

POPS: Point of Payment Solution for eGovernment Systems

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Abstract

It was recognized that eGovernment related applications act independently of each other, specifically in handling the same data and payment collection. **Objective:** To address the issue, this paper proposes an interoperable payment system that is highly integrated from the end-users' perspective, and highly interconnected with the different eGovernment related applications. The proposed system also incorporates data analytics to allow policymakers to see a range of perspectives in decision-making for better public policies, programs, and processes. **Methods/Analysis:** Using the modified Princeton Project Management Methodology as the software development framework, three essential modules were developed: Payment Processing, Report Generation, and Data Analytics. Moreover, the municipal treasury officers of Nabua and Bula, Camarines Sur, Philippines assessed the level of acceptability of POPS based on ISO 9126 software quality metrics using the Developmental- Descriptive research methods. **Findings:** Based on results, the overall Likert score rating of POPS is 4.21 or an adjectival perceptions rating of strongly agree. **Novelty/ Importance:** This implies that POPS implements the necessary functional requirements for an eGov payment system according to the recommended ISO software quality metrics as perceived by the end-users and IT experts' respondents.

Keywords: e-Governance, Interoperability, Local Government Unit, Payment System, ICT

1. Introduction

Most individuals and other state clients have to make government payments at some point or another. For example, tax payment, apply for a new building permit or renew a business permit. According to¹, the payment system is the major economic growth determinant to any particular country. However, Ndou² criticized the traditional model of public service delivery for its inefficiency and incompetence. In particular, Morse³ highlighted the significant drawbacks of traditional payment system such as slow processing workflow, non-uniformity of procedures, and lack of data integration. A simple example of this drawback is the significant legwork it takes to process a single payment transaction at a Local Government Unit (LGU). A client has to give similar information (such as name, address, etc.) to different offices and provide the same to the cashier to

make a payment. Once the payment is settled, the client still has to coordinate back or return to the intended office in order to confirm the payment for record purposes. These observations have often been interpreted in the context of reforming the traditional payment system to consequently lower operating cost³, and streamline the process⁴. Hence, efforts to modernize the government payment system must be leveraged to improve the public service, financial system, as well as the efficiency of the economy.

Movements toward the adoption of information technology and improvement in the government services encouraged the initiative to serve the public electronically, popularly known as "eGovernment." The word eGovernment short for Electronic Government or eGov has established a global meaning as "the delivery of public services by means of information technology"⁵.

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An eGov system is a suite of applications that includes an interoperable real-time payment system interlinked across multiple offices. In⁶ we find information integration and process integration as prominent concepts to guide interoperability efforts, but they seem to point to different directions. This paper aims at contrasting the different characteristics of both approaches and concludes with recommendations according to the intended organisational scope of integration. To be successful in these efforts it is important to understand that Klischewski defines interoperability as the ability of ICT systems to share data and information across multiple systems. In the context of eGov, the framework aims at making all the information systems relevant to public service to operate in an integrated way⁷. Although it is evident that a number of eGov models⁵⁻⁸ and initiatives⁹ have been implemented, many have failed² putting citizens to remain discouraged and frustrated¹⁰. For instance, the Philippine government developed a Philippine eGovernment Interoperability Framework or PeGIF (<http://www.i.gov.ph>), which began in 2011. PeGIF was initiated to support the competitiveness of the country's economy in the arising globalization change by way of information sharing across different government agencies¹¹. The aim is to increase efficiency, improve decision-making, and reduce costs in the Philippine government. While PeGIF Part 1 was initiated to promote technical interoperability, and PeGIF Part 2 otherwise known as Information Interoperability Framework (IIF)¹² is on information interoperability, evidence still suggests that the adoption has been slow and inconsistent. Since the inception of PeGIF Part 1 and IIF, no tangible results have yet been established and the consultations still remain ongoing¹³. To date, the relative advantage of having an interoperable payment system in eGov remains poorly understood.

Moreover, in actual, only very few eGov applications have been developed, which are usually standalone or decentralized^{14,15}. As a result, citizens are still obligated to provide similar data repeatedly for each engagement per office. This confirms the observation of¹⁶ that the development of ICT applications between government agencies has been unequal. These studies suggest that a minimum priority may have been placed in the development of a centralized eGov payment system.

