# Financial Services Request Evolution

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## Abstract

This text uses the operational data of a financial services company in Colombia with about 10 million clients nationwide and with more than 50 offices in the country. With operational records for the provision of their services for a period of 30 months, which includes periods of 4 different calendar years. Using the ANOVA models and the coefficients of the associated linear regression model, the effect of the year, the week of the year, the day of the month, the day of the week on the arrival rates, waiting time, time in service, rate of outlet for the attention of each of the products. In the same way, the evolution of performance measures since the modification of the system is identified. Using this information, it is possible to propose changes or use data analysis schemes that identify cyclical variation with different time lengths and identify the evolution of changes in the working method within the organization.

## Keywords
Methods Engineering, Labor Standards, Financial Sector, Colombia.

## 1. Introduction
The identification of the activity and the workload affects the possibility of providing the service. The modeling of queuing systems can be carried out by different techniques: inventory systems, queuing theory, queuing chain theory, mean value analysis, stochastic networks, Petri nets, simulation, among others. All of them assume one degree or another in the randomness of the available information that the system represents. This text presents a way to identify the variability in the performance parameters or measures for a workload allocation system in the management of financial products. To do this, the following is identified: first the availability of the information in its database; second, the relevant variables of the system that can be calculated from the available information; third the performance measures for this company; fourth, the time series database for these performance measures; fifth, an ANOVA model of effects of the effect of the year, week of the year, is obtained to identify the evolution of the workload.

### 1.1 Objectives
Identify the evolution of the performance measures of the system according to the date of the year for the attention in financial products in a company in Bogotá D.C, from the statistics based on the available management information.

## 2. Literature Review
The study of the workload is relevant for estimating the characteristics and factors of determining the quality of service in various industries and in the provision of services since this objective or subjective burden affects the provision of services such as aeronautics ( Alaimo et al., 2020), among others, for surgeries in humans (Lowndes et al., 2020) and tries to be estimated by indirect measures such as physiometric markers such as heartbeat (Hughes et al., 2019), ( Puma et al., 2018) and in educational services (Widiasih & Nuha, 2019) to estimate the effect on the response caused by this workload (Iqbal et al., 2020), (Wulvik et al., 2020), in such a way similar to how the workload and use for computer systems could be estimated when attending to service requests (Al-Faifi et al., 2018).

The assignment of workloads and the design and understanding and forecast of work in work centers not only affect the provision of the service, in addition, they also affect the life of the worker in this case in the financial sector (Ling et al., 2014 ) verifying it in different industries and sectors (Craveiro & Dussault, 2012). both for the bank's own operations and for operations to support the main financial activity such as call centers (Van Klaveren & Sprenger, 2008). In this way, the coupling in the provision of the service, the customer and the response can take the character of a strategic activity in relation to the positioning and retention of customer segments (Batt, 2000), whether internal or external customer service entails costs the customer loyalty opportunity (Sørensen & Weinkopf, 2009), (Sieben & Grip, 2004).

Therefore, establishing estimation guidelines and understanding the evolution of demand and potential workload is considered relevant in the presentation and provision of financial services, this is the focus of this work. The measurement and estimation of labor standards for both physical and intellectual activities in the real or financial sector have a long tradition (Lin & Hwang, 1998), (Almeida & Almeida, 2011), (Mourali & Lakhal, 2020). As well as in activities that require the execution of multiple simultaneous tasks (Castro et al., 2019). (Young et al., 2008), (Ruth et al., 1990).

The measurement of the workload makes use of physiological markers for both the physical and mental aspects (Marinescu et al., 2018), (Miller et al., 2011) and therefore according to the nature, complexity and requirements of the service to treat, can affect the workload scheduling based on the level of emotional and physical load of the workforce (Dewi & Septiana, 2015), coordination with the work group (Kim et al., 2016), (Nonose et al., 2016), so it is considered relevant to have models to estimate their values (Christopher D. Wickens, 2017).

