	1.The traveler selects the recharge card option. 2.The application is redirected to the payment option screen
PRE-CONDITIONS	1.traveler starts the interaction with the TVM. 2.traveler selects the desired language.
POST-CONDITION	After selecting the recharge option, the traveler is taken to the payment screen.
EXCEPTIONS	The traveler cancels the session.

Table 5.3: Use Case 3 - Recharge Metro Card

NAME	Print Ticket
ID	UC4
DESCRIPTION	The TVM prints the Ticket
ACTORS	TVM
NORMAL FLOW	1.The traveler pays for the selected ticket. 2.The machine prints the ticket.
PRE-CONDITION	The traveler selected a ticket option and payment was successful.
POST-CONDITION	The ticket is printed.
EXCEPTIONS	The payment was failed.

Table 5.4: Use Case 4 - Print Ticket

NAME	Make Payment
ID	UC5
DESCRIPTION	Handles and authenticate payments
ACTORS	traveler and Bank
NORMAL FLOW	1.The TVM displays the payment option (Cash/credit or debit). 2.If cash option is selected, the balance amount is returned. 3.If debit/credit option is selected, then the payment is authenticated by the bank. 4.TVM redirects to the receipt generation page.
PRE-CONDITION	The traveler selected a ticket option and payment was successful.
POST-CONDITION	The payment is successful and the application redirects to the receipt generation page.
EXCEPTIONS	The payment was failed.

Table 5.5: Use Case 5 - Make Payment

NAME	Choose Receipt Type
ID	UC6
DESCRIPTION	The traveler can select the type of receipt, paper based or email.
ACTORS	traveler
NORMAL FLOW	1.The TVM displays the receipt preference option (print/email). 2.The traveler might choose to receive it on print or via email. 3.If email option is selected, then traveler must input email address to receive the ticket
PRE-CONDITION	The payment was successful.
POST-CONDITION	The traveler receives the ticket as per his/her preference.
EXCEPTIONS	The email address was invalid.

Table 5.6: Use Case 6 - Choose Receipt Type

NAME	Generate Payment Receipt
ID	UC7
DESCRIPTION	A payment receipt is produced after a successful transaction.
ACTORS	TVM
NORMAL FLOW	1.The traveler selects to receive a receipt on print or via email. 2.The traveler receives the payment receipt as per his/her preference.
PRE-CONDITIONS	1.The payment was successful. 2.The receipt is generated.
POST-CONDITION	The traveler receives the ticket as per his/her preference.
EXCEPTIONS	NA

