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Identification of Predictive Nursing Workload Factors: A Six Sigma Approach

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Abstract: A balanced nursing workload is crucial for patient and staff safety. Although there are several nursing planning models, there is no generic methodology to identify critical workload factors and their relative impact on different healthcare environments. We propose Six Sigma (SS) as a generic methodology and its DMAIC (Define, Measure, Analyze, Improve, Control) framework to identify statistically proven factors that affect nursing workload (NW) in any healthcare environment. Additionally, using a regression model, we estimated their relative importance. For our case study, we found that the number of patients per ward, the number of times medication was administered per shift, the number of nurses and the type of shifts were significant factors in predicting nursing workload. Using their relative importance as input for the nursing planning process, we improved the nursing assignment process performance from 0.09 to 1.05, with an increase in the sigma level from −0.34 to 2.97. Also, we reached the 55% target for the percentage of NW, from a baseline of 50.3%. We also reached the percentage target of NW set by the management of 55%, from the baseline of 50.3%. This study shows that SS can be used effectively to estimate the importance of the main factors that affect nursing workload, providing a methodology to improve the nurse–patient assignment process.

Keywords: healthcare; nursing workload; Six Sigma; DMAIC; nurse–patient assignment; nurse scheduling; nursing management; healthcare management

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1. Introduction

The pressure on health organization budgets and changes in epidemiological profiles have exposed healthcare systems to the challenge of reducing costs and improving the quality of services [1,2]. This problematic scenario is worsened by the decreasing availability of professional nursing staff resulting from causes such as increased population aging [3], increased need for healthcare services [4], and nursing staff turnover due to burnout [5].

Under these circumstances, paying attention to the factors affecting nursing workload is critical in providing adequate patient care by matching specific patient needs with the vital resources of skilled nurses [6]. According to [7–15], it is evident that nursing workload significantly influences patient safety quality. For instance, nursing fatigue due to overtime substantially correlates with medication errors [16]. Another adverse patient outcome is the correlation of nursing workload (NW) with the development of infections in ICU patients [17]. Thus, appropriately identifying factors influencing NW allows a balanced nurse assignation, improving satisfaction and reducing nursing turnover [18].

The present work proposes using Six Sigma (SS) as a methodology to identify the main factors affecting NW as a part of the nurse–patient assignment process. Although several proposed models have tried to balance NW in specific situations, such as surgery units [19] or oncology clinics [20], there is no general methodology to determine the relative importance of potential factors on NW.

The critical variable in this project is the nursing workload [21]. NW represents the time nurses spend on activities related to patient care [22]. In practical terms, it is time that the nurses spend on work, actions, or activities contributing to the health or recovery of patients [23].

NW is a growing management concern in the Ecuadorian pediatric hospital presented in this case study, which is characterized by budgetary constraints and limitations on the available number of qualified healthcare professionals. The variability in the NW has resulted in shifts with the underutilization of nurses or excessive NW. Several studies focus on the adverse outcomes associated with excessive workload, and authors such as Hauck et al. [24] have identified that a shift in the workload from high to low or low to high can predict lower performance and an increase in stress. In hospitals, the NW variability appears to affect the quality of care and is a work stressor. Motivated by this problem, we present the following research question:

RQ: Is the DMAIC (Define, Measure, Analyze, Improve, Control) framework suitable for determining the relative importance of different potential factors on the nursing workload in a hospital environment?

The answer to this question can provide researchers and practitioners with a methodological option to identify significant factors influencing NW, which facilitates the proposition of new approaches for developing nurse–patient assignment methods.

1.1. Six Sigma in Healthcare

Several studies have applied SS in healthcare environments. According to Salah et al. [25], the first SS implementation in healthcare organizations began in 1998 in the Commonwealth Health Corporation (CHC), with projects aimed at improving quality and reducing waste and costs. Although healthcare was initially slow to adopt the SS methodology, it has been one of the fields where the number of publications presenting SS applications has been growing in recent years [26]. Its capability to reduce variation and achieve safer and quicker responses makes SS a robust methodology to deal with crucial patient needs and process improvement challenges in the healthcare sector [27]. DelliFraine et al. [27] conducted an exhaustive literature review considering Six Sigma and Lean projects. The articles were classified in the following areas: the improvement of clinical outcomes, improvement in processes of care, an increase in operating room throughput, an increase in emergency department throughput, a reduction in medication errors, and a decrease in patient waiting times. Several studies show interest in emergency departments adopting SS to reduce long waiting times and improve the added value delivered to patients [28–30]. Other authors, such as Al-Qatawneh et al. [31], Mason et al. [32], and Sunder and Kunnath [33], have analyzed the suitability of SS for quality improvement initiatives in the healthcare sector. Most evaluate projects related to increasing the system's ability to meet patient expectations and are empirical case studies with different response variables, such as waste reduction, decreasing patient waiting time, and increasing patient satisfaction [34]. This research shows promising results and recognizes the contribution of SS in providing an objective and systematic method to enhance healthcare systems [34,35]. In the medical field, several articles present successful DMAIC applications in a vast range of clinical specialties such as cardiology [36], post-anesthesia care units [37], radiology [38], surgery [39], internal medicine [40], and pathology [41]. Although the previous references show the extensive literature on SS in healthcare, the lack of academic articles presenting DMAIC applications in scheduling human resources is evident.