## 3. Methods
First, the database of the financial sector company is identified for the 4 products created by Law 100 of social security of Colombia. From there, the characteristics of the product, operation, work centers, design specifications and information on the relevant administrative management dates are obtained. From here, work on the effect of the service

characteristics for this level is omitted; however, it is chosen to work with the characteristics of the product flow to identify the effect of time cycles. From here, products 1, 2, 3 and 4 are identified. Also the date of assignment or arrival of the service request, the date of completion or end of the process, the expiration date given the matter or type of service to be worked on, and the expected duration in business days expected to comply with the request; Second, the basic performance variables for the service request system were identified for each calendar day: entry, completion, inventory of requests in process; business days required to reply, calendar days used to reply, calendar days remaining, or slack to reply; Third, the above performance variables are identified as the variables required to model the system. As a fourth step, the database is summarized in the following tables.

## 4. Data Collection

The total workflow can be broken down into four different databases. Table 1 For each of them, the following has been identified: the quantity, Q; the number of attachments used, Attach; the Duration in Days, Term placed, or Total Ideal Managerial Time, TIMT; the TEMT or Total Effective Duration, Total Effective Managerial Time; and Total Effective Slack. Note that the date in calendar days is not the same as the required number of days in business days. The relationship of these variables for the four products.

Table 1. List of financial products.

| Product | Q | Attach | Timt | Temt | Test |
|---|---|---|---|---|---|
| Layoffs | 5.725 | 11.005 | 49.152 | 40.932 | 34.481 |
| Mandatory pensions | 9.759 | 62.741 | 263.414 | 304.716 | 90.841 |
| Voluntary pensions | 17.571 | 28.730 | 57.732 | 62.001 | 28.150 |
| Society | 6.845 | 7.747 | 107.252 | 133.816 | 27.421 |
| Grand Total | 39.900 | 110.223 | 477.550 | 541.465 | 180.893 |

In table 2, for the 4 products, the number of service requests has been identified for 39,900 requests, of the 110,223 annexed documents, product 2 with 9,759 requests and 62741 annexes total 263,414 calendar days of administrative term, TIMT, 304,716 days of time to attend them with and a remainder of remaining days of 90,841. Descriptive statistics for each for each of the products are below, for 611 calendar days. Each column identifies a variable: Inc, is the number of incoming service requests; Out, is the number of completed services; TIMT is the number of administrative days in business days in Colombia; TEMT is the number of calendar days used to process incoming processes; Inv. It is the average level of units in inventory.

Table. 2 Descriptive statistics for the four products.

| Data 611 | Inc. | Out. | TIMT | TEMT | TEST | Inv. |
|---|---|---|---|---|---|---|
| Sum | 39.900 | 39.900 | 477.550 | 541.465 | 180.893 | 425.905 |
| No zeros | 581,00 | 550,00 | 550,00 | 545,00 | 480,00 | 610,00 |
| Maxim | 216,00 | 193,00 | 3.747,00 | 4.840,00 | 2.373,00 | 1.736,00 |
| Mean | 65,30 | 65,30 | 781,59 | 886,19 | 296,06 | 697,06 |
| Min | - | - | - | - | (1.442,00) | - |
| Std. Desv. | 40,95 | 39,47 | 625,37 | 759,03 | 395,62 | 344,28 |
| Curtosis C. | (0,52) | (0,38) | 1,61 | 2,42 | 3,96 | (0,33) |
| Assimetry. C. | (0,08) | (0,11) | 1,12 | 1,31 | 1,31 | 0,83 |
| Spearman C. | (0,32) | (0,23) | (0,34) | (0,36) | (0,13) | (0,73) |

The table 3, table 4, table 5 and table 6 shows the variables during the 611 days for each financial service. These contains: sum or aggregate of the daily record; No zeros is the number of days with non-zero records; the statistics Maximum, mean, minimum and the standard deviation, Std.Dev; the Kurtosis, Skewness and Sperman correlation coefficients with respect to the date. The tables are presented to discriminate the differentiated behavior of the products.