Table 5.7: Use Case 7 - Generate Payment Receipt

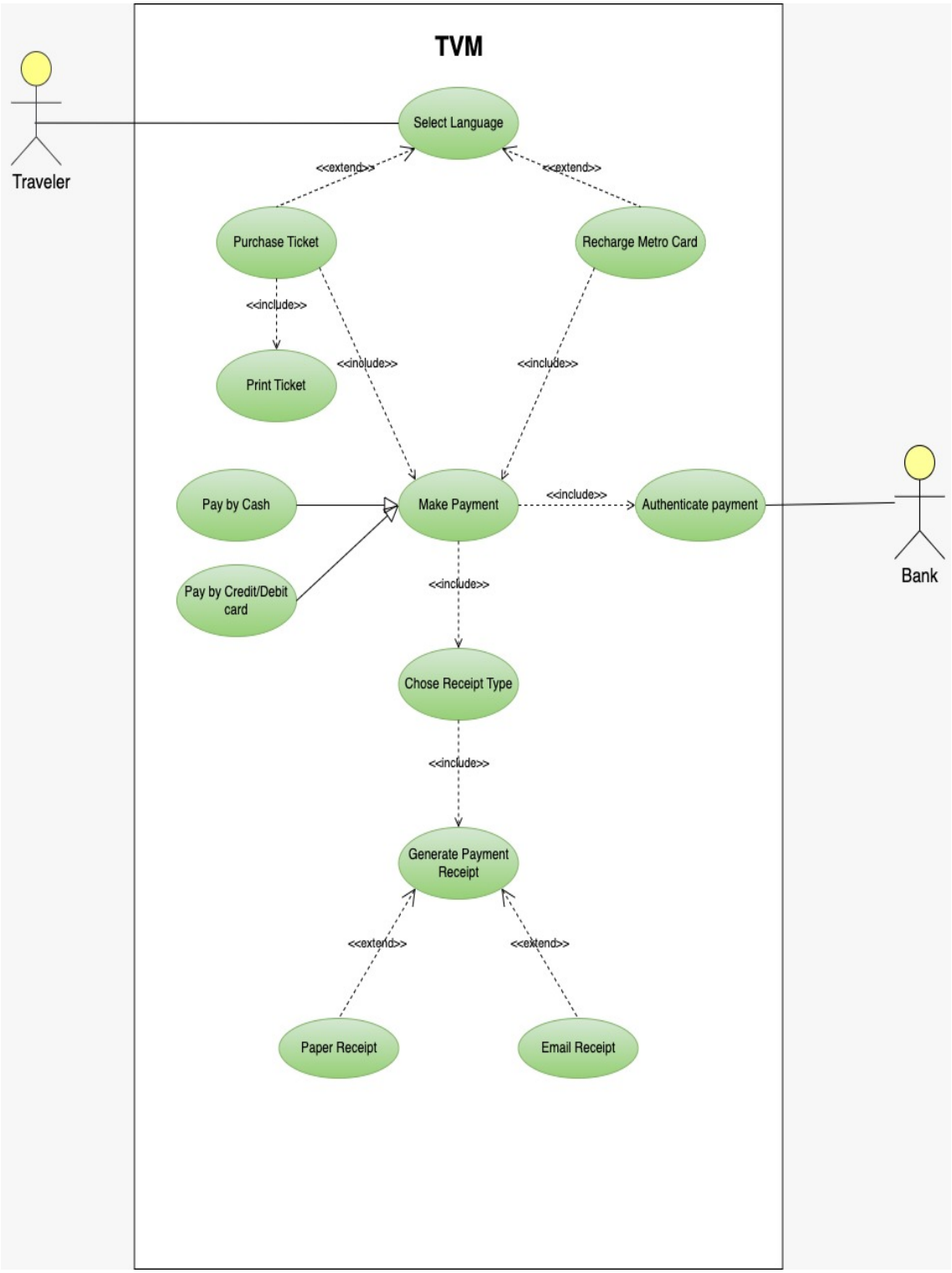

Figure 5.1: Use Case Model Diagram

Problem 5

UML activity diagrams are a type of behavior diagram used in software engineering to model the flow of activities and actions within a system. They are used to visually represent the sequence of steps or processes involved in a particular task, as well as the decisions and conditions that guide those processes. Activity is started by traveller actor who needs to buy a ticket. Ticket vending machine will ask to select the language of the application. Then traveller will be given a choice to choose among recharge metro card or purchase a ticket. Based on the info machine will calculate payment and request payment options such as cash or debit/credit card. After payment is complete, ticket is dispensed to the traveller as per his preference such as paper based receipt or email.