The World Bank⁴ defines the perspective of interoperability in the payment system as the handling and

processing of payments between different ICT applications through a centralized point of payment system. The approach allows multiple applications to interoperate with one payment application system, then seamlessly exchange and reuse services in terms of technical, and information domains⁷. All domains are directed towards shared services from data integration, information access, and presentation, to content management and analytics. However, given all the advantages of interoperability in payment systems¹⁰⁻¹⁷, the field still remains to be unexplored along the subject of eGov.

Furthermore, setting a centralized eGov payment system implies accommodation of certain obstacles. Research has shown that the ICT transaction cost can be a burden expense especially for developing countries such as the Philippines¹⁸. A survey of 142 countries found that 39% of low-income countries lag far with regards to payment system development¹⁹, where the Philippines has been classified as low-middle income economy based on a World Economic Forum 2015 report. Indeed, developing countries may find reinventing the payment system costly in economic, political and social terms¹⁸ due to the lack of funding and promotion to increase oversight capabilities on the advantage of an interoperable payment system. Other challenges identified include policy issues and leadership role²⁰, and decision-making strategy²¹. According to²², eGov success demands top management involvement to initiate the creation of new legislative rules and policies. In² supported this idea particularly on matters of governmental changes that direct revenue collection. In this effort, top leaders can play a fundamental role in influencing acceptance desire among its constituencies. On the one hand, leaders can institute intelligent and tangible rules and strategies when data analytics are accessible. Nevertheless, these hindrances should not limit developing countries to harness the advantages of reinventing its payment system.

This is the first work that focuses on the payment system interoperability domain named as Point of Payment Solution or POPS for eGov Systems, which is highly integrated from the administrators and end-users' perspective, and highly interconnected along and across the different eGov-related applications. Sections 2 and 3 discusses the adopted research design and software development methodology, and the findings of the study along the live functionality of POPS using the real-life

data from LGUs, respectively and the findings along with the live functionality of POPS using real-life data from LGUs, respectively. The conclusion, acknowledgment, and references are presented in Sections 4, 5, and 6, respectively.

2. Materials and Methods

2.1 Research Design and Methods

This project primarily used Developmental Type 1 research design based on the proposed research model of²³. Its essential feature is the use of different or multiple research methods in each phase of the project development. For this paper, descriptive methods such as semi-structured interview and direct observation were utilized to gather the case study data, while simulation test and questionnaire survey was used together to evaluate the level of acceptability of POPS based on the six ISO 9126 Software Quality metrics.

Since the project seeks strong collaboration and involvement from the respondents, a face-to-face semi-structured, in-depth interview was conducted to four municipal treasury officers of Nabua and Bula LGUs of Camarines Sur, Philippines from July-September 2017. The open-ended interviews concentrated on how the service is currently delivered, problems and issues encountered, and the reports submitted or forms used in the existing payment system. The method, administered in native dialects (Tagalog and Rinconada), also allowed respondents from both municipalities the opportunity to explain their responses. Simultaneously, direct observation was also conducted to corroborate the credibility of the interview result^{25,26}.

To determine the level of acceptability of POPS, a simulation test directly followed by survey questionnaire was conducted in October 2018. The simulation test is a replication of a typical payment transaction scenario using the proposed payment system. While the one-page survey questionnaire was prepared in two sets and pre-tested by expert reviewers; three researchers involved in the eGov project. The first set of the questionnaire consisted of 16 mixed closed-ended questions along efficiency, usability, reliability and functionality, and was distributed to the first set of respondents (end-user) from the Municipal Treasury Office (MTO) of the two municipalities. The second set included eight questions on maintainability

and portability and was responded by 10 IT experts from the ICT department of the Camarines Sur Polytechnic Colleges. Each set had an equal number of items per metric and was tested for reliability using the principle of Cronbach's alpha.

Furthermore, frequency tables and Likert scaling technique were used to describe the calculated scores for each of the metric statements. The Likert scores, ranging from 1-5, were calculated by multiplying the number of respondents per item statement. The range gives the weight of the responses, where ≤ 1.80 = Strongly Disagree (SD), 1.81- 2.60 = Disagree (D), 3.40- 2.61 = Fairly agree (F), 3.41-4.20 = Agree (A), and 4.21-5.0 = Strongly Agree (SA). In addition, the Likert scores for each metric were also averaged in order to provide the overall software quality scores.

