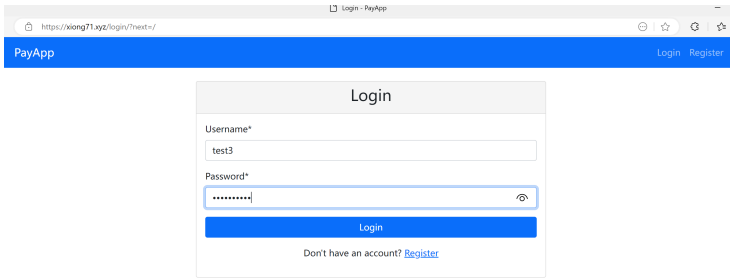
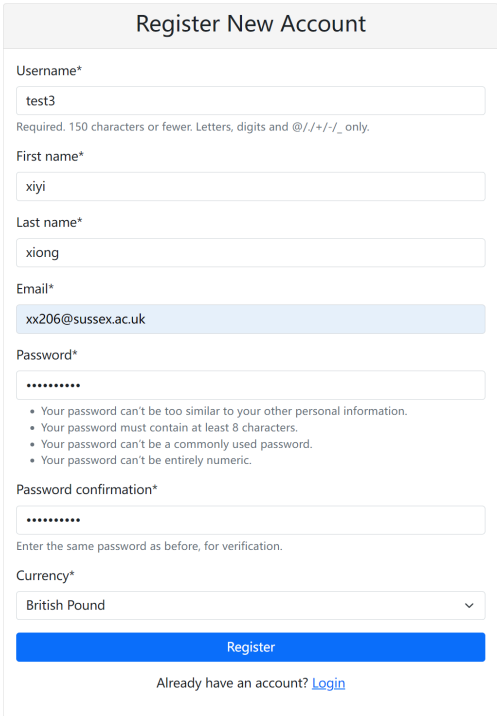
WebPay2025: An Online Payment System Based on Django - Project Report

1. Presentation Layer Implementation

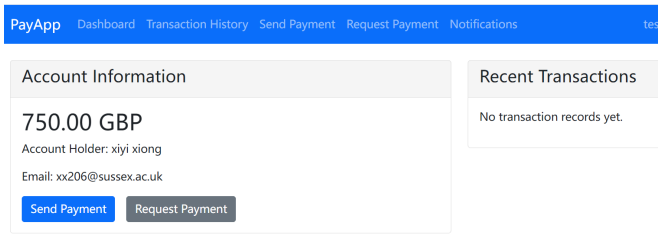
This system is built using the Django framework, providing users with an intuitive and efficient interface covering registration, login, dashboard display, transaction management, and notifications. The system utilizes the Bootstrap framework for responsive design, and all forms are implemented with Django form system and Crispy Forms components for validation and aesthetic enhancement.