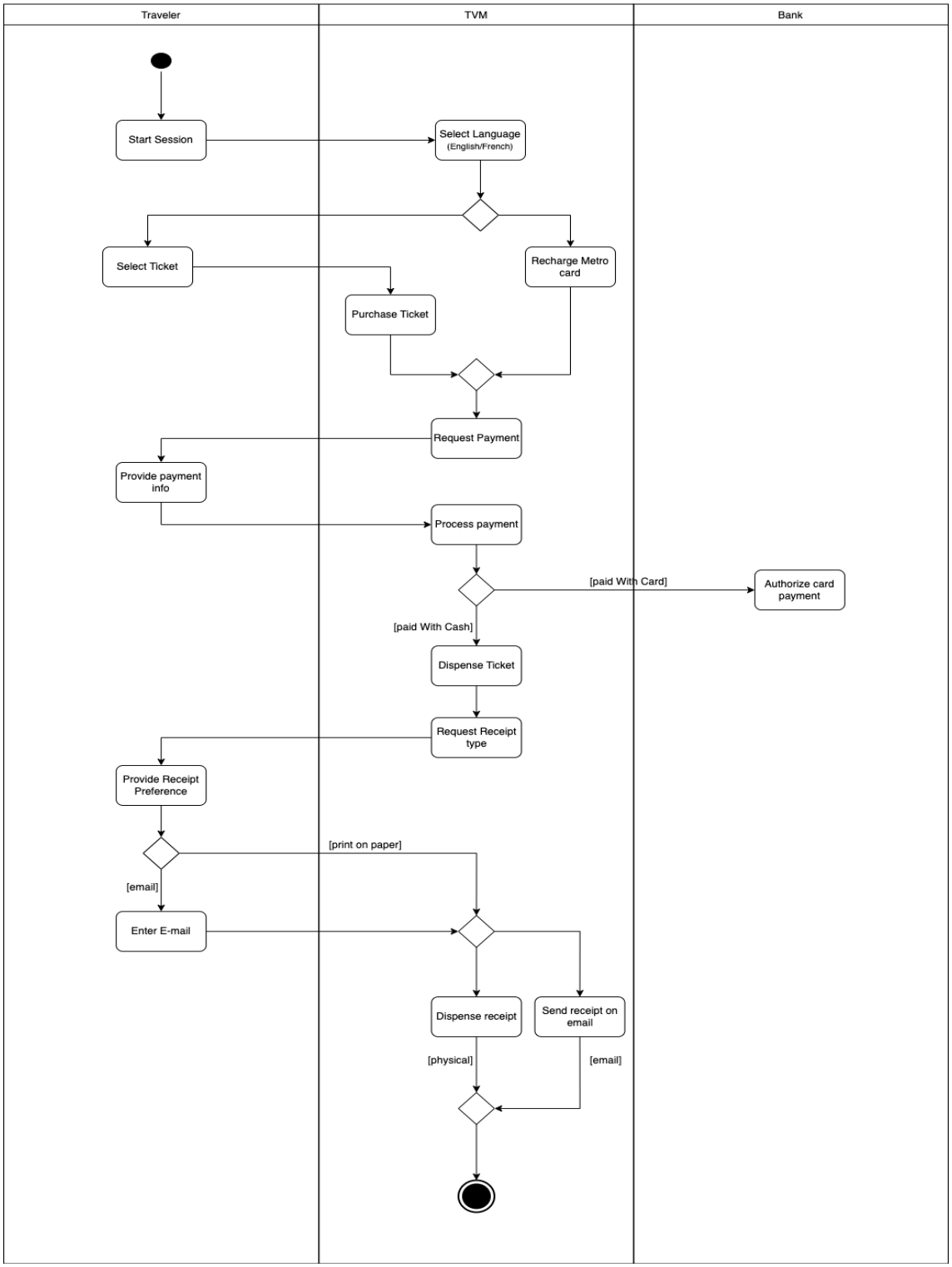

Figure 6.1: UML activity diagram - 1

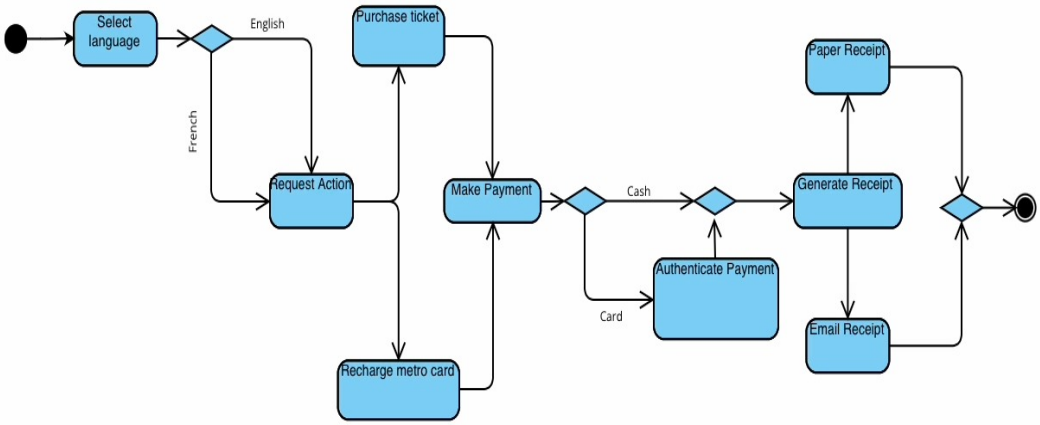

Figure 6.2: UML activity diagram - 2