1.2. Methods for Identifying Factors Affecting Nursing Workload

There are numerous approaches to nursing planning, and they can be classified according to four stages, as proposed by Punnakitikashem [42]: budgeting, scheduling, rescheduling, and assignment of nursing staff. The precise factors that affect the assignment of nursing staff are the focus of the present study. Based on Allen [43], nursing assignment is the process of matching nursing staff capacity with the requirements of the patients during a specified period. The nurse–patient assignment process is a crucial part of the healthcare process because of its potential to affect patient safety, mortality, hospital-acquired infections, and other quality hospital outcomes [10].

The significant effects of adequate nursing staff on critical health outcomes explain why several authors have developed tools that improve the allocation of nursing resources by identifying the factors influencing nursing workload.

For instance, Myny et al. [44] developed and validated a self-administered questionnaire that, based on an integrative review, focus groups, and a survey, identified relevant nursing-related factors on the workload in Belgian hospitals. Similarly, Bahadori et al. [45] determined the factors affecting NW in an intensive care unit through a census method developed using four hundred nurses in a Tehran hospital. Expert opinions confirmed the relevant factors, which were analyzed using exploratory factor analysis (EFA). Busari [46] and Azimi Nayebi et al. [47] have applied workload indicators of staffing needs (WISN) to estimate nursing staff requirements. The WISN methodology, proposed by the World Health Organization, is a workload-based method that uses the time requirement of each nursing activity as the factor for determining the nursing staff. Similarly, Moghri et al. [48] developed a norm for estimating the number of nurses using standard ratios of nursing requirements based on the specific time required for patient care activities. Finally, Ivsiku et al. [49] identified nursing workload predictors using online surveys to evaluate the perceived nursing workload in different patient care activities.

Although several proposed methods exist to determine the appropriate nursing staff, they rely on surveys or standards for specific specialties. To the best of our knowledge, there is no evidence of a generic methodology to identify statistically proven critical factors affecting NW and to measure their relative impact.

The remainder of this paper is structured as follows: Section 2 describes the research methodology. Section 3 contains a detailed explanation of our case study, including the results. In Section 4, we discuss the implication of our results, success factors and barriers, and compare our proposal with previous research. Finally, in Section 5, we present the conclusions of our work.

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2. Research Methodology

This work is a case study that combines quantitative and qualitative results to illustrate the use of SS for identifying the factors influencing NW in an Ecuadorian pediatric hospital. According to Yin [50], this study is classified as exploratory since we want to determine how the DMAIC framework can be used as a methodology for the nursing assignment process in a real-life context in a South American hospital.

We followed the formal and explicit procedure of the DMAIC framework. Following the description made by Flynn et al. [51], we used participant observations for the data collection. The subsequent section describes in detail the implementation and data collection.

The hospital where the methodology was applied is part of an outreach project sponsored by a local university that aims to improve quality performance indicators in Ecuadorian hospitals. The study lasted six months and included one researcher who visited the hospital at least once a week and a group of part-time research assistants who worked directly with the hospital personnel. The pediatric hospital has 160 beds and six wards; two wards were excluded from the study since they are used for teaching purposes and intensive care units.

The exploratory research in this study follows the DMAIC roadmap. With the help of the first three stages, Define–Measure–Analyze, we identified the significant factors influencing NW. As part of the Improve phase, the significant factors were included in a binary logistic regression model to estimate the NW in the hospital under study. Finally, we used an optimization model to schedule the number of nurses required per ward and evaluated the methodology. We presented the results as part of the Control phase, where we validated the impact of our proposal.

3. Case Study

3.1. Define

The first step of DMAIC seeks to describe the problem. The definition of the response variable and the construction of a baseline allows for identifying improvement opportunities.

In the regular nursing assignment process, the chief of nurses establishes the number of nurses assigned per ward in the different shifts. Every day, the chief nurse assigns the staff using only the number of patients in the wards as a predictive factor. The hospital has not developed an analysis to identify other factors influencing the nursing workload.

The nursing workload (NW) is adopted as the response variable to determine the effectiveness of the factors considered in the nurse–patient assignment process. We calculated the percentage of the NW by adding the time dedicated to direct care and indirect care per ward during a shift and dividing this by the nurse's planned schedule per shift according to Equation (1).

$$NW = \frac{DC + IC}{\text{Planned Scheduled time}} \times 100\% \quad (1)$$

Direct care (DC) time involves activities associated with patient care executed in the patient's presence. Indirect care time (IC) is the care activities that do not require direct patient interaction. The planned schedule time corresponds to the hours scheduled per shift in a ward.