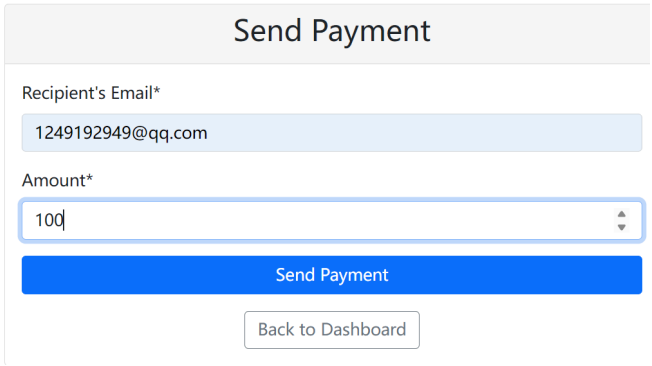


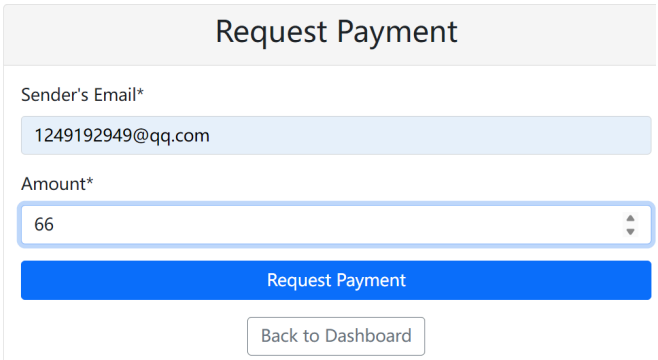


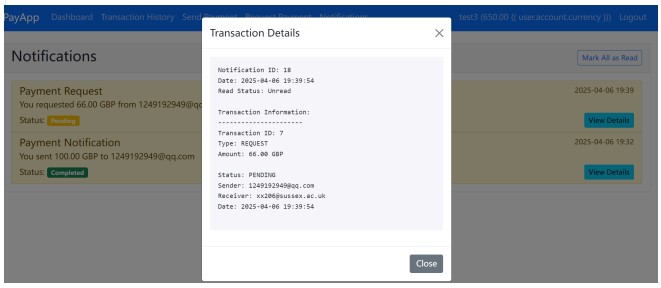
After logging in, users can access a feature-rich dashboard that clearly displays account balance, recent transactions, and received notifications. Payment functions include both direct payment and

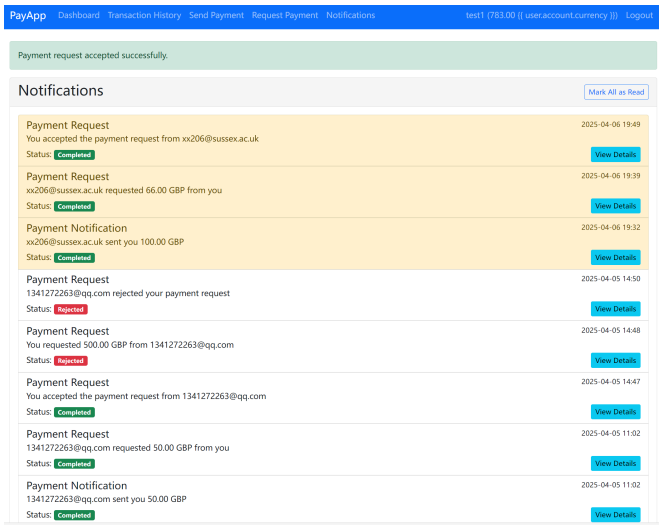
payment request options, while the transaction history and notification system allow users to view and manage all financial activities at any time.



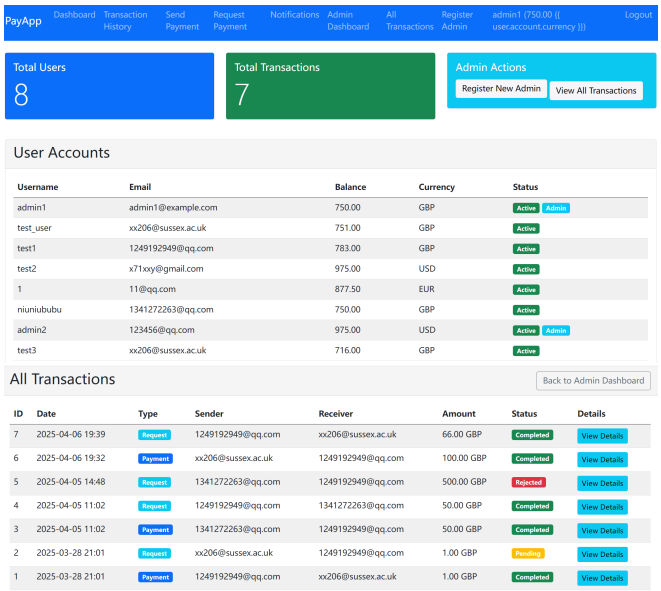








The system provides administrators with a dedicated interface to implement global user and transaction management and monitoring, including viewing all user account information, monitoring all transactions in the system, and adding other administrator accounts.



