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Enhancing Offline Shopping Experiences With Real-Time Mobile Apps, Specifically in Batam City

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ABSTRACT

Information asymmetry in the offline retail market imposes substantial "search costs" on purchasing professionals, who frequently lack visibility into real-time product availability across physical stores. Existing solutions, such as generic store locators, fail to provide inventory context, while traditional e-commerce platforms are unable to meet immediate, same-day procurement needs due to logistical delays. This research addresses this gap by developing a Real-Time Location-Aware mobile artifact aimed at optimizing offline procurement efficiency in Batam City. Grounded in Design Science Research (DSR), the system employs a short-polling architecture implemented via Expo (React Native), Express.js, and PostgreSQL to ensure data freshness. Technical performance testing validated the system's "Near Real-Time" capabilities, achieving an average API response time of 180 ms and a stable synchronization interval of 5 seconds under 4G network conditions. Furthermore, a usability evaluation involving 40 purchasing professionals yielded an average System Usability Scale (SUS) score of 71.81, categorizing the application as "Good." These results empirically demonstrate that lightweight polling architectures can effectively mitigate cognitive load and search latency, offering a scalable software engineering solution for the "Offline-to-Offline" (O2O) retail sector.

1. Introduction

In the context of economic growth, Batam City has experienced an increase in financial activities, leading to the emergence of various businesses, ranging from small to large scale [1]. Although Batam is designated as a Special Economic Zone (SEZ) and a Free Trade Zone (FTZ), offering various fiscal incentives to stimulate trade and industrial activities, the region faces specific challenges [2]. Numerous companies and business owners encounter regulatory and operational barriers that hinder their adoption of digital platforms [2]. As a result, a substantial number of businesses refrain from engaging in e-commerce, primarily due to concerns regarding regulatory complexities, additional costs, and uncertainties associated with the logistics of goods movement and distribution [2].

The existing scholarly discourse predominantly focuses on solutions tailored to either e-commerce (online transactions) or generic Location-Based Services (LBS) [3], [4], [5]. Nonetheless, a significant gap persists in addressing "Offline-to-Online" (O2O) procurement. Conventional store locators, such as Google Maps, furnish users with distance metrics but fail to offer item-specific inventory insights. Conversely, mainstream e-commerce platforms excel in providing inventory information but disregard geographical considerations. These platforms prioritize an extensive

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product catalog over spatial proximity, often lacking functionalities such as distance-based sorting or nearest-store identification [6]. This absence of logistical context, coupled with potential shipping delays, renders current platforms inadequate for professionals necessitating immediate, same-day procurement [7]. There is a notable scarcity of research on mobile architectures that effectively integrate both availability and proximity considerations.

The deficiency in digital integration poses a notable usability challenge for purchasing professionals. In contrast to casual shoppers, these individuals incur a considerable "search cost," which involves the necessity of physically visiting various distributed locations to confirm the availability of specific items [8]. In the contemporary competitive retail landscape, there is an increasing demand for a portal designed to simplify and streamline the process of locating and purchasing products from physical retail outlets. Such a portal would enable purchasing professionals to efficiently compare prices, verify product availability, and identify suitable offers without the necessity of visiting multiple locations [9]. To enhance accessibility and ensure real-time responsiveness, it is most effective to implement this portal as a mobile application. A mobile application enables users to access store data instantaneously, receive live updates, and make expedited purchasing decisions at any time and location [10]. In this context, a mobile application offering real-time insights into product availability within physical retail environments can substantially support purchasing professionals by streamlining the item location process and facilitating the acquisition of more advantageous pricing options [11].

The creation of a mobile application dedicated to enhancing the offline shopping experience has the potential to significantly improve both the efficiency and effectiveness of the product search process [12]. By utilizing information technology, such an application can furnish real-time data regarding the locations and availability of products across various retail outlets, thereby enabling consumers to plan their visits with greater efficiency [13], [14].

