FACULTY OF COMPUTING

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BCI 2313 ALGORITHM AND COMPLEXITY

ASSIGNMENT 2

Section : 1B

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Group : 28

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Table Of Contents

1. Introduction

In today's rapidly changing laundry service industry, payment methods for washing machines are experiencing significant advancements that provide consumers a variety of options catered to their individual needs. Placing pennies into the machine's slot to start a wash cycle has long been a dependable method of conventional coin payments. However, in keeping with contemporary technology, more advanced and adaptable payment choices are gradually replacing this conventional approach.

Introduction of smart cards, sometimes known as laundry cards, which operate as a prepaid system akin to a digital wallet, is one such breakthrough. Consumers have the option to add credit in advance by using an existing smart card or by purchasing a specific laundry card. The payment process is improved by the ease with which the card can be swiped or tapped on the machine to instantly deduct the appropriate amount, offering a speedy and practical cashless option. However, the washing facility where these cards were provided is usually the only place they can be used.

Another advancement in technology is the integration of payment systems using QR codes. Through specialised smartphone apps connected to their bank accounts or digital wallets, consumers may effortlessly make payments by scanning a QR code shown on the washing machine. This development demonstrates how technology is always improving daily tasks by streamlining payments and making the laundry process more convenient.

Furthermore, the effect of the digital world is demonstrated by the fact that certain washing machines have card scanners that can read debit and credit cards. The necessity for specific laundry cards or cash is eliminated when users input their bank cards and authorise payments immediately. This fusion of traditional laundry procedures with cutting-edge payment systems shows a dedication to accommodating a wide range of consumer preferences and improving the entire laundry experience.

2. Problem Statement

The laundry service industry is changing dramatically, and more advanced payment methods like smart cards, QR code payments, and card scanners are replacing the coin-operated washing machines of the past. However, this shift has not been without its challenges, and several issues now need to be fixed.

First, there's the convenient cashless laundry card system for using smart cards to pay for services. However, these cards are typically only valid at the same establishment where you purchased them. Customers are unable to use the same card at many laundry facilities because of this restriction, which lessens the overall convenience and flexibility that these cards are designed to give.

Second, the incorporation of QR code payment systems, which enables consumers to make payments via smartphone apps connected to their digital wallets or bank accounts, is a noteworthy technological achievement. Although this method makes payments easier, users must download and utilise specialised apps, which may not be user-friendly or accessible to all users. For people who are not tech-savvy or do not have access to cellphones, this might be very difficult.

Moreover, cash or specific laundry cards are no longer needed thanks to washing machines' integration of card scanners that read debit and credit cards. Notwithstanding this benefit, not all laundry machines have these card readers installed, which results in inconsistent payment choices. Customers may become confused and inconvenienced by this inconsistency if they are unsure of the payment options offered at a certain site.

All things considered, the lack of consistency and the transitional difficulties involved in implementing these new payment options underscore the need for a more unified and user-friendly strategy. The industry has to endeavour to incorporate these contemporary payment options in a manner that guarantees broad accessibility and user-friendliness, thus improving the experience that customers have in laundry facilities.

3. Objective

The objective of this case study is to create a thorough and complete washing machine payment system that integrates the innovative payment techniques that have been launched in the changing laundry services market. The problems listed in the problem statement should be addressed and fixed by this system. The primary goals are:

1. **Standardise Payment Methods**: To guarantee consistency and customer simplicity of use, establish a uniform payment system that easily incorporates smart cards, QR code payments, and card scanners throughout all laundry facilities.
2. **Improve Smart Card Usability**: Change the smart card system so that cards can be used at different launderettes. This will remove the restriction that now exists and improve convenience for customers.
3. **Simplify QR Code Payments**: Create an intuitive user experience for QR code payments that doesn't require a lot of technical expertise. This will enable people from various backgrounds to utilise it, including those who are not familiar with smartphone applications.
4. **Increase the Number of Card Scanners Available**: Make sure that all washing machines have card scanners that can read debit and credit cards installed in order to offer a widely available cashless payment alternative.

5. **Enhance User Experience**: Provide a simple and effective payment method that minimises misunderstanding and trouble, improving everyone's laundry experience in the process.
6. **Assure Widespread Accessibility**: Create a payment system that is user-friendly and inclusive, accommodating the different needs and preferences of customers using different laundries.