The system URL structure is designed with clarity and follows RESTful design principles, mainly including paths for home page, dashboard, user authentication, and transaction management.

```
urlpatterns = [
    path('', views.home_view, name='home'), path('dashboard/', views.dashboard_view, name='dashb
    path('register/', views.register_view, name='register'), path('login/', views.login_view, na
    path('logout/', views.logout_view, name='logout'), path('transactions/', views.transactions_
    path('send-payment/', views.send_payment_view, name='send_payment'),
    path('request-payment/', views.request_payment_view, name='request_payment'),
]
```

2. Business Logic Layer Implementation

The business logic layer is the core of the system, responsible for handling all business rules and data operations. All key logic is implemented using Django view functions, with transaction mechanisms ensuring data consistency.

The user dashboard view aggregates key information, including account balance, recent transactions, and unread notifications:

```
@login_required
def dashboard_view(request):
    account = request.user.account
    transactions = Transaction.objects.filter(Q(sender=request.user) | Q(receiver=request.user)
    notifications = Notification.objects.filter(user=request.user, is_read=False).order_by('-tir
    return render(request, 'payapp/dashboard.html', {
        'account': account, 'transactions': transactions, 'notifications': notifications,
        'unread_count': notifications.count()
    })
```

Transaction processing involves multiple steps such as account balance verification, currency conversion, transaction record creation, and notification sending, all encapsulated within database transactions to ensure data consistency:

```
@login_required
def send_payment_view(request):
    with transaction.atomic():
        # Currency conversion (if necessary)
        if sender_account.currency != recipient_account.currency:
            converted_amount = convert_currency(sender_account.currency, recipient_account.curre
        # Create transaction and update balances
        transaction_obj = Transaction.objects.create(sender=request.user, receiver=recipient, ar
        sender_account.balance -= amount
        recipient_account.balance += converted_amount
        # Create notifications
        Notification.objects.create(user=recipient, transaction=transaction_obj)
        Notification.objects.create(user=request.user, transaction=transaction_obj)
```

The payment request function allows users to initiate payment requests to other users, who can choose to accept or reject. The system manages the entire lifecycle of requests through status tracking mechanisms, ensuring each request is appropriately handled.

The administrator function module provides system management and monitoring capabilities, including user management, transaction monitoring, and system maintenance. The administrator dashboard aggregates system data, providing key metrics such as user count and transaction volume. The administrator registration function allows existing administrators to create new administrator accounts.

Auxiliary functions such as the currency conversion service support cross-currency transaction capabilities through an internal API, supporting conversions between the three main currencies: British Pounds, US Dollars, and Euros.

3. Data Access Layer Implementation

The system's data access layer is implemented based on Django ORM, adopting a clear model structure and relationship design. Core data models include the User model, UserProfile model, Account model, Transaction model, and Notification model.

```
+-------------+       +--------------+       +---------------+
|    User     |<----->| UserProfile  |<----->|    Account    |
+-------------+       +--------------+       +---------------+
| id, username|       | id, user_id  |       | id, user_id   |
| email, pwd  |       | currency     |       | balance, curr.|
+-------------+       +--------------+       +---------------+
      |
      v
+----------------+     +----------------+
|  Transaction   |<--->|  Notification  |
+----------------+     +----------------+
| id, sender,rcvr|     | id, user, trans|
| amount, status |     | message, read  |
| type, timestamp|     | timestamp      |
+----------------+     +----------------+
```

The UserProfile model extends Django's built-in User model, adding currency preference settings to support users' selection of one of the three main currencies (GBP, USD, or EUR) as their default currency. The Account model corresponds one-to-one with users, storing the user's account balance and current currency type. The implementation code for these two models is as follows:

```python
class UserProfile(models.Model):
    CURRENCY_CHOICES = [('GBP', 'British Pound'), ('USD', 'US Dollar'), ('EUR', 'Euro')]
    user = models.OneToOneField(User, on_delete=models.CASCADE, related_name='profile')
    currency = models.CharField(max_length=3, choices=CURRENCY_CHOICES, default='GBP')

class Account(models.Model):
    user = models.OneToOneField(User, on_delete=models.CASCADE, related_name='account')
    balance = models.DecimalField(max_digits=10, decimal_places=2)
    currency = models.CharField(max_length=3)
```

The Transaction model records detailed information of all transaction operations, while the Notification model implements the system's internal messaging mechanism. The system uses Django signal mechanisms to automatically create initial accounts and implements multiple query optimization measures, including indexes, queryset method chains, and pagination mechanisms.