Table 3. Descriptive statistics for the Severance product.

| Data 611 | Inc. | Out. | TIMT | TEMT | TEST | Inv. |
|---|---|---|---|---|---|---|
| Sum | 5.725 | 5.725 | 49.152 | 40.932 | 34.481 | 33.308 |
| No zeros | 511,00 | 498,00 | 498,00 | 492,00 | 473,00 | 610,00 |
| Maxim | 79,00 | 68,00 | 1.063,00 | 1.261,00 | 473,00 | 289,00 |
| Mean | 9,37 | 9,37 | 80,45 | 66,99 | 56,43 | 54,51 |
| Min | - | - | - | - | (210,00) | - |
| Std. Desv. | 10,45 | 10,11 | 103,29 | 106,20 | 75,65 | 50,12 |
| Curtosis C. | 6,70 | 4,51 | 18,07 | 37,68 | 6,11 | 6,00 |
| Assimetry. C. | 2,21 | 1,84 | 3,20 | 4,86 | 2,05 | 2,37 |
| Spearman C. | (0,25) | (0,23) | (0,32) | (0,34) | (0,21) | (0,53) |

Table 4 Descriptive statistics for the Obligatory Pensions product.

| Data 611 | Inc. | Out. | TIMT | TEMT | TEST | Inv. |
|---|---|---|---|---|---|---|
| Sum | 9.759 | 9.759 | 263.414 | 304.716 | 90.841 | 235.199 |
| No zeros | 529,00 | 524,00 | 524,00 | 520,00 | 405,00 | 610,00 |
| Maxim | 119,00 | 92,00 | 2.548,00 | 3.613,00 | 1.933,00 | 1.216,00 |
| Mean | 15,97 | 15,97 | 431,12 | 498,72 | 148,68 | 384,94 |
| Min | - | - | - | - | (1.602,00) | - |
| Std. Desv. | 15,47 | 14,54 | 465,43 | 575,04 | 303,50 | 277,42 |
| Curtosis C. | 6,41 | 4,12 | 3,12 | 4,69 | 7,92 | (0,02) |
| Assimetry. C. | 1,95 | 1,65 | 1,66 | 1,88 | 1,49 | 0,95 |
| Spearman C. | (0,38) | (0,24) | (0,29) | (0,33) | (0,04) | (0,65) |

Table 5. Descriptive statistics for the Voluntary Pensions product.

| Data 611 | Inc. | Out. | TIMT | TEMT | TEST | Inv. |
|---|---|---|---|---|---|---|
| Sum | 17.571 | 17.571 | 57.732 | 62.001 | 28.150 | 51.345 |
| No zeros | 529,00 | 503,00 | 503,00 | 499,00 | 493,00 | 610,00 |
| Maxim | 104,00 | 89,00 | 324,00 | 529,00 | 262,00 | 157,00 |
| Mean | 28,76 | 28,76 | 94,49 | 101,47 | 46,07 | 84,03 |
| Min | - | - | - | - | (103,00) | - |
| Std. Desv. | 18,56 | 19,14 | 67,04 | 81,55 | 47,26 | 30,90 |
| Curtosis C. | (0,42) | (0,45) | (0,50) | 1,42 | 2,02 | 0,20 |
| Assimetry. C. | (0,05) | 0,04 | 0,23 | 0,85 | 1,23 | (0,09) |
| Spearman C. | (0,16) | (0,13) | (0,14) | (0,09) | (0,17) | 0,02 |

Table 6. Descriptive statistics for the product Society.

