CREATION OF THE SMIA: MANAGEMENT MODEL
APPLIED TO SERVICE PROCESSES IN HEALTH CARE

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The evaluation of service operations strategies has increased the efficiency of third sector activities or processes. The use of evaluative methods in the management of operations in the health area could contribute to the work process and better results. Understanding the possible applicability of practices that involve the planning, execution and monitoring of actions within an organization are ways of propose improvements in primary or specialized care services and in research focused on vulnerable or specific populations. The methodological process of developing a scope for continuous improvement within the evaluation of operations strategies starts from the basic principles of routine management and guidelines. This work proposes a new performance evaluation model for recruitment strategies of potential participants for HIV prophylaxis, through operations management tools, quality management and sensitivity analysis in probabilistic models, called SMIA (study, monitoring, improvement and analysis). Studies were carried out with this premise, using data from a field survey on pre-exposure prophylaxis to HIV for recruiting and prospecting potential participants (young gay men, trans women and transvestites aged between 15 and 19 years): understanding the operations strategies in the field (field diagnosis), portrait of these processes in the form of performance indicators and improvement through quality tools. The presented results report unfolds the methodological specificities of the recruitment strategies, the profile of the recruitment in the field, with direction of the possible improvements that should be made new prospects of participants in the research. These results indicate the potential of these strategies to improve processes for inviting new participants. The proposed partially validated SMIA model can be replicated in different health services, in other research and in different processes, according to the specificities and objectives that are pursued by the organization.

Keywords: SMIA, PDCA, Quality tools, Health Care, Operation Strategy, Performance Indicators
1. Introduction

The health services are widely using the concepts of performance measurements and sectoral quality to evaluate and improve their processes (KURDI et al., 2023). Traditional reproduction methods such as PDCA have become routine in many organizations managing healthcare services (Chan et al., 2020). The improvement of these methodologies comes with refinement and the serial need to understand details of the process with other tools that previously could not be used separately. The systematic use of analysis, evaluation and improvement tools becomes the way to create a new model adapted for processes, including health services, seeking better understanding to support the work process in services and management. The oriented way of using PDCA as a cycle can reference creations of other methods based on quadrants and with specific tools at each stage. This work proposes to develop a new performance model for services called study, monitor, improve and analyze (SMIA) for evaluating service processes. The proposed SMIA model allowed: (i) analyze the recruitment strategies used in the service; (ii) relate the recruitment strategies used in the healthcare service with the monitoring indicators of young people attracting processes; (iii) support to decision-making from the quality tools used in recruitment processes. To develop these objectives of the article, the SMIA model will be tested in a Pre-Exposure Prophylaxis to HIV/AIDS (PrEP) health service, focusing on the evaluation of recruitment strategies of potential participants for HIV prevention (health care model), through operations management tools, quality management and sensitivity analysis in probabilistic models.

2. Materials and Methods

2.1. The proposed SMIA model

The work in question is based on data from a research project focused on HIV/AIDS prevention, and it is intended to create a qualitative and quantitative evaluation model based on database and interviews that can be used in future projects. Thus, the solution of a practical problem and the creation of a new model of predictive evaluation are sought. The quantitative character of the research is verified in the use and analysis of the data for the construction of a model of improvement, forecasting and prediction through analysis of variables control statistics, quality tools and monitoring indicators. From the point of view of its objectives, it has an explanatory character, as it aims to study and understand the behavior of data from a health service, in the area of recruitment., taking the form of an ex post facto research. The technical procedures will follow the pattern of exploratory research where the object of study are the recruitment values.
and variables that influence their behavior will be analyzed. Using the PDCA cycle (PLAN, DO, CHECK and ACTION) integrated with the SDCA (STANDARD, DO, CHECK and ACTION) applied for problem solving, the author proposes a new performance model based on an adaptation of previous models for evaluating research or other healthcare processes, described as SMIA (Study, Monitoring, Improvement and Analysis) using continuous improvement methods.

