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Investigating the relation between First Call Resolution and Average Handling Time in a call center

RESEARCH PAPER BUSINESS ANALYTICS

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Abstract

This paper is written as a compulsory part of the Master's degree in Business Analytics at the Vrije Universiteit Amsterdam. The specific research is focused on analyzing call center data extracted from the records of the Municipality of Rotterdam, Netherlands.

The main goal for the call center management, especially in a governing body, is to ensure the satisfaction of customers or in this case - callers. Customer satisfaction is currently not being measured, so this research focuses on two other call center performance measures - Average Handling Time (AHT) which indicates the average time an agent handles a call, and the First Call Resolution (FCR) which indicates the percentage of the customer calls that are solved in the first call with the call center. The lower the FCR, the more frequently the customer calls back and inquires about the same topic.

The relation between these aforementioned metrics is used to analyze the quality of the work the call center agents are conducting, and can be used to investigate the risk of reduced customer satisfaction. The call center management has to decide whether there is a need for focused efforts to increase the call AHT to expect an increase in the FCR. The aim of this research is to help make an educated decision that is based on the analysis of the call center data.

Contents

Abstract	i
Contents	ii
1 Introduction	1
2 Methodology	2
2.1 Average Handling Time (AHT)	2
2.2 First Call Resolution (FCR)	4
2.3 The relationship between FCR and AHT	5
3 Data exploration and cleaning	6
3.1 Abandoned calls	6
3.2 Queue lines	7
3.3 Customer ID	8
3.4 Agent ID	8
3.5 Arrival time	9
3.6 Handling time	10
3.7 Recurrent calls	11
4 Results	13
4.1 Queue line 30172 - GBR and Parking	13
4.1.1 Waiting time	13
4.1.2 Handling time	14
4.1.3 Relation between FCR and AHT	16
4.2 Other queue lines	17
5 Discussion	18
A Appendix	21

Chapter 1

Introduction

A call center is a division within an organisation and it focuses on inbound and outbound communication with customers. The call center under review in this research belongs to the Municipality of Rotterdam.

The author of this paper has been provided with inbound call data extracts from the call center database. It consists of information about the different queue lines corresponding to the topics the customers or callers are interested in, information that helps identify the caller and the agent that worked the case, information about the times and dates when the calls were made, information about the call itself.

The author conducted data exploration and cleaning activities which led to a reduction of the initially given dataset while enabling data analysis.

The main goal of this paper is to investigate the relation between two quantitative measures used in determining the productivity of the call center agents and the quality of the service the customer received. One of the measures is the Average Handling Time which depicts the productivity or the time it takes for the agent to handle the calls on average. The other is the First Call Resolution that measures the number of times an inquiry by a caller is completed on the first call without the need for a follow-up or the second call. It is used as an assumptive measure also towards the customer satisfaction levels.

In this paper a summary of the investigation results is given, which are then used to facilitate a discussion that could assist the call center management in making a decision on how to achieve their business objectives or a needed trade-off between the call duration and the quality of the call.

Chapter 2

Methodology

Call center performance should be analyzed by using quantifiable measures. Some of the call center quality aspects are comparably easier to measure, e.g., call waiting time. Determining the First Call Resolution rate requires the use of data analysis techniques and advanced data analysis tools. For other qualities such as the perceived friendliness of the call center agent it is necessary to conduct customer surveys - one example could be to ask the customer after the call to rate the friendliness of the agent or the quality of the call in a scale of 1 to 10 ([4]).

Continuously rising customer expectations and demands put government agencies under the same pressure as any company in the broader marketplace and business environment. Thus, a municipality call center aims to achieve some service level - quite often waiting time is used as the quantitative measurement. To reduce that, agents are forced to shorten the handling time to enable managing a larger amount of calls. This in turn negatively affects the quality of the service.

2.1 Average Handling Time (AHT)

The measure often used to depict the call center agent productivity is the Average Handling Time (AHT).

Let i be an agent with $j = 1, \dots, n_i$ answered calls. If there is no work required after the service call, the AHT is equal to the average of all call durations ([2]). In our specific case the duration of a call or the call handling time is computed by using Formula 2.1:

$$HT_j = time_hangup_j - time_answered_j \quad (2.1)$$

and the Average Handling Time for an agent i is computed follows:

$$AHT_i = \frac{1}{n_i} \sum_{j=1}^{n_i} HT_j. \quad (2.2)$$

As described by Harts [2], the call handling time among other things is dependent on these following factors:

- the type of calls the agent handles - an agent usually works longer when solving a complex computer problem than an agent that performs a simple appointment scheduling;
- the number of questions answered in a conversation - when a customer asks multiple questions during the conversation, an agent will have an AHT longer than an agent who handles a call with only a single question from the customer;
- the type and number of systems used to answer the questions - the more systems the agent is required to use and the more complex those systems are, the more time it takes to use them. An agent that provides the necessary information in a simple way, finds it faster than an agent who needs to navigate through multiple systems that make the information difficult to find;
- the level of knowledge and the system skills of the agent who handles the conversation - the more knowledge of the systems and the services the agent has, the quicker he can give answers to the customer's request. A more experienced agent with lots of knowledge can answer the customer's question immediately. If he does not have the knowledge himself, he can quickly look the information up as he does work well with the system;
- the communicative skills of the agent - the better the agent is able to facilitate a conversation, the shorter the call.