| Data 611 | Inc. | Out. | TIMT | TEMT | TEST | Inv. |
|---|---|---|---|---|---|---|
| Sum | 6.845 | 6.845 | 107.252 | 133.816 | 27.421 | 106.053 |
| No zeros | 505,00 | 512,00 | 512,00 | 512,00 | 379,00 | 610,00 |
| Maxim | 64,00 | 64,00 | 1.226,00 | 1.596,00 | 734,00 | 427,00 |
| Mean | 11,20 | 11,20 | 175,54 | 219,01 | 44,88 | 173,57 |
| Min | - | - | - | - | (645,00) | - |
| Std. Desv. | 10,25 | 9,07 | 180,59 | 246,97 | 123,28 | 88,09 |
| Curtosis C. | 4,37 | 3,31 | 6,74 | 5,95 | 6,02 | 0,31 |
| Assimetry. C. | 1,61 | 1,23 | 2,19 | 2,13 | 0,07 | 1,05 |
| Spearman C. | (0,18) | (0,09) | (0,21) | (0,16) | (0,14) | (0,49) |

## 5. Results and Discussion

### 5.1 Numerical Results

The table 7 shows the standardized coefficient by categorical linear regression for each of the performance variables for each week of year for all financial services, so that the evolution of the coefficients between the weeks of the year will be evident in the graphic section.

Table 7. standardized coefficient of categorical linear regression for performance variables.

| B Std. Week of Year | Inc. | Out. | TIMT | TEMT | TEST | Inv. |
|---|---|---|---|---|---|---|
| D WoY-1 | -0,03 | -0,06 | 0,03 | 0,01 | 0,05 | 0,08 |
| D WoY-2 | -0,01 | -0,05 | 0,13 | 0,05 | 0,17 | 0,15 |
| D WoY-3 | -0,02 | -0,08 | 0,14 | 0,04 | 0,21 | 0,12 |
| D WoY-4 | -0,10 | -0,11 | 0,10 | -0,04 | 0,27 | 0,11 |
| D WoY-5 | -0,05 | -0,07 | 0,16 | 0,02 | 0,29 | 0,10 |
| D WoY-6 | -0,06 | -0,06 | 0,12 | 0,01 | 0,20 | 0,12 |
| D WoY-7 | 0,00 | -0,01 | 0,16 | 0,04 | 0,25 | 0,12 |
| D WoY-8 | 0,04 | 0,00 | 0,16 | -0,02 | 0,34 | 0,09 |
| D WoY-9 | -0,02 | -0,04 | 0,10 | -0,01 | 0,21 | 0,01 |
| D WoY-10 | -0,03 | -0,05 | 0,04 | -0,08 | 0,17 | -0,06 |
| D WoY-11 | 0,02 | 0,00 | 0,06 | -0,08 | 0,25 | -0,06 |
| D WoY-12 | -0,01 | -0,10 | 0,01 | -0,13 | 0,23 | -0,08 |
| D WoY-13 | -0,13 | -0,16 | -0,07 | -0,13 | 0,06 | -0,03 |
| D WoY-14 | -0,10 | -0,17 | -0,05 | -0,10 | 0,01 | -0,06 |
| D WoY-15 | -0,10 | -0,08 | -0,05 | -0,10 | 0,04 | -0,03 |
| D WoY-16 | -0,05 | -0,09 | 0,04 | 0,00 | 0,09 | -0,01 |
| D WoY-17 | -0,07 | -0,07 | -0,03 | -0,07 | 0,04 | -0,01 |
| D WoY-18 | -0,12 | -0,12 | -0,05 | -0,09 | 0,02 | 0,02 |
| D WoY-19 | -0,09 | -0,07 | -0,03 | -0,07 | 0,03 | 0,08 |
| D WoY-20 | -0,03 | -0,06 | -0,01 | -0,04 | 0,03 | 0,11 |
| D WoY-21 | 0,01 | -0,11 | 0,05 | 0,02 | 0,06 | 0,05 |
| D WoY-22 | -0,06 | -0,13 | -0,01 | -0,07 | 0,07 | 0,05 |
| D WoY-23 | -0,06 | -0,09 | 0,03 | -0,02 | 0,06 | 0,05 |
| D WoY-24 | -0,06 | -0,12 | 0,00 | -0,05 | 0,05 | 0,05 |
| D WoY-25 | -0,04 | -0,11 | 0,02 | -0,01 | 0,04 | 0,03 |
| D WoY-26 | -0,12 | -0,18 | -0,03 | -0,04 | -0,02 | 0,02 |
| D WoY-27 | -0,09 | -0,13 | -0,02 | -0,04 | -0,01 | 0,04 |
| D WoY-28 | -0,06 | -0,10 | 0,03 | 0,02 | -0,02 | 0,03 |
| D WoY-29 | -0,06 | -0,11 | 0,00 | -0,04 | 0,04 | 0,02 |
| D WoY-30 | -0,09 | -0,12 | 0,00 | -0,05 | 0,07 | 0,02 |
| D WoY-31 | -0,08 | -0,15 | -0,05 | -0,08 | -0,01 | 0,05 |
| D WoY-32 | -0,15 | -0,19 | 0,00 | -0,04 | 0,03 | 0,05 |
| D WoY-33 | -0,12 | -0,24 | 0,00 | -0,07 | 0,09 | 0,01 |
| D WoY-34 | -0,20 | -0,25 | -0,05 | -0,13 | 0,08 | -0,03 |
| D WoY-35 | -0,15 | -0,23 | -0,07 | -0,13 | 0,03 | -0,03 |
| D WoY-36 | -0,17 | -0,20 | -0,07 | -0,10 | -0,05 | -0,03 |
| D WoY-37 | -0,14 | -0,12 | 0,00 | -0,04 | 0,03 | 0,00 |
| D WoY-38 | -0,10 | -0,12 | 0,02 | -0,05 | 0,08 | 0,03 |
| D WoY-39 | -0,09 | -0,13 | 0,07 | -0,02 | 0,14 | 0,01 |
| D WoY-40 | -0,07 | -0,13 | 0,09 | 0,02 | 0,11 | 0,03 |
| D WoY-41 | -0,09 | -0,12 | 0,07 | 0,00 | 0,11 | 0,04 |
| D WoY-42 | -0,10 | -0,19 | 0,05 | 0,00 | 0,09 | 0,01 |
| D WoY-43 | -0,11 | -0,16 | 0,05 | 0,00 | 0,07 | 0,00 |