According to the hospital manager, a target of 55% was defined as an appropriate NW with lower and upper specification limits of 45% and 65%, respectively. The reason is that in addition to direct and indirect care, the nurses execute administrative tasks that include documentation activities, staff meetings, and other non-clinical activities, such as training and education, representing 25% and 30% of the scheduled time. Therefore, the NW's hospital target of 55% implies between 80% and 85% of the total workload. The expected target is benchmarked against the total workload of 78%, considered by Hurst [52] when studying the UK's time-out allowance of general wards. Our NW range is similar to a case study conducted by Riklikiene et al. [53] in an anesthetics and intensive care unit, where they set a target of between 41% and 60% for the time the nurses spend on patient care.

We recorded the NW during the morning and night shifts for 50 days to establish the baseline. The data presented in Figure 1 do not present evidence suggesting that the data are not normally distributed. The graphical summary shows that the average NW is 50.3%, with a standard deviation of 20.3%. In the following phases, we will identify the factors influencing the NW to increase it from 50.3% to 55%.

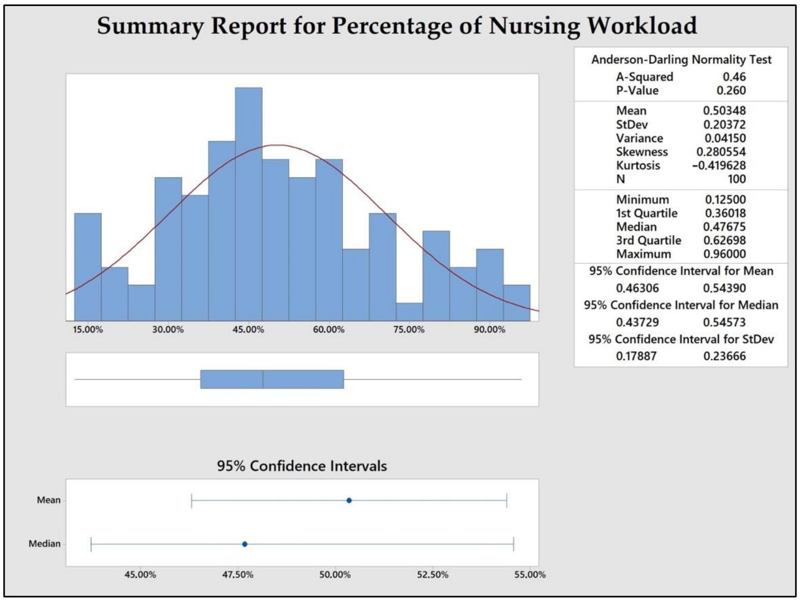

Figure 1. Summary report of nursing workload.

3.2. Measure

During the Measure phase, we gathered information to evaluate the current process in detail and determined its stability and capability to achieve the hospital's goals. For 50 days, we monitored the NW for the morning and night shifts to identify if a particular shift was linked with underutilization or high NW levels. A Voice of the Customer (VOC) discussion with the hospital nursing staff suggested that job stress and burnout were associated with the shifts when the total workload exceeded 90%. These results follow [54], which shows that excessive workload contributes to nursing burnout.

Figure 2 shows that 26% and 40% of the morning shifts had an NW over and under specification limits, respectively. Figure 3 shows that 20% and 48% of the night shifts had an NW over and under specification limits, respectively. Similarities in the percentage of the ward under and over specifications made it impossible to focus the analysis of the factors exclusively on one of the two types of shifts.

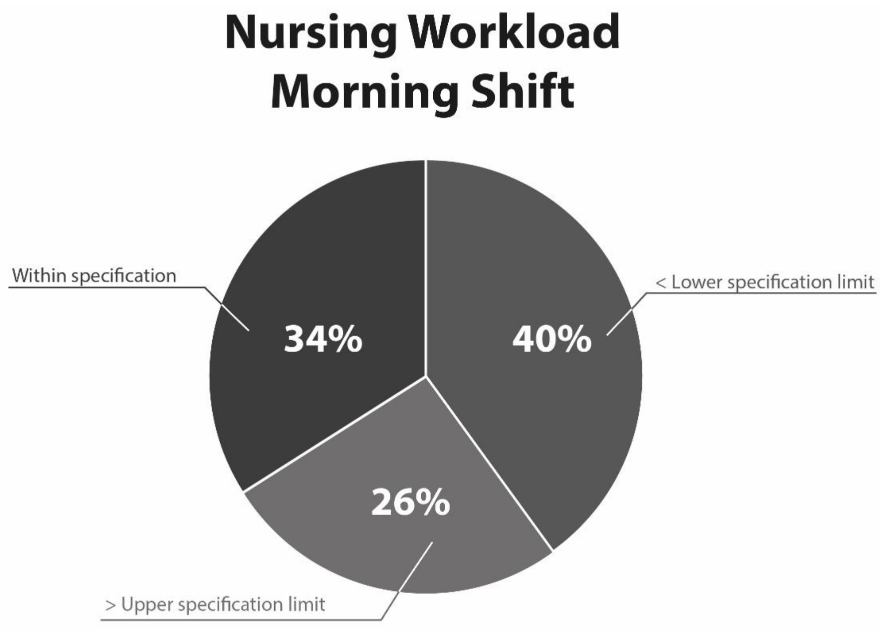

Figure 2. Breakdown of nursing workload per morning shift.