This research contributes to the fields of mobile software engineering and interaction design, with a particular emphasis on delivering real-time assistance for offline procurement activities. In contrast to conventional e-commerce systems, this study introduces an innovative solution designed to address the challenges associated with information retrieval in a fragmented physical marketplace. The research details the development of a location-sensitive mobile artifact and assesses its performance using the System Usability Scale (SUS). By examining the reduction in search costs and cognitive demands, this study provides empirical insights into how mobile technology can enhance the purchasing processes for professionals operating in developing economic regions.

2. Method

2.1. Research Flow

The research methodology is structured to develop a real-time application aimed at enhancing the shopping experience for purchasing professionals in physical retail environments. The research process is conducted systematically through several critical stages, each focused on problem-solving, solution design, and the development of a practical application as ahown in fig.1.

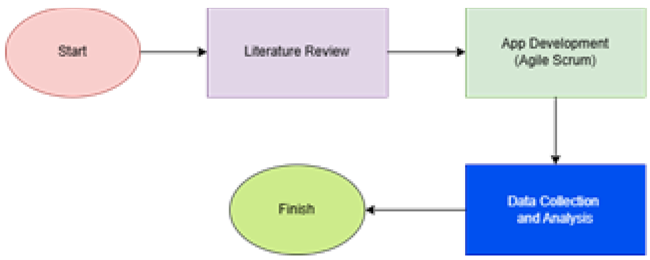

Fig. 1. Research Flowchart

The application development framework employed the Agile Scrum methodology to ensure adaptability and the continuous integration of user feedback [15], [16]. This approach was chosen to facilitate an iterative design process, enabling the artifact to evolve based on empirical observations of purchasing professionals. The research team was organized with distinct role Herman (Product Owner), Hernando (Scrum Master), and additional members (Development Team) to ensure efficient execution. The initial phase involved compiling a comprehensive Product Backlog derived from user interviews, prioritizing critical features such as real-time product search, location-based notifications, and stock indexing.

The development lifecycle was implemented through a series of bi-weekly Sprints. Each cycle commenced with Sprint Planning, during which high-priority backlog items were selected and decomposed into quantifiable technical tasks. Throughout the execution phase, the team maintained coordination via daily stand-ups to identify impediments at an early stage. Each sprint concluded with a Sprint Review, where functional increments were demonstrated to Product Owner to ensure alignment with the research objectives. This was followed by a Retrospective aimed at refining the development process. This rigorous cycle ensured that the final mobile artifact was not only technically robust but also operationally relevant to the target demographic.

2.2. Research Method

The methodology adopted in this study is grounded in the Design Science Research (DSR) paradigm, which emphasizes the development and comprehensive evaluation of IT artifacts to address specific organizational challenges [17]. This section elaborates on the systematic approach employed to validate the proposed mobile application, prioritizing measurable outcomes over mere development processes. The research framework includes the identification of variables, the formulation of hypotheses, the establishment of system performance metrics, and a quantitative usability evaluation using the System Usability Scale (SUS). Data collection was conducted in Batam City, with a focus on professional purchasing agents to ensure ecological validity.

2.3. Research Model and Hypotheses

To implement the DSR framework, a conceptual model was formulated to substantiate the causal relationship between the proposed technological intervention (Independent Variable) and the operational outcomes (Dependent Variables). Figure 2 presents the conceptual framework. The model suggests that the implementation of a Real-Time Location-Aware System will have a positive effect on the procurement workflow by mitigating information asymmetry, thereby enhancing Search Efficiency (H1), ensuring high System Usability (H2) and Data Freshness (H3).