| | | | | | | |
|---|---|---|---|---|---|---|
| D WoY-44 | -0,07 | -0,12 | 0,02 | -0,01 | 0,01 | 0,01 |
| D WoY-45 | -0,12 | -0,13 | -0,01 | -0,08 | 0,07 | 0,03 |
| D WoY-46 | -0,10 | -0,15 | -0,02 | -0,08 | 0,07 | 0,03 |
| D WoY-47 | -0,13 | -0,17 | -0,03 | -0,11 | 0,11 | 0,01 |
| D WoY-48 | -0,04 | -0,11 | 0,15 | 0,02 | 0,25 | 0,01 |
| D WoY-49 | -0,03 | -0,13 | 0,12 | 0,06 | 0,13 | 0,00 |
| D WoY-50 | -0,10 | -0,15 | 0,06 | -0,01 | 0,12 | -0,01 |

### 5.2 Graphical Results

Since the important parameter to review is the duration of the process and its stability over time, the figure 1 shows the daily evolution of the three times of interest: the number of calendar days of the term, the number of days used to respond, the number of calendar days available. In any case, it is identified that this relationship is the number of calendar days of the term is greater than the number of days used to respond and it is greater than the number of available business days. It should be noted that this figure evolves according to the combination of applications. It starts at 0 on day 1, evolves up to 26 days until day 222 and stabilizes around 22 calendar days after 560 days of system operation.