Confidence intervals of AHT When analyzing an agent's Average Handling Time, another important and related measure is the confidence interval of the AHT. For example, if an agent has multiple shorter than 10 second long calls, it is possible that he intentionally terminated them to reduce the AHT as often for such agents the regular call takes longer than the overall average in between all agents. In these cases the AHT will be a rough estimate with wide intervals on both sides.

The calculation of the 95% confidence interval for an agent i is computed by formula:

$$\left[AHT_i - \frac{1.96\sigma_i(HT)}{\sqrt{n_i}}; AHT_i + \frac{1.96\sigma_i(HT)}{\sqrt{n_i}} \right], \quad (2.3)$$

where

$$\sigma_i(HT) = \sqrt{\frac{1}{n_i - 1} \sum_{j=1}^{n_i} (HT_j - AHT_i)^2}. \quad (2.4)$$

The interpretation of this confidence interval is that 95% of all calls the agent handles by duration fall in this range. The wider the interval, the less consistent the call handling times an agent has.

2.2 First Call Resolution (FCR)

The percentage for calls that do not require any follow up work or another call on the same case, is defined as the First Call Resolution. From the clients perspective on FCR, the call center work should be angled according to an evaluation for what they consider as satisfactory for their needs. For example, instead of looking at "how fast" the case was handled, the "how well" the call was handled should be measured. With such logic, FCR has a big impact on customer satisfaction levels. An increase in the satisfaction value by way of smaller number of repeat callers results in smaller operating costs. Also, a reduced risk that a customer can switch to a competitor, reduces the revenue risks. When employees work with happy customers, employees themselves are more satisfied with their work and are motivated to give a service of a higher quality. If an agent has to deal with repeated calls from frustrated clients, the morale of the employee as well as the quality of the customer service is reduced ([3]).

The FCR rate of an agent can be computed manually. First, an indicator variable I_k is created for each recorded call $k = 1, \dots, m$ as

$$I_k = \begin{cases} 1, & \text{if the customer does not call again after the call,} \\ 0, & \text{if the customer calls again later.} \end{cases} \quad (2.5)$$

Then the FCR_i for an agent i can be computed by averaging the indicator variable I across all the calls the agent has answered

$$FCR_i = \frac{1}{n_i} \sum_{j=1}^{n_i} I_j. \quad (2.6)$$

The FCR measure indicates the percentage of calls that were completely handled in the first call and no repeat call was necessary - so the value is in the range $[0; 1]$. The closer to 1, the higher the perceived quality of the calls an agent has answered.

This definition does not take under consideration the period between the call reconnects. Estimation of the call reconnects is difficult in practice due to lack of information about the callers identity. It is possible that the customer reconnects a month after the initial call, but with a completely different question, but it is impossible to distinguish that in the call center data so the call is classified as a reconnection not a fresh call.

For this reason, an assumption was made: if the customer calls within 3 days after the previous call, it is a reconnection. If the customer calls after more than 3 days, it is assumed to be a fresh call. The reasoning behind this assumption will be explained in the Section 3.7.

2.3 The relationship between FCR and AHT

In theory there is a possible relation between the FCR and the AHT of the call. These relationships are explained by Harts [2]:

- High AHT and high FCR - the agent delivers quality, but takes a long time to serve the customer. An example case can be when an agent does not possess little knowledge about the subject matter but can eventually produce the correct answer to the customer by looking it up internally.
- High AHT and low FCR - the agent does not deliver quality and takes a long time to handle the case. This is the case, for example, when an agent has limited knowledge, but keeps the customer on hold for a long time without finding the right answer in the end.
- Low AHT and low FCR - the agent handles the call quickly, but does not deliver the quality. This is the case, for example, with an agent who reduces his AHT by dropping calls.
- Low AHT and high FCR - the agent handles the conversation quickly and with high quality. This is the case when an agent knows the answer or quickly can search through the internal systems to obtain the needed answer.

All of the call centers are interested in the latter - low AHT and high FCR resulting in higher number of answered calls and decreasing the waiting time for the customer resulting in higher customer satisfaction level.

Chapter 3

Data exploration and cleaning

The initial data set used in this research contains 498508 entries of calls from a call center based in Rotterdam, Netherlands of a period from 01.04.2012 till 30.09.2012. A short explanation of the 11 variables and their types can be found in the Table 3.1.

TABLE 3.1: The explanation of the initial data set variables

Variable name	Explanation	Variable type
received_Date	date/time a call was received by the call center	time
customerID	hashed last nine digits of the customers phone number	factor
queueType	queue line called	factor
agentID	personnel number of the agent handling the call	factor
time_receive	moment a call was received by the call center	time
time_routed	moment a call was routed by the call center	time
time_answered	moment a call was answered by the call center	time
time_consulted	moment a call between agent and second line was started	time
time_transfer	moment a call was transfered to the second line	time
time_hangup	moment a call was hung up	time

All the time variables were first given as a Unix time in milliseconds (ms since 1-1-1970 UTC). These were converted to the World's Time Standard - UTC format. A deeper explanation about the variables will be given in the following paragraphs.