2.2 Software Development Methodology (SDM)

Princeton Project Management Methodology or PPMM is the software methodology adopted to conceptualize and develop POPS, which was modified into three major phases described in Figure 1. The first phase- Initiation include iterative discussions among the researchers (project team), and interviews with the stakeholders to gain their perspective and experiences in using the existing system along with the assessment of the present status of its IT infrastructure. The result of this phase was the Initiation plan, which included the initial draft of POPS' objectives, scope, purpose, technical requirements, roles and responsibilities, and deliverables based on a provisional Workplan. The major purpose of this phase is to involve, inform and gain the stakeholders' endorsement especially that POPS require change and creation of new local ordinances.

The second phase is an integration of Planning, Tracking, Reporting and Review (PTRR) into an iterative process, which begins with completing the detailed Initiation Plan and full Workplan. The Workplan included



Figure 1. Modified PPMM.

the scheduled timeline along with the activities per expected output. The activities and deliverables included verification of the process and technical requirements from the stakeholders, design, and development of POPS from the conceptual framework to coding, and testing and review based on status and end-user-testing reports. Also, consultations and committee hearings with the end users and Sangguniang Bayan's legislative body were facilitated to ensure that project requirements were met and local ordinances were created and enacted.

For the last phase, Delivery and Close-out- entails the completion and assessment of the project. The phase includes implementation of the training plan for the end-users, live implementation of POPS, and closing meetings for the final audit and review of POPS to ensure that created modules are within expected quality.

3. Results and Discussion

3.1 Phase 1- Initiation

The respondents from Nabua and Bula corroborated that there are indeed problems and issues in the existing payment process that needs immediate attention, as summarized in Table 1.

Based on the analysis of the existing payment process, including the identified deficiencies and available

Table 1. Common problems encountered in the existing payment system

Common Problems	Description
Too much legwork	The actual handling time to process a single payment is not in accordance with the office's citizens' charter
Decentralized collection.	Manual recording of transaction per offices using packaged office software.
Difficulty in report generation	The officers of the municipal treasury office manually generate reports for mandatory submission to the regional agencies. The report generation gets more strenuous when the request is the collection per offices, which requires manual searching of code per office using the packaged office software.

technologies, the proposed POPS intend to build a tailored-fit application that can be installed on common platforms, and integrate the relevant eGov applications to improve efficiency. The following are the components that comprise the proposed POPS for LGUs: (1) Payment Processing; (2) Report Generation; (3) Data Analytics; (4) Payment Integration for Business Permit and Licensing (eBPLS) (5) Payment Integration for Building Permit (eBPS); (6) Payment Integration for Legislative document requests (LemTrac), (7) Payment Integration for Real Property and Tax Assessment (RPATS), and (8) Integration for Local ID System (LIDS), for payment and verification of clients.

3.2 Phase 2- PTTR

The conceptual design of POPS in Figure 2 highlights the modules, user privileges, and interaction with the various eGov applications. The three modules in the rectangle box include the Payment Processing (PPM), Report Generation (RGM), and Data Analytics (DAM).

The end-user logs-in or registers with POPS through the PPM interface. This module consists of two components: The CodeIgniter-Bootstrap Framework, and RESTful API. The CodeIgniter and Bootstrap are web-based UI frameworks integrated to achieve an elegant and uniform front-end design, which is adopted by the rest of the eGov applications integrated to POPS. However, other components of the template were customized based on necessity using Native PHP v7, HTML5, CSS3 and Javascript. For instance, the payment interface was made into a single-page interface to improve network bandwidth and load time. Likewise, the database back-end adopted the MariaDB 0.1.26 and Apache 2.4.27 for the web server.