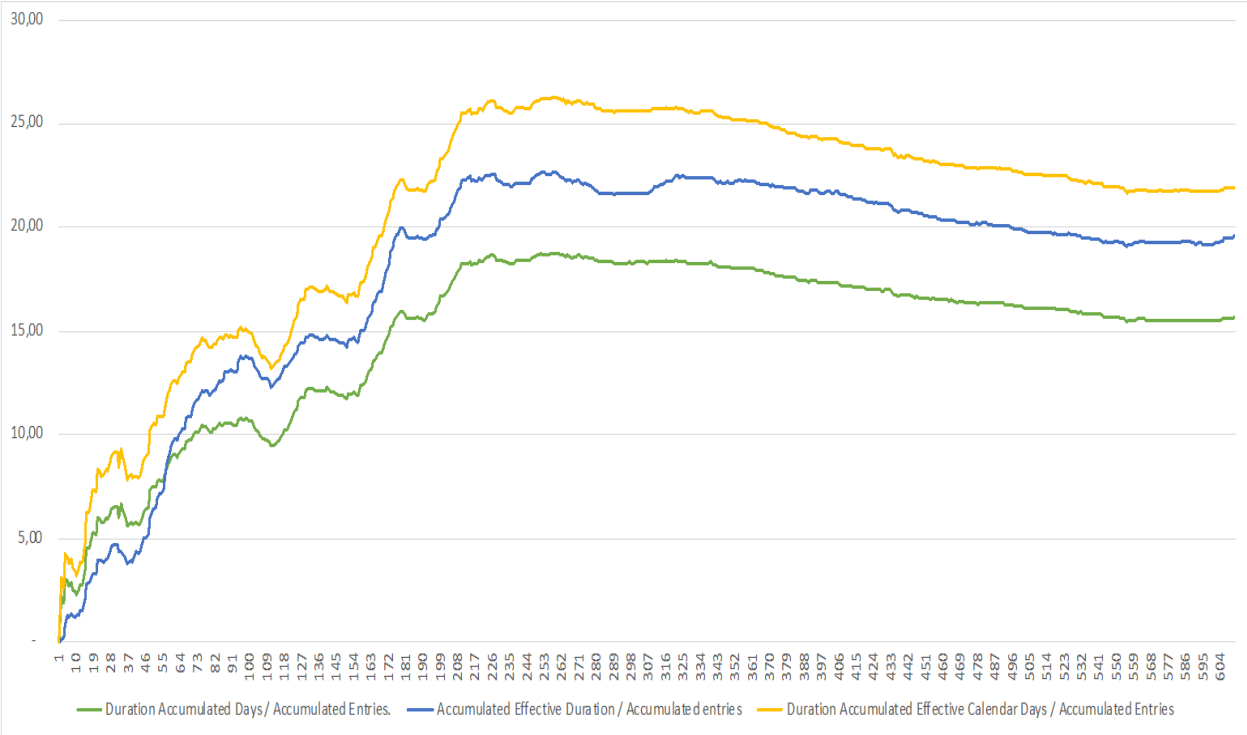


Figure 1. Daily evolution of the three times of interest.

The Figure 2 shows the evolution of the standardized coefficients for the 6 performance measures and previously correlated, which shows high values in the first weeks of the year, decreasing substantially in week 13 to rise again at the end of the year in the week 48. Therefore, the evolution of the performance parameters of the system is represented in graphs, that is, both the input and output variables as well as the performance variables are associated and evolve with the times of the year, which indicates a change based on the culture and the conditions of the system which builds the operating conditions of the same.