Figure 1 – Schematic process of SDCA and PDCA

Source: Adapted from Falconi (2009)

The description of the stages of the SMIA model would be: Study – study of the operations strategies used and their impacts and changes in the project; Monitoring - Monitoring of quantitative indicators on the information generated through these recruitment strategies; Improve – Use of analyzes to carry out the improvement of each of the strategies or discontinuity, when applicable; Analysis - Perform demand forecast sensitivity analysis to generate new operation and recruitment strategies. Each study topic in the collection aims to describe each of these steps, with the exception of the analysis step (Analyze for the method), which refers to the sensitivity analysis. The proposed model exercises the application in a case study in the PrEP1519 project and proposes that new rounds of applications be carried out to ensure that the first 3 quadrants of the proposal give results and help in the decision making of field research projects. The final proposal is based on use of each stages illustrated in the studies and proposes an integration of these methods to reach the desired SMIA model.
2.2. The PrEP healthcare service

The impact of Pre-Exposure Prophylaxis to HIV/AIDS (PrEP) healthcare service in controlling the HIV epidemic is associated with prophylaxis coverage rates and rates of use of other preventive methods in the community (JUUSOLA et al., 2012; LeVASSEUR et al., 2018), which has led to recommendations for public and non-governmental institutions to make efforts to incorporate and promote the wider use of PrEP, preferably as part of integrated prevention policies. In Brazil, despite the increase in HIV testing in recent years, young people remain with the lowest rates of knowledge of their serological status (ELLIS et al., 1995). Thus, the development of strategies to identify and link vulnerable individuals to prevention services, especially when associated with offering HIV testing and interventions in communities, is essential to increase the impact of PrEP. This becomes relevant when it comes to adolescents who, historically, have low demand for and attachment to health services (CLARO et al., 2006).

The forms of recruitment strategies identified for the project, through the literature review identified in other projects related to HIV/AIDS, are listed below, with the definition and methodology used. These strategies can be divided into strategies with social media and without social media. The figure of the peer educator (human factor for the application of these strategies) described how they recruited young people based on the research protocol of the PrEP for young people. PrEP1519 is a project that aims to offer HIV pre-exposure prophylaxis (PrEP) to young people aged between 15 and 19 years, more specifically from the population of men who have sex with men (MSM) and transgender and transvestite women. This project takes place in 3 Brazilian capitals: Salvador, São Paulo and Belo Horizonte with the institutional partnership within the Federal University of Bahia (UFBA), the State University of Bahia (UNEB), the Federal University of Minas Gerais (UFMG) and the University from São Paulo (USP). The main objective was to demonstrate the effectiveness of the use of PrEP healthcare service in adolescents for the age group and target audience where the prevalence of HIV has increased.

2.3. Data collection

Collection of qualitative data for the study and application of the SMIA through interviews with peer educators (professionals who work in the sexual education of young people), who described how they identify the recruitment processes and the way each strategy is used in the field, defining the standard methodological scope to replicate and guide any other educator to approach the young person through the chosen strategy. Quantitative data collection was carried out through a virtual verification sheet, with transversal cuts, based on the quantification of all
the contacts made by the peer educators with the young people. To complete this sheet, key information was considered in the collection when approaching the participant: age, sexual orientation, gender identity, contact information (social media, chat apps or e-mail) and the strategy that was used for the reach the young man in the field. In order to establish a chronology of the use of these tools and strategies in the project and apply it to the SMIA model, it was divided into three service moments, having as a cutoff point 160 project participants, separated by months: the first moment, from April/2019 to June/2019; second moment, from July/2019 to September/2019 and; third moment, from October/2019 to February/2020. The knowledge and monitoring of the strategies with this division into moments elucidate and explain how the project behaved with the strategies that were gradually implemented and direct the positive and negative aspects, with the continuous resolution of the latter.