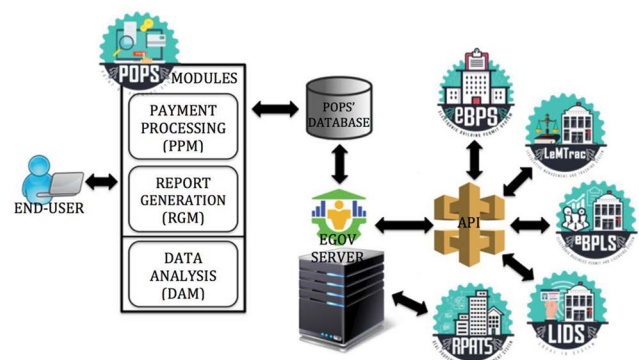


Figure 2. Conceptual Framework of POPS

On the one hand, the main objective of POPS is hosted by PPM via the RESTful API. The use of API restricts the data that can be fetched from the database—represented by the double-headed arrows, which limits data visibility to increase database privacy. For example, when an applicant is ready for payment, only the assessment of fees is fetched from the backend server via the API in the JSON data format (except RPATS), and is then forwarded in the payment interface of PPM. This allows the client to directly pay the fees through POPS without printing order of payment. To identify which fee from the list, the client only has to present his local ID to the end-user before payment. Once the payment is settled, POPS automatically generates and forwards the proof of payment (OR number) to the eGov application counterpart. This mechanism promotes a paperless transaction, as well as streamlines the process and save resources, which resolves the identified drawbacks², and recommendations³.

Since the MTO follow a template in submitting mandatory operations report to regional agencies, the RGM is incorporated with a report generator component. The end-user can select from the available data fields to feed to the report generator to create customizable content or just use the ready-form templates then save or print the reports in PDF formats. Additionally, the dashboard of the end-users includes widgets that provide an overview of the important metrics relevant to POPS, such as number count of incoming payment transactions, completed payment transactions, etc.

The eagerness of the top management from Nabua LGU to help empower their decision-making through new information and perspective motivated the creation of DAM. The module, in line with the provision of PeGIF¹⁵ on decision-making, uses a data mining technique to generate new information in a form of visualizations from the raw dataset such as deriving fields like daily, weekly, monthly based on date fields. Moreover, the prototype



Figure 3. Sample Output of DAM.

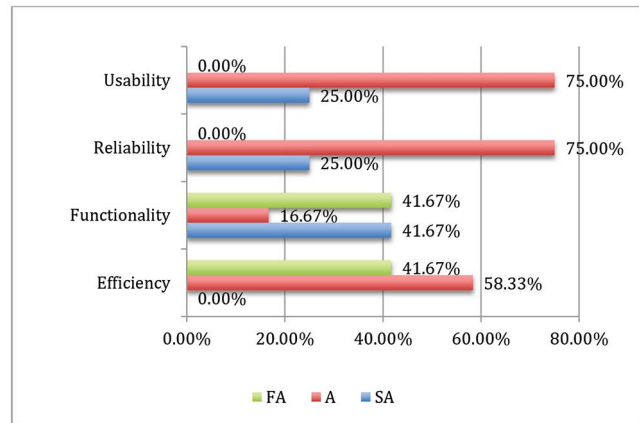


Figure 4. End-users' rating.

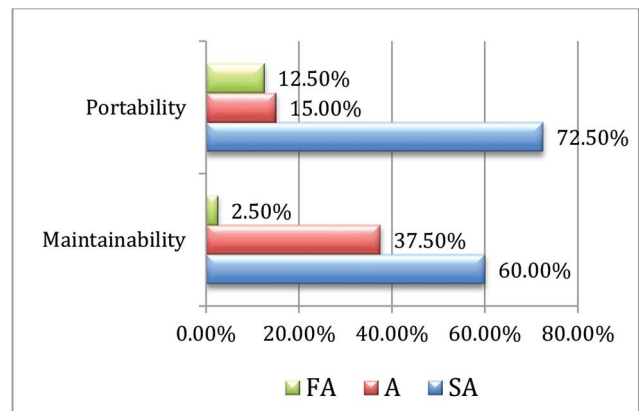


Figure 5. IT Experts' rating.

used a user-friendly design to provide intuitive visuals as shown in Figure 3. On the other hand, the horizontal line dividing the rectangle box in Figure 2 represents the user privilege to access the module.

After the system planning and development, POPS was submitted for user testing to assess its level of acceptability in terms of ISO 9126 software quality metrics. The findings from the survey for the end-users and IT experts are summarized in Figures 4 and 5, respectively.

