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A Forecourt Operations Management System for Oil Marketing Companies: The Ghanaian Context

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ABSTRACT

This study set out to propose an optimal forecourt operations management system for oil marketing companies within Ghana. This study, motivated by (Danquah,2017)'s recommendation for the need to design a comprehensive optimal forecourt operations management system uses an inductive approach to gathering requirements. It was based on data collected from retail outlets of Oil Marketing Companies where products are served to customers at their respective forecourts. Based on findings from interviews and observations, an optimal information technology-based solution is then proposed to facilitate processes for how people, activities, information, and resources are involved in providing products and services to customers as well as accurately and efficiently keeping records for all relevant activities. A number of core required functionalities were identified and designed for possible development into products that can be purchased off the shelf for deployment. The design details use cases, conceptual model, relational model and business rules. The system design is based on the Ghanaian context and is relevant for practitioners in the systems development sector to be developed and implemented as a solution for the oil marketing retail sector. It is recommended that further research is done in other jurisdictions to ascertain the iterability of this proposed solution.

Keywords: Forecourt Operations Management System, Oil Marketing Companies, Software System Design

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1. INTRODUCTION

An efficient and effective management system is critical to the operation of any business, the forecourt operations of oil marketing companies is no exception. Regulation significantly influences the way the Oil Marketing Companies (OMCs) operate, this requires relatively flexible systems to be deployed for the purpose of adjusting to modifications as and when needed. The forecourt of an oil marketing company is the part where products and service of downstream oil companies are delivered to clients. Typically, this is where fuel and gas are accessed by the consumers. This is referred to as the downstream end of the industry because they tend to be at the end of supply chain of the oil marketing process. Danquah (2017), in the proposed automated supply chain management system provided insight into the entire supply chain of oil marketing within the Ghanaian oil industry as shown in figure 1.

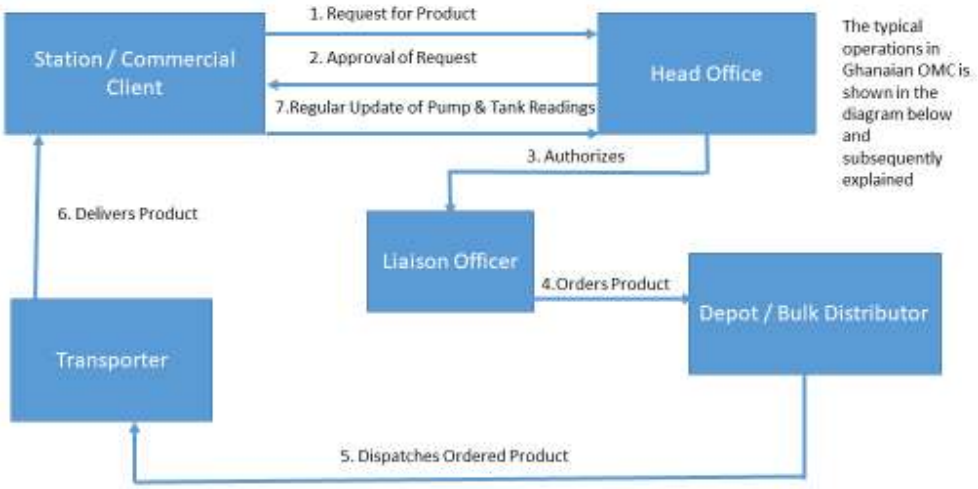

Figure 1 - Cycle of Oil Marketing Supply Chain
Source: Danquah (2017)

In the Ghanaian context, the supply chain process in an OMC involves the fuel stations' request for products from their head office via phone calls, upon receipt of the request by the head office, a bulk distribution company is selected for purchase at the depot where the oil product is stored. Upon purchase, the transporter is selected to deliver the product at the requesting station. Danquah (2017), in the study indicated "A striking lapse was the revelation that no company had an integrated solution for their stations' forecourt operations and the tracking of product orders and delivery. The forecourt operations consist of tracking opening stock and reading of their various storage tanks and pump/nozzle for all products respectively, tracking product sales at the stations, credit sales, expenses, daily lodgment to the banks and any products returned to tanks/storage."
The forecourt of the station subsequently needs to manage its operations to ensure effective accountability and service delivery. Pursuant to this objective, this study set out to design a comprehensive information technology based solution for optimal operations at the forecourt of fuel dispensing stations.