2.4. Analysis Tools
Performance measurement and decision-making through 4 stages (Study, Monitoring, Improvement and Analysis) using cross-tabulation statistical tools and statistical correlation with chi-square applied to the collected database, directing to the most relevant strategies, which attract more participants. There is a transformation of data and information that will help in the decision-making process of the project (OLIVEIRA, 2008). This analysis was carried out using the SPSS statistical and Minitab softwares, as an aid to the data processing to generate the necessary information for decision-making. For this study, the cost base was not used empirically or applied, based only on the perception of the operator (peer educator) of the available recruitment resources.

3. Results and Discussions
Due to the time limitations of the study, only the first 3 quadrants will be validated using statistical tools, except the last one, Analyzes. It will be one of the propositions for future studies of the article.

3.1. First quadrant of the SMIA: Study
With the measurement of the results of the strategies, it is possible to make some statistical analyzes and elucidate which strategies will be used to improve the effectiveness of the recruitment processes in HIV/AIDS research. For this, all the strategies exposed were summarized in 3 to facilitate the interpretation of the chi-square and minimize errors in the statistical table: (i) peer education, with care network/navigator, events and actions and peer educator; (ii) social media, with all social media in the study and; (iii) participant's spontaneous
demand, with participant indication, formative research, study site contact network, and spontaneous demand. The neighborhoods were categorized into five macro-regions with a categorization not informed by the participants: seafront, railway suburb, outskirts, downtown, RMS (metropolitan region of Salvador), and uninformed. The results for gender identity \((p = 0.006)\) and sexual orientation \((p = 0.007)\) were statistically relevant and therefore will be considered influential for direct observation of recruitment strategies. Only the variables that do not show great statistical relevance will be deployed in the study and understand the behavior through the evaluation framework based on the chi square, such as education \((p = 0.399)\), place of residence \((p = 0.262)\), age \((p = 0.340)\) and race/color \((p = 0.729)\).

<table>
<thead>
<tr>
<th>Variable</th>
<th>Pearson chi-square</th>
<th>Cramer value</th>
<th>Likelihood ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender Identity</td>
<td>(p = 0.006)</td>
<td>0.283</td>
<td>0.001</td>
</tr>
<tr>
<td>Sexual orientation</td>
<td>(p = 0.007)</td>
<td>0.237</td>
<td>(&lt;0.001)</td>
</tr>
<tr>
<td>Education</td>
<td>(p = 0.399)</td>
<td>0.157</td>
<td>0.346</td>
</tr>
<tr>
<td>Place of Residence</td>
<td>(p = 0.262)</td>
<td>0.221</td>
<td>0.275</td>
</tr>
<tr>
<td>Race/Color</td>
<td>(p = 0.729)</td>
<td>0.119</td>
<td>0.750</td>
</tr>
<tr>
<td>Age</td>
<td>(p = 0.340)</td>
<td>0.189</td>
<td>0.260</td>
</tr>
</tbody>
</table>

a) Relationship Recruitment Strategy x Macro-region

The categorization made for macro-regions of the Salvador study site was based on how the management of the city hall classifies the division of neighborhoods, associating the demographic density of the region, characteristics of mobility and culture, facilitating the approach and conclusions of the studies (IBGE, 2023; BERNARDES et al., 2021). The descriptive statistical analysis shows that there is a greater relationship between recruitment strategies 1 and 2 in areas 3 and 4, which are crucial for the research since they are characterized as regions with low income and education in the face of a survey by the competent bodies in the city of Salvador. There is a significant correlation between virtual recruitment strategies and the most vulnerable regions, strategies that require a network of people with the same profile as young people were the most effective in attracting them, which can demonstrate the effectiveness of using peer educators with an identity profile and age close to the young people to be recruited (KITETELE et al., 2022). That makes it possible to enter social networks and relationship applications, the same conclusion can be drawn from the relationship between schooling and study macro-region. Those with less education live in the most vulnerable
socioeconomic regions and would need face-to-face recruitment to join the project and have access to information about PrEP (KITETELE et al., 2022; KOPO et al., 2023).

