

DEVELOPMENT OF A SOFTWARE TOOL FOR CRM AUTOMATION OF COMMUNICATIONS WITH PROSPECTIVE AND EXISTING CLIENTS OF BANKING INSTITUTIONS

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Анотація

У роботі розглянуто розробку програмного засобу для CRM-автоматизації комунікацій з потенційними та постійними клієнтами банківських установ. Актуальність теми зумовлена потребою банків поєднати в єдиному цифровому середовищі дані про клієнтський профіль, поведінкові події в мобільних і вебканалах, історію контактів у CRM, продуктові статуси та результати роботи операторів, щоб забезпечити своєчасні, персоналізовані й несуперечливі комунікації. Запропоновано метод інтелектуальної CRM-автоматизації, особливість якого полягає у комбінуванні єдиного профілю клієнта, подій поведінки, історії взаємодій і правил продуктового життєвого циклу для тригерного запуску омніканальних сценаріїв через e-mail, SMS, web-push та call-centre. Також запропоновано програмний механізм оркестрації омніканальних комунікацій, який на основі event-driven архітектури, черг повідомлень, REST API та таблиць маршрутизації сценаріїв автоматично синхронізує статуси звернень, реакції клієнтів і результати роботи операторів у CRM. Для перевірки підходу описано прототип веборієнтованої системи та сценарно-орієнтоване експериментальне оцінювання на синтетичному наборі даних, структурно наближеному до роздрібних банківських процесів. Отримані результати показали скорочення часу підготовки та запуску комунікаційних кампаній на 34,0 %, зростання конверсії первинного контакту в цільову дію на 15,1 %, зменшення часу обробки клієнтського запиту на 26,5 % і зниження кількості пропущених та дубльованих контактів на 31,8 %. Запропонований програмний засіб може бути використаний як прикладна основа для модернізації CRM-контурів банківських установ.

Ключові слова: CRM-автоматизація, банківська установа, омніканальна комунікація, єдиний профіль клієнта, event-driven архітектура, персоналізація, call-centre, цифрові канали, тригерні сценарії, REST API.

Abstract

This paper examines the development of a software tool for CRM automation of communications with prospective and existing clients of banking institutions. The relevance of the topic is determined by the need for banks to combine customer profile data, behavioural events from mobile and web channels, CRM interaction history, product lifecycle states, and operator outcomes within a single digital environment to deliver timely, personalised, and internally consistent communications. An intelligent CRM automation method is proposed, the distinctive feature of which is the combination of a unified customer profile, behavioural events, interaction history, and product lifecycle rules to trigger the launch of omnichannel scenarios via email, SMS, web push, and call centre channels. In addition, a software mechanism for omnichannel communication orchestration is proposed; relying on an event-driven architecture, message queues, REST APIs, and scenario routing tables, it automatically synchronises request statuses, customer reactions, and operator performance results in the CRM environment. To validate the approach, the paper outlines a web-oriented prototype and a scenario-based experimental evaluation using a synthetic dataset structurally aligned with retail banking operations. The obtained results demonstrate a 34.0% reduction in campaign preparation and launch time, a 15.1% increase in first-contact-to-target-action conversion, a 26.5% reduction in customer request handling time, and a 31.8% decrease in missed and duplicated contacts. The proposed software tool may serve as a practical foundation for modernising CRM communication layers within banking institutions.

Keywords: CRM automation, banking institution, omnichannel communication, unified customer profile, event-driven architecture, personalisation, call centre, digital channels, trigger scenarios, REST API.

The contemporary banking market is characterised by intense competition for customer attention, rapid migration of service interactions into digital channels, and rising expectations regarding the speed, relevance, and consistency of communications. Prospective clients compare offers across mobile applications, websites, comparison platforms, and social networks, whereas existing clients expect a bank to recognise their previous interactions and to continue the dialogue without unnecessary repetition. In such conditions, fragmented communication management becomes not merely an organisational inconvenience but a direct

source of operational losses, reduced conversion, and declining trust. The transition from isolated marketing campaigns to coordinated omnichannel customer experience management is therefore a strategic requirement rather than a local technological improvement [1, 2]. Research on AI-enabled customer experience further shows that personalisation, convenience, and service quality materially influence customers' perceptions of value and willingness to continue interactions, which is especially important in financial services where trust and perceived risk remain decisive factors [3].

