Cost-effective way of implementing SMS marketing in small to middle-sized enterprises using Raspberry Pi

1st mr Miodrag Šljukić

PhD student Department of e-Business
Faculty of Organizational Sciences
Belgrade, Serbia
miodrag.sljukic@gmail.com

Abstract—**Among other specificities of SMEs (Small and middle-sized enterprises) is their lack of financial, human and technical resources. This important barrier forces SMEs to optimize their market advent and put it in line with their capabilities, without losing competitiveness in their market niche. One important marketing channel is SMS (Short Message Service). Although technologically very old, it still has large marketing value and potential to bring competitive advantage to an enterprise. This paper proposes a sustainable and cost-effective model for sending short marketing messages using the combination of Raspberry Pi device and mobile technology. Conceptual model has been developed, as well as a prototype of hardware and software solution, a list of use cases and brief financial analysis of effects of this kind of solution. The results show that using the proposed system, SMEs can achieve a significant reduction in marketing campaign costs without losing its quality.**

Keywords—*m-marketing, web service, IoT, cost-efficiency*

INTRODUCTION

One of the most challenging aspects that SMEs (Small and Middle-sized Enterprises) face is the lack of human, technical and financial resources. This affects various aspects of business, including marketing efforts as well. Mobile marketing can be used as a channel to access existing customers and keep them loyal to the firm. SMS (Short Message Service) is a simple form of communication between two persons which enable the transfer of text message between mobile telephones.[1] Although very old, SMS is a very popular service with 3.2 trillion business messages in 2019 and an estimated 3.7 trillion in 2020.[2] In addition, there were 6.95 billion mobile users in the world in 2020. with projections to 7.41 billion by the year 2024.[4], and contrary to e-mail with an open rate of only 22%, research shows that 98% of text messages are opened by the receiver.[3] Besides being widely available and with a faster response rate than e-mail, SMS marketing is 99% legitimate, with only 1% of spam.[3] These facts make mobile marketing one of the most promising channel for building customer loyalty and providing post-sale services.

SMS marketing is a part of mobile marketing where messages are sent and paid for by the company as a part of an advertising or promotional campaign.[5] Since marketers can identify the receiver of the message, they can personalize the message and easily adopt a one-to-one marketing strategy.

Using advanced technological solutions based on smart devices and IoT, SMEs can reduce the cost of an SMS marketing campaigns. At the same time, it is important to keep the solution simple to fit the technical expertise affordable by SME. One such solution based on Raspberry Pi is proposed in this paper.

Raspberry Pi is a low-cost, small, and portable computer board that can be used to plug in a computer monitor, television, keyboard, mouse, etc.[6] Its technical features provide additional benefit given its capability to be adapted for application in other contexts within the organization's domain. Using such a solution can be proven to be more cost-efficient than using existing web services which are cloud-based and often offer complete solutions for SMS marketing at a relatively high price. Also, the scalability of the solution makes it useful to SMEs of different sizes, organizational forms, and stages of technological development.

METHODOLOGY

The main goal of this research is to create a flexible framework for low-cost SMS marketing campaigns ready to be easily adopted by SMEs. The research should answer the following questions:

1. Is there a low-cost alternative to the existing web services for SMS marketing?
2. Is it possible to develop such a solution and integrate it with SMEs' existing information system?
3. What are the use cases and possible benefits of such a solution?

A preliminary literature review showed that using the Raspberry Pi device as an SMS server was applied in several fields. But literature review didn't reveal similar research in the field of marketing for SMEs, which indicated the research gap.

To answer these questions a two-step analysis has been conducted. In the first step, a literature review was conducted to find appropriate hardware devices suitable for the concept. Also, market research was conducted to find business and pricing models already available. Based on this information the cost-benefit analysis was conducted to show the effectiveness of the model.

In the second step, a conceptual model of the solution was developed, together with a prototype of hardware and

software solution which can integrate sending of SMS messages into the legacy information system of SME. Finally, possible hardware and software configurations of the proposed model, which enable it to be used in different environments, are identified.