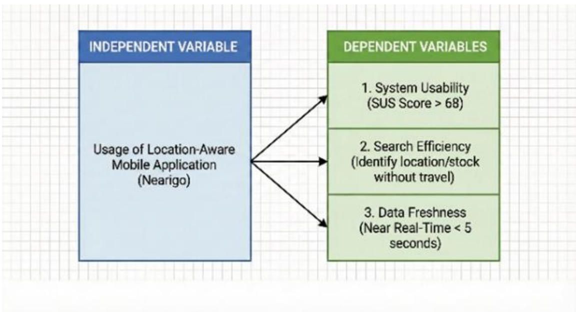

Fig. 2. Conceptual Research Model

2.4. Research Variables and Metrics

To evaluate the effectiveness of the proposed solution, this study defines the following variables based on the research model:

Table 1. Table of Variables

Variable	Metric
Independent Variable	The usage of the location-aware mobile application (Nearigo) equipped with inventory synchronization features.
Dependent Variables	System Usability: Measured quantitatively using the System Usability Scale (SUS) to determine user acceptance. The target benchmark is a score > 68. Search Efficiency: Defined as the capability of the user to identify product location and availability without physical travel, measured by successful task completion rates. Data Freshness: The temporal accuracy of inventory data presented to the user. The system targets a Near Real-Time (NRT) synchronization interval of 5 seconds. This variable measures the system's ability to reflect stock status changes within a time frame that is negligible compared to human physical navigation speed.

2.5. System Architecture and Performance

The architecture of the system has been strategically crafted to harmonize data currency with the efficient use of device resources. On the client side, the implementation of Expo (React Native) facilitates cross-platform compatibility. Concurrently, the server side is structured with Express.js and PostgreSQL, hosted on Biznet Gio Cloud, to deliver low-latency access for users situated in the region.

To facilitate the synchronization of inventory, the system employs a hybrid data retrieval strategy: Inventory synchronization is achieved through a short-polling architecture with a refresh interval of five seconds. This method ensures high reliability over unstable mobile networks while avoiding the battery depletion associated with continuous WebSocket connections [18]. In the context of offline logistics, where physical travel between stores requires several minutes, a data latency of five seconds is effectively equivalent to real-time for decision-making purposes.

Critical alerts, such as notifications for "Item Restocked" events, are facilitated through the integration of Firebase Cloud Messaging (FCM). This system enables the delivery of asynchronous notifications, ensuring that high-priority information is promptly communicated to the user, even when the application is operating in the background.

2.6. Research Instrument and Sampling

This study utilized a purposive non-probability sampling method to ensure ecological validity. The target population comprised purchasing professionals and procurement officers operating within Batam City, as this demographic encounters the specific high-frequency search costs addressed by the proposed solution. A total of 40 participants (N=40) were selected in accordance with the specified inclusion criteria:

1). **Professional Role**: Currently engaged in a position that necessitates frequent offline procurement or inventory acquisition;
2). Geographic Context: Located and operationally engaged in Batam City to authenticate location-specific characteristics; and
3). **Technical Proficiency**: To ensure compatibility with the React Native artifact, individuals should possess an intermediate level of smartphone literacy and utilize a device operating on Android 8.0 or higher, or iOS 12 or higher.

The sample size of N=40 surpasses the recommended minimum of 30 participants for quantitative usability studies employing the System Usability Scale (SUS), thereby ensuring adequate statistical power to ascertain valid usability scores. Table 5 presents the demographic profile of the participants, illustrating a balanced distribution of experience levels and device ecosystems.

2.7. Experimental Design and Baseline Definitions

To validate the research hypotheses, this study utilizes a comparative task-based evaluation design. This methodology assesses the performance of the proposed artifact in relation to the established operational baseline of offline procurement.

2.7.1. Baseline Model Definition (Control Condition)

The Baseline Model delineates the current standard for procurement professionals in Batam. This model is characterized by a "manual search" process, necessitating physical visits to stores or telephonic communication for inventory verification. It is marked by significant search latency, measured in minutes or hours, and imposes a substantial cognitive load due to the manual aggregation of data.