4. Scope

In recent years, the laundry service sector has experienced substantial changes, both in terms of technology developments in washing machines and customer payment methods. This case study examines and assesses three specific payment mechanisms in the context of laundry services: QR Code Payments, Laundry Card Payments, and Token Payments. Every approach poses distinct difficulties and possibilities, requiring a thorough examination to comprehend their consequences and suggest remedies for improved customer experiences.

5. QR Code Payments: Incorporating Quick Response (QR) codes into laundry services has offered an innovative payment option. This section will examine the functionality of QR code payments, with a focus on highlighting its advantages and difficulties. Particular emphasis will be placed on the senior demographic, who may encounter challenges in utilizing this technology. Proposed strategies will be presented to improve accessibility for all users, including the elderly, acknowledging the significance of inclusion in contemporary payment systems.

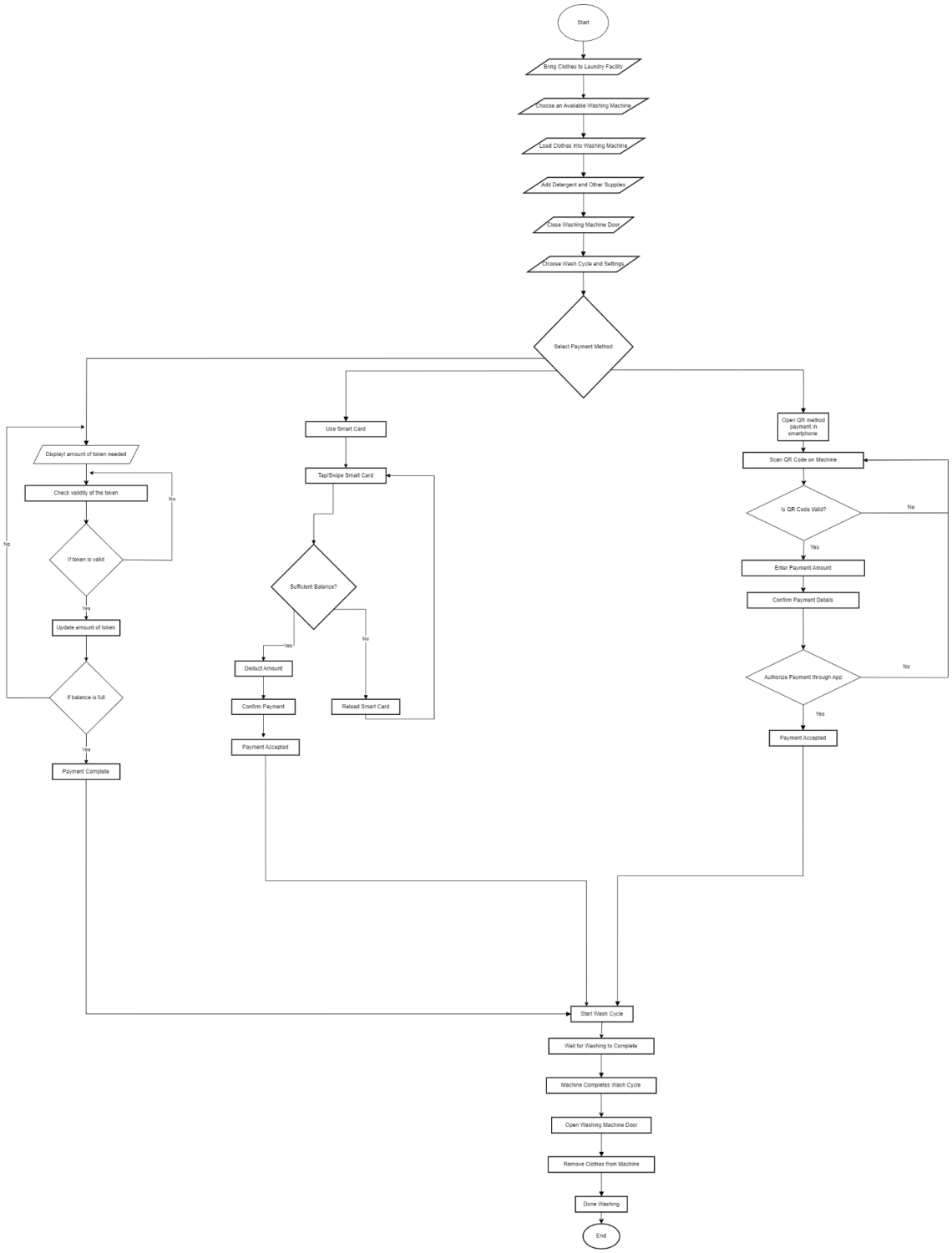
6. Laundry card payments have gained popularity as a convenient and efficient way of payment, making transactions easier for customers. This section will examine the advantages and drawbacks of using laundry cards, with a specific focus on the challenges of compatibility between different laundry facilities. The study will provide novel strategies to improve the usability and adaptability of laundry cards, guaranteeing a smoother and more convenient experience for clients.