2. LITERATURE REVIEW

The industrial world of oil and gas involves critical processes and machinery for the exploration, extraction, refining, transporting and marketing petroleum products. Oil and gas companies need to control, monitor, maintain and secure the processes and industrial assets in an efficient manner, (Aalsalem, Khan, Gharibi, Khan and Arshad, 2018). An attempt to present an ingenious solution to the highlighted problems, which are essentially related to supply chain integration issues of optimal stock level, demand forecasting, order penetration point, and logistics by (Qazi, Chaudhry and Zaid, 2019) developed a microcontroller, a load sensor and a GSM module to send periodic messages about LPG level based on weight on load sensor, allowing to estimate LPG level and hence detection of demand even before the need arises. Solutions of this nature typically feed into the forecourt operations management which requires an information management system that constitutes a database and transaction management system. (Aalsalem et al,,, 2018) also presented a comprehensive review and detailed comparison of the most recent systems or techniques developed for monitoring various anomalous events that are involved in the three sectors (upstream, midstream, downstream) of oil and gas industry.

Thom Smith, vice-president for Lubricant Technology at Valvoline and a 40-year veteran of the industry, believes the lubricant firms are performing well on the technical side, however, the challenge is converting "technical speak" into "marketing speak" and developing marketing claims that are more meaningful (Fuels and Lubes International, 2018). This assertion inadvertently supports need for an efficient and effective forecourt operations management system.

It is worth noting that the forecourt operations management system is a component of the entire supply chain management system that emphasizes on automating storage, processing and reporting of the typical operations within the forecourt of a fuel station for oil marketing companies. The use of technology in forecourt management has the potential to improve an OMC's competitiveness. The forecourt management's capability is as important to a company's overall strategy as overall product strategy, its integration with the supply chain management encourages management of processes across departments. By linking the forecourt operations with the supply chain objectives to company strategy, decisions can be made between competing demands on the supply chain. Tracking of products is a critical component of supply chain management, real-time tracking is useful for proactive control strategies and detecting schedule/headway deviations in the system (Shalaby & Farhan, 2004). Further studies on supply chain system concluded that the use of technology is an important support tool for sustainable supply chain management practices since it brings benefits to the organization, suppliers, and customers. Emphasis is laid on how technology positively influences the operational, financial, and environmental performance of the organization (Fiorini & Jabbour, 2017). "The evolution of buyers requesting suppliers to comply with IT systems can be observed in the overall evolution of IT adoption in the extended supply chain" (Vanpoucke, Vereecke & Muylle, 2017).

In the Ghanaian context, the country's industry regulations require that Oil Marketing Companies procure and sell refined petroleum products to bulk consumers and the general public through retail outlets thus fuel/gas stations (Amponsah & Opei, 2014). The Ghanaian OMCs have an association which represents the collective interests of the companies involved in the oil marketing and petroleum products in Ghana, coordinating with the major Stakeholders in the Industry which include: Ministry of Petroleum, Ministry of Finance & Economic Planning, Bank of Ghana, National Petroleum Authority (NPA), The Energy Commission, Environmental Protection Agency (EPA), Tema Oil Refinery (TOR), Revenue Agencies Governing Board (RAGB), Ghana Standard Board, Ghana Fire Service, Customs Exercise and Preventive Service (CEPS), Internal Revenue Service (IRS) and Bulk Oil Storage and Transportation Co. Ltd (BOST). The OMC population consists of 85 registered OMCs in Ghana (Association of Oil Marketing Companies, 2019), "the regulation required every registered OMC to have a minimum of five outlets for sale of their products. The largest OMC in Ghana operates about 320 outlets country wide" (Danquah,2017).

Monczka and Morgan (1997), in their study explained the importance of process integration in supply chain management. The gap identified in the literature review is a comprehensive definition of the processes that constitute forecourt operations management in Ghanaian OMCs together with the required technological interventions to optimize the operations management. Prior studies by (Danquah, 2017) proposed a number of modular systems which included a Purchase Order System, GPS Fleet Tracking System, Credit Reference System and Forecourt Operations management system (FOMS). The study further indicated that a comprehensive integration of these modules should ensure people, activities, information, and resources involved in moving oil products and services from the depots to the consumer operates optimally.

This is the basis for setting out to obtain knowledge of what constitutes the forecourt operations management processes within the oil marketing sector in Ghana with an eye towards modeling a customized information technology system to address the forecourt management lapses within the oil marketing sector. The system will operate between the distributor and customer as the retailer system, this position is visually represented in figure 2 on the next page

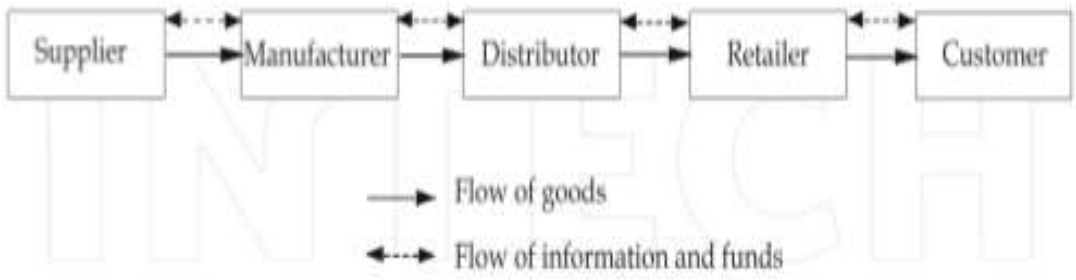

Figure 2 - Basic Supply Chain
Source: Chopra and Mendi, 2001

3. METHODOLOGY

The research approach was an inductive approach as a basis for designing the proposed system, requirements gathering was based on empirical data obtained from the data collection. Forty Two out of the 85 OMCs were used in this research. A total of 57 individuals were interviewed and observed, these ranged from operations managers, forecourt attendants at stations and station supervisors. Specific numbers are provided below;