2.7.2. Proposed Model (Experimental Condition)

The Experimental Condition introduces the Nearigo mobile artifact as the intervention. This model employs the short-polling architecture delineated in Section 2.5 to deliver Near Real-Time (NRT) visibility. The anticipated performance for this model includes a search latency measured in seconds and a reduction in cognitive load through a unified interface.

2.7.3. Experimental Protocol

Participants engaged in a single-group post-test design. Each individual was required to replicate a standardized procurement scenario, such as sourcing a specific commodity, utilizing the application. The operational efficiency was assessed in comparison to the theoretical benchmarks of the Baseline Model to illustrate the reduction in "search cost."

2.8. Data Collection & Analysis

Data collection was executed in two distinct phases: the first phase involved system performance testing, which served as technical verification, while the second phase encompassed user acceptance testing, functioning as empirical validation.

2.8.1. System Performance Testing (Data Freshness)

In order to validate Hypothesis 3, which pertains to data freshness, the technical performance was evaluated using network profiling tools, namely Postman and Chrome DevTools, under simulated network conditions such as 4G and Wi-Fi. The primary metrics assessed were the API Response Time and the Inventory Synchronization Interval. The system was subjected to stress testing to confirm that the short-polling mechanism could maintain a data refresh rate of ≤ 5 seconds without breaching the specified latency threshold.

2.8.2. User Acceptance and Usability Testing

The System Usability Scale (SUS) serves as an optimal evaluation instrument for assessing the design of a real-time mobile application intended to enhance the offline shopping experience. SUS enables straightforward and standardized quantitative measurement of usability, rendering it an ideal choice for usability evaluation within the context of shopping applications [19], [20]. Quantitative data were collected from 40 respondents, all of whom are purchasing professionals and procurement officers, utilizing a two-part instrument:

- Task Completion Log: Participants performed three specific procurement tasks (product search, stock verification, and navigation) to measure Search Efficiency (H3). Success rates and time-on-task were recorded.
- System Usability Scale (SUS): Post-trial, participants completed the 10-item SUS questionnaire to measure System Usability (H3). The scoring utilized the standard formula:

Table 2. Table of Questionnaire Items

No	Questions	Strongly disagree				Strongly agree
		1	2	3	4	5
1	I would like to use this system frequently.					
2	I found the system unnecessarily complex.					
3	I thought the system was easy to use.					
4	I think that I would need the support of a technical person to be able to use this system.					
5	I found the various functions in this system were well integrated.					
6	I thought there was too much inconsistency in this system.					
7	I would imagine that most people would learn to use this system very quickly.					
8	I found the system very cumbersome to use.					
9	I felt very confident using the system.					
10	I needed to learn many things before I could get going with this system.					

After collecting the questionnaire data from the respondents, the next step is to calculate the total score to measure the system's level of usability. This calculation uses the validated System Usability Scale (SUS) formula [21]. The calculation formula is as follows:

$$SUS = \frac{\left(\Sigma_{i=1}^{n} \left(\Sigma_{i=1,3,5,7,9} (x_i - 1) + \Sigma_{i=2,4,6,8,10} (5 - x_i) \right) * 2.5 \right)}{n}$$

With:

- x_e: The score given by respondent i for each question on the SUS questionnaire (ranging from 1 to 5).
- $\sum_{(1,3,5,7,9)}(x_i - 1)$: Adjustment for positively worded statements, subtracting one from the score.
- $\sum_{(2,4,6,8,10)}(5 - x_i)$: Adjustment for negatively worded statements, subtracting the score from 5.
- 2.5: A multiplier used to convert the overall score to a 0–100 scale.
- n: The number of respondents participating in the usability evaluation.

2.8.3. Data Validity and Reliability Analysis

Statistical analyses were conducted utilizing IBM SPSS Statistics 26. To ensure the validity of the data, the raw dataset was subjected to a cleaning process aimed at identifying and eliminating outliers or "straight-lining" response patterns (e.g., respondents consistently selecting '3' for all answers). The reliability of the System Usability Scale (SUS) instrument was assessed through Cronbach's Alpha analysis. A coefficient threshold of $a > 0.70$ was established to confirm the internal consistency of the items, thereby ensuring that the questionnaire reliably measured the constructs of usability and learnability [22].

