Control panels in human talent processes for professionals in physics in public organizations

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Abstract. The research follows a cross-sectional inferential quantitative approach, supported by qualitative analysis. Its objective is to evaluate, based on $T^2$ Hotelling, the quality of the human talent process in professionals in physics, through observation of subprocesses and service provided by public servants. The diagnosis was made using the techniques of interview, Delphi and expert audit applied to a sample of 200 users in public institutions in process executed by professionals in physics, and 3 experts in human talent during the year 2019. Results show imaginaries that affect the quality of the process human talent focused on selection of the public servant, bureaucratic processes, waiting time and negative attitudes that affect the perception of these professionals; Bayesian control limits calculated with the distribution of predictive probability posteriori, does not show signs that the process is out of control, but shows three alarms, whose adjustment of parameters through robust methods leads to obtaining a behavior protected from outliers, it was conclusion is that the behavior of the human talent process in institutions and entities in which public servants work in Colombia is under control.

1. Introduction

Being agile is a priority in an organization that seeks to stay in the market [1]. Being flexible and having metrics allows the organization to anticipate and respond to opportunities for improvement and threats that may face [2], the organization to the changes in the environment in which it operates being three the main causes that force an organization to have the ability to adapt to change quickly become the emergence and strengthening of the global economy [3]; the transformation of industrial economies and societies into service economies based on knowledge and information [2]; and the transformation of business enterprises based on customer requirements, including the proposal of products that do not exist and generate a need for consumption [4]; but to meet these characteristics requires human resources with high skills and qualities that add value to the processes; and, in terms of quality in the processes that involve human resources, this has evolved and requires a continuous control and improvement and implementation of procedures, technical and administrative activities, to maintain an optimal level, in the quality characteristics [5], of the services offered in public entities and institutions; characteristics that represent random variables described by a distribution of probability that together with the variability of mission processes [6], allow for its achievement, the implementation of statistics. To
prevent and detect problems when they occur, without waiting for the process to be completed, statistical process control techniques are implemented, including control charts or graphs, which represent the evolution over time of a quality characteristic, measured from a sample [7]. In any process the same effects do not always occur, since the elements involved do not always work exactly, giving rise to certain variability, the causes of which must be investigated [8]. Process variability may be due to non-assignable causes of process variation, and non-random assignable causes, which produce unpredictable irregular variation that must be corrected [9].

In the control charts traditional, control limits are determined by the history of the process and if the initial data set is established under control, the control limits are used to monitor future data, otherwise the limits may be revised, and the procedure repeated [10]. The scarcity of data in phase one of the control process [11], is a common problem because of the difficulties encountered if the data set used to estimate the parameters and limits are small. The phase one has sufficient records despite the small data set, an approximation to the problem should be made from the Bayesian [12], starting with an a priori distribution for the process parameters, to obtain posteriori distributions from which inferences can be made about the process. In this proposal for a Bayesian analysis, the a priori knowledge of the parameters of the a priori distribution of experts is modelled [13].

2. Methodology
The research follows a quantitative inferential approach [14], supported by qualitative analysis [15]; in the diagnosis, a cause-effect diagram was drawn up to determine, through brainstorming, the causes that affect the quality of the human resource process. In order to choose it, the 6M method was taken into account, and the critical processes of the operation were determined [16], corresponding to those processes that cannot be stopped because they affect the normal operation of an entity. To initiate the load balancing in the area under study, the variables and factors that influence the operation were defined through the diagnosis of the current processes [17], it was established what data or information is provided by external parties to initiate the process, and the results or outputs were described. In phase 1, the experts opted to obtain an a priori distribution constructed by hand by the experts [18], the intention of the tool being that they should graphically describe their knowledge of the probability distribution of the variable of interest in this case the non-conformities in the selection of public servants in the human resources units of public entities in Colombia. Instruments implemented were the interview and observation format of experts. The research was supported by the tool for obtaining a priori information using the Delphi method [19]. The target population of the research was made up of three expert auditors, citizens. Around citizens, an intentional sample of users was taken during three weeks when leaving the offices of 30 higher education institutions and public entities of the department. Two hundred data from each of the distributions were simulated and an a priori probability distribution was obtained for the number of non-conformities.