b) Recruitment strategy ratio x Age group

The operation carried out in strategy 1 (mainly in the peer educator subcategory, related to the person who carries out the dissemination of combination prevention methods in person or through his/her network of contacts) proved to be the closest in covering the entire age group of the study (WHO, 2016). In the next stages of data collection for new participants, investing in peer education strategies would be necessary to cover more participants in the 15 to 17 age groups, reduced in the other strategies (PATEL et al., 2022). Virtual strategies are similar in importance to those used with peer educators when all age groups are observed. Understanding that young people have greater access and affinity to relationship apps and social networks reflected in the impact in a similar amount to strategy 2. With difficulty in the research field in attracting young people in the 15 to 17 age group, strategies 1 and 2 are shown to be more effective in recruiting these adolescents (MAGNO, et al., 2022).

3.2. Second quadrant of the SMIA: Monitoring

For the survey indicators within the scope of participant recruitment, not only coefficients were developed, but also indices and some indicators of absolute values, since the quantification of the survey goal to make it effective is based not only on adherence of the intake of PrEP but also on the number of participants in the research.

- Conception and structuring of recruitment indicators

An indicator is a real-valued function $I : D \rightarrow R^+$ such that $I(X) \leq I(X')$ if and only if the status $X$ is at least as good as the status $X'$. Dash boards were created with the most diverse types of graphics that could translate the recruitment processes in the project into indicators. The design of each indicator must comply with one of the project's strategic objectives. Table 2 shows all the proposed indicators with the usage profiles and the way in which the data should be shown. Not all types of indicators were used, however the SMIA model predicts the pattern of usage based on visual analysis and monitoring.

<table>
<thead>
<tr>
<th>Indicator Description</th>
<th>Layout type</th>
<th>Type KPI</th>
<th>KPI</th>
<th>Variable</th>
<th>Objective</th>
<th>Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of contacts per month of recruitment on the Salvador site</td>
<td>area</td>
<td>Laggings KPIs</td>
<td>number of contacts</td>
<td>1. number of contacts</td>
<td>show changes or compare values over time</td>
<td>Evolution of the demarcated area over time with the seasonality of the recruitment process</td>
</tr>
<tr>
<td>Number of participants per month of recruitment on the Salvador site</td>
<td>line</td>
<td>Laggings KPIs</td>
<td>Number of participants</td>
<td>1. Number of participants 2. Time</td>
<td>It presents values (numerical sequence) in a certain space of time with evolutions or decreases of</td>
<td>Evolution over time with formation of time series</td>
</tr>
</tbody>
</table>

Table 2 - Standard indicators with usage profiles and demonstration form
some phenomenon.

- Monitoring by indicators

This goal was credited as an absolute number of people on PrEP (using prophylaxis) and people in the non-PrEP arm (who are performing all follow-up exams, but there is no use of prophylaxis). The treatment of the database served to guide which indicators would be created and which indices would also be interesting to show the efficiency of the recruitment processes, when compared with the established goals and when related to the resources available to carry out the approach with future participants. From the general result, we have the number of contacts made that did not necessarily generate queries. The figure used was an area chart, to give dimension to the number of contacts that were generated.

Figure 3 - Contacts made in the PrEP1519 project in 2019, Salvador site, in area graph (number of contacts per month of recruitment)
From the contacts made in general, it is possible to identify in different ways which recruitment strategies were used. For the bar graph, it was built considering all 9 months of study, differentiated by color of the recruitment carried out.

Figure 4 - Contacts made in the PrEP1519 project, Salvador site, structured by recruitment strategies, in vertical bar graph (recruitment strategy)

When checking the profile of those enrolled in the project, and initially analyzing the recruitment methods, we have the main indicator that includes all strategies over the 9 months of the project. Even in absolute values, there is a way to build an area chart and analyze the behavior of strategies over time. What can be seen in the behavior of the graph would be the appearance of moments in time when a certain strategy is prevalent, with the area graph of a certain strategy overpowering others. This helps in temporal decision-making in the study of which strategy to use at a given time of the year.