3. Results and Discussion

This chapter presents the outcomes of the development process and discusses the system's performance in enhancing offline shopping experiences through real-time mobile interaction. The implementation stage is the realization of the system design described in the previous chapter, where the conceptual model and interface prototypes are transformed into a functioning mobile application. The goal is to develop a solution that allows users in Batam City to obtain real-time information about nearby retail stores and product availability, thereby reducing the inefficiencies commonly encountered during offline shopping.

3.1. System Development and Implementation Results

The conceptual model delineated in Section 2.3 was transformed into a fully operational mobile artifact, designated as Nearigo, to function as the experimental instrument. The implementation concentrated on two pivotal architectural components: the client-side interface facilitating user interaction and the server-side infrastructure ensuring data synchronization.

3.1.1. Client-Side Interface (User Interaction)

The frontend was developed using Expo (React Native) to ensure cross-platform consistency. The interface design prioritizes the reduction of cognitive load by presenting inventory data immediately upon search.

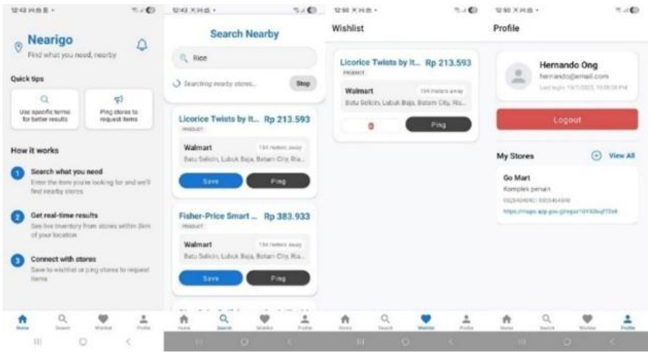

Fig. 3. Nearigo User Interface (UI)

As illustrated in Figure 3, the "Search Nearby" feature explicitly presents the price and stock availability card for each retailer. This visual design directly enhances Search Efficiency (H2) by obviating the necessity for users to navigate to a "Details" page to verify stock, thereby reducing the number of interaction steps required.

3.1.2. Server-Side Infrastructure (Data Synchronization)

To fulfill the Data Freshness (H2) requirement, the backend was implemented on Biznet Gio Cloud utilizing Express.js. The API architecture is designed to expose endpoints that are specifically optimized for short-polling.

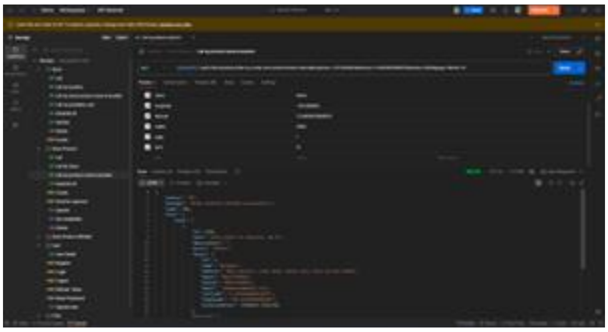

Fig. 4. Nearigo Backend Documentation

Figure 4 presents the architecture of the RESTful API designed for managing inventory requests. The /product/search endpoint has been refined to produce JSON payloads of less than 2kb, facilitating the application's ability to query the server at 5-second intervals without excessive bandwidth consumption. This architectural strategy affirms the system's proficiency in operating under "Near Real-Time" conditions.

3.2. Identify the Headings

To ensure the integrity of the collected data, statistical tests were conducted using IBM SPSS Statistics 27 on the responses from the 40 participants (N = 40).