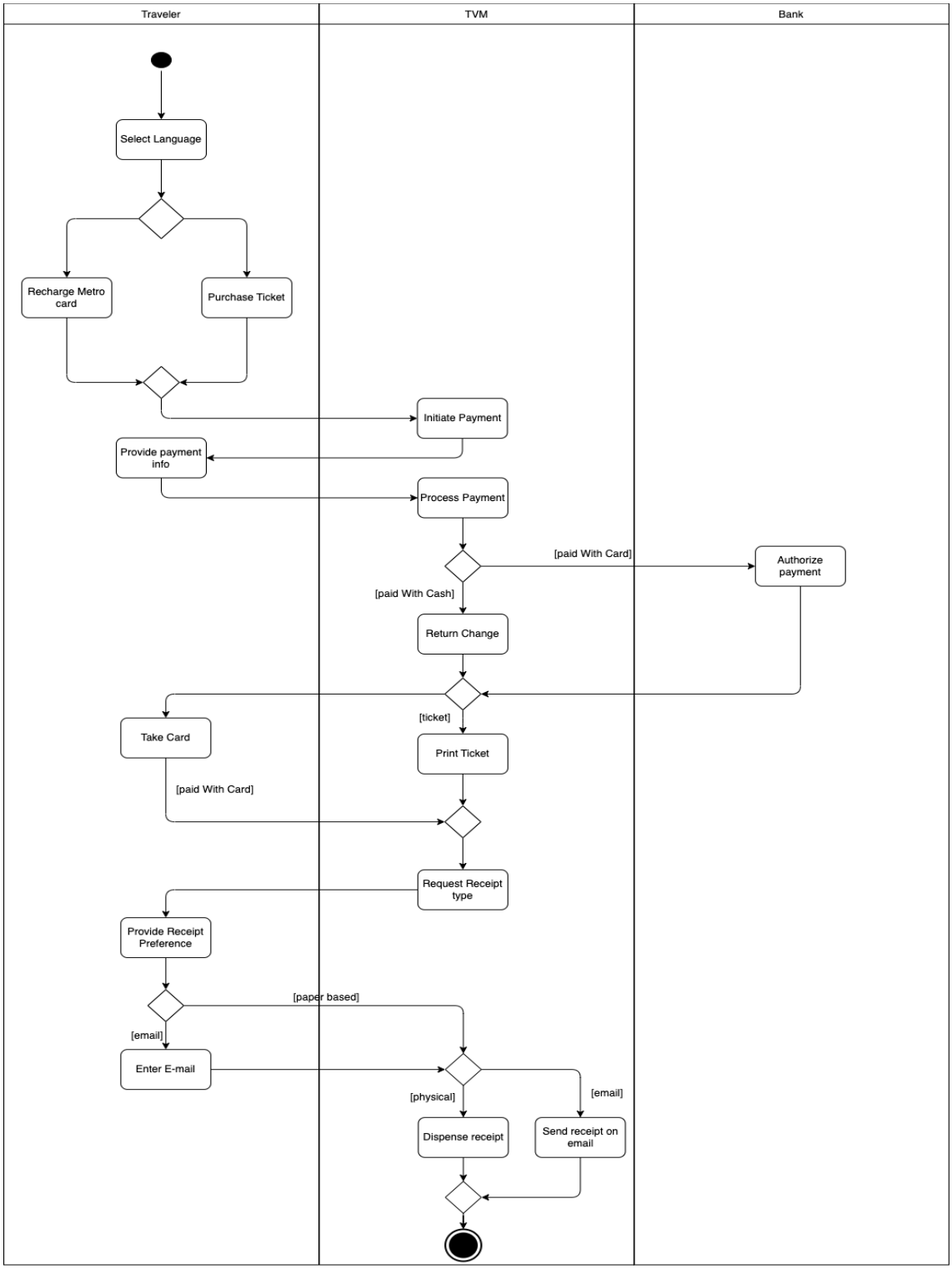

Figure 6.3: UML activity diagram - 3

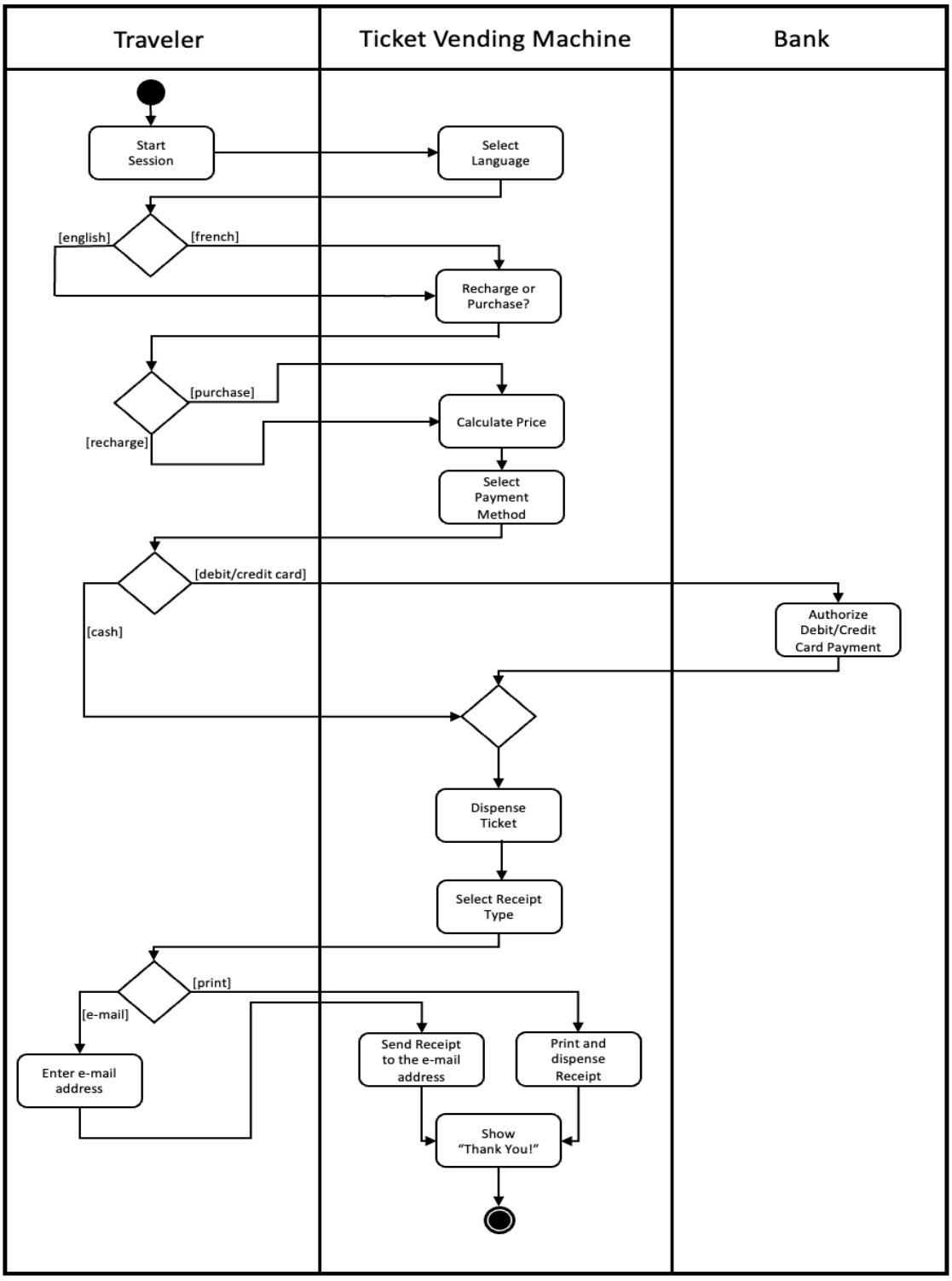

Figure 6.4: UML activity diagram - 4