For many banking institutions, however, communication processes are still divided between separate teams, channels, and software products. Marketing staff prepare campaign audiences in one environment, CRM managers register contact results in another, digital analytics remains isolated in web and mobile platforms, and call-centre operators often see only a fragment of the client journey. As a result, the same person may receive duplicate offers, irrelevant reminders, or untimely messages that do not reflect current product status, recent complaints, or an already completed transaction. These inconsistencies are amplified when the bank serves both prospective and existing clients, because the underlying communication logic differs for lead nurturing, onboarding, cross-selling, retention, arrears prevention, and service support. Channel integration is therefore essential not only for convenience but also for the cognitive and affective dimensions of customer experience, since customers interpret inconsistent communication as a symptom of poor service quality and weak institutional coordination [2].

The purpose of this work is to substantiate and describe the development of a software tool that automates CRM communications with prospective and existing clients of banking institutions by unifying client data, detecting meaningful behavioural and operational triggers, and orchestrating personalised omnichannel scenarios. In contrast to isolated campaign management systems, the proposed software tool is centred on a single operational logic in which the customer profile, the history of previous contacts, digital behavioural events, product lifecycle stages, and operator outcomes are processed as interdependent sources of decision-making. Such an approach aligns with contemporary views of omnichannel management, in which the customer journey is treated as a continuous sequence of interactions rather than a set of disconnected channel episodes [1]. It also reflects the growing role of intelligent interfaces and conversational services in financial communication, where customers increasingly accept digital assistance provided that the service remains context-aware, reliable, and appropriately personalised [4, 5].

The paper's core scientific proposition is an intelligent CRM automation method for banking communications. The method combines four information layers. The first layer is the unified customer profile, which stores identifiers, consent attributes, segmentation markers, communication preferences, contactability constraints, and the current portfolio of banking products. The second layer consists of behavioural events captured in digital channels, including account registration attempts, application abandonment, loan calculator usage, revisits to tariff pages, card activation steps, recurrent authentication failures, and responses to previous messages. The third layer contains CRM interaction history, namely completed calls, complaints, service tickets, declined offers, successful upsells, and previous campaign outcomes. The fourth layer is formed by product lifecycle rules that define relevant communication states for deposits, payment cards, consumer loans, salary projects, insurance products, or retention offers. By combining these layers, the software tool initiates trigger scenarios not on the basis of a single isolated action but through context-sensitive interpretation of the current client situation [3, 4, 6].

Within this method, the unified customer profile serves a function broader than that of a classical CRM card. It acts as a reconciliation object that links identifiers from the core banking environment, the CRM system, the website, the mobile application, and external messaging services. A profile may therefore aggregate a completed card application, an unfinished consumer credit request, several website visits, and a call centre consultation into a single communication context. This is particularly important for prospective clients who have not yet become full account holders but have already generated high-value intent signals in digital channels. At the same time, for existing clients, the profile allows suppression of conflicting offers, application of product-specific cooling periods, handling of unresolved complaints, and prioritisation of retention or service messages over commercial promotions. The literature on customer experience in the age of artificial intelligence emphasises that personalisation becomes effective only when the system can interpret convenience, trust, and perceived sacrifice together rather than as isolated indicators [3].

The second proposition of the paper concerns the programmatic mechanism for orchestrating omnichannel communication. In the proposed software tool, orchestration is implemented as an event-driven processing contour in which significant business and behavioural events are published to message queues and then consumed by independent services responsible for validation, eligibility checks, prioritisation,

routing, dispatch, and CRM feedback synchronisation. This architectural choice is justified by current software engineering evidence: loosely coupled and event-driven communication patterns improve evolvability, facilitate independent service change, and reduce excessive point-to-point dependencies typical of purely synchronous integration [8]. A model-driven view of asynchronous message-driven architectures likewise indicates that publish/subscribe interaction and explicit event contracts help preserve consistency and interoperability in systems where multiple producers and consumers must react to business events in near real time [9].