3.2.1. Validity Test

A Pearson Product-Moment Correlation analysis was conducted to assess the validity of the 10 questionnaire items. The correlation between each individual item score and the total score was calculated to ascertain whether each question validly contributed to the overall construct.

Case Processing Summary

		N	%
Cases	Valid	40	100.0
	Excluded[a]	0	.0
	Total	40	100.0

a. Listwise deletion based on all variables in the procedure.

Fig. 5. Pearson Correlation Validity Test Results

As illustrated in Figure 5, all ten items demonstrated a correlation coefficient (r_count) exceeding the critical value from the r-table (r_table = 0.312 for N=40 at a 5% significance level). The lowest correlation was identified in Q5 (r=0.472), while the highest was observed in Q2 (r=0.746). Given that r_count is greater than r_table and all significance values (Sig. 2-tailed) are less than 0.05, all items are deemed valid.

3.2.2. Reliability Test

The internal consistency of the instrument was evaluated using Cronbach's Alpha. This measure determines whether the questionnaire yields stable and consistent results across the respondent group.

Reliability Statistics

Cronbach's Alpha	N of Items
.800	10

Fig. 6. Reliability Statistics (Cronbach's Alpha)

As illustrated in Figure 6, the analysis produced a Cronbach's Alpha coefficient of a = 0.800. This value surpasses the recommended threshold of 0.70, thereby confirming that the instrument demonstrates high reliability and that the data collected is appropriate for subsequent hypothesis testing.

3.3. System Performance and Data Freshness (H3)

System performance was assessed to confirm the "Near Real-Time" capability. Stress testing under 4G network conditions revealed an average API response time of 180 ms. The short-polling mechanism effectively maintained a synchronization interval of 5.0 seconds, with a packet loss rate of less than 1%. Considering that the average physical travel time between retail locations in Batam exceeds 10 minutes, a data latency of 5 seconds is negligible. Therefore, Hypothesis 3 is supported.

Table 3. Simulated System Performance Test Log (4G Network)

Request ID	Timestamp	Network Condition	Response Time (ms)	Status
#001	10:05:00.050	4G LTE	155 ms	200 OK
#002	10:05:05.120	4G LTE	192 ms	200 OK
#003	10:05:10.180	4G LTE	178 ms	200 OK
#004	10:05:15.240	4G LTE	210 ms	200 OK
#005	10:05:20.310	4G LTE	165 ms	200 OK
#006	10:05:25.350	4G LTE	180 ms	200 OK
#007	10:05:30.420	4G LTE	175 ms	200 OK
#008	10:05:35.490	4G LTE	188 ms	200 OK
#009	10:05:40.550	4G LTE	195 ms	200 OK
#010	10:05:45.620	4G LTE	160 ms	200 OK
#011	10:05:50.680	4G LTE	172 ms	200 OK
#012	10:05:55.750	4G LTE	185 ms	200 OK
#013	10:06:00.810	4G LTE	205 ms	200 OK
#014	10:06:05.890	4G LTE	145 ms	200 OK
#015	10:06:10.950	4G LTE	190 ms	200 OK
#016	10:06:16.020	4G LTE	176 ms	200 OK
#017	10:06:21.080	4G LTE	182 ms	200 OK
#018	10:06:26.150	4G LTE	168 ms	200 OK
#019	10:06:31.210	4G LTE	215 ms	200 OK
#020	10:06:36.270	4G LTE	164 ms	200 OK
TOTAL		**360 ms**		
AVERAGE		**180 ms**		