Table 1 - List of interview respondents

No	Rank	Quantity
1	Operations managers	9
2	Forecourt Attendants	31
3	Station Supervisors	17

The study employed a predominantly qualitative approach to data collection in order to establish the accurate requirements of the retail outlets' operations. Behavioural sciences require empirical data to investigate the decision processes and communication strategies within and between organisms in a social system (Leady & Ormrod, 2010). An attempt to determine requirements for an efficient and effective design for oil marketing retail outlets required the collection and abstraction of as much empirical data as possible to be used for analysis. The choice of subjects and instrumentation therefore required utmost reliability to ensure data collected was credible. Given the chosen subjects of operations managers, forecourt attendants at stations and station supervisors, more than one method was used to collect data from the same source at any point in time to ensure reliability.

Specifically interviews and observations were used to gather the requirements. A predominantly qualitative approach is also used in the analysis as that is essential to determine more accurate first-hand information on operations. Peshkin (1993) explains that qualitative research approach is used for the purposes of description, interpretation, verification and evaluation. This therefore makes it ideal for the obtaining real patterns in OMC operations and the forecourt operations of their retail outlets. The design details use cases, conceptual model, relational model and business rules. The Unified Modelling Language and Chen notation are used in the design of the system.

4. RESULTS AND ANALYSIS

4.1 Mode of Operation at Ghanaian OMC Retail Outlets

The products sold by the oil marketing companies range from Super Premium Motor Spirit, Diesel Automotive Gas Oil to Kerosine, Liquefied Petroleum Gas and Residual Fuel Oil. Data collected revealed from 42 oil marketing companies showed that some Ghanaian OMCs employ the use of information technology partially whereas others do not use any form of information technology. It was observed that there were no companies that had successfully employed end to end technology use in its supply chain management.

Investigations pointed to two major reasons namely;

1. High cost of implementation and operation
2. Inadequate fully customized technology solution to suite the requirements for operation.

Most OMCs had an accounting application software whereas some had improvised with Microsoft Excel, a significant number had no enterprise application for managing its routine operations hence a lot of daily activities were carried out manually. Some companies used applications like JD Edwards, SAGE and SAP whereas others used applications such as ACCPAC, TAS Books and Tally. The monitoring of product movement and sale was significantly delayed as records and documents were manually transferred via transportation to responsible officers for monitoring.

The main elements involved are the retail outlet attendants, supervisors and the operation managers for the OMCs.

Table 2 - List of actors in the Forecourt Operations Management System

No	Actor	Location	Function
1	Forecourt Attendants	Retail Outlet	Serves Customers with Products Sells/Markets Products
2	Station Supervisors	Retail Outlet	Makes Daily Pump Reading Entries Makes Daily Tank Reading Entries Supervises Delivery of Products Supervises Return to Tank Tests Makes Product Requests Lodges Sales made on a daily basis to the bank
3	Operations Managers	Retail Outlet	Supervises activities of stations

The typical operations of the station or retail outlet involves the attendants at the retail outlet serving the customers with petroleum products of interest. Unlike other parts of the world where vehicle drivers serve themselves at the retail outlets, all interviewees indicated that their customers are served by an attendant at the retail outlet, this was confirmed via observation. Further to this, the supervisor at the retail outlet must keep record of stock levels and sales by recording daily opening stock levels and closing stock levels of storage tanks for the petroleum products as well as opening readings and closing readings on the pumps and their respective nozzles. Periodically, quality assurance teams from regulators visit the retail outlets to assess the quality of products being sold. This exercise requires that a sample of the product is drawn from storage for testing, upon completion, it is returned to the storage.