RESULTS AND IMPLICATIONS

A. *Similar solutions*

An extensive literature review was conducted to find similar solutions in previous academic researches. The capability of Raspberry Pi to work as an SMS server, thus providing connectivity for IoT-based networks, was found in different areas. For example, [7] proposes a solution for an advanced automatic driving system using sensors that will monitor driving conditions and send them to the cloud through SMS. According to [8], a similar idea can be applied in agriculture providing a green house monitoring system where Raspberry Pi is used for controlling the network of sensors and alarming on critical conditions through SMS. Other applications include areas such as construction [9], smart homes [10], health care [11], flood detection [12] etc. An interesting concept comes from [13] where Raspberry Pi is used in combination with a fingerprint reader to inform the head of the faculty department about the execution of classes' schedule. In the field of marketing, there is a solution [14] for sending advertising messages using SMS to display them on the publicly available electronic notification board. This solution can be used by tourist organizations to provide general information about the place or by other organizations who want to broadcast the message to public. This differs from the solution proposed in this research because the public message is not personalized for the targeted one-to-one marketing.

Another search was conducted to explore the characteristics of existing SMS-gateway-as-a-service solutions which can provide entrepreneurs and SMEs with personalized one-to-one marketing tools. These services can be bought from providers of such services on a per-use base. Looking at available cloud solutions aggregated at [15], it is evident that there exists many cloud solutions that differ in terms of features, usage, and price. The majority of these providers offer complete CRM solutions which can gain benefit to SMEs if they don't have an in-house solution. While some of them charge monthly, others charge on a pay-as-you-go basis. Although most of them have free offers, the limits which are set are quite narrow for the purpose set in this paper.

B. *Cost analysis*

Before creating a model for the solution, a brief cost-benefit analysis was conducted. Pricing models for the top five providers found on Google Search are summarized in Table I.[17, 18, 19, 20, 21]

TABLE I.		SMS SERVICES PRICING

Pricing model	Min. price (EUR)	Max. price (EUR)
Monthly Basis	40 per user	1000 EUR unlimited
Pay-as-you-go	0.029 per SMS	0.079 per SMS

Although the sample is rather small, it gives hints about the range of prices. It is important to notice that the price differs for different countries, which makes it relatively hard to compare offerings. Some providers don't provide service in Serbia.

On the other hand, mobile operators offer different packages, each having a different level of services included. Prices of packages for business users with limitless SMS from three Serbian mobile operators, which are of interest to this research, are shown In Table II.[16]

TABLE II.		MOBILE OPERATORS PACKAGES

Mobile operator	Monthly price (din)
Telenor	2.199
mts	1.650
a1	1.499

The minimal price of SMS service on the monthly basis is greater than a monthly subscription to any of the mobile operator's packages. Even the lowest pay-as-you-go price is around the range of the regular price of a single text message charged from a mobile operator.

Based on this data, the break-even point can be calculated with the goal of determining the point where the benefits of the proposed solution become greater than costs, compared to the alternatives. Figure 1. shows break-even analysis graphically.

In Figure 1. it can be seen that this point comes at approximately 440 messages[1]. If less than 440 messages monthly are to be sent, it is more profitable to use solutions based on the pay-as-you-go pricing model. After that number of text messages is sent, an enterprise is better off buying a mobile operator package with unlimited SMS than using some of the available SMS services.
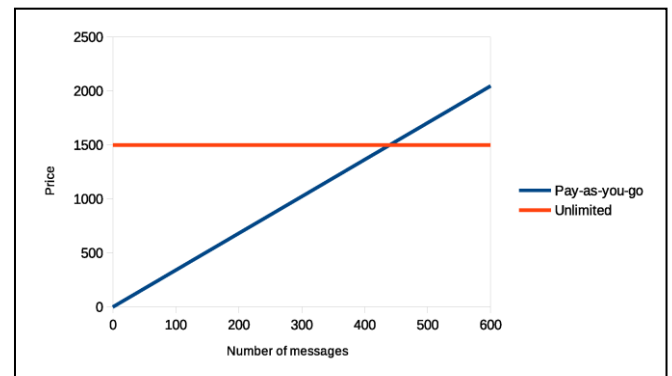

Fig. 1.	Break-even analysis of the proposed solution.

Initial investment requires a Raspberry Pi device which comes in multiple formats. The latest version is 4 with technical features that far surpass the requirements of the proposed solution. The price of the basic model is $35, which makes the initial investment very low.