Figure 5 – Recruitment methods over time for participants enrolled in the Project (number of contacts per month of recruitment)

In the first quarter analyzed (Apr-Jun), 59 adolescents were contacted and, of these, 31 were enrolled in the cohort. After the implementation of monitoring, the second quarter (Jul-Sep) registered an increase of 55.9% (n=92) and 70.9% (n=53) of adolescents contacted and enrolled, respectively. The third quarter (Oct-Dec) recorded an increase of 400% (n=295) and 48.4% (n=46) of adolescents contacted and enrolled, respectively.

Table 4 – Data on the evolution of the main recruitment indicators

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Variable</th>
<th>Apr-Jun</th>
<th>%</th>
<th>Jul-Sep</th>
<th>%</th>
<th>Oct-Dec</th>
<th>%</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender identity</td>
<td>Cisgender</td>
<td>86,44%</td>
<td>79</td>
<td>85,87%</td>
<td>272</td>
<td>92,20%</td>
<td>86,44%</td>
<td>402</td>
</tr>
<tr>
<td></td>
<td>Transgender</td>
<td>13,56%</td>
<td>13</td>
<td>14,13%</td>
<td>23</td>
<td>7,80%</td>
<td>13,56%</td>
<td>44</td>
</tr>
</tbody>
</table>
The greatest increase in adolescents contacted and enrolled was registered among MSM and in the virtual modality.

### Table 5. Evolution of the period without and with monitoring of indicators

<table>
<thead>
<tr>
<th>Monitoring Status</th>
<th>Period</th>
<th>Joined Cohort</th>
<th>Increase in %</th>
<th>Contacts made</th>
<th>Increase in %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Period without Monitoring</td>
<td>Apr-Jun</td>
<td>31</td>
<td>-</td>
<td>59</td>
<td>-</td>
</tr>
<tr>
<td>Primeiro Período do Monitoramento</td>
<td>Jul-Sep</td>
<td>53</td>
<td>70,97%</td>
<td>92</td>
<td>55,90%</td>
</tr>
<tr>
<td>Segundo Período do Monitoramento</td>
<td>Oct-Dec</td>
<td>46</td>
<td>48,39%</td>
<td>295</td>
<td>400%</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>130</td>
<td>446</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

### 3.3. Third quadrant of the SMIA: Improve

To use quality tools in improving strategies, it is necessary to study the entire recruitment process and see what would be the most effective approaches and which will bring more results. In other words, the focus is on prioritizing the methodologies to: (i) which ones would be more effective; (ii) would get more impact on the recruitment results of absolute values; and (iii) which would bring more treatment of STIs and prevention with the ingestion of PrEP (in this specific case, with the prevention treatment of contamination with HIV).

- **Control Charts**

After plotting the collected data using the control chart for attributes (c-Chart), we identified statistical control trends. A chart without and with trends was made to understand better how recruitment strategies finding can effectively find younger people. The dominance of 18- and 19-year-olds is still a reality, but there is a tendency for minors to enter the research.

Figures 6 - Control charts without (a) and with (b – run chart) trend line for the age variable (by vertical)
• Scatter diagram

The first dispersion used for analysis must be done with the critical variables of the project. Age and forms of recruitment are two of them. This dispersion can be identified in Figure 5. The predominance of the peer educator recruitment method is notorious, followed by Grindr (relationship application).

Figures 7 – Scatter diagram with age variables and forms of recruitment

• Pareto diagram

The monthly Pareto chart is used to understand the distribution over the months in a structured way. The prioritization of strategies for future investments of efforts will be in the Grindr relationship application and the peer educators network strategy, represented by blue and red colors, respectively. Through a greater unfolding, the research can also provide, which occurred in May. There was a greater proportional distribution of available recruitment strategies. This may indicate seasonality or, for this month, differentiated actions provided the emergence of new participants in the survey for the less effective strategy in the other months. The software used (Minitab) is unable to order the Pareto chart values, which is one of the illustrative limitations of the study.