In relation to the perceived usability and reliability of POPS, the majority (75%) of the respondents indicated their strong agreement, while only a small percentage (25%) agreeing. The result suggests the ease of which POPS functions can be easily understood and operated, along with its solid ability to catch faulty response and section failure. The computed Likert score of 4.25 for both the metrics implies that POPS strongly exhibits the definition of a user-friendly UI and fault tolerant system. Response to the functionality metric indicates

that almost half (41.67%) of the respondents strongly agreed with a similar percentage fairly agreeing, and a small number (16.67%) agreeing, giving a Likert score of 4.0. The results reveal that nearly half of the respondents were hesitant to agree or disagree on the ability of POPS to address the operational requirements, particularly on the correctness of the analytics, generation of reports, or the authorization access control. It can be assumed that the respondents were reluctant to use the new system or resistant to change, which attributes to the eGov challenge mentioned by¹⁹. With respect to efficiency, over half of the respondents (58.33%) agreed that the system was acceptable, while about half (41.67%) fairly agreeing. The Likert score of 3.58 implies that the less than one-minute response performance, along with the amount of savings (effort and resources) in completing a payment transaction had a positive effect to the respondents' perception.

The metric maintainability indicated that over half (60%) of the IT expert respondents strongly agreed that POPS is acceptable, whereas more than one-third (37.50%) agreed, with only a small percentage (2.5%) fairly agreeing, as shown in Figure 5. The Likert score was 4.58, suggesting that the code readability of POPS facilitated by modularization (callable functions) is highly notable. This implies that POPS' source code is easy to learn, hence, maintenance efforts are reduced particularly when corrective issues or required enhancements arise. Finally, the portability rating shows that majority (72.50%) of the IT experts strongly agreed that the system is acceptable, with less than one-fifth (15% and 12.50%) agreed and fairly agreed, respectively. The responses gave a Likert score of 4.60, which suggests that POPS is adaptable to different operating environments from front-end to back-end since all programming codes used are open-source.

The overall software quality rating of POPS gave a Likert score of 4.21 or adjectival perceptions rating of strongly agree. This manifestation implies that POPS implements the necessary functional requirements for an eGov payment system according to the recommended ISO software quality metrics as perceived by the end-users and IT experts' respondents.

3.3 Phase 3- Delivery and Closeout

In this last phase, the implementation of the training plan was conducted successively to the end-users of the two

(2) municipalities, along with the distribution of the user's manual. Moreover, the sustainability plan was discussed to the top management, which includes consultation and extension services on matters of software maintenance and revisions. The live implementation alongside public pronouncement of the new ordinances for POPS was also conducted under this phase. A closing meeting for the final review and transition feedback on the project was also conducted to ensure that the expected operations and functionalities are met and in order.

4. Conclusion

In this work, a point of payment system for eGov coined as POPS that is centralized, integrated, user-friendly, and more efficient than the existing traditional payment systems have been developed and presented. POPS is comprised of three tiers of modules, namely: the Payment Processing (PPM), Report Generation (RGM), and Data Analytics (DAM). Employing the real-life data from the municipal treasury offices of Nabua and Bula, Camarines Sur, Philippines and given the evidence from findings, POPS manifested highly agreeable results as per ISO 9126 software quality metrics for various reasons. Firstly, POPS via an API mechanism in PPM was able to allow clients to pay the fees directly and confirm a payment without going back and forth to the concerned offices. The mechanism also reduced the payment transaction to less than one minute, which is supported by the Likert score of 3.58 for the efficiency metric. Similarly, a report generator component was incorporated in RGM to allow end-users use the ready-form report templates or create customizable content that they can save or print in PDF formats. This allows end-users to generate reports quickly and conveniently in just a few clicks.

Also, a data mining technique was used in DAM to examine raw dataset and generate new information in a form of visualizations, which can be useful information for the top management to improve legislative or business decision-making. These features gave a Likert score of 4.0 for the functionality metric. Secondly, POPS adopted a UI framework to create an elegant, uniform and intuitive front-end interface that is also fault-tolerant with respect to errors at the UI. This feature pleased the end-users and gave a usability and reliability Likert score of 4.25. Thirdly, POPS modular code design and open-source programming platforms reduce maintenance efforts and

promotes flexibility when changes on the platform or back-end engines arise. Thus, were regarded highly by the IT experts and were given the Likert scores of 4.58 and 4.60 for maintainability and portability, respectively.

This is the first work that focuses on the payment system interoperability domain for eGov with data analytics. It is also important to note that the solution may have been intended for adaptation to any LGUs; however, the solution was developed based on the best perspective from the two target municipalities. There is no one approach that best suits all, thus, revision can still be possible if another LGU would want to deploy a similar system. Presently, POPS runs on a private network. Thus, a cloud-based infrastructure with a high focus on scalability and security is the future work of this paper.

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