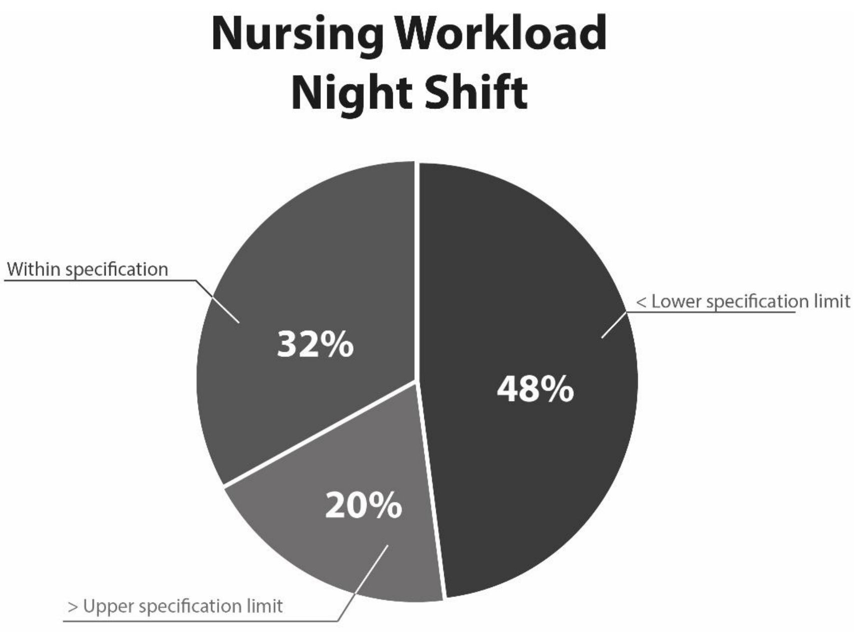

Figure 3. Breakdown of nursing workload per night shift.

Considering that the data presented in Figure 1 are normally distributed, it is suitable to use an individual moving range (I-MR) control chart to evaluate the stability of the NW. Figure 4 shows no plotted points outside the control limits and a non-random pattern in the control chart. This result indicates that the average NW is stable over time and influenced by common causes of variation. The common causes of variation are associated with the current methodology used to assign the number of nurses per shift, considering the number of patients per ward as a unique factor.

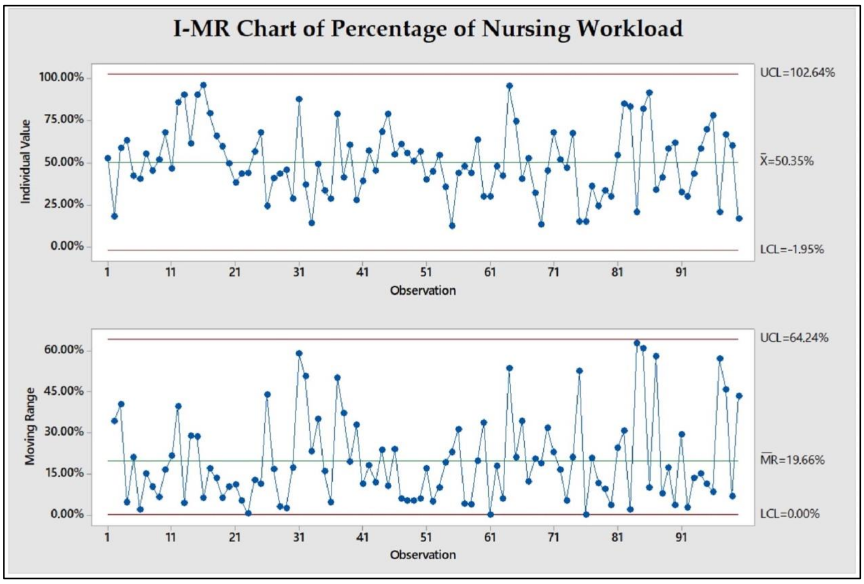

Figure 4. I-MR chart of nursing workload.

Figure 5 shows a capability analysis with a Ppk = 0.09; the results are a process not capable of accomplishing the NW hospital specifications. A low Ppk value shows an NW with a broad shift distribution that exceeds the lower and upper NW specifications. Although underutilization seems to be a more frequent event, it is vital to consider the cases of burnout, given their negative consequences on patients.