4. Web Services Implementation

The system implements a complete RESTful API service, primarily used for currency conversion functionality. The API design follows REST principles, transmitting parameters required for conversion through URL path parameters. The API endpoint format is `/conversion/{currency1}/{currency2}/{amount}` , for example, `/conversion/GBP/USD/100` will return the result of converting 100 British Pounds to US Dollars.

The API implementation combines Django view functions with HTTP method decorators, ensuring only GET requests are accepted. The function internally implements currency conversion calculations through a hardcoded exchange rate dictionary, supporting conversions between the three main currencies (GBP, USD, and EUR) in the system. The implementation code is as follows:

```
@csrf_exempt
@require_http_methods(["GET"])
def conversion_view(request, currency1, currency2, amount):
    # Exchange rates dictionary
    exchange_rates = {'GBP_USD': Decimal('1.30'), 'GBP_EUR': Decimal('1.17'), 'USD_GBP': Decimal
    # Conversion logic
    rate_key = f"{currency1}_{currency2}"
    rate = exchange_rates.get(rate_key)
    converted_amount = Decimal(amount) * rate
    return JsonResponse({
        'from_currency': currency1, 'to_currency': currency2, 'from_amount': amount,
        'converted_amount': str(converted_amount.quantize(Decimal('0.01'))), 'exchange_rate': st
    })
```

The business logic layer calls the conversion API through client functions, integrating API calls, response parsing, and error handling logic to provide a stable and reliable service interface.

5. Security Implementation

The system's security implementation adopts a multi-layered defense strategy, including three main aspects: authentication authorization, security configuration, and Web attack defense.

The authentication system is based on Django's built-in framework, implementing secure login verification and session management. All passwords are stored after processing with the PBKDF2 algorithm and SHA256 hash function, using random salt values to enhance security. Access control implements permission checks through the decorator mechanism:

```
@login_required
def admin_dashboard_view(request):
    if not request.user.is_staff: return redirect('dashboard')
    # Administrator function implementation...
```

In terms of security configuration, the system enables multiple security middlewares, including HTTPS redirection, XSS protection, and CSRF protection. Production environment security settings include:

```
SECURE_SSL_REDIRECT = True      # Force HTTPS
SESSION_COOKIE_SECURE = True    # Secure Cookie
CSRF_COOKIE_SECURE = True       # Secure CSRF Token
X_FRAME_OPTIONS = 'DENY'        # Prevent clickjacking
```

Password policy is enforced through Django's password validators, requiring users to create strong passwords and preventing the use of common passwords:

```
AUTH_PASSWORD_VALIDATORS = [
    {'NAME': 'django.contrib.auth.password_validation.UserAttributeSimilarityValidator'},
    {'NAME': 'django.contrib.auth.password_validation.MinimumLengthValidator', 'OPTIONS': {'min_
    {'NAME': 'django.contrib.auth.password_validation.CommonPasswordValidator'},
    {'NAME': 'django.contrib.auth.password_validation.NumericPasswordValidator'},
]
```

The system has also configured Content Security Policy (CSP), limiting the sources of executable scripts and loaded resources, effectively preventing XSS and other injection attacks:

```
# CSP configuration
CSP_DEFAULT_SRC = ("'self'",)
CSP_STYLE_SRC = ("'self'", 'https://stackpath.bootstrapcdn.com')  # Bootstrap CDN
CSP_SCRIPT_SRC = ("'self'", 'https://code.jquery.com')            # jQuery CDN
CSP_FONT_SRC = ("'self'", 'https://stackpath.bootstrapcdn.com')   # Font CDN
CSP_IMG_SRC = ("'self'", 'data:')                                 # Allow data URI images
```