C. *Proposed technical solution*

In the proposed model, Raspberry Pi is treated as another node in the network architecture of SME. Raspberry Pi is given a static IP address within the range of local IP

1	Euro to dinar conversion is made using the official conversion rate of NBS on May 28th, 2021. which is 117.5708 din. for 1 EUR. This means that the lowest cost of SMS on pay-as-you-go is 3.41 din. per message.

addresses so it can be easily accessed from a local network. It is extended with modem and SIM card which makes it capable of accessing mobile network. Due to its strong technical capabilities, depending on the architecture of the existing ERP solution of enterprise, it can be programmed to offer a user interface for managing the entire SMS marketing campaign. Alternatively, it can be equipped with only the necessary parts of the software solution used for sending text messages.

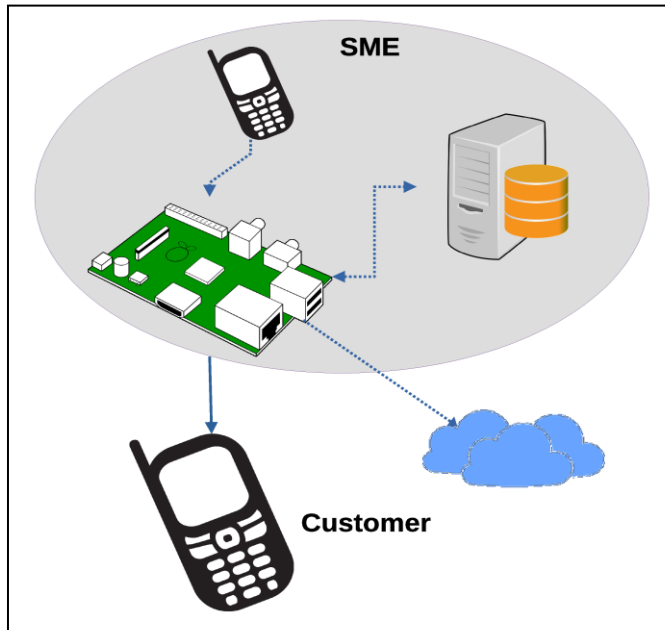The global architecture of the proposed model is shown in Figure 2.

Fig. 2. The architecture of the proposed model

Depending on the architecture of existing ERP/CRM software and intended way of using the service, there can be several different configurations:

- in the case where SME doesn't use ERP/CRM, it is possible to put complete software solution to Raspberry Pi device, including a web server, customer database, and user interface

- if SME uses in-house ERP/CRM it is possible to pull client's data directly from ERP/CRM. In this case, only GSM routines and service for retrieving data are installed on Raspberry Pi

- if SME uses cloud ERP/CRM solution, the service will probably be impossible to run directly from the cloud. In that case, it is possible to start the process from Raspberry Pi either through the web interface or by text message

In any of these cases, it is possible to make service configurable not only through the web interface but also using SMS. In this case, messages would be sent to the GSM modem with different parameters, including time of campaign start, names and phone numbers of clients, message content, etc. Although this kind of solution is not very practical because of limited user interface capabilities, it illustrates the scalability potential of the solution: in its smallest configuration, an entrepreneur or SME doesn't even need a computer.

To implement the proposed solution, the following hardware and software components are required:

- Raspberry Pi device connected to a local network through LAN or Wi-Fi connection. The minimal configuration of the device should support the installation of Apache web server, MySQL, and PHP to support user interface for campaign management. The prototype has been build using a Raspberry Pi 3b+ motherboard with 4 processors working on 1.4GHz, 1 GB of RAM, and a 16GB SD card. The installed operating system is Linux raspberrypi 5.10.17-v7+;

- GSM modem with SIM card attached to an USB port of Raspberry Pi;

- The software interface to the GSM modem is made of a set of scripts written in Python. These are used for sending text messages to GMS modem or reading messages received by modem;

- Software interface to the user and ERP/CRM - depending on the chosen architecture, this can be Python script which will run service of ERP/CRM asking for data about the campaign. It is also possible that Apache web server, PHP, and MySQL are needed for running user interface for managing marketing campaign directly on Raspberry Pi if that is the configuration of SMEs information system. Also, adapter routines might be needed which provide field mapping for the service to communicate with different providers of data. These routines should be able to understand different data formats (CSV, JSON, XML) and different data structures, depending on the provider of data. The web server also allows running service for campaign starts on Raspberry Pi. In the prototype: campaign management software is installed on the desktop computer which calls service on Raspberry Pi web server for the start of the campaign. The prototype uses Apache 2.4.38 (Raspbian), MariaDB 10.3.27, and PHP 7.3.27 installed on Raspberry Pi.