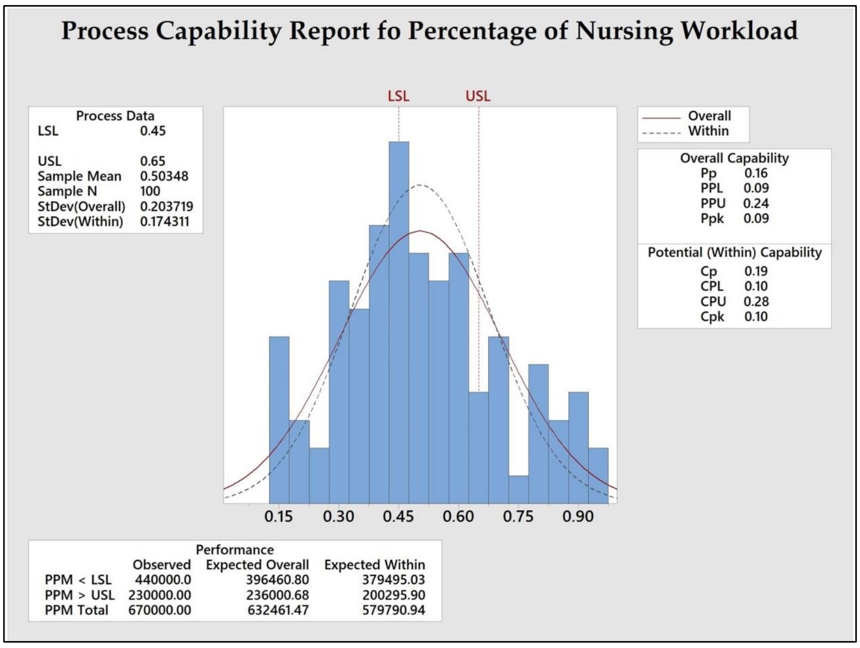

Figure 5. Process capability analysis of the percentage of nursing workload.

3.3. Analyze

During the Analyze phase, we carried out brainstorming with the project team to generate potential factors that influence the NW. The researchers provided possible ideas from a previous literature review during the brainstorming. However, no ideas given by the researchers were included if the project team had not previously evaluated them. The brainstorming resulted in a group of fourteen potential factors, presented in Figure 6 according to the categories of the 4S fishbone diagram. The potential factors obtained in the 4S fishbone diagram were weighted using a cause-and-effect matrix.

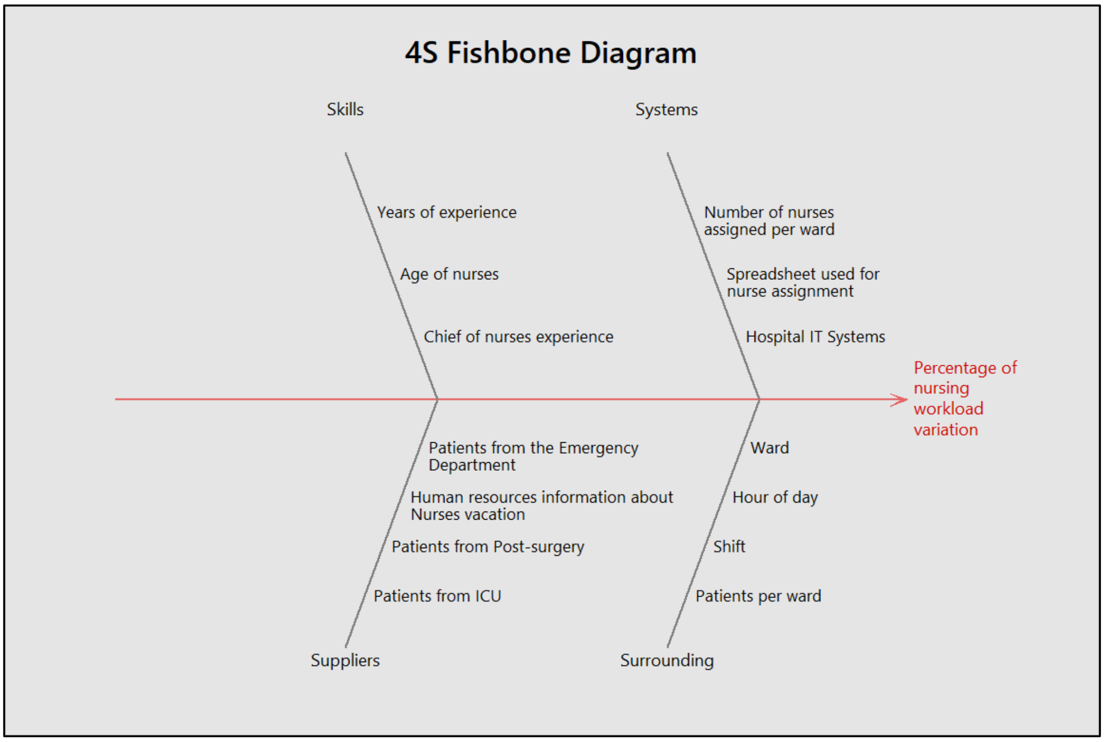

Figure 6. Cause-and-effect diagram.