Once the parameters of probability of non-conformities in the provision of the service or attention to the public were obtained, a technique of mixing the opinion line \( p(\theta) = \sum_{i=1}^{n} \omega_i p_i(\theta) [20] \), where \( n \) is the number of experts, \( p_i(\theta) \) represents the distribution of the i-th expert for the variable \( \theta \), \( p(\theta) \) represents the combined distribution and \( \omega_i \) represents the weight assigned to expert i; the Bayesian mixed log opinion approach with \( n = 3 \) experts provide information \( g_1, g_2, g_3, \ldots, g_n \) for decision making about the amount of interest \( \theta [21] \), and, the combined probability distribution \( p(\theta) = k \prod_{i=1}^{n} p_i(\theta)^{\omega_i} [21] \), where \( k \) is a normalized constant [20], and the weights \( \omega_i \) satisfy some restrictions, to unify the distributions and obtain only one containing the information from the three experts [21]. The expectation–maximization (EM) algorithm allows finding the probability distribution with the maximum plausibility to the data [22]. Hotelling's \( T^2 \) control chart is used on the original information and on the residues obtained after filtering the information, using robust estimators from the family of truncated means [22].
3. Results

Qualitative analysis of which variables are considered to affect the quality of the human resource process, interviewees stated variables such as profile, bureaucratic processes (associated with the use and change of formats), waiting time in response and customer service by employees with more time in the entity or, preference of managers in personnel selection. The planning of the human resources process was associated with sub-processes of selection, recruitment, training, induction, orientation, evaluation and promotion. The collective imagination of citizens, points out that a key element in the transformation of society is technology, they support that automates routine tasks, identify scientific and technological advances are not implemented even in state institutions that serve large numbers of users, artificial intelligence, big data, computers and robots were mentioned tools for improving speed (waiting time) which in turn generate more changes and forces organizations to seek innovative strategies to find competitive advantage. However, they state that, in this evolutionary dynamic, it seems that human resources within entities remain static in liquid modernity and have gone from being the most important resource of entities, to be an element that is often seen as an obstacle for the organization.

Analyzing integrally I, sequentially S, availability D, and opportunity O, and completeness C, performed the freehand elicitation of the probability of the average number of nonconformities per user served per day, when leaving the offices of public entities or institutions, according to each of the experts, where it is allowed to express their idea of the probability of occurrence of each event, shows beta parameters between 0.8 and 1.8 and for alpha parameters between 2.9 and 5, a priori distributions obtained from the experts' opinions are summarized in Table 1. The result after 200 iterations for the mixed a priori distribution with an equal weighting for each of the professionals who participated in the process, the variable of interest has a Poisson distribution, for the priori distribution of the parameter λ indexed (for every point of the control limits depends on each innovation at the instant i-1), a negative binomial gamma distribution is used (α,β) [23], with mean $\frac{\sum_{i=1}^{n}x_{i}+\alpha}{\alpha+\beta}$ and variance $\frac{\sum_{i=1}^{n}x_{i}+\alpha}{\alpha+\beta+1} (n + \beta + 1)$ with interval that with some probability $p'$, covers the value of $p$, i.e. $\frac{1+p'}{2}$ and $\frac{1-p'}{2}$ [24].

| Table 1. Parameters of the a priori gamma distribution proposed by each of the experts. |
|-----------------|---|---|---|---|---|
| Auditor 1       | 3 | 3.070 | 1.047 | 2 | 3 | 2 | 3 |
| Auditor 2       | 4 | 2.927 | 0.970 | 3 | 4 | 3 | 5 |
| Auditor 3       | 2 | 4.751 | 1.804 | 2 | 3 | 1 | 3 |
| Mixed gamma expert distributions | - | - | - | - | - | 2.913 | 0.875 |

The predictive distribution a posteriori is given by $p(x_{G}|x)$, probability of occurrence of the innovation (Equation (1)), thus allowing the calculation of a confidence interval for the mean response that translates into the location of the control limits for $x_{G+1}$. For the final construction of the control chart an interval with $p' = 0.95$ is estimated. The classical method determined four points of the process outside the control limits.