5.3 Web Attack Defense Measures

The system takes multiple measures to defend against common Web attacks:

CSRF Protection: All forms use CSRF tokens for protection, preventing cross-site request forgery attacks. Each POST request must include a valid CSRF token to be processed:

```
<form method="post" action="{% url 'send_payment' %}">
    {% csrf_token %}
    {{ form.as_p }}
    <button type="submit">Send Payment</button>
</form>
```

SQL Injection Defense: The system relies entirely on Django ORM and parameterized queries, avoiding the risk of direct SQL string concatenation:

```
# Secure: user = User.objects.get(email=email)  # Parameterized query
# Insecure: cursor.execute("SELECT * FROM users WHERE email = '" + email + "'")  # SQL injectio
```

XSS Defense: Django's template system automatically escapes all variable outputs, ensuring user input is appropriately processed before rendering:

```
<!-- Variables automatically escaped: <p>{{ user_message }}</p> -->
<!-- Only safe content: <div>{{ safe_html|safe }}</div> -->
```

Clickjacking Protection: Prevents the website from being embedded in iframes of malicious sites by setting appropriate X-Frame-Options headers.

Sensitive Data Protection: All transaction data and user information are encrypted via HTTPS during transmission, ensuring data transmission security.

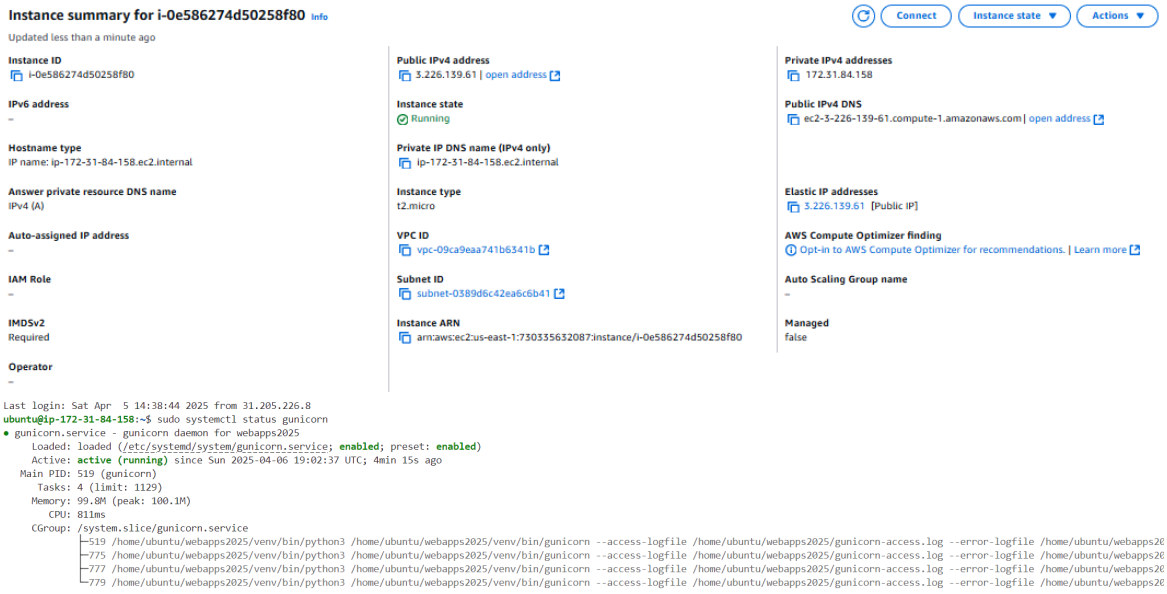
Transaction Integrity: All operations involving data changes are encapsulated in database transactions, ensuring the atomicity of operations and data integrity, preventing data inconsistency due to partial operation failures:

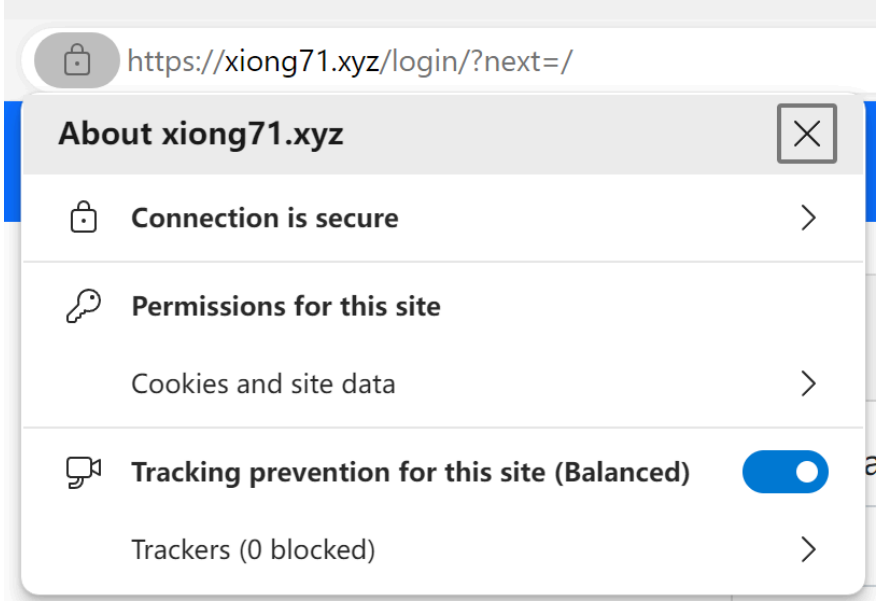
```
with transaction.atomic():
    transaction_obj = Transaction.objects.create(...)    # Create transaction record
    sender_account.balance -= amount; sender_account.save()    # Update sender
    receiver_account.balance += converted_amount; receiver_account.save()    # Update receiver
    Notification.objects.create(...)    # Create notification
```

Through the comprehensive application of these security measures, the system effectively defends against common Web application security threats, safeguarding user data security and transaction reliability.

6. AWS Deployment Implementation

The system has been successfully deployed on the AWS cloud platform, adopting a standard web application deployment architecture. Core components include EC2 instances, Nginx reverse proxy, Gunicorn WSGI server, and SQLite database, with HTTPS communication implemented through SSL certificates obtained from Let's Encrypt.





The deployment process includes four main steps: EC2 instance creation, environment configuration, application deployment, and web service configuration. The system chooses Ubuntu Server 20.04 LTS as the operating system, configures security groups to open ports 22/80/443, and assigns an elastic IP (3.226.139.61) pointing to the domain xiong71.xyz. Key configurations include:

1. Gunicorn as the WSGI server, communicating with Nginx through a socket
2. Nginx handling static files and forwarding dynamic requests to Gunicorn
3. Let's Encrypt providing SSL certificates for HTTPS access
4. System service configuration ensuring automatic application startup and error recovery