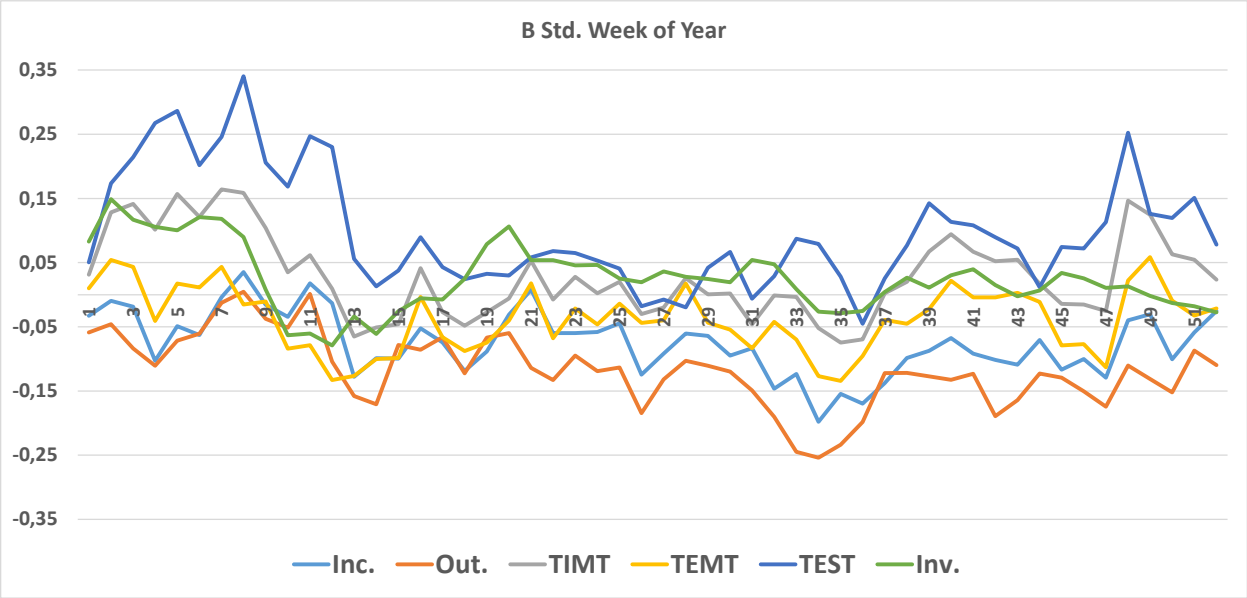


Figure 2. Evolution of standardized coefficients.

### 5.3 Proposed Improvements

A greater availability of data from a longer period of time, including daily records, or an increase in frequency or detail at the hour level or the availability of this same information by client or with records detailed to the second will allow a more description. Detailed process as it allows to increase the power level of the estimates and allows to identify the history and the modification or change in the technology or modifications in the organization of provision of the service, as well as the identification of cyclical components of a greater periodicity, of lapses or economic cycles of the order of the decade.

### 5.4 Validation

A regression model was obtained for each of the performance variables as indicated in table 8. In any case, the adjusted coefficient of determination, R Adj. It is greater than 0.36 and less than 0.70, with which all models explain between 1/3 and 2/3 of the variability of the respective variable, all based on the same regression model based on fixed effects ANOVA. In general, it is observed that all the models are subject to a strong serial correlation since their DW statistics deviate from the target value of 2 in a systematic way. In any case, the models are statistically significant.

Table 8. Regression model for performance variables.

| Statistic | Inc. | Out. | TIMT | TEMT | TEST | Inv. |
|---|---|---|---|---|---|---|
| $R^2$ | 0,62 | 0,61 | 0,54 | 0,52 | 0,46 | 0,73 |
| $R^2$ adj. | 0,56 | 0,54 | 0,46 | 0,43 | 0,36 | 0,69 |
| MSE | 688,21 | 768,05 | 211.626,26 | 327.562,28 | 100.065,05 | 37.171,41 |
| RMSE | 26,23 | 27,71 | 460,03 | 572,33 | 316,33 | 192,80 |
| MAPE | 90,61 | 148,39 | 303,83 | 251,44 | 315,10 | 23,94 |
| DW | 1,41 | 1,01 | 1,22 | 1,40 | 1,46 | 0,08 |
| AIC | 4.075,79 | 4.142,86 | 7.575,90 | 7.842,82 | 7.118,26 | 6.513,20 |
| SBC | 4.477,57 | 4.544,63 | 7.977,67 | 8.244,59 | 7.520,03 | 6.914,97 |

In the Table 9 the Sperman correlation for the standardized coefficients by weeks shows that all of them are significant with a confidence level of 95% or higher, except the relations of Inventory with Income and with TEST.