Considering their years of service in the hospital, five experts were selected to develop the cause-and-effect matrix. The chief of nurses, two experienced nurses, and two administrative workers formed the panel of experts that prioritized the causes using the cause-and-effect matrix. Each expert separately judged the weight of each priority factor according to their potential impact on NW using a non-linear scale (0-1-3-9) where 0 = very low and 10 = very high. Finally, we collected the results of the experts and assigned a final value for each potential factor according to the mode of the expert evaluations. In cases where we did not obtain a mode, a final discussion with the experts was used to evaluate the divergences. This discussion began with a short description of the potential factor that forced exploration and interaction between the experts. This final discussion generated, in all the cases, an agreement among the experts on the importance of the factor. The participation of the experts to propose potential factors that influence NW is similar to other studies, such as by Myny et al. [44], who used a literature review and expert criteria to determine potential factors affecting NW.

The cause-and-effect matrix prioritized ten of the fourteen potential factors identified in the 4S fishbone. We verified the influence of the ten potential factors on NW by applying statistical tools, such as regression analysis, Pearson correlation, a *t*-test, and ANOVA (Table 1). To assess the potential factors, we considered that values of $p < 0.05$ were statistically significant. As a result, we identified four of the ten variables as statistically significant: the number of patients per ward, number of times medication was administered per ward, number of nurses assigned per ward, and the shift type.

Table 1. Shortlisting of significant factors.

Potential Factors	Statistical Tool	*p*-Value
X_1: Number of patients per ward	Regression Analysis	<0.0001
Number of patients from: X_2: Intensive care unit/X_3: Post-surgery	Multiple Regression Analysis	0.801/0.853
X_4: Number of times medication administered per ward	Regression Analysis	<0.0001
X_5: Number of nurses assigned per ward	Regression Analysis	<0.0001
X_6: Hour of day	Pearson correlation	0.051
X_7: Shift type	*t*-test	<0.0001
X_8: Ward	ANOVA	0.20
X_9: Age of the nurses	Pearson correlation	0.113
X_{10}: Years of experience	Pearson correlation	0.637

3.4. Improve

We first used a binary logistic regression model during the Improve phase to estimate the NW using the critical factors identified in the previous stage. Then, we used a linear optimization model to establish the required number of nurses. The model's details can be found in the work of Buestán et al. [55].

According to Table 1, four of the ten factors revealed a significant relationship ($p < 0.05$) with the response variable; however, the number of patients (X1) and the number of times medication was administered per ward (X4) presented a positive ($p = 0.883$) and significant correlation ($p < 0.0001$) between them. Consequently, the factor number of patients (X1) was excluded from the model to avoid multicollinearity.

As a result, the logit model presented in Equation (2) is composed of three predictors, namely:

- The number of times medication was administered per ward;
- The number of nurses assigned per ward;
- The shift.

$$P(Nursing\ Workload) = \frac{e^{Y'}}{(1 + e^{Y'})} \tag{2}$$

where, for the day shift, Y′ is defined as:

$$Y' = -0.2293 + 0.02237\ \textit{Number of times medication administered per ward} - 0.3508\ \textit{Nurses} \tag{3}$$

For the night shift, Y′ is defined as:

$$Y' = -0.6134 + 0.02237\ \textit{Number of times medication administered per ward} - 0.3508\ \textit{Nurses} \tag{4}$$

Note that the negative term in Equation (4) increases in absolute value for the night shift, suggesting a reduction in the percentage of NW during this period. This difference results from the usual practice of leaving administrative activities until the end of the day, reducing the time dedicated to direct or indirect patient care.

To validate the predictive model presented in Equations (3) and (4), we implemented it in 66-morning shifts and 65-night shifts. During each shift, the NW was calculated based on three predictors: the shift, the number of nurses assigned per ward, and the number of times medication was administered per ward. At the same time, a group of observers recorded the time dedicated to direct care and indirect care to patients and used this information to calculate the current NW using Equation (1). We compared the predicted NW and actual NW using a paired *t*-test. There was no statistical difference between the actual and the predicted mean of the NW ($p = 0.245$). The results of the predictive model did not change if the data were analyzed by separating the morning ($p = 0.06$) and night shifts ($p = 0.71$).

This result shows that the three factors identified in the Analysis phase are good predictors of the NW.

Once validated, we included the predicted model in a nurse–patient assignment optimization model. The optimization model proposed by Buestán et al. [55] uses a lineal expression of Equation (2) to estimate the NW considering a different number of nurses per shift according to Equations (3) and (4). The model finds an optimal solution when the number of nurses minimizes the difference between the predictive NW and the specification limits. We used the optimization model for one week as a pilot test. Table 2 presents the data collected during the pilot test. In all the cases, the observed NW is within the specification limits.

Table 2. Pilot implementation results of optimization model application.