The terminology for this process is therefore referred to as return to tank. The retail outlets also make requests for products from their respective head offices via the operations manager resident at the head office(s). From the head office, the operations manager oversees activities at the station. In peculiar contexts, some retail outlets have pumps the use electronic reading mechanisms as well as mechanical readings. Responses from interviews showed that malicious attendants are able to manipulate mechanical pump readings to exploit the sales of the retail outlets. On the basis of these activities, the required core functionalities of an information technology based operations management for the forecourt of the oil marketing companies' retail outlets were induced as outlined below;

1. Daily Sales Tracking: A component of the system that tracks how much of the products have been dispensed on a daily basis. This encompasses the difference between daily opening and closing stocks of the storage tanks as well the opening and closing readings on the pumps and nozzles.
2. Monitoring Daily Tank Levels: This function of the system ensures records of tank levels are kept during the commencement of business and the closure of business daily.
3. Monitoring Daily Lodgments: A component of the system that records lodgment of daily sales to the bank.
4. Tracking of Expenses: This function is used for recording any related expenses made for business operations.
5. Tracking of Credit Sales: A component of the system that records and tracks credit sales made by the attendant or supervisor of the retail outlet.
6. Tracking of Return to Tank Entries: A component of the system for recording quantities of products drawn and returned to storage by quality assurance teams from regulators.
7. Product Request Tracking: This function enables the retail outlet to electronically request for products from their head office.
8. Product Receipt Tracking: This function enables the retail outlet to electronically acknowledge receipt of delivered products and comment on status.

The above listed are fundamentally core and basic functionalities required by the fore operations management system. Additional functionality if required are namely;

1. Automated Tank Gauging System: This functionality uses installed sensors on tanks that automatically update the system with tank level readings on regular basis. Levels may also be determined on real time basis by viewing dashboard of various stations.
2. Automated Pump Reading: This functionality uses installed sensors on pumps that automatically updates system with sale information regular basis without any human interference. Levels may also be determined on real time basis by viewing dashboard of various stations.

The automated tank gauging system and automated pump reading components are relevant and ideal for situations where human interventions are to be completely eliminated for the purpose of avoiding erroneous human entries. This feature however was considered a relatively huge investment for most companies in the industry, two companies out of the forty-two however, had implemented it on pilot basis at a limited number of their retail outlets. Feedback from respondents showed that it was not a short term priority requirement despite its possible optimization of efficiency and effectiveness in their operations management by avoiding any possible erroneous human interventions.

Further to the identified core functionalities were essential reports to be generated from the system, the reports identified were namely;

- Sales: This report shows sales made over a period for a retail outlet at a glance
- Tank Levels: This report shows tank levels at any point in time for a retail outlet
- Lodgments: This report shows lodgments made to the bank at any point in time for a retail Outlet
- Variance: This report compares pump/nozzle outflows to tank/storage outflows

- Tank Readings: This report is generated to show all dips for opening and closing stock entries for particular tanks/products at the respective stations over any specified duration.
- Pump Readings: This report is generated to show all opening and closing stock entries for particular pumps/nozzles at the respective stations over any specified duration.
- Station Expenses and Credit Sales: This report tracks is used to track all entries made at the respective retail outlets regarding daily credit sales and expenses made.
- Shortages: This report is generated to show all delivery shortages experienced over a specified duration.
- Station Ledger: This report shows all sales, expenses, credit sales and net value.
- Comparison of Electronic and Mechanical Pump Readings: This report enumerates compared results from pumps that have both mechanical readings and electronic readings in an attempt to detect variances.
- Analyzed Sales Reporting: This report produces a variance comparison of actual sales against projected sales at a retail outlet.

4.2 Designed System

This section provides a detailed design of the proposed solution for the management of forecourt operations. An architecture of the system is detailed showing the composition and components of the system and interface between the components. Subsequently, the various use cases of the system are outlined, an entity relation diagram is also detailed as a model for developing the relational schema and database of the system. Critical processes are also further outlined to depict essential constraints and business rules.

4.3 Architecture of System

The forecourt attendants would use the mobile devices with the installed local mobile app, the app will communicate with database via an API interface on the cloud based web server. The API would have inbuilt the business rules and direct connectivity with the database of the system. The operations managers and the station supervisors would interact with the system via a web browser which accesses the application on the cloud based web server via a web interface. The web interface on the web server is essentially connected to the database of the application. The diagrammatic representation of the system architecture is presented below.