3.1 Abandoned calls

In the call centers it also happens that the live contact has been made but no agent is available to take the call. These type of calls we name as abandoned. In the data set 10.4% (51 781 of the total 498508 calls) are abandoned. These can not be taken into account when we talk about the recurrent calls as it is only logical that the customer will call again until he is connected to an agent.

Abandoned calls are not taken into account in the further steps of data exploration as it is more reasonable to look at the handling times of the calls and the recurrent calls of the same customer. When the customer calls again and the call is abandoned, it is not included in the calculation of FCR as it was not possible to resolve the call.

In the Figure 3.2 the abandonment rate per queue type can be seen.

3.2 Queue lines

When a person calls to the service center, he is immediately connected to an interactive voice response (IVR) where the caller has to choose between the lines depending on the topic or a problem he wants to talk about.

The explanation of the sizes and queue line types are shown in the Table 3.2. These are translated from Dutch.

TABLE 3.2: Call centers queue lines the customer can choose from

Queue Type	Explanation	# of entries	Abandonment rate
30170	City hall	69539	5.9% (4094)
30171	Municipal Taxes (GB)	16483	9.9% (1626)
30172	GBR and Parking	88335	11.2% (9892)
30173	non-standard waste	68538	11.4% (7827)
30174	Social Affairs and Employment (SZW)	48768	11.0% (5353)
30175	Other	168827	11.2% (18874)
30066	Expats	4634	9.5% (440)
30181	Pilot Dynamostraat	7288	9.2% (671)
30176	Hotline	461	33.4% (154)
30178	Testline	113	23.0% (26)
30179	Backing speech recognition	25477	11.1% (2824)

The customer can always choose between the lines 30170-30175, 30066 and 30181. But there are also the special lines:

- the Hotline- a line with a higher priority, it gets calls only from the police;
- the Testline- a line that is used for testing purposes only;
- the Backing speech recognition- a line where the calls are directed from the central number available for all municipalities. It uses speech recognition in order to direct calls to the Rotterdam call center. So only when a person dials 14010 and says "Rotterdam", he gets the Rotterdam IVR, and he can choose between the regular queues 30170-30175, 30066 and 30181. When the person says something that can not be recognized by the speech recognition, he gets directed to this "Backing speech recognition" line.

The majority of the calls are received in the queue line "Other". As it is not possible to verify whether the recurring call from the same customer is about the topic he called before, the calls from this line will not be taken into account.

In the same way, the special lines "Hotline", "Testline" and "Backing speech recognition" will not be taken into account as they are not completely related to the customers.

From the total number of 446727 non-abandoned calls, 173000 (38.7%) entries are removed resulting in 273727 registered calls.

3.3 Customer ID

In the data set each caller has a unique, hashed value for the variable "customerID". In total there are 102519 customers in the dataset.

When looking closely at the number of calls per customerID, there are two special cases for this field, "Anonymous" is when there is no caller ID available - 58962 calls (21.5%). "Internal" means the call is transferred internally, for instance when an agent does not have the correct skill and the customer made the wrong IVR choice. There are 14606 Internal calls (5.3%) from the customerID value equal to "Internal". In both cases, it is not possible to recognize the initial caller and whether the person calls again so these calls will also be omitted leaving the data set with 200159 registered calls which is $\approx 40.2\%$ of the initial data set.

The total number of calls per queue type also reduced as the internal and anonymous calls were thrown out. The number of calls per queue line can be found in the Table 3.3.

TABLE 3.3: Number of calls per Queue type left after omitting the internal and anonymous calls

Queue type	30170	30171	30172	30173	30174	30181
Number of calls	55328	11729	57969	44622	30508	3

From now on, the paper will focus only on the queue types 30170-30174 as they have a sufficient number of calls per queue to be able to make conclusions out of them. The final data set consists of 200156 registered calls with a distribution by the queue type shown in the Table 3.4.

TABLE 3.4: Queue line sizes that are used in the further research

Queue type	30170	30171	30172	30173	30174
Number of calls	55328	11729	57969	44622	30508

3.4 Agent ID

This paper is mainly focused on the quality of the agents job. After looking deeper in the data set, it turned out that there are agents that work only on specific queue lines and there are

agents who works on all of the queue lines. In the Table 3.5 the number of agents working per queue line can be found. In the final data set there are 196 agents from whom 16 has answered less than 100 calls in total. The dataset of less than 100 answered calls is too small to evaluate performance of an agent therefore the FCR and AHT relation will be inspected only for agents that have answered more than 100 calls on one queue line.

TABLE 3.5: Number of calls per Queue type left after omitting the internal and anonymous calls

Queue type	30170	30171	30172	30173	30174
Number of agents	147	79	102	109	132
Number of agents answered more than 100 calls	126	47	79	88	96

3.5 Arrival time

The data analysis starts with determining the arrival rate and whether it depends on the hour of the day – for checking that the per-hour sum of all the calls throughout the whole period is plotted in Figure 3.1. As seen from the graph the arrival rate is not constant and is indeed time dependent – the hour of the day has a huge impact on the amount of calls.