Day	Shift	Nurses	Number of Times Medication Administered	Predicted Nursing Workload	Observed Nursing Workload	Difference
1	2	2	71	56.8%	56.72%	0.08%
2	1	2	48	54.01%	49.7%	4.31%
3	1	2	38.33	41.89%	41.76%	6.13%
4	2	1	65.33	53.65%	54.13%	0.48%
5	1	1	50	63.14%	48.75%	14.39%
6	1	2	51	55.23%	62.94%	7.71%
7	1	2	28	42.4%	45%	2.60%
Nursing workload average difference						5.1%

3.5. Control

In the Control phase, the hospital adopted the optimization model for 50 days as part of the nursing planning assignment process. Figure 7 presents the capability analysis of the current NW resulting from the optimization model application. The capability analysis shows a significant improvement in process performance (Ppk index), which increased from 0.09 to 1.05, increasing the sigma level from −0.34 to 2.97. The parts per million (ppm) dropped from 579,790 to 247 in the short term and from 632,461 to 1499 in the long term. These results suggest a significant reduction in the probability of underutilized or overloaded shifts. These successful results show that SS is a suitable methodology to determine the relative importance of factors on the NW in a hospital environment.

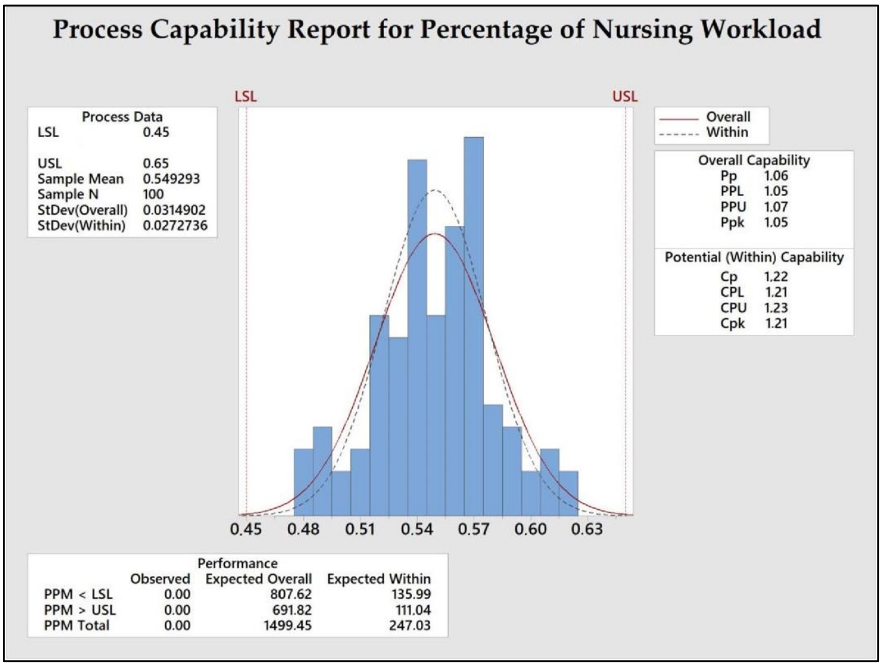

Figure 7. Process capability results after optimization model implementation.

Finally, the project team continued supporting the hospital for three additional months. They developed a user-friendly application to automate the application of the optimization model as a nursing planning tool.

4. Discussion

We have presented a case study where we applied SS, specifically DMAIC, as a methodology to identify the factors that significantly influence nursing workload and quantify their relative importance. Measuring these factors is the first step in planning processes such as nurse–patient assignment.

Although different authors have previously proposed methodologies for identifying factors affecting nursing workload, such as Myny et al. [44], who presented a cross-sectional study in hospitals within the acute hospital care setting using a self-administered questionnaire to identify the main factors affecting NW, or Ivziku et al. [49] who used an online survey to register nurses' perceived workload at the end of every shift, their work does not measure the relative impact on NW, and the results are only relevant for a specific healthcare environment. We propose a generic methodology that can be applied in different healthcare environments and institutions, regardless of their economic or development stage, and that allows us to measure the impact of the identified factors on NW.

The proposed generic methodology uses a group of statistical tools to determine the correlation of potential factors with NW. The application of the statistical tools used to identify the most important factors influencing NW is similar to previous studies by Mark et al. [56], Sounder and O'Sullivan [57], Spence et al. [58], Welton et al. [59], and Blegen et al. [60]. All of these studies propose numerous factors influencing NW; however, according to Griffiths et al. [61], the largest group of studies provides little evidence of how considering these factors in nursing assignments leads to more efficient use of the nursing staff. Our work provides evidence that applying this generic methodology reduces NW variability and locates the NW according to the hospital specification through the application of Six Sigma performance metrics.