7. Token payments offer a distinct method for conducting laundry service transactions, while they have their own set of difficulties. This section will examine the accessibility of tokens and the challenges that users encounter in acquiring them. Efforts will be made to create strategies that enhance the convenience and inclusivity of token payments, including addressing concerns about their utilization in the context of washing services.

5. Flowchart

Flowchart Draw.io Link:

https://drive.google.com/file/d/1e0yhPAPNlXYKE2llovA-zN9Os1ZBiH0j/view?usp=sharing



DFA Diagram

1. Token Payment (**CA21019**)

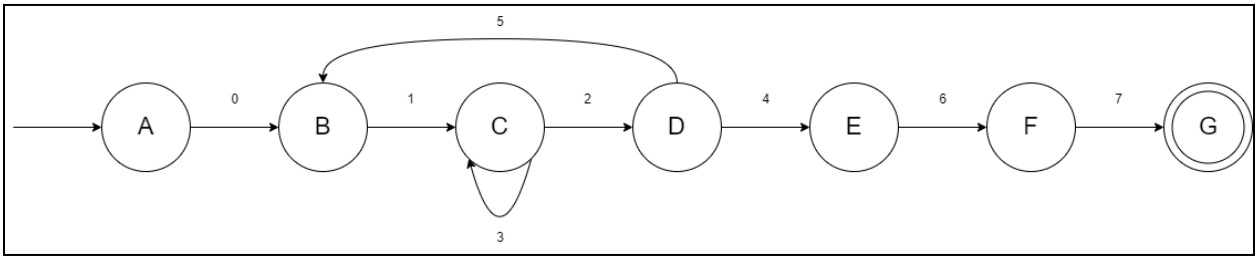


Figure 4: DFA Diagram of Token Payment

Q: List of States = {A, B, C, D, E, F, G}
∑: List of Inputs = {0, 1, 2, 3, 4, 5, 6, 7}
q0: Initial State = {A}
F: Final State = {G}
δ: Transition Function = Q × ∈ → Q

i. List of States

State	Description
A	Idle: Wait for user payment method selection
B	Token required: Display the amount of token needed to start the washing
C	Token check: Validate the inserted token
D	Balance check: Check the remaining token needed to start the washing
E	Payment complete: All the tokens has been inserted
F	Washing
G	Finish washing: Stop the washing

ii. List of Input

Input	Description
0	Token payment selected
1	Token inserted
2	Token pass the validation
3	Token fail the validation
4	Fully inserted required token amount
5	The amount of token required not complete
6	Start button is pressed
7	Washing timer ended

iii. Transaction Function

	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**
A	B	-	-	-	-	-	-	-
B	-	C	-	-	-	-	-	-
C	-	-	D	C	-	-	-	-
D	-	-	-	-	E	B	-	-
E	-	-	-	-	-	-	F	-
F	-	-	-	-	-	-	-	G
G	-	-	-	-	-	-	-	-