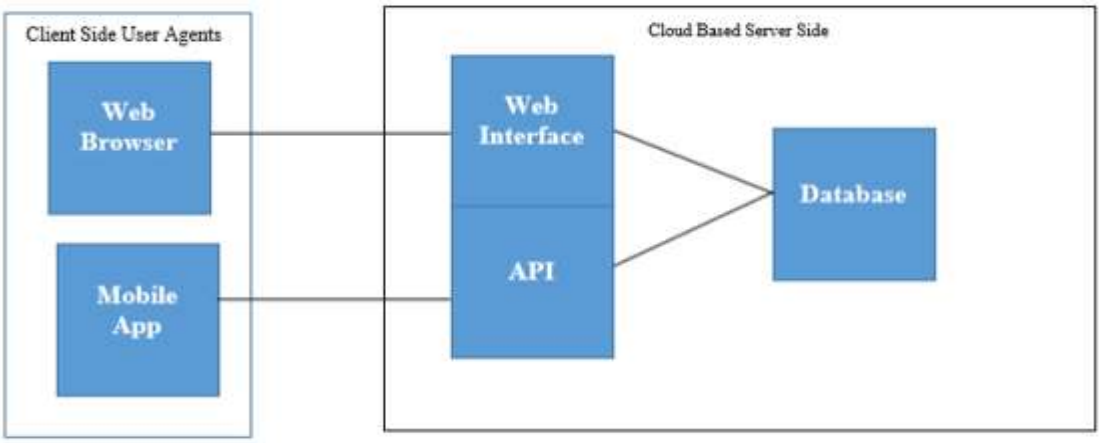

Figure 3: Architecture of Operations Management System

4.4 Use Cases

This section presents use cases of the actors in the FOMS. Use cases are used to explain and document the interaction that is required between the user and the system to accomplish the user's task. Table 3 presents a use case for recording product sales onto the forecourt operations management system. Use cases on recording pump readings and tank readings are also presented in tables 4 and 5 respectively. Table 6 presents a use case on taking delivery of product whereas tables 7 and 8 present use cases on request product and return product to tank respectively. The operations manager is able to oversee all transactions and activities that occurs in all stations with the help of the FOMS by generating various kinds of reports. Figure 4 sums up all use cases in a use case diagram.

Table 3 - Use case for "record product sales"

Use Case Name: Record product sale **ID:** UC-1 **Priority:** High

Actor: Forecourt Attendant (FA)
Description: This use case describes how a forecourt attendant records a product sale on the Forecourt Operations Management System
Trigger: FA records product sale
Type: External

Preconditions:

1. The FA identity is authenticated
2. The pump reading is up-to-date and on-line
3. Product is available for sale (pump reading is not equal to zero or any threshold priorly specified)

Normal Course:

1. Record product sales on to the system
   - 1.1. The FA selects requested product
   - 1.2. The system verifies quantity on hand
     - 1.2.1. If the pump reading falls below specified threshold, Product Request is notified of product outage and system prompts FA to exit use case
     - 1.2.2. The system displays a field to enter quantity of product needed (in liters)
   - 1.3. The FA specifies product quantity required
     - 1.3.1. If the quantity on hand is less than quantity specified, the FA specifies the quantity he will take
     - 1.3.2. Product Request is notified of product outage and system exits use case
   - 1.4. The system asks the FA to confirm the request for the quantity specified
   - 1.5. The system displays the total transaction amount
   - 1.6. The system stores the sales record in the Product Sales datastore
   - 1.7. The system updates and displays new pump reading

Postconditions:

1. Product sales record is stored in the FOMS
2. Pump Reading is updated

Table 4 - Use case for "record pump reading"

Use Case Name: Record pump reading **ID:** UC-2 **Priority:** High

Actor: Station Supervisor (SS)

Description: This use case describes how the station supervisor records pump readings

Trigger: SS decides to make opening and closing stock entries for pumps and nozzles onto the system

Type: External

Preconditions:

1. SS is authenticated
2. Pump reading datastore is available and online

Normal Course:

1. Record pump reading on to system
   - 1.1. The SS selects a pump and a nozzle
   - 1.2. System displays pump details and last readings and prompts SS to verify pump detail and to confirm continuation to work with selected pump
     - 1.2.1. If pump detail is incorrect, SS clicks cancel. System prompts SS to start process all over
     - 1.2.2. SS clicks continue button
   - 1.3. System activates field to enter pump reading
   - 1.4. SS enters pump reading and date
     - 1.4.1. If reading is closing reading and is less than opening reading, System displays error and prompts SS to re-enter a valid closing reading
     - 1.4.2. SS clicks button to save entry
   - 1.5. The system asks the SS to confirm action
   - 1.6. The system stores pump reading in the Pump Reading datastore
   - 1.7. The system updates and displays new pump reading

Postconditions:

1. Pump reading is stored in the Forecourt Operations Management System
2. System returns success/failure message onto screen

Table 5 - Use case for "record tank reading"

Use Case Name: Record tank reading	**ID:** UC-3	**Priority:** High

Actor: Station Supervisor (SS)

Description: This use case describes how the station supervisor records tank readings

Trigger: SS decides to make opening and closing stock entries for tanks onto the system

Type: External

Preconditions:

1. SS is authenticated
2. Tank reading datastore is available and online

Normal Course:

1. Record tank reading on to system
   1.1. The SS selects a tank
   1.2. System automatically populates opening reading field with value for selected tank
      1.2.1. If SS is not satisfied with populated value, SS enters a value manually
      1.2.2. SS enters date
   1.3. SS clicks button to save entry
      1.3.1. If reading is closing reading and is greater than opening reading, System displays error and prompts SS to re-enter a valid closing reading
      1.3.2. The system stores tank reading in the Tank Reading datastore

Postconditions:

1. Tank reading is stored in the Forecourt Operations Management System
2. System returns success/failure message onto screen

Exceptions:

Table 6 - Use case for "take product delivery"

Use Case Name: Take product delivery	**ID:** UC-4	**Priority:** High

Actor: Station Supervisor (SS)

Description: This use case describes how the station supervisor takes delivery of product onto the system

Trigger: Product gets delivered by a tanker driver

Type: External

Preconditions:

1. SS is authenticated
2. Product has already been ordered and recorded in the system
3. Order has been approved and paid for
4. Orders and products datastore are available and online

Normal Course:

1. Take delivery of product onto FOMS
   - 1.1. SS navigates to “delivery comments” page
   - 1.2. SS enters an order ID to search
     - 1.2.1. If order is not found, system displays a message and use case is terminated
     - 1.2.2. Order is found and SS clicks to complete delivery form
   - 1.3. SS clicks button to submit delivery form
   - 1.4. System prompts SS for confirmation
     - 1.4.1. SS clicks cancel button and use case is terminated
     - 1.4.2. SS clicks continue button
   - 1.5. Order is updated as delivered in the orders datastore
   - 1.6. Waybill is generated

Postconditions:

1. Product requested is marked as delivered in the Forecourt Operations Management System
2. System displays a success message onto screen
3. Waybill document is generated

Table 7 - Use case for "request product"

Use Case Name: Request product	**ID:** UC-5	**Priority:** High

Actor: Station Supervisor (SS)

Description: This use case describes how the station supervisor requests product using the system

Trigger: SS decides to request a product

Type: External

Preconditions:

1. SS is authenticated
2. Product datastore is available and online

Normal Course:

1. Request product using system
   1.1. SS navigates to request product page
   1.2. The SS provides detail for products to request and clicks a button to make request
   1.3. System prompts SS to confirm request
      1.3.1. If SS cancels request, use case is terminated
      1.3.2. SS clicks continue button
   1.4. The system stores product request in the Orders datastore

Postconditions:

1. Product request is stored in the Forecourt Operations Management System
2. System returns success/failure message onto screen
3. Request is forwarded to headquarters for approval

Table 8 - Use case for "Return product to tank "

Use Case Name: Return product to tank **ID:** UC-6 **Priority:** High

Actor: Station Supervisor (SS)

Description: This use case describes how the station supervisor records returns to tank onto the system

Trigger: SS needs to record a return to tank activity

Type: External

Preconditions:

1. SS is authenticated
2. Product and tank reading datastores are available and online

Normal Course:

1. Record return product to tank activity
   1.1. SS navigates to “return to tank” page
   1.2. The SS selects a product, provides quantity and date for selected products and clicks button to save entries
   1.3. System prompts SS to confirm request
      1.3.1. If SS cancels request, use case is terminated
      1.3.2. SS clicks continue button
   1.4. The system stores request to tank entry in the RRT datastore

Postconditions:

1. Request to tank entry is stored in the Forecourt Operations Management System
2. System returns success message onto screen