Among the different methodologies for estimating the number of staff required in a healthcare environment, the WISN index is the most common workload indicator used, as in the work by Azimi Nayebi et al. [47], Ozkan and Yildrim [62], and Stankovic and Santric [63]. The WISN methodology first requires identifying the main components of the nursing workload through surveys or interviews and then estimating the standard time for each activity. However, by using the SS methodology, we can identify the root of the problem. In our case, it was the NW variability, not only using the NW as an index. Secondly, we can find which factors affect the NW and its variability, allowing us to improve the nursing assignment process.

Our results show an improvement in the nursing assignment process capability, manifesting in a reduction of the variability of the NW and the achievement of the NW level set by the management.

The research contribution of our work is that we use a systematic data-driven procedure, with statistically proven results, to define the main factors affecting NW. In contrast with the literature previously discussed, where the main input is staff opinion, we reduced any possible bias from our methodology.

The results of our work show that the DMAIC methodology, besides its proven application as a continuous improvement tool, can also be used as a tool for strategic management. We found the significant factors that affected the NW and identified the relative importance of each factor. This information is critical for efficient resource planning, such as for nursing schedules.

This research can be enhanced by considering other healthcare environments that generalize our findings since our study is limited to the geographical location of the case study context. Guo et al. [64] found differences in how stress factors affect nurses in different countries. Therefore, when applying our methodology, the management should be careful about the treatment of NW.

Another advantage of our proposed methodology is that, given its generic nature, it can be applied to other service processes in healthcare, such as cleaning, security, or logistics, or even to other service industries where staff planning is a complex task.

A relevant success factor in our research was the leadership and involvement of the top management positions. The hospital's director hired additional personnel for the Process Improvement Department, allowed training and discussion sessions during working hours, and was a visible champion for each project. This finding aligns with the results from Patri and Suresh [65] and Raja Sreedharan et al. [66], who found that leadership and top management commitment are critical factors for successful lean and SS implementation.

Another success factor was the external team of experts that led the implementation. We trained the hospital staff on the basic concepts of SS, but the external experts guided the implementation. This result supports the finding of Singh and Singh [67], who found that training and understanding of the Six Sigma methodology, tools, and techniques were among the 'vital few' critical success factors for SS implementation.

Although we have shown that DMAIC is a valuable tool for nursing planning, it does not mean that any organization can implement it without difficulty. We encountered barriers identified by other authors such as Antony et al. [68]. A common barrier is the inadequate knowledge of SS since the healthcare institution needs qualified staff in advanced statistics and continuous improvement techniques. This requirement can be a challenge for institutions with limited resources, but it can also be an opportunity for collaborative work with local universities.

Similar to the findings from Antony et al. [68] and Henrique et al. [69], another impeding factor was related to the resistance to change and cultural issues. Initially, the head nurse did not want to follow the recommendations from the nursing assignment model. Therefore, the external team needed to provide the necessary training for using the tool with support from the quality improvement team. We also focused on presenting the positive impacts on patient quality of life and a more balanced workload for the nurses.

One of the study limitations is that we only focused on NW and showed an improvement in the NW level and its variation. However, we did not measure the impact of our methodology on patient care or patient satisfaction. According to Grifftihs et al. [61], this is one of the most common shortcomings of the nurse staffing methodologies proposed in recent years.

5. Conclusions

Six Sigma has been successfully applied in the manufacturing industry since the 1970s, and one of its more prominent characteristics is the DMAIC methodology. Although SS in healthcare is becoming more popular, it has not been used for planning and scheduling human resources.

We proposed using the DMAIC methodology to identify significant factors affecting nursing workload and to evaluate their relative impact. In this way, planning activities, such as nurse scheduling, could be more accurate, avoiding the under- or over-utilization of staff.

For our case study, we identified the following factors as statistically significant: the number of patients per ward, the number of times medication was administered per ward, the number of nurses assigned per ward, and the shift type. Since the number of patients and medication administration are positively correlated, we only included the number of times medication was administered in the rest of the work.

Using a nursing workload predictive model, we quantified the relative effect of the identified factors. That information can be used as input for nurse scheduling models and guarantees that the management only focuses on the most relevant aspects to estimate the nursing workload.

As a result, the process performance improved from 0.09 to 1.05, with an increase in the sigma level from −0.34 to 2.97. Note that a process variation reduction results in a decrease in the over- or under-utilization probability. Furthermore, we reached the 55% target for the percentage of NW.

One of the shortcomings of our study is that it is limited to one case study. The authors recognize this, and future research will present a cross-sectional analysis of several case studies in developing countries. Another limitation of the study is the length of the follow-up phase. As in most DMAIC projects, the continuity of the results can be challenging. Our methodology is generic and does not depend on the specialty of healthcare; therefore, it is easily transferable. Furthermore, it does not require special equipment or software and can, therefore, be applied in healthcare institutions with scarce resources.

Our work proposed a systematic approach using DMAIC to identify the critical factors that affect nursing workload and their relative importance. In this way, regardless of the characteristics of the healthcare institution, we can find statistically proven factors that can be used in planning processes, ensuring fair use of resources and quality of service for the patients.

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