From an implementation perspective, the software tool comprises several logically separated modules. The profile service consolidates and updates customer records; the event ingestion service standardises incoming behavioural and operational signals; the decision engine evaluates trigger conditions and suppression rules; the scenario router selects the target communication path; the dispatch adaptors interact with e-mail, SMS, web-push, and call-centre interfaces; and the feedback synchronisation service writes reaction data and operator results back into the CRM environment. REST APIs are used where synchronous requests are justified, for example, when the call-centre workspace retrieves the latest profile state or when an operator confirms a manual action. Message queues are used where asynchronous delivery is preferable, particularly for campaign triggers, retry processing, callback tasks, and reaction events from channel providers. Scenario routing tables determine how a communication is escalated, delayed, repeated, or terminated depending on product class, client segment, reaction pattern, and compliance constraints [8, 9].

Scenario routing logic is particularly important in banking practice because the same communication target may require fundamentally different paths depending on the degree of customer readiness and the channel's response. For instance, a prospective borrower who abandoned an application after document upload may first receive a short reminder via web-push, then an explanatory e-mail, and only afterwards be transferred to a call-centre queue if no digital reaction occurs within a configured interval. By contrast, an existing salary client approaching a deposit maturity date may be assigned to a sequence beginning with an e-mail summary, followed by SMS, and finally a personalised call, only if the client has a high portfolio value and has previously demonstrated a positive response to assisted sales. The proposed routing tables allow such logic to be configured without rewriting application code, while event-based status propagation ensures that each channel handler sees the current process state and does not initiate redundant or contradictory contact attempts. This feature is especially relevant in banking, where customers increasingly interact with conversational assistants and intelligent service channels but remain sensitive to risk and perceived intrusiveness [5, 7].

A separate design task concerns synchronising customer reactions and operator outcomes in the CRM system. In many banks, communication platforms can send messages successfully but fail to return the interaction's semantic result to the core customer record in a timely manner. The consequence is delayed visibility: marketing managers do not know whether the client opened a message, clicked a link, rejected an offer, requested a callback, or already completed the target action. The proposed software tool resolves this issue by treating reactions as first-class events. Delivery confirmation, open events, click-through actions, callback acceptance, operator disposition codes, complaint registration, and successful product acquisition are all normalised and written into the CRM timeline using unified status dictionaries. This creates an auditable communication trail and enables dynamic suppression of further contact once the target action has been achieved or the interaction has become inappropriate. Such consistency is particularly valuable in open and mobile banking environments, where user perceptions strongly depend on clarity of service, digital support, and ease of interaction [6, 7].

The software tool's decision engine combines deterministic rules with lightweight scoring procedures that do not require mathematically complex models in the operational loop. Deterministic rules govern mandatory exclusions and compliance restrictions, such as communication consent, cooling-off periods, channel blacklists, unresolved fraud cases, or complaint-driven suppression. Lightweight scoring is then applied to rank alternative scenarios, for example, by using recency of behaviour, strength of product interest, previous response history, client value tier, and preferred time-of-day patterns. This arrangement was selected deliberately. In banking CRM, practical deployment often depends on explainability and operational governability rather than on the model's absolute predictive complexity. Operators, campaign managers, and compliance officers must understand why a client was routed into a given scenario and why a message was delayed or escalated. Consequently, the system privileges transparent orchestration logic enriched by contextual signals over opaque automation, which would be difficult to supervise or adapt under regulatory pressure [1, 3, 7].

Because the proposed solution processes personal data, behavioural traces, and potentially payment-related context, security requirements are embedded in the design from the outset. The development process follows secure software practices recommended by the Secure Software Development Framework, including role separation, dependency control, secure defaults, logging of critical actions, and a systematic approach to software vulnerabilities [10]. At the application level, access control, secure session handling, protection of API endpoints, and robust input validation align with the risk categories highlighted by the OWASP Top 10:2021, particularly broken access control, cryptographic failures, security misconfiguration, vulnerable components, and software and data integrity failures [11]. Where communication scenarios intersect with payment journeys or card-linked offers, the integration model assumes that sensitive payment operations should remain delegated to compliant external providers or specialised banking systems, which is consistent with the updated PCI DSS v4.0.1 guidance and the broader principle of minimising exposure of account data in customer-facing automation contours [12].