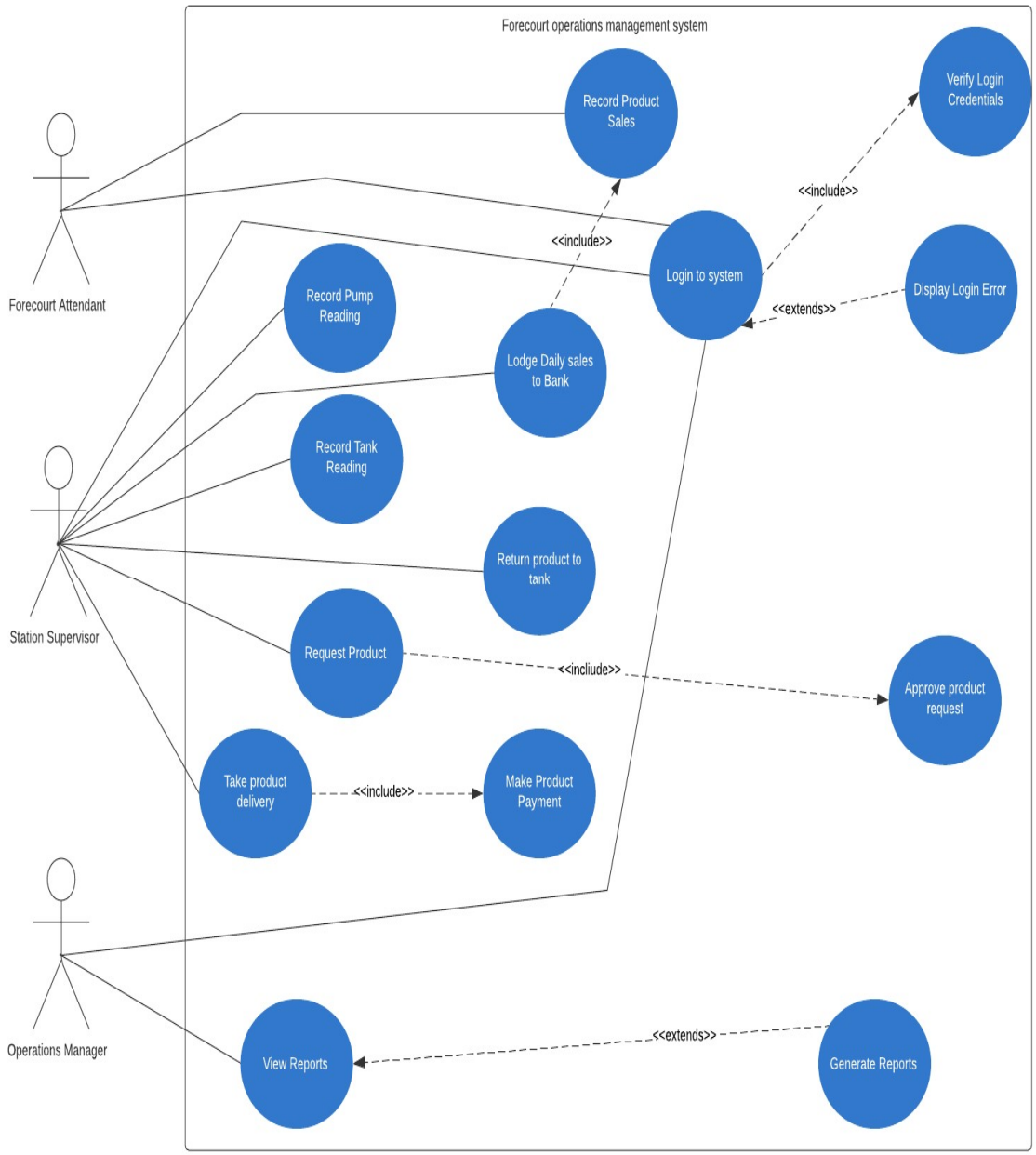

Figure 4 - Use Case diagram for the forecourt operations management system

4.5 Entity Relationship Diagram

The entity relation diagram or conceptual model presents and illustrates how "entities" such as people, objects or concepts relate to each other within a system and serves as structure for developing a relational model and the development of the physical model. This section provides a summary on the how data for the forecourt operations management system is represented. A logical data model following the Chen notation for entity relationship diagram is used to depict a portion of the data represented in this system in figure 5.

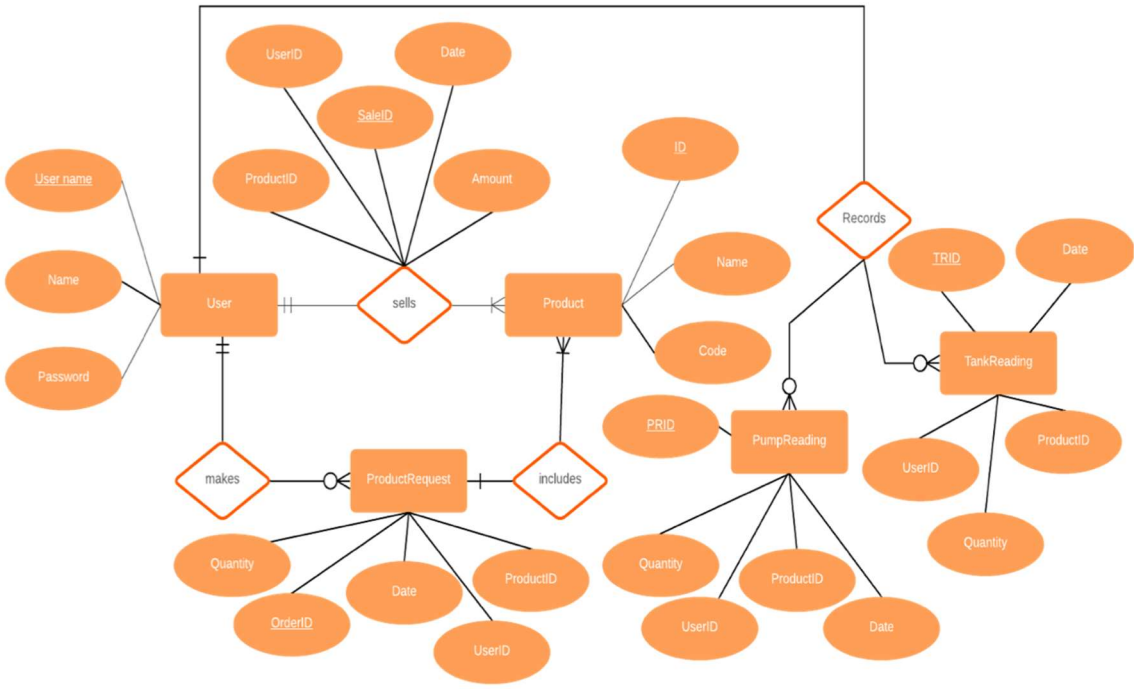

Figure 5 - Forecourt Operations Management System ERD

4.6 Deduced Relational Schema from Conceptual Model:

The relational schema is extracted from the entity relation diagram on the basis of a relation that contains a minimum amount of redundancy and allows users to insert, modify and delete the rows without errors or inconsistencies. Other essential considerations are the change attributes that represent relationships into relationship types and the determination cardinality ratio and participation constraint of each relationship type. Below is the relational model or scheme for the forecourt operations management system;