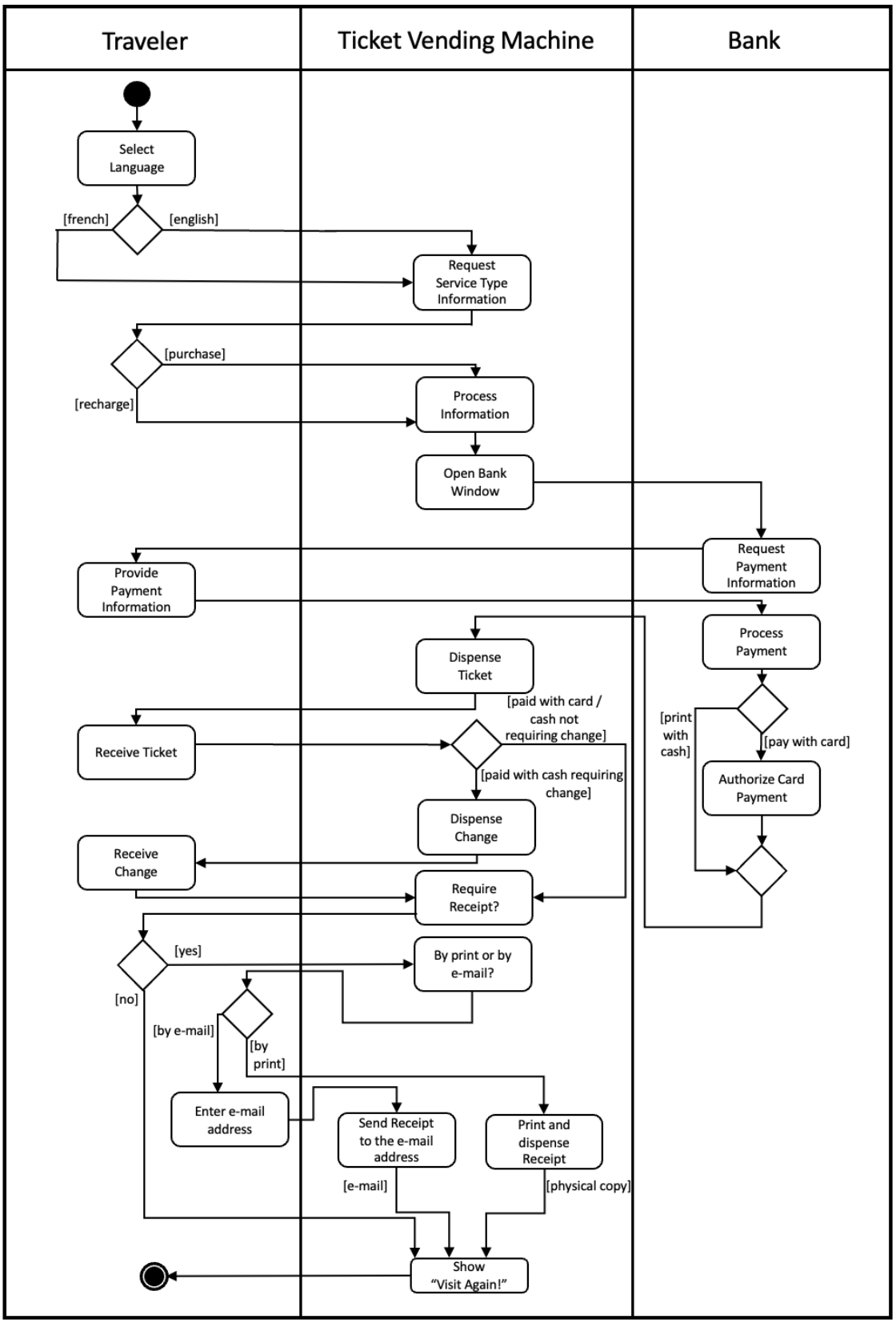

Figure 6.5: UML activity diagram - 5

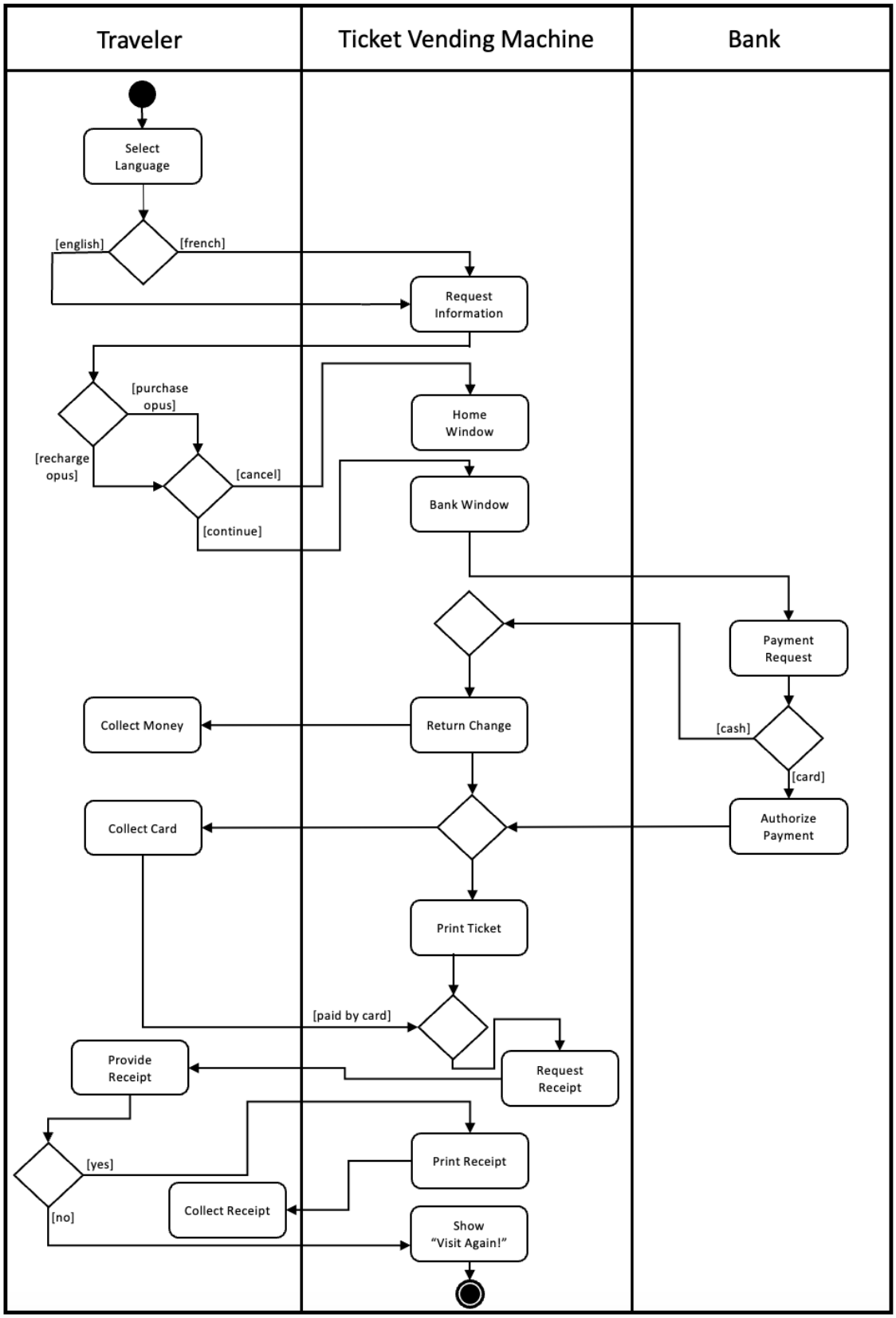

Figure 6.6: UML activity diagram - 6

References

Collaboration environments

1. **Github :** https://github.com/imadshawl/SOEN-6461
2. **Drive :** https://drive.google.com/drive/folders/1b0mt23kT-G4uAI-RrVGLyzsj0DgpAj8a?usp=sharing

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1. https://www.stm.info/en
2. **Lecture notes by Prof. Pankaj Kamthan**