Data requirements for the process are as follows:

- the list of customers which contains their names, phone numbers, and personalized messages

- data about the campaign itself include the start and finish time of the campaign and the frequency of sending messages.

This information are stored in the database and managed either through the provided user interface or using existing ERP/CRM software. Using built-in procedures for profiling customers, the latter provides better possibilities for precise targeting of customers and adjusting the message following perceived preferences of target customers.

To prove the concept, a prototype has been made. The activity diagram for the prototype is presented in Figure 3.

The process starts by clicking the button on the web interface installed on a desktop computer. This carries the control over to the service which is installed on Raspberry Pi. In the first step, Raspberry Pi will obtain data from the data provider. In the case of the prototype, the database is located

on the same desktop computer, but it can be anywhere within the reach of Raspberry Pi, including the cloud. The data provider should return a list containing the personalized messages and phone numbers for each of the selected customers. Prototype returns the data in JSON format. After the data is received it is processed on a row-by-row basis and sent to the Python script responsible for sending it to the GSM modem, which sends the message to the customer. After the last message had been sent, Raspberry Pi provides a report to the data provider by running the appropriate service.

It is also possible to start the process by sending a text message to the Raspberry Pi modem directly. In this case, receipt of the message will trigger a service which obtains data from the data source and the process continues the same way as in the previous case. Implementation of this feature requires a cron-job on Raspberry Pi which will check for received messages and respond to them appropriately. The

procedure can be extended to process a set of commands received by SMS, including feedback from a customer if any is appropriate.

D. Use cases for the solution

Since it is possible to classify customers according to defined criteria and personalize the content of text messages on a one-to-one basis, the proposed solution can benefit from existing knowledge about customers. Advanced CRM algorithm for matching customers only with the offer suitable to their taste creates value for both buyer and seller. This way buyer is not overwhelmed with unsolicited information, while the seller can better target his potential customers.

Flexibility of the proposed solution, very high open rate of text messages, and low level of unsolicited messages provide opportunities for the marketing managers to plan its use in different scenarios. Possible use cases include:
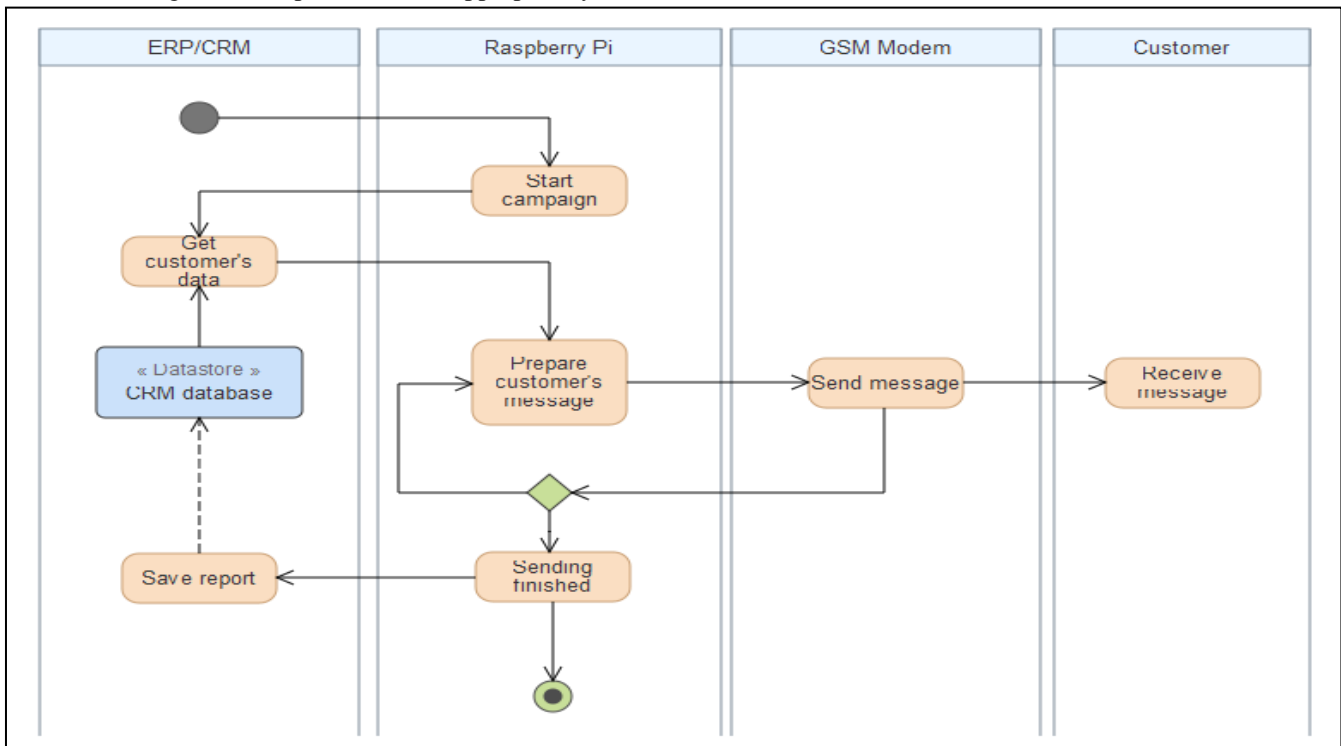