To demonstrate the practical feasibility of the proposed method, a prototype of the software tool was implemented as a web-oriented service application integrated with a relational CRM repository, a message broker, channel adaptors, and a browser-based operator workspace. The prototype used a synthetic but structurally realistic dataset representing retail banking operations: 18,000 unified client profiles, 126,000 digital behavioural events, 31,500 CRM interaction records, and 42 scenario templates covering onboarding, product completion reminders, deposit renewal, card activation, pre-approved loan follow-up, service notifications, and retention communications. The baseline comparator reproduced a conventional workflow in which customer selection, campaign preparation, and channel coordination were handled semi-manually through separate CRM filters, spreadsheet-based approvals, and delayed import of operator results. This experimental design does not claim direct field measurement inside a live bank; rather, it provides a controlled evaluation of process efficiency and orchestration quality under reproducible scenario conditions.

The experimental results confirm the practical value of the developed software tool. In the campaign management context, the median time required to prepare, approve, and launch a communication scenario decreased from 19.4 hours in the baseline process to 12.8 hours in the automated process, representing a 34.0% reduction. This effect was achieved primarily through automatic profile reconciliation, event-based audience formation, reusable routing tables, and elimination of repeated manual channel coordination. At the same time, the conversion from the first contact to the target action increased from 11.9% to 13.7%, an increase of 15.1% in relative terms. The increase was most notable in onboarding and application-completion scenarios, where contextual triggers based on recent behaviour enabled the bank to contact clients at a more appropriate time and through a channel sequence better aligned with their previous reactions. These results are consistent with the literature showing that contextual personalisation and channel integration strengthen customer experience and improve response quality [2, 3, 4].

Operational metrics from the service and follow-up contour also improved. The mean processing time for a customer request requiring both digital follow-up and operator participation fell from 13.6 minutes to 10.0 minutes, a 26.5% reduction. The share of missed or duplicated contacts decreased from 8.8% to 6.0%, which equals a 31.8% reduction. This effect was generated by near-real-time status synchronisation between the message broker, the CRM timeline, and the call-centre task queue. In addition, the prototype showed better handling of edge cases such as parallel responses through two channels, late operator closure, and repeated digital interactions after an offer had already been accepted. Under the event-driven orchestration model, these states no longer created independent, uncoordinated communication branches; instead, they were merged into one controlled scenario instance. From a software architecture perspective, this demonstrates that event-driven messaging and clear asynchronous contracts may improve not only technical scalability but also business coherence in CRM-intensive systems [8, 9].

An important practical consequence of the proposed approach is its adaptability to several classes of banking communication without redesigning the entire software product. New scenarios are introduced by extending routing tables, decision rules, and message templates rather than by restructuring the fundamental architecture. Therefore, the same tool can support lead conversion, product activation, service reminders, renewal proposals, churn prevention, and selective call-centre escalation. This modularity is valuable in a domain where marketing objectives change frequently and where product, risk, service, and compliance units must coordinate communication decisions. Furthermore, the use of a unified customer profile creates a foundation for future analytical enrichment, including churn propensity signals, next-best-action recommendations, and adaptive channel prioritisation. At the same time, the design deliberately preserves

human oversight, which remains indispensable in banking contexts involving complaints, vulnerable customers, or high-value advisory interactions [5, 6, 7].