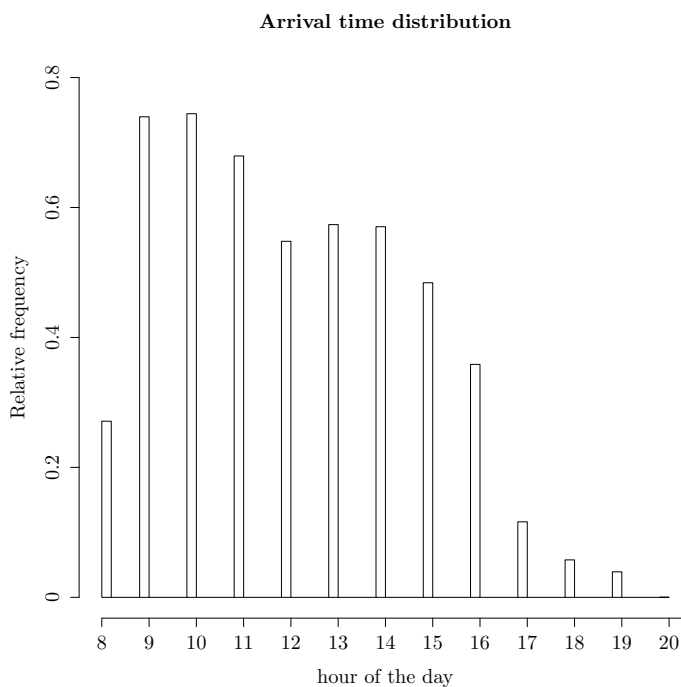


FIGURE 3.1: Arrival time distribution with relative frequencies by hour of the day.

3.6 Handling time

The data analysis is continued with plotting the call duration frequency to get the service time distribution. The distribution of the handling times is presented in the Figure 3.2. This histogram contains all 5 of the mentioned queue types. The handling time distributions of each of the queue line can be found in the Appendix, Figure A3, page 24.

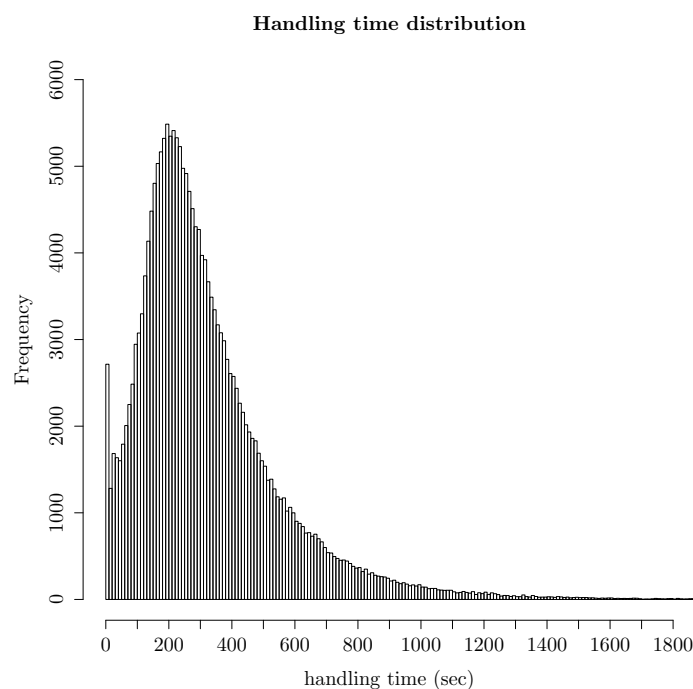


FIGURE 3.2: Handling time distribution by length of a call in seconds.

Handling times with less than 20 seconds are questionable. In the provided description of the data set, the call center manager mentions listening to 20 randomly chosen short calls, in about 10 of them the person hangs up after the agent has said his or her name, 6 of the calls are just silence so the agent might not realize that there is a call, or doesn't want to take it and keeps quiet, for the other 4 calls people realize that they have called the wrong number. The phenomenon of agents "abandoning" customers is not uncommon - it often happens due to the incentive schemes in place at the organization. Some overemphasize short average handling time or the total number of calls an agent handles ([1]).

By the form of the probability density function of the handling times in Figure 3.2, we can conclude that the service time distribution is not exponential as it is often assumed by standard queuing theory. When excluding short calls (less than 40 sec long), analysis reveals a remarkable fit to the log-normal distribution. The guess can be made that the service (handling) time is combined from multiple distributions but further analysis will not be included in this paper as it

is not relevant to the main topic and omitting the short calls would result in an incorrect AHT and FCR measures so they are kept in the further analysis.

In the Table 3.6 the main statistics of the handling times for each call line and combined calls can be found.

TABLE 3.6: Handling time statistics for each queue line and combined distribution

	30170	30171	30172	30173	30174	All lines together
Min	0	0	0	0	0	0
1st quantile	185	168	186	154	167	172
Median	268	289	313	222	279	268
Mean	310.6	345.6	370.1	265.8	330.1	322.9
3rd quantile	387	453	486	328	430	412
Max	4055	3495	4164	2608	3270	4164
SD	207.6	263	269.5	186.22	242.2	234.8

3.7 Recurrent calls

In the given dataset there is no indication of whether the customer calls with a new question (fresh call) and the case of the previous call was closed or the customer reconnects with a call center because there are still some questions left after the previous call. To get an insight of the length of the period between the reconnect calls from a customer, a new variable was introduced. The call center is closed on Sundays and the variable is a Date so have to be careful with calculating days between dates. Sundays can not be included in the calculations. Table 3.7 illustrates quantile distribution of this variable for each of the queue line.