2. Laundry Smart Card (**CA21089**)

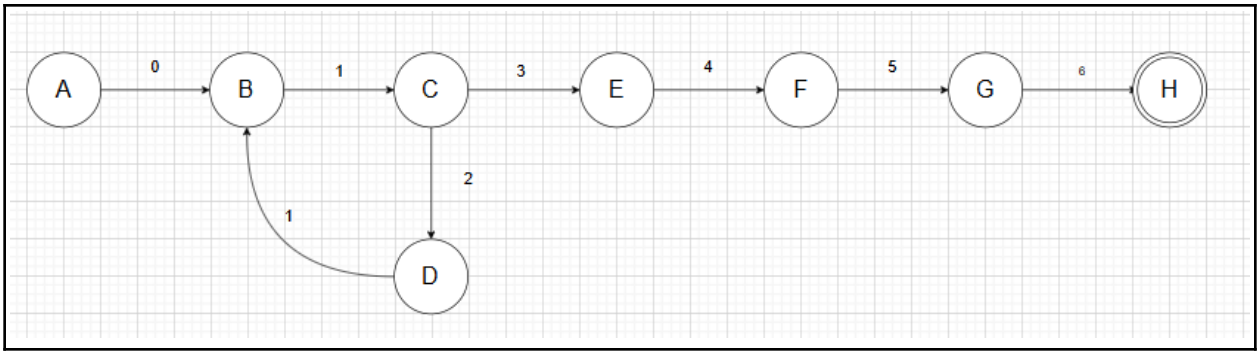


Figure 3 shows the DFA Diagram of the Laundry Smart Card

Q: List of States = {A, B, C, D, E, F, G, H}

∑: List of Inputs = {0, 1, 2, 3, 4, 5, 6, 7}

Q0: Initial State = {A}

F: Final State = {H}

δ: Transition Function = $Q \times \in \rightarrow Q$

i. List of states

State	Description
A	The user chooses to pay with a laundry card.
B	They swipe or tap their smart card on the washing machine.
C	The machine will check it if the balance is sufficient or not.
D	Machine will prompt consumers to recharge their smart card. The users must add money to their card.
E	The machine will deducts the necessary amount
F	The machine will verifies the payment
G	The machine will accepts the payment
H	The machine will start the wash cycle until the wash cycle complete

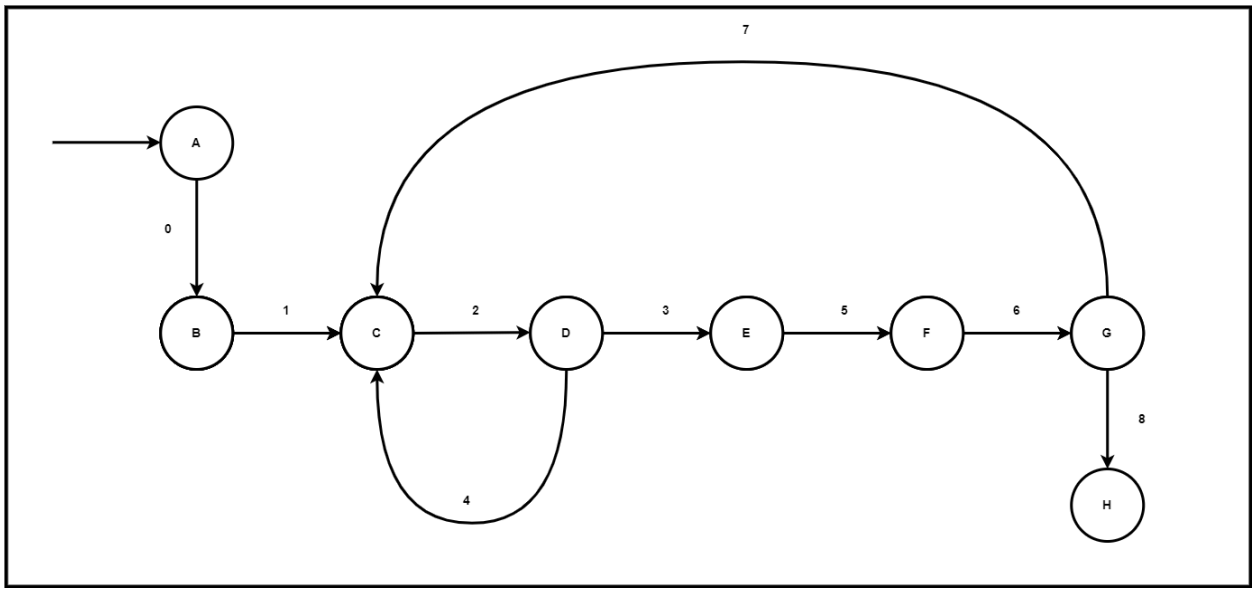
ii. List of Inputs

State	Description
0	Laundry smart card selected.
1	Swipe or tap their smart card.
2	Balance is not sufficient.
3	Balance is sufficient.
4	Deducts money
5	Payment accepted
6	start the wash cycle

iii. Transition Function

	0	1	2	3	4	5	6
A	B	-	-	-	-	-	-
B	-	C	-	-	-	-	-
C	-	-	D	E	-	-	-
D	-	B	-	-	-	-	-
E	-	-	-	-	F	-	-
F	-	-	-	-	-	G	-
G	-	-	-	-	-	-	H
H	-	-	-	-	-	-	-