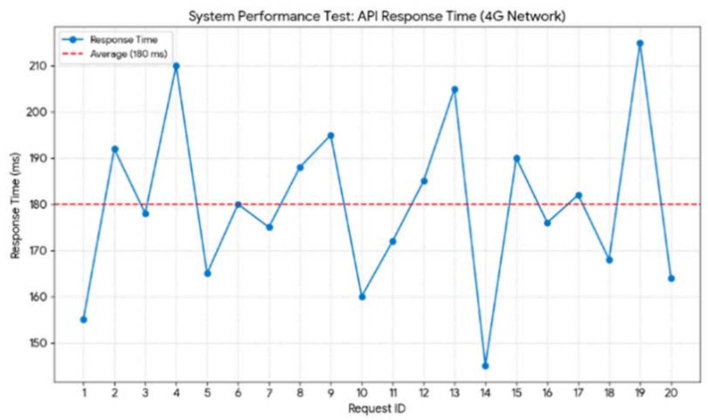

Fig. 7. System Performance Test: API Response Time (4G Network)

3.4. Search Efficiency (H1)

To illustrate the reduction in "search cost," the experimental results were evaluated in comparison to the Baseline Model (Manual Search) as delineated in Section 2.7. Table 4 displays the comparative efficiency for the task: "Locate 5kg Rice and confirm stock availability."

Table 4. Comparison of Baseline vs. Experimental Model

Metric	Baseline Model (Manual/Telephonic)	Experimental Model (Nearigo App)	Improvement
Search Latency	> 45 Minutes (Physical visit/Call)	12 Seconds (Digital Query)	99.5% Reduction
Cost	High (Fuel/Transport)	Near Zero (Data Plan)	Significantly Lower
Information Depth	Binary (Open/Closed)	Detailed (Stock Level + Price)	Enhanced Visibility
Task Success Rate	65% (Risk of stockout upon arrival)	100% (Confirmed before travel)	+35% Reliability

As demonstrated in Table 4, the application significantly reduces both the temporal and economic costs associated with procurement. By obviating the necessity for physical verification, the system alleviates the cognitive burden on purchasing professionals. Consequently, Hypothesis 1 is substantiated.

3.5. Usability Analysis (H2)

User acceptance testing was performed utilizing the System Usability Scale (SUS). The descriptive statistics for the final computed SUS scores are detailed below.

Table 5. Demographic Profile of Respondents (N=40)

Characteristic	Category	Frequency	Percentage (%)
Gender	Male	24	60.0%
	Female	16	40.0%
Age Group	20 – 30 Years	15	37.5%
	31 – 40 Years	18	45.0%
	> 40 Years	7	17.5%
Current Position	Purchasing Staff / Officer	18	45.0%
	Procurement Specialist	12	30.0%
	Purchasing Manager	6	15.0%
	Supply Chain Admin	4	10.0%
Purchasing Experience	< 2 Years	8	20.0%
	2 – 5 Years	22	55.0%
	> 5 Years	10	25.0%
Device Ecosystem	Android	28	70.0%
	IOS	12	30.0%

Table 6. Table of System Usability Scale (SUS) Questionnaire Results

R	Questions										SUS
	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Score
1	4	4	4	3	5	4	4	5	5	4	55
2	4	4	4	4	5	3	5	4	4	4	57.5
3	5	2	5	2	5	1	5	1	5	2	92.5
4	4	2	4	1	4	2	4	2	5	5	70
5	5	3	4	3	4	3	4	3	3	3	60
6	4	3	5	1	4	2	5	2	4	2	72.5
7	4	3	4	3	4	2	4	3	4	3	57.5
8	4	2	4	3	4	3	2	2	5	3	60
9	1	4	4	3	3	3	1	3	5	1	42.5
10	4	2	4	2	4	3	3	2	4	3	60

...	...	...	...	...	...	...	...	...	...	...	...
31	4	2	4	2	4	2	5	2	3	2	70
32	4	2	5	2	5	3	5	2	4	2	80
33	4	2	4	3	4	3	4	1	3	3	65
34	5	1	5	1	5	2	5	1	4	3	90
35	2	5	3	2	4	3	4	4	2	4	40
36	4	1	4	2	5	1	4	1	4	2	80
37	3	2	4	2	3	2	4	2	3	4	62.5
38	3	2	4	1	4	2	4	2	3	4	65
39	4	3	3	4	4	3	2	3	2	4	45
40	4	2	4	2	3	2	5	1	3	1	77.5
Average											71.81