TABLE 3.7: Quantile distribution of the days between the recurrent calls of a customer

Quantile	Days between calls				
	30170	30171	30172	30173	30174
25%	0	0	0	0	0
30%	0	0	0	1	1
35%	0	0	1	2	1
40%	1	0	1	3	1
45%	1	1	2	4	2
50%	2	1	3	5	3
55%	3	1	5	7	4
60%	5	2	6	9	5
65%	7	3	9	12	7
70%	9	4	12	17	10
80%	17	7	23	30	19
90%	35	14	46	56	40
100%	117	34	153	152	152

From the Table [3.7](#) it can be seen that roughly in all the queue lines, at least 50% of the reconnected calls were done in 3 days after the previous call.

Hence an assumption is being introduced - if the reconnection is done after more than 3 days, it is a fresh call.

In the Chapter [4.1.3](#) the results with and without this assumption will be compared.

Chapter 4

Results

The handling time of a call is one of the measures the call center is interested in. As it was shown in the Section 3.2, the customer can choose between the queue line types meaning that the complexity of the conversations varies between the queue lines resulting in different average handling times for each of the queue. The extensive analysis will be explained only for the queue line 30172 as it has the most call records. The results of the other 4 queue lines will explained in the Section 4.2

4.1 Queue line 30172 - GBR and Parking

4.1.1 Waiting time

The waiting time of a call is computed as the difference between two given time variables - `time_answered` and `time_receive`:

$$waiting_time = time_hangup - time_receive. \quad (4.1)$$

This variable shows the time period needed for an agent to pick up the call. Long waiting times means the agents are busy. When the waiting time is short - more likely that there are free agents and they can pick up the call faster. The distribution of the waiting times starting from 1 second for queue line 30172 can be found in the Figure 4.1. This histogram does not include the waiting time of 0 seconds as it is considered as no waiting in the queue at all. By the form of the probability density function of the waiting times in Figure 4.1, we may guess that the distribution is exponential. There are no further analysis on this in this paper as it is not relevant to the main topic.

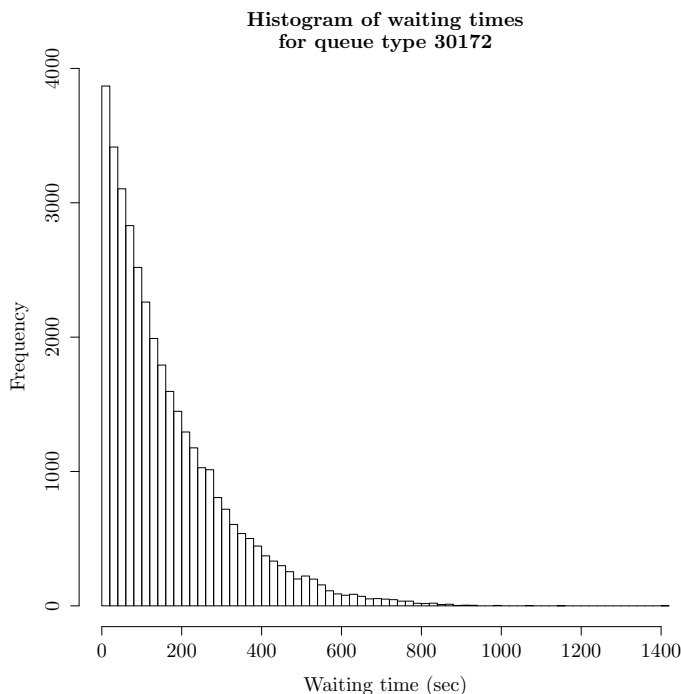


FIGURE 4.1: Histogram of the handling times for calls from queue line 30172.

As explained in the previous chapter, the analysis does not include the abandoned calls so the distribution contains only the waiting times of the calls that were answered.

4.1.2 Handling time

One of the quality measures the call centers mostly look at is the handling time of a call. The handling time was computed by the Formula 2.1.

In the Figure 4.2 the histogram of call handling times can be found. There is a peak of very short calls as mentioned already in the Section 3.6. When looked on the quantiles of this distribution, only 1% of the calls were unreasonably high (longer than 21 minutes). The most of the calls are distributed between 3 minutes (180 sec) to 8 minutes (480 sec). Even when the calls are received from the same queue line and they must be about similar topics, it is hard to set a boundary for when the time spent on the call is considered optimal. There might be a desired length of the call expected from an agent but every case is different and every customer has different speed of understanding things.

We are also interested whether the handling times change depending on the day of the week. From Figure 4.3 it can be seen that there are some outliers with very long call durations. These may be explained as very hard cases for agents to solve or the agent forgot to hung up the phone properly after the call and the system has registered it as continuation of a call.