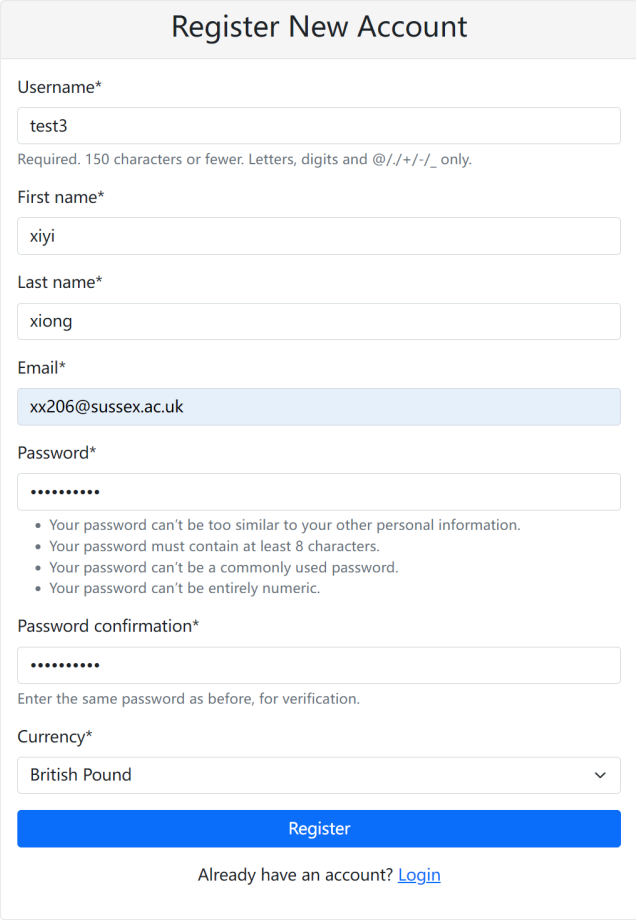
7. User Guide

7.1 Regular User Function Guide

7.1.1 Registration and Login

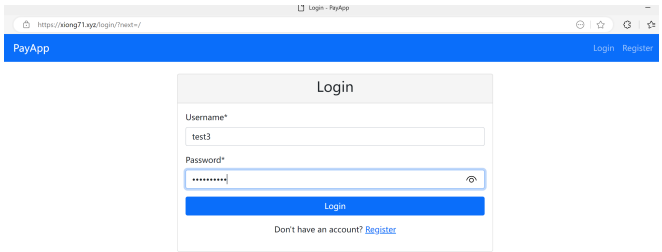
New Account Registration:

1. Visit the website homepage https://xiong71.xyz
2. Click the "Register" link
3. Fill in username, password, and currency selection (GBP/USD/EUR)
4. Click the "Register" button to submit
5. After successful registration, the system will automatically create your profile and account, with an initial balance of 750 GBP or the equivalent in your selected currency



User Login:

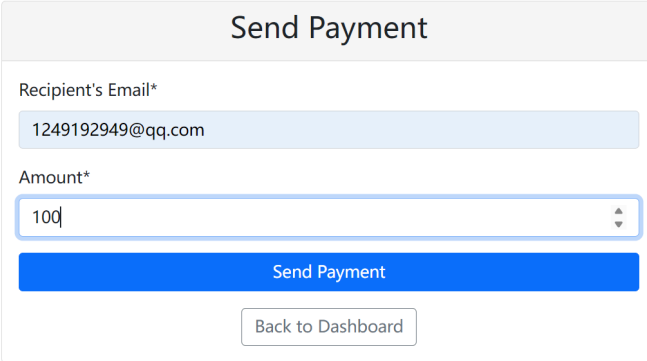
1. Visit the homepage, click the "Login" link
2. Enter your username and password, click the "Login" button
3. After successful login, you will enter the user dashboard



7.1.2 Core Function Operations

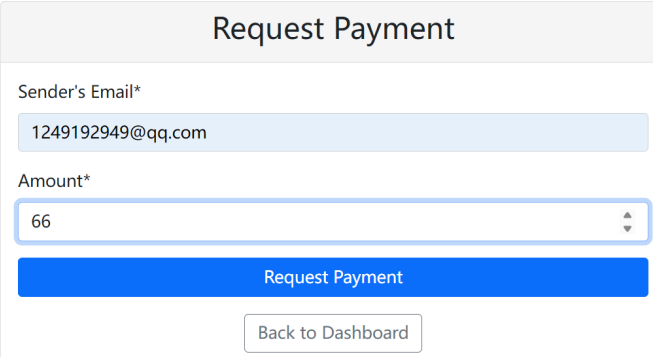
Send Payment:

1. Click "Send Payment", enter the recipient's username and amount
2. The system will verify the recipient exists and your balance is sufficient
3. Click the "Send" button to confirm, after the transaction is completed, both parties' balances will be updated and notifications sent



Request Payment:

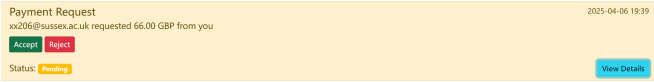
1. Click "Request Payment", enter the payer's username and amount
2. Click "Request" to submit, the system creates a transaction record with "PENDING" status
3. The system sends a notification to the payer



Process Payment Requests:

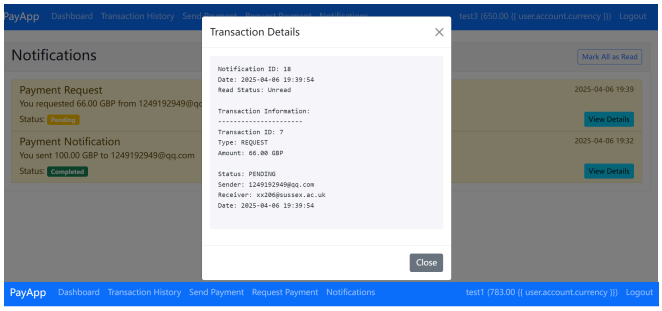
1. View received requests in notifications or transaction history

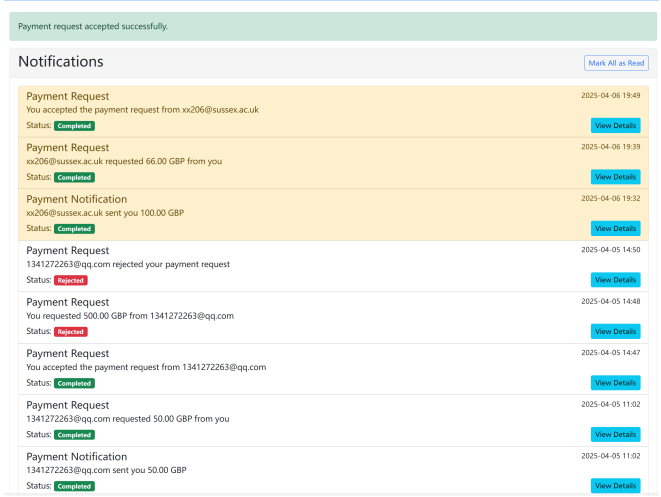
2. Click "Accept" to accept or "Reject" to decline
3. If accepted, the system automatically completes the fund transfer; if rejected, only the status is updated



View Notifications and Transaction History:

1. Click "Notifications" to view all notifications, which can be marked as read
2. Click "Transaction History" to view complete transaction records
3. Click "View Details" to see details of any transaction



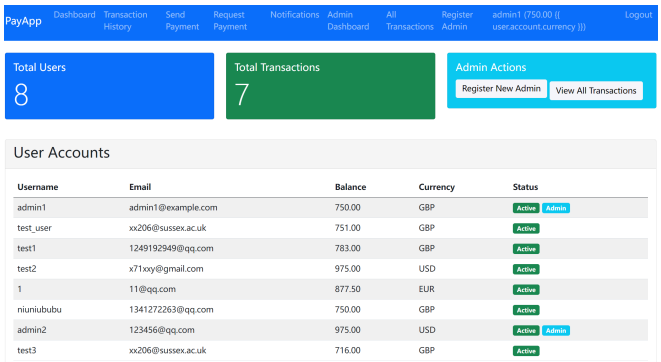


7.2 Administrator Function Guide

Administrator users have higher permissions and can access additional functions by logging into the system with an administrator account:

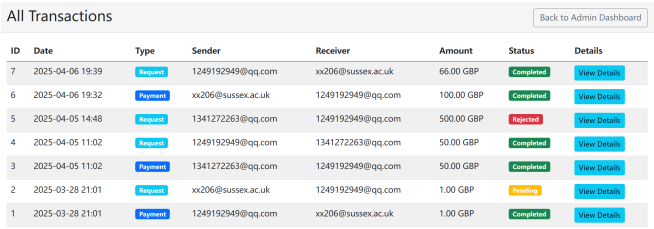
User Management:

1. Access the administrator dashboard to view a list of all users
2. Information includes username, email, account balance, currency type, etc.



Transaction Monitoring:

1. View all system transaction records
2. Each record contains transaction ID, both parties' users, amount, type, status, etc.



Administrator Registration:

1. Select the "Register Admin" option
2. Fill in new administrator information, click "Create Admin"
3. The system automatically assigns administrator permissions and initial balance