3. QR Code Payment (**CA21036**)



Q : List of States = {A, B, C, D, E, F, G, H}

∑ : List of Inputs = {0, 1, 2, 3, 4, 5, 6, 7, 8, 9}

q0: Initial State = A

F : Final State = H

Δ : Transition Function = $Q \times \sum \rightarrow Q$

i. List of States

List	Description
A	Open the QR method of payment on a smartphone.
B	Scan the QR code on the machine.
C	The system validates the QR code.
D	The user enters the payment amount.
E	The user confirms the payment details.
F	The system authorizes the payment.
G	Payment is accepted.
H	The user presses the start button.

ii. List of Inputs

State	Description
0	Open QR method
1	Scan QR codes on the machine
2	Valid QR
3	Not Valid QR
4	Enter payment amount
5	Confirm payment details
6	Payment authorized
7	Payment authorization failed
8	Payment accepted
9	Press the start button

iii. Transition Functions

	0	1	2	3	4	5	6	7	8	9
A	B	-	-	-	-	-	-	-	-	-
B	-	C	-	-	-	-	-	-	-	-
C	-	-	B	D	-	-	-	-	-	
D	-	-	-	-	E	-	-	-	-	-
E	-	-	-	-	-	F	-	-	-	-
F	-	-	-	-	-	-	E	G	-	-
G	-	-	-	-	-	-	-	-	H	-
H	-	-	-	-	-	-	-	-	-	H

7. DPA Explanation

1. Token Payment (**CA21019**)

The washing machine starts in an idle state where it awaits the user to put in their laundry, choose their washing settings, add detergent, and choose payment method. After they choose the token payment method, the machine moves to the second state that displays the amount of token needed to start the wash. After the user inserted a token, the machine moves to the token check state where the machine checks the validity of the token. If the token is valid, it moves to the fourth state, otherwise ejects the invalid token. In the fourth state, the machine checks the remaining number of tokens needed to start the wash. If the token inserted meets the required amount, the machine transitions to its fifth state; otherwise go back to its second state to display the remaining amount of token needed to start the wash. In the fifth state, the machine is ready to transition to its sixth state once the user presses the start button. In the sixth state which is the washing state, the washing machine washes the user's laundy for the duration of the preset washing time. After the timer ends, the machine transitions to its final state which stops the washing process to let the user collect their clean clothes.

2. Laundry smart Card **(CA21089)**

Laundry is a necessity for residents of dorms with communal laundry facilities. In this case, to start, they swipe or tap their smart card on the washing machine, which scans it. The device determines whether the card has a sufficient balance. The machine deducts the necessary amount, verifies the payment, and accepts it if the balance is sufficient. However, in this case their smart card balance is insufficient. The machine will prompt consumers to recharge their smart card. Next, users must use the payment kiosk in the dorm to add money to their card. Once the machine has been reloaded, users can go back in, tap or swipe their card once more, and continue the payment the machine deducts the necessary amount, verifies the payment, it displays “Payment Accepted”. At that point, it will start the wash cycle until the wash cycle complete.

3. QR Code Payment (**CA21036**)

The washing machine using the QR payment method starts in the initial state (q0), where the user opens the QR payment method on their smartphone. Upon choosing the QR payment method, it transitions to the scan QR code state (q1), where the user scans the QR code displayed on the machine. If the QR code is invalid, it returns to q1; if valid, it moves to the enter payment amount state (q2), where the user inputs the required payment amount. After entering the amount, it proceeds to the confirm payment details state (q3), where the user reviews and confirms the payment details. The system then transitions to the payment authorization state (q4) to verify the payment. If the payment is not authorized, it returns to q3 for the user to retry; if authorized, it moves to the payment accepted state (q5). Finally, the user presses the start button, transitioning to the washing state (q6), where the laundry is washed for a preset duration, and then to the completed state (q7), allowing the user to collect their clean clothes.

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