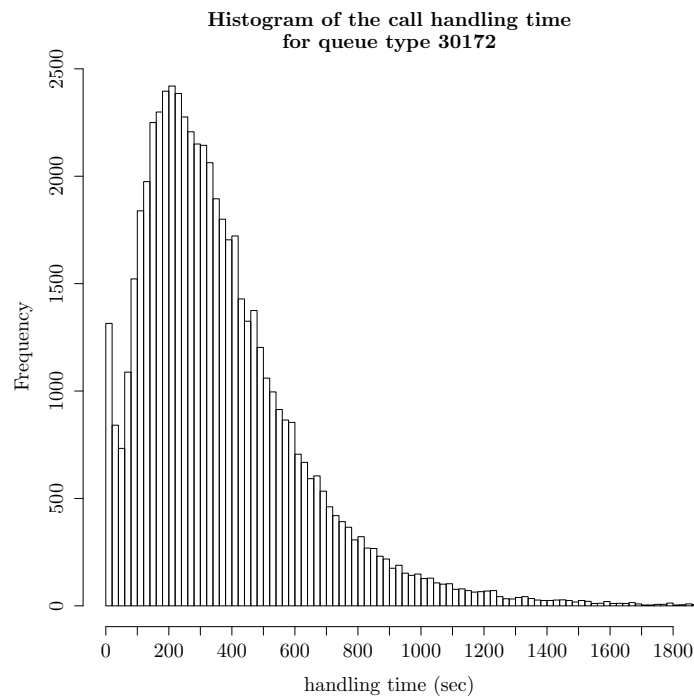


FIGURE 4.2: Histogram of the handling times for calls from queue line 30172.

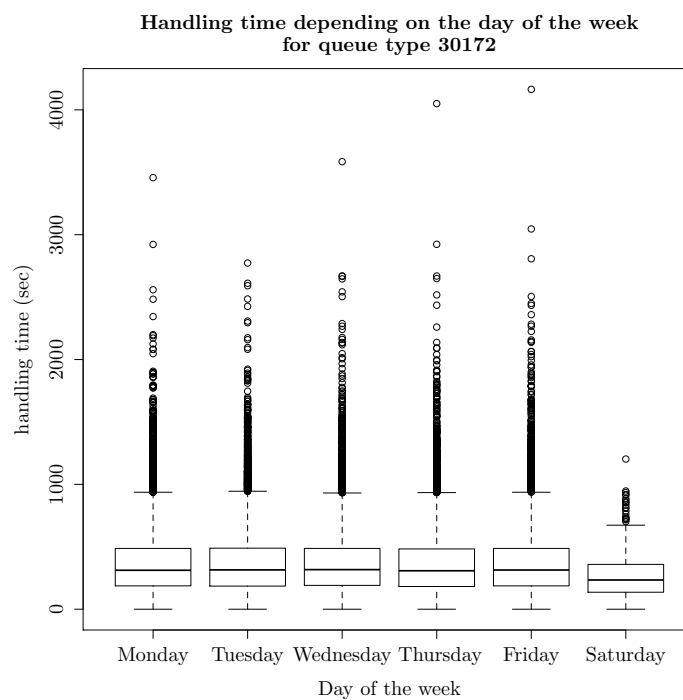


FIGURE 4.3: Boxplot of the handling times depending on the day of the week for calls from queue line 30172.

The mean handling time over the working days seems to be quite similar. The duration of the calls on Saturday are usually shorter than it is on the working days. It might be explained

that municipality calls are not that urgent so people usually want to wait until Monday and sort their problems on working day or they assume that the call center will not work on a Saturday.

4.1.3 Relation between FCR and AHT

FCR is not easy to define as its value is sensitive to the assumptions about the reconnection period. In the Figure 4.4 the relation between FCR and AHT with 95% confidence intervals are illustrated. As mentioned in the Chapter 3.4, a sample of less than 100 calls answered per agent is too small to make conclusions of the agents performance. Therefore the figures below includes only those agents who have answered more than 100 calls in this queue line.