Figure 8 - Pareto charts by month with the deployment of strategies.
In the description for the histogram, several analyses were performed with one of the main study variables, which is the age of the participants. First, the data were plotted on the histogram with a normal curve to verify this variable’s normality and behavior. After that, interpreting the capacity of the process and the trend of change from the CpK and Cp based on age, with maximum and minimum limits, 19 and 15 years, respectively, would be the main products for the analysis of this tool.

Since Cp < 1 and CpK << 1, the process can be considered effective and potentially not decentralized. The Pp < 1 and the PpK << 1 also infer the global insufficiency of the process due to its variability when comparing the specification limits. This imposes the difficulties of reaching the layers of the population at risk from 15 to 17 years old to centralize the normal curve and project a Cp greater than 1 and the behavior of the process in the future. Suppose there are no changes in recruitment strategies and methodologies. In that case, there will always be a greater number of participants between 18 and 19 years old (by Brazilian legislation, they are their legal guardians) fewer of participants between 15 to 17 years old. The latter needs formal authorization from legal guardians and characterizes greater difficulty in accessing health education.

### 3.4. Validation of the SMIA model

In the first quadrant, the objectives were based on the analysis of the recruitment strategies used in the research and forwarding the best strategy for a given base variable of the study to decision-making, thus verifying the efficiency to reach the target audience. The SMIA model in the first quadrant proposes an action based on a pre-existing study. It is understood that for
this first quadrant of the proposed method, the statement that there was a preliminary understanding of the strategies and the actions for decision-making was proposed due to the analyzes carried out and the best direction of the strategy through the main related variables is valid. In the second quadrant, there was a main direction in monitoring the recruitment process with the creation of performance indicators in the recruitment process in scientific research and support the choices, definitions, and prioritization of strategies already used in the project.

The SMIA model in the second quadrant proposes monitoring based on processes involving databases. It is understood that for this second quadrant of the proposed method, the statement that performance indicators were created for the recruitment process that can help in decision-making and the best direction of each strategy, optimizing the resources available in the project, is valid. In the third quadrant, the general objective would be the application of quality tools to improve the management of the recruitment process and its consequent continuous improvement, enhancing the use of resources in these strategies. The SMIA in the third quadrant proposes an improvement of processes based on processed data, whether through indicators or the database itself. It is understood that for this third quadrant of the proposed method, the statement is valid that, in addition to the application of quality tools based on the state of the art of Quality Engineering, there were improvements made in the recruitment process with the application of tools based on project data.

The methodological proposal of the last quadrant, analysis, defines a sensitivity analysis after the improvement carried out to adapt the available improved resources and optimize them based on the best decision-making. It is a type of approach not contemplated in the project due to the time required to carry out this validation in the PrEP healthcare service (limitations of the study).

4. Conclusions

The main objective was achieved, with the development of the SMIA model applied to a healthcare service, increasing the number of people recruited with the improvement of strategies. The results of the collection of the 3 quadrants manage to complement each other and provide the answer to the proposed evaluation of the model with the consequent improvement of strategies and the project's recruitment sector. The understanding and analysis of the strategies in Quadrant 1, the demonstration of each strategy in Quadrant 2 and the applications with a focus on improvements based on some of the quality tools in Quadrant 3 underlie the creation of the SMIA method.
To approach this new model, it is important to have previous knowledge of other tools (some of them applied in articles and others that may arise through the scope of use of quality engineering). With the understanding of the strategies with the highest degree of effectiveness, the proposal to show through indicators the results obtained throughout the project helps in the analysis of more accurate decision making, which categorizes the dashboard created for management with a focus on results. There was a significant number of new people in the project, who had everything from missing sex education in schools and at home with their parents to treatment and referral to various health services. These scenarios provided a lower incidence of HIV/AIDS in the young population and helped, based on evidence of the effectiveness of PrEP, to make the drug available to health services for an even younger population (from 15 to 17 years old).

For future work, there is the possibility of validating the fourth quadrant by targeting the database for sensitivity and capability analysis. This is a more in-depth analysis of variables with trends and statistical variations that make it possible to identify the best forecast model that the strategy is studying to attract more young people to the project.

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