User (**username**, name, password)
Sells (**salesid,** date, amount, **productid, userid**)
Product (**id**, name, code)
ProductRequest (**orderid,** date, quantity, **userid, productid**)
PumpReading (**prid**, quantity, date, **userid, productid**)
TankReading (**trid**, quantity, date, **userid, productid**)

The tables to be used in the system are namely; user, sells, product, productrequest, pumpreading and tankreading. The attributes for the user table are username, name and password with username as the unique identifier or primary key. The attributes for the sells table are productid, salesid, userid, date and amount with the salesid as the primary key and the userid and productid as foreign keys. The product table has attributes id, name and code with id as the primary key. The table producrequest has the attributes userid, orderid, quantity, productid and date with orderid as the primary key and productid and userid as the foreign keys. The table pumpreading has the attributes prid, quantity, userid, productid and date with prid as the primary key, userid and productid as foreign keys. The table tankreading has the attributes trid, quantity, userid, productid and date with trid as the primary key, userid and productid as foreign keys.

4.7 Essential Business Logic and Process Flow

This section employs structured English to express the business logic governing some specific use cases identified earlier in this paper. Use cases, whose business logic are quite straight forward and require no alternative path are not represented in this section. Examples of such include “view reports”, “Return product to tank”, “lodge daily sales to bank”, “request product” and “take product delivery”. Figure 6 represents an expression of the “Record Product Sales” use case, whereas Figures 7 and 8 provides the business logic of the “Record Pump Reading” and “Record Tank Reading” use cases respectively.

```
RECORD PRODUCT SALES
//////////////////////////////////////////////////////////////////

Enter product id, quantity and date Of Purchase
IF quantity supplied exceeds quantity in stock
THEN
    Error message is diaplayed AND entries are not saved
ELSE
    Entries are saved AND a success message is displayed
```

Figure 6 - Business Logic for "Record Product Sales" use case

```
RECORD PUMP READING
//////////////////////////////////////////////////////////////////////////
Select pump, nozzle AND Enter opening reading and date for the selected
IF opening reading is LESS THAN last reading
THEN
    Error message is display and pump reading is not saved
ELSE
    Pump reading is saved and success message is displayed
```

Figure 7 - Business Logic for "Record Pump Reading" use case

```
RECORD TANK READING
//////////////////////////////////////////////////////////////////
Select a tank
Opening reading is automatically populated
IF opening reading is not accurate
THEN
    New opening reading is entered
ELSE date is entered
IF previous stock is not closed
THEN
    Error message is displayed and tank reading is not recorded
ELSE
    Tank reading is saved and success message is displayed
```

Figure 8 - Business Logic for "Record Tank Reading" use case

5. CONCLUSION

The proposed IT based forecourt operations management system for Ghanaian oil marketing companies has been focused on using the optimal processes of any oil marketing company's retail outlet in Ghana as the basis for the system design. The operation the forecourt has been conceptually computerized, the intention was to addresses how people, activities, information, and resources involved in delivering oil products and services to customer as well as keeping accurate records for various optimal reporting requirements. The gathering of requirements was inductive and based on data collected from retail outlets of Oil Marketing Companies where products are served to customers at their respective forecourts. Based on findings from interviews and observations, an optimal information technology based solution is then proposed. Core required functionalities identified and designed for possible development into solutions are daily sales tracking, monitoring daily tank levels, monitoring daily lodgments, tracking of expenses, tracking of credit sales, tracking of return to tank entries, product request tracking and product receipt tracking.

Additionally, an automated tank/storage gauging system and automated pump reading component are proposed though considered not to be a core functionality. A number of fundamentally essential reports required include sales, tank levels, lodgments, variance, tank readings, pump readings, station expenses and credit sales, shortages, station ledger, comparison of electronic and mechanical pump readings, analyzed sales reporting. It needs to emphasized that the system design and its components is based on the Ghanaian context and is relevant for practitioners in the systems development sector to be developed and implemented as a solution for the oil marketing retail sector. It needs to be also be emphasized that this proposed system should ideally be integrated into a comprehensive supply chain management system for the entire oil marketing company. A comprehensive integration of these designed components should ensure people, activities, information, and resources involved in delivering products and services to customers at the retail outlets and keeping good records for informative and effective management operates optimally.

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