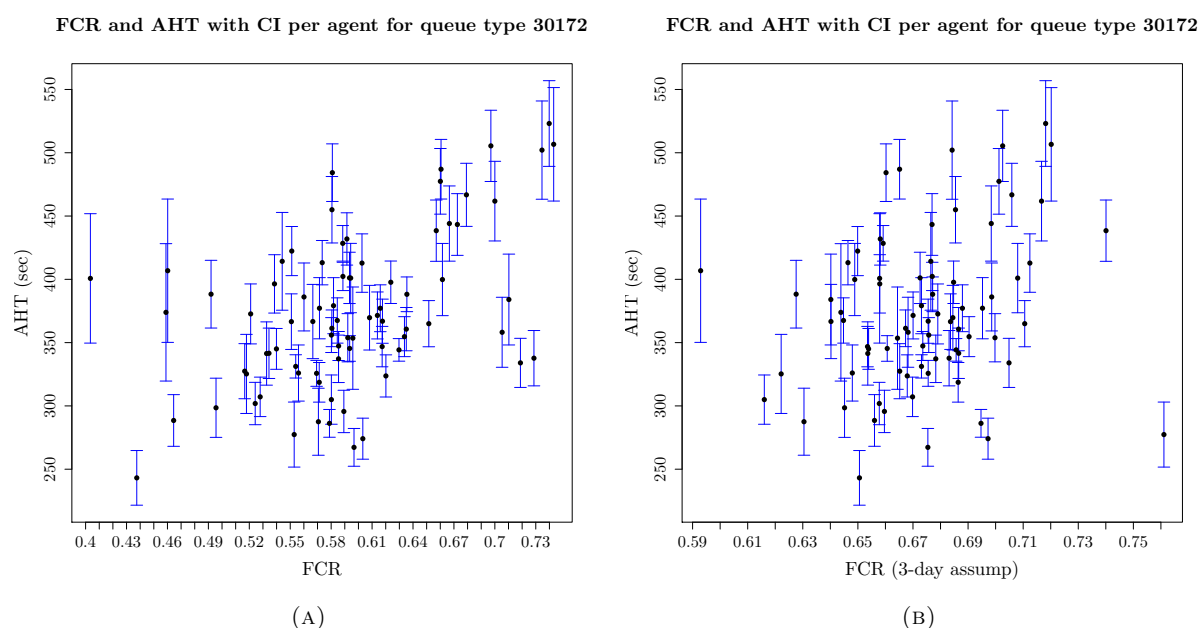


FIGURE 4.4: Relation between AHT with 95%CI and (A) FCR without assumptions made, (B) FCR with 3-day reconnection assumption for the agents from queue line 30172.

The plot on the left side of the Figure 4.4 uses the FCR without assumptions made for the reconnection meaning that all the calls from the same customer counts as a reconnection. On the right side of this figure the call from the customer is considered as a reconnection if the next call is made within 3 days after the previous call. When comparing the values of the FCR in both cases, it is just logical that the FCR without assumptions has lower values. Even when a customer calls to the call center 45 days after the previous call, this FCR takes it as a reconnection and lowers the FCR value for the agent.

The overall tendency is that the longer the agent handles the call, the better the FCR becomes. The Pearson correlation between these two measures for the left plot is 0.49 and 0.42 for the plot on the right which makes sense. In the plots we can see that there are better performing agents (lower right corner) indicating that they can handle calls promptly with a higher number

of resolved first calls and there are worse performing agents (mid to upper left corner). The 3-day reconnection assumption aligns the agents more in the center making it harder to indicate linear dependency.

4.2 Other queue lines

All the figures related to the queue lines 30170, 30171, 30173 and 30174 can be found in the Appendix.

Handling time depending on a day of the week. Looking at the Figure A1 (page 22 in the Appendix), there are no such differences between the handling times of the calls for queue lines 30170 and 30173. These topics are more related to daily life such as arranging an appointment with a City hall or garbage problems. The queue lines 30171 and 30174 are related to employment matters so people might not want to have extensive talks about these topics on their weekends.

Waiting times and service times. The size of the queue line 30171 is relatively small comparing to the other queue lines. There are less calls received to this line so logically less agents are working on it. But still the distribution of the waiting times (Figure A2) for all the lines are similar. There is relatively higher peak of short handling times (Figure A3) for queue line 30171 than to other lines.

Relation between FCR and AHT. In the Figures A4 and A5 from the Appendix (pages 25 and 26), there is an agent in every queue that clearly spends less time on his calls than others. After looking deeper and comparing these agents, turned out they were not the same. The recommendation to the call center manager would be to trace these agents and let them work on the lines they are better and exclude them from picking up the lines they are bad at.

We can also see that there is an agent in the queue lines 30170, 30173, 30174 that always spends more time on the calls than others. When looking closer, turned out this is the same agent. In some cases it is useful to spend more time on the call and resolve it but in the queue lines where agents spend less time on calls and have the same FCR, this agent performs worse.

Between the (B) and (D) plots of the Figure A4, there are no meaningful differences, only the FCR is proportionally changed. The Pearson correlation coefficient for case (B) is 0.524 and for case (D) it is 0.519, so very close. As we look back to the Table 3.7, the percentage of the calls made within 3 days was already large - 65%. For the queue line 30173 there were only 40% of the calls made within 3 days. We can see that the graph (C) on in Figure Figure A5 is more scattered than in plot (A). The correlation for (A) is 0.579 and 0.513 for (C) so the assumption changes the linear dependency by quite a lot.

Chapter 5

Discussion

This research and results are based on the provided call center dataset. The data includes registered calls from the government institution therefore the call center manager should be more focusing on increasing customer satisfaction of the call center. This means the agents should be spending more time on explaining the answers to customers and to be sure that they understand everything. Even the AHT is high for some agents, as long as the FCR is also high, the customers should be satisfied. This strategy decreases costs for the company as the less re-work has to be done and the morale of the employees increases but the waiting times for the customers increases.

The investigation has confirmed the fact that for call centers it is challenging to effectively track whether customers are satisfied with the resolution they have received. In regards to determining whether the case was resolved successfully on the first call, based on an assumption that a call back after a 3 day or 72 hour time frame is recognized as an increasing FCR. If a customer calls back within this period, the FCR decreases. The flaw in using this logic when analyzing the call center dataset is that quite possibly a call within this 3 day time frame is related to a completely new matter or vice versa.

A suggestion to tackle this issue is an investment in a system that indicates whether and what inquiries a particular caller has made to the municipality in the past - this could mean a reduction in the average handling time and increase the productivity of the call center employee. Also, callers that are reconnecting about the same topic should be assigned to the same agent that handled the case in the past so the caller do not have to explain the situation again.