Fig. 3. Activity diagram for the prototype

- flash sales - sales that last only one day require a quick response from potential customer

- order tracking - to plan their supply, business customers need to know the current status of their orders. The proposed solution offers SME cost-effective way of providing this kind of information, enhancing customer's satisfaction

- calendar or event reminder - SMS might prove a better solution than e-mail, thanks to the high open rate

- sending coupon code using SMS is convenient for customers since they can bring the code to the store on a mobile phone

- new products or services notification - SMS is a fast way to inform the interested customers about new products or services. Thanks to the smaller rate of

spam, the probability that text messages will get noticed are much higher compared to e-mail.

- discount notifications for discounts that last for short time etc.

In all these cases, the need for getting more attention and faster reaction to messages makes text messaging a preferred solution compared to e-mail. The proposed solution provides all the benefits of SMS marketing at lower prices.

DISCUSSION

As has been shown earlier, the use of Raspberry Pi for sending short text messages is well known in the literature and had been applied in different contexts, including marketing. The research presented is aimed to apply the technical solutions in the context of personalized one-to-one marketing scaled to SMEs' financial and technical reach. Although this solution is also applicable for large enterprises

or banks, it is more probable that they will pay more attention to the quality of the hardware because of durability and speed. For example, large banks can have millions of simultaneous requests for the token, which can be proven to be an impossible task for the solution this simple.

The main stakeholders and their benefits of using the proposed solution are shown in Table III.

TABLE III.   STAKEHOLDER BENEFITS

Stakeholder	Benefit
Customer	Getting relevant information in the convenient way
SME	Lower costs of marketing capaign Closer communication to customers One more channel to access customers Offering additional services to customers Simple solution which doesn't require a lot of technical skills or expensive hardware

The solution offers numerous advantages to enterprises whose needs for speed and scale are moderate. Besides the lower price per message, SMEs can benefit from having Raspberry Pi as a powerful multi-functional smart device capable of executing different enterprise tasks.

The main constraint which prevents the solution from being more usable in other contexts is related to the scale of the campaign measured by the number of messages sent. It is possible to multiply the solution by adding several Raspberry Pi devices in order to extend the capacity of the model, but that requires more complicated software for managing information flow compared to the one described in this paper. The solution proposed in this research needs practical verification in order to acquire a deeper insight into possible implementation issues.

CONCLUSION

This paper proposes a technical solution to SMS marketing in SMEs using Raspberry Pi. In the view of research questions, it can be said that the main benefit of this solution for SMEs is its cost-effectiveness compared to other identified solutions. The prototype has been made which proves the feasibility of the solution. The flexibility and scalability of the solution enable it to be applied in different mobile marketing scenarios.