$$p(x_{G}|x) = \frac{\Gamma(x_{G}+\sum x_{i}+\alpha)}{\Gamma(\sum x_{i}+\alpha)\Gamma(\sum x_{G}+1)} \left( \frac{n+\beta}{n+\beta+1} \right)^{\sum x_{i}+\alpha} \left( \frac{1}{n+\beta+1} \right)^{x_{G}}.$$ (1)

On the other hand, when performing the Bayesian control chart with control limits calculated with the predictive probability distribution in hindsight, it does not show signs that the process is out of control, but it does show three alarms that need to be checked. In this case, there are observations 70, 120 and 170, whose values of the $T^2$ statistic are 24.5, 24.56 and 24.6 respectively, values higher than the upper control limit of 23.

To rule out an underestimation of the order of the model as a cause of the existence of anomalous values, the estimation of a var model produces a similar behavior graph, with three out-of-control observations, and a greater reduction in the autocorrelation between residues (with a maximum absolute
value of 0.051), whose cause of the control outputs towards the bad behavior of the graphs constructed with autoregressive (AR) model residues is due to the presence of a high and positive autocorrelation. Applying Hotelling's $T^2$ control graph to the original information only shows one data out of the limits, and in the graph from Hotelling's $T^2$ on the residues obtained once the information has been filtered, using the robust estimators from the family of truncated means; it can be seen that, although the behavior of the statistic is parallel to the behavior in the classic $T^2$ case, there is no observation located outside the control limits. This implies that the adjustment of the parameters of the control chart by robust methods leads to obtain of a behavior under control in the phase one, protected from outliers (out of control), thus avoiding, developing iterative calculations and obtaining estimates center on the information. In accordance with the result, the behavior of the human resources process of public employees in institutions and entities in 2019, is under control. However, the cross-checking of qualitative and quantitative information shows the need to incorporate value and competitive advantage to the institutions, given the existence of non-random assignable causes, which produced irregular variations that must be corrected.

4. Discussion
The organizations need to be agile and adaptable in accordance with the social requirements of modernity, especially influenced by globalization, the transformation of the knowledge-based economy and the need to meet customer requirements or even to propose products that generate new needs. Modernity that, metaphorically [25], called liquid modernity, its main characteristic is that it is not static [28], but is in continuous and absolute change, without taking a determined form, and that aims to transform the known social structures to give way to new ones that mean freedom for the individual. Attitudes affect the perception of physics professionals, manifested in particular in the educational area, in which teachers show how being is influenced by conceptions of greatness of self, high self-esteem that lead them to bias, alter or filter reality. In this regard, Bleuler [26] differentiates two types of reactions in professionals or individuals, the holotymic and the catatymic, the former are variations of mood (for example, mood changes in mania and melancholy), the latter are linked to certain events or experiences of a vital nature, and with the representative complexes that are constituted in relation to these.

On the other hand, the application of Bayesian control charts of the number of nonconformities allows the capacity of the process to be greater in the sense that a smaller volume of false alarms is generated, in this sense, it is necessary to construct a procedure for the calculation of the characteristic operation curves for these control charts, which move away from the theory of normality of the data [27]. An advantage of using control charts is that experts can adjust their opinions at any time, adjusting the control limits calculated from their experiences and the plausibility of the data. A priori probability distributions are the most relevant object of study for the definition of a useful control chart [28]. The advantages of considering the parameters of the control chart as random variables, allows that to the extent that the interventions of the process have an effect on the data, as is the case of nonconformities in customer service, the limits are self-adjusting without the need to restart the process of building the control chart.

5. Conclusions
The behavior of the human talent process in institutions and entities in which public servants who are professionals in physics work in Colombia, in 2019, is under control. Selection processes, bureaucratic administrative procedures, waiting time, attitude and service are associated with nonconformities in citizens; availability and completeness are highlighted with low scores in nonconformities by experts. The construction of control charts is a valid tool to analyze the quality of the human resources process, supported by the participation of trained audit staff responsible for controlling the process directly.

The Bayesian control avoids the absence of data for the achievement of phase I of the process of construction of a control chart. The adjustment of the parameters of the control chart by means of robust
methods leads to obtaining a behavior under control in phase I protected from outliers, avoids developing iterative calculations and obtains estimates centered on the information.

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