Another potential improvement is to create a simple customer satisfaction survey - basically a questionnaire after the call where the customer rates whether his problem was solved in way that resembles a good trade-off between the call handling time and the quality of the service. This could provide a further insight into the FCR, especially in a governing organization where

customer satisfaction and experience is key. Having this additional call quality measure and balancing it with FCR would produce valuable insight for the call center management about the "health" of the organization they are running - improving and achieving a high FCR score can save resources as there would be a smaller amount of repeated calls, improved customer satisfaction with the Municipality of Rotterdam.

Having a combined and a trustworthy quality measure would allow the call center to experiment and reliably test new ideas - for example, understanding whether and to what extent the waiting time for the customer affects their satisfaction. Findings from this test could allow making a data analysis based decision about the need to reorganize - reassign, reduce, increase - the call center staff.

As seen in the Results section, not all of the agents are confident talking on different queue lines. The management of the call center should more focus on investigating their agent strengths and weaknesses and to assign them on the lines they are performing better. From the graphs it is easy to see the outlying agents that either perform very good or worse than others. The managers should more focus on getting to know methods the good agents use and train other agents that do not perform that well.

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Appendix A

Appendix

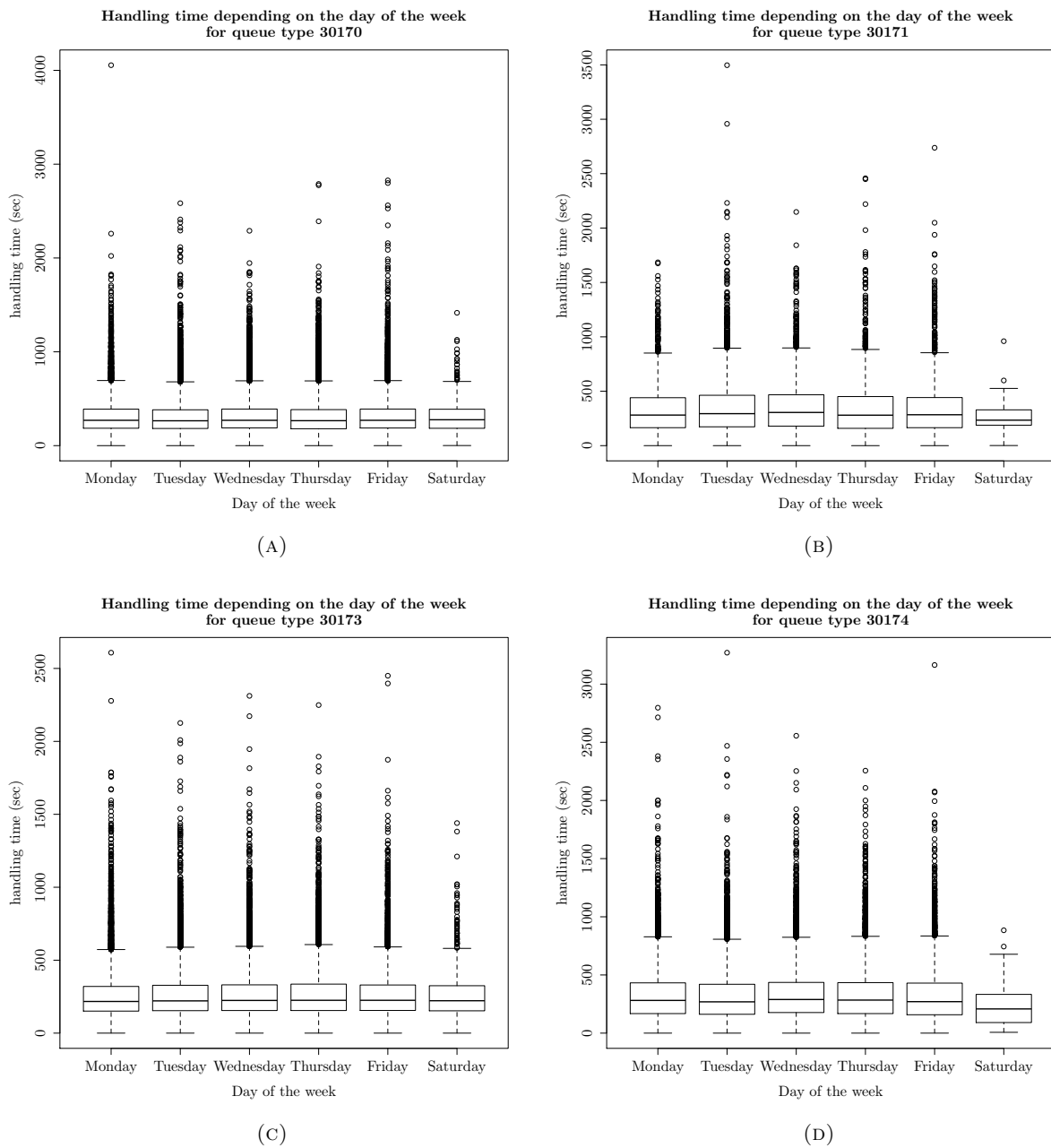


FIGURE A1: Boxplot of the handling times depending on the day of the week for calls from queue line (A) 30170, (B) 30171, (C) 30173, (D) 30174.