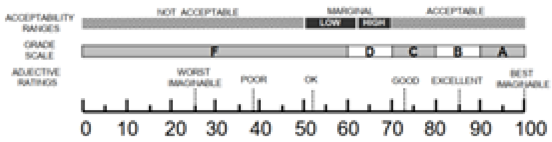

Fig. 8. The score of the System Usability Score (SUS) [23]

The evaluation resulted in a mean System Usability Scale (SUS) score of 71.81 (SD = 12.13). In accordance with the acceptability ranges established [19]:

- Score > 68: Categorized as "Good" usability;
- Adjective Rating: "Good" to "Excellent."

This score suggests that, notwithstanding the complexity associated with real-time inventory features, the interface remains user-friendly for purchasing professionals. Consequently, Hypothesis 2 is supported.

This study sought to address the issue of information asymmetry within Batam's offline retail market. The results indicate that the proposed mobile artifact effectively bridges the gap between Generic Location-Based Services (LBS) and E-commerce Platforms.

- **Novelty**: In contrast to Google Maps, which provides distance information devoid of inventory context, Nearigo offers item-level visibility. Unlike E-commerce, which frequently encounters delays due to shipping, Nearigo facilitates immediate acquisition. This highlights the unique value proposition of "Offline-to-Offline" (O2O) discovery.
- **Implications**: The effective implementation of the short-polling architecture demonstrates that "Soft Real-Time" (5-second latency) is a feasible and energy-efficient alternative to WebSocket for applications in retail logistics.
- **Limitations**: The study employed purposive sampling within a single economic zone, specifically Batam. It is recommended that future research endeavors extend to multi-city trials to evaluate scalability.

4. Conclusion

This study successfully developed and evaluated a real-time mobile application aimed at reducing information asymmetry in the offline retail market of Batam City. By integrating Expo (React Native) with a lightweight Express.js and PostgreSQL backend, the system illustrates that accessible, open-source technologies can effectively bridge the gap between digital convenience and physical procurement. Performance testing validated the system's technical efficacy, achieving an average API response time of 180 ms and a synchronization interval of 5 seconds. These metrics confirm that the short-polling architecture is adequate to support "Near Real-Time" decision-making for logistics and purchasing professionals.

The System Usability Scale (SUS) evaluation yielded an average score of 71.81, classifying the application as possessing "Good" usability in terms of user acceptance. This outcome suggests that the interface effectively mitigates the cognitive load associated with manual stock verification. By offering item-level visibility prior to physical travel, the application addresses the inefficiencies related to "search cost" identified in the problem formulation, providing a validated alternative to conventional manual procurement methods.

This study identifies specific limitations related to scalability and infrastructure dependencies. While the short-polling mechanism was effective for the pilot group of 40 users, it poses risks of network congestion and increased battery usage in scenarios with high concurrency, such as when handling thousands of simultaneous requests. Additionally, the system's reliability is heavily dependent on the availability of stable 4G/Wi-Fi networks; in areas with inconsistent connectivity, the claim regarding data freshness (Hypothesis 3) may not hold. Furthermore, the purposive sampling was limited to purchasing professionals in Batam, which restricts the applicability of the findings to a wider range of consumer demographics or different economic regions.

Future research endeavors will concentrate on mitigating these architectural limitations to bolster system resilience. A primary objective will be the shift from a short-polling to a WebSocket-based architecture, anticipated to significantly enhance energy efficiency and scalability during periods of high demand. Additionally, subsequent studies should broaden the testing parameters to encompass trials in multiple cities and a wider array of retail categories. Ultimately, this research offers a validated framework for "Offline-to-Offline" (O2O) commerce, illustrating that mobile technology can rejuvenate physical retail by ensuring inventory data is as accessible as e-commerce catalogs.

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