From the theoretical point of view, the main contribution of this research is its potential to create a new way of looking at the usage of smart devices in mobile marketing in the context of SMEs. For marketing managers and entrepreneurs this research offers a low-cost solution for conducting their marketing campaign.

Further practical implementation is needed in order to gain full insight into potential problems or additional benefits and development possibilities of the proposed solution.

REFERENCES

[1] D. Chaffey and F. Ellis-Chadwick, "Digital Marketing Strategy, Implementation and Practice" 6th ed, London:Pearsons, 2016, pp.135.

[2] "SMS Business Messaging to Hit 3.5 Trillion Messages in 2020, Despite Collapse of Tourism Industry", https://www.juniperresearch.com/press/business-messaging-to-hit-3-5-trillion-messages, 11.05.2021.

[3] "SMS Marketing Wallops Email with 98% Open Rate and Only 1% Spam", https://mobilemarketingwatch.com/sms-marketing-wallops-email-with-98-open-rate-and-only-1-spam-43866, 10.05.2021.

[4] "Forecast Number of Mobile users Worldwide from 2020 to 2024, https://www.statista.com/statistics/218984/number-of-global-mobile-users-since-2010/, 28.05.2021.

[5] A. S. L. da Silva, A. R. Neto, R.A. Luna, G. T. de Oliveira Cavalcante, A. R. de Moura, "Mobile Marketing: An Approach on Advertising by SMS", Brasilian Journal of Management, 2018

[6] C. W. Zhao, J. Jegatheesan, S. C. Loon, "Exploring IoT Applications using Raspberry Pi" International Journal of Computer Networks and Applications, vol. 2, Issue 1, 2015.

[7] P. Mariaraja, T. Manigandan, S. Arun, R. M. Sundaram and K. Dhenesh, "Design and Implementation of Advanced Automatic Driving System using Raspberry Pi," 2020 5th International Conference on Communication and Electronics Systems (ICCES), 2020, pp. 1362-1367, doi: 10.1109/ICCES48766.2020.9138082.

[8] T. Pidikiti, K. Yadlapati, F. Samson, K. Sakthiraj, M. Gudavallid, K. R. Madhavie, "Wireless Green House Monitoring System Using Raspberry PI", Turkish Journal of Computer and Mathematics Education, Vol. 12, No. 2, 2021pp. 2163-2169

[9] Ajay L. Ghatol, Ajay N. Mohurle, Amol V. Tipramwar, Dipali A. Ingole, Anuprita P. Linge, "Autonomous Robot For Crack Detection Using Raspberry Pi With IOT & Ultrasonic", Journal of Signal Processing, Vol. 3, Issue 1, 2017.

[10] R. Majeed, N. A. Abdullah, I. Ashraf, Y. Bin Zikria, "An Intelligent, Secure, and Smart Home Automation System", Scientific Programming, Vol. 2020,

[11] R Lavanya1, A Mallika, K Deepika, G Swetha, M Divya,D Keerthana, "Remote health monitoring, home automation and alarm system using Raspberry Pi", International Research Journal of Engineering and Technology (IRJET), Vol. 7, Issue 3, 2020.

[12] D Satria et al, "Implementation of SMS Gateway in the flood notification system using Raspberry Pi", IOP Conf. Ser.: Mater. Sci. Eng. 796 012029, 2020

[13] G. Saritha, V. Swarupa, SK. Masthabi, Y.Manikumar, "Time table management system using Raspberry Pi and biometric module", Pramana Research Journal, Vol.9, Issue 3, 2019.

[14] J. Gaikwad, Y. Kadam, M. Maindarkar, "Electronic notice board using GMS and Raspberry Pi", International Research Journal of Engineering and Technolog (IRJET), Vol. 4, Issue 5, 2017.

[15] https://www.softwareadvice.com/sms-marketing/

[16] https://www.ceneusluga.rs/rs/mobilna_telefonija.html

[17] https://www.twilio.com/sms/pricing/rs

[18] https://sms.to/pricing

[19] https://www.bulksms.com/pricing/

[20] https://www.smsglobal.com/pricing/

[21] https://messagemedia.com/us/pricing/