Table 9. Spearman's correlation for standardized coefficients.

| *C B Std. Week of Year* | *Inc.* | *Out.* | *TIMT* | *TEMT* | *TEST* |
|---|---|---|---|---|---|
| Out. | 0,82 | | | | |
| TIMT | 0,66 | 0,56 | | | |
| TEMT | 0,54 | 0,41 | 0,81 | | |
| TEST | 0,56 | 0,53 | 0,81 | 0,33 | |
| Inv. | 0,29 | 0,36 | 0,49 | 0,57 | 0,25 |

The table 10 contains the p-values in the categorical ANOVA model for the selected date variables: Year, Week of the Year, day of the month, day of the week. There in no case is the number of the day of the month significant. Two other combinations are significant: the year for the number of services rendered; and the day of the week the number of units in inventory. Table 11 shows the information or sumof squares decomposition for each source for each performance measure. The sources are about the date: year (D Y); Week of the Year (D WoY); Day of Month (D DoM); Day of Week (D DoW). Table 12 shows the total variance decomposition : Sum of Squares Modeled, SSM, Sum of squares of Error, SSE; and Sum of Squares Total, SST. After of this the F statistic and p-value of linear regression model are calculated

Table 10. P-values in the categorical ANOVA model.

| P- Values | Inc. | Out. | TIMT | TEMT | TEST | Inv. |
|---|---|---|---|---|---|---|
| D Y | 0,002 | 0,252 | 0,000 | 0,000 | 0,000 | 0,000 |
| D WoY | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 |
| D DoM | 0,782 | 0,494 | 0,317 | 0,358 | 0,611 | 0,997 |
| D DoW | 0,000 | 0,000 | 0,000 | 0,000 | 0,058 | 0,898 |

Table 11. Sum of Squares Analysis - ANOVA model.

| SCM | Inc. | Out. | TIMT | TEMT | TEST | Inv. |
|---|---|---|---|---|---|---|
| D Y | 967 | 153 | 1.527.601 | 1.790.953 | 340.268 | 1.879.718 |
| D WoY | 8.243 | 5.731 | 3.774.879 | 6.101.714 | 1.643.989 | 1.178.802 |
| D DoM | 1.811 | 1.636 | 676.397 | 1.380.381 | 348.712 | 30.365 |
| D DoW | 9.626 | 10.968 | 2.054.129 | 3.212.396 | 157.195 | 5.350 |

Table 12. Variance analysis - ANOVA model.

| | Inc. | Out. | TIMT | TEMT | TEST | Inv. |
|---|---|---|---|---|---|---|
| SSM | 24.447 | 21.413 | 9.362.333 | 15.064.314 | 2.621.454 | 3.486.998 |
| SSE | 39.784 | 28.852 | 10.563.481 | 22.203.813 | 6.664.941 | 1.254.688 |
| SST | 64.231 | 50.265 | 19.925.814 | 37.268.127 | 9.286.395 | 4.741.686 |
| F | 3,550 | 4,288 | 5,121 | 3,920 | 2,2725152 | 16,057 |
| P(F) | **<0,0001** | **<0,0001** | **<0,0001** | **<0,0001** | **<0,0001** | **<0,0001** |

## 6. Conclusion

Week of Year Cyclicity is dominant for each performance measure. The models explains 36% to 69% of the total of information using all categorical variables about the date: Year, Week of year, day of Mont and Day of Week. Could be very useful to expand the correlation analysis with the Wavelet analysis in order to obtain simultaneity in frequency each time in each variable pair

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