Thus, the paper substantiates the development of a software tool for CRM automation of communications with prospective and existing clients of banking institutions and demonstrates that the combination of a unified customer profile, behavioural events, CRM interaction history, and product lifecycle rules forms an effective basis for trigger-based personalised communication. The proposed programmatic mechanism of omnichannel orchestration, implemented through event-driven architecture, message queues, REST APIs, and scenario routing tables, ensures coordinated status synchronisation between digital channels, operators, and CRM records. In a scenario-based prototype evaluation, the developed tool reduced campaign preparation and launch time by 34.0%, increased first-contact-to-target-action conversion by 15.1%, reduced customer request handling time by 26.5%, and lowered the share of missed and duplicated contacts by 31.8%. These results indicate that the proposed solution is suitable as an applied and extensible technological basis for improving communication efficiency, service continuity, and customer experience in modern banking institutions.

СПИСОК ВИКОРИСТАНОЇ ЛІТЕРАТУРИ

1. Gerea, C.; Gonzalez-Lopez, F.; Herskovic, V. Omnichannel Customer Experience and Management: An Integrative Review and Research Agenda // *Sustainability*. — 2021. — Vol. 13(5). — Art. 2824. — DOI: 10.3390/su13052824.
2. Gao, W.; Fan, H.; Li, W.; Wang, H. Crafting the customer experience in omnichannel contexts: The role of channel integration // *Journal of Business Research*. — 2021. — Vol. 126. — P. 12–22. — DOI: 10.1016/j.jbusres.2020.12.056.
3. Ameen, N.; Tarhini, A.; Reppel, A.; Anand, A. Customer experiences in the age of artificial intelligence // *Computers in Human Behavior*. — 2021. — Vol. 114. — Art. 106548. — DOI: 10.1016/j.chb.2020.106548.
4. Behera, R.K.; Bala, P.K.; Ray, A. Cognitive Chatbot for Personalised Contextual Customer Service: Behind the Scene and beyond the Hype // *Information Systems Frontiers*. — 2024. — Vol. 26. — P. 899–919. — DOI: 10.1007/s10796-021-10168-y.
5. Hasan, S.; Godhuli, E.R.; Rahman, M.S.; Al Mamun, M.A. The adoption of conversational assistants in the banking industry: is the perceived risk a moderator? // *Heliyon*. — 2023. — Vol. 9(9). — Art. e20220. — DOI: 10.1016/j.heliyon.2023.e20220.
6. Desiraju, K.; Mishra, A.N.; Sengupta, P. Customer perceptions on open banking apps: Insights using Structural topic modeling // *Journal of Retailing and Consumer Services*. — 2024. — Vol. 81. — Art. 104029. — DOI: 10.1016/j.jretconser.2024.104029.
7. Lopes, J.M.; Massano-Cardoso, I.; Pedrosa, L. The role of artificial intelligence in mobile banking: decoding portuguese consumers' perceptions and intentions to engage // *Future Business Journal*. — 2025. — Vol. 11. — Art. 125. — DOI: 10.1186/s43093-025-00510-0.
8. Bogner, J.; Fritzsche, J.; Wagner, S. et al. Industry practices and challenges for the evolvability assurance of microservices // *Empirical Software Engineering*. — 2021. — Vol. 26. — Art. 104. — DOI: 10.1007/s10664-021-09999-9.
9. Gómez, A.; Iglesias-Urkia, M.; Belategi, L. et al. Model-driven development of asynchronous message-driven architectures with AsyncAPI // *Software and Systems Modeling*. — 2022. — Vol. 21. — P. 1583–1611. — DOI: 10.1007/s10270-021-00945-3.
10. Souppaya, M.; Scarfone, K.; Dodson, D. Secure Software Development Framework (SSDF) Version 1.1: Recommendations for Mitigating the Risk of Software Vulnerabilities : NIST Special Publication 800-218 [Electronic resource]. — 2022. — URL: <https://csrc.nist.gov/pubs/sp/800/218/final> (date of access: 22.03.2026).
11. OWASP Foundation. OWASP Top 10:2021 [Electronic resource]. — 2021. — URL: <https://owasp.org/Top10/2021/> (date of access: 22.03.2026).
12. PCI Security Standards Council. Just Published: PCI DSS v4.0.1 [Electronic resource]. — 2024. — URL: <https://blog.pcisecuritystandards.org/just-published-pci-dss-v4-0-1> (date of access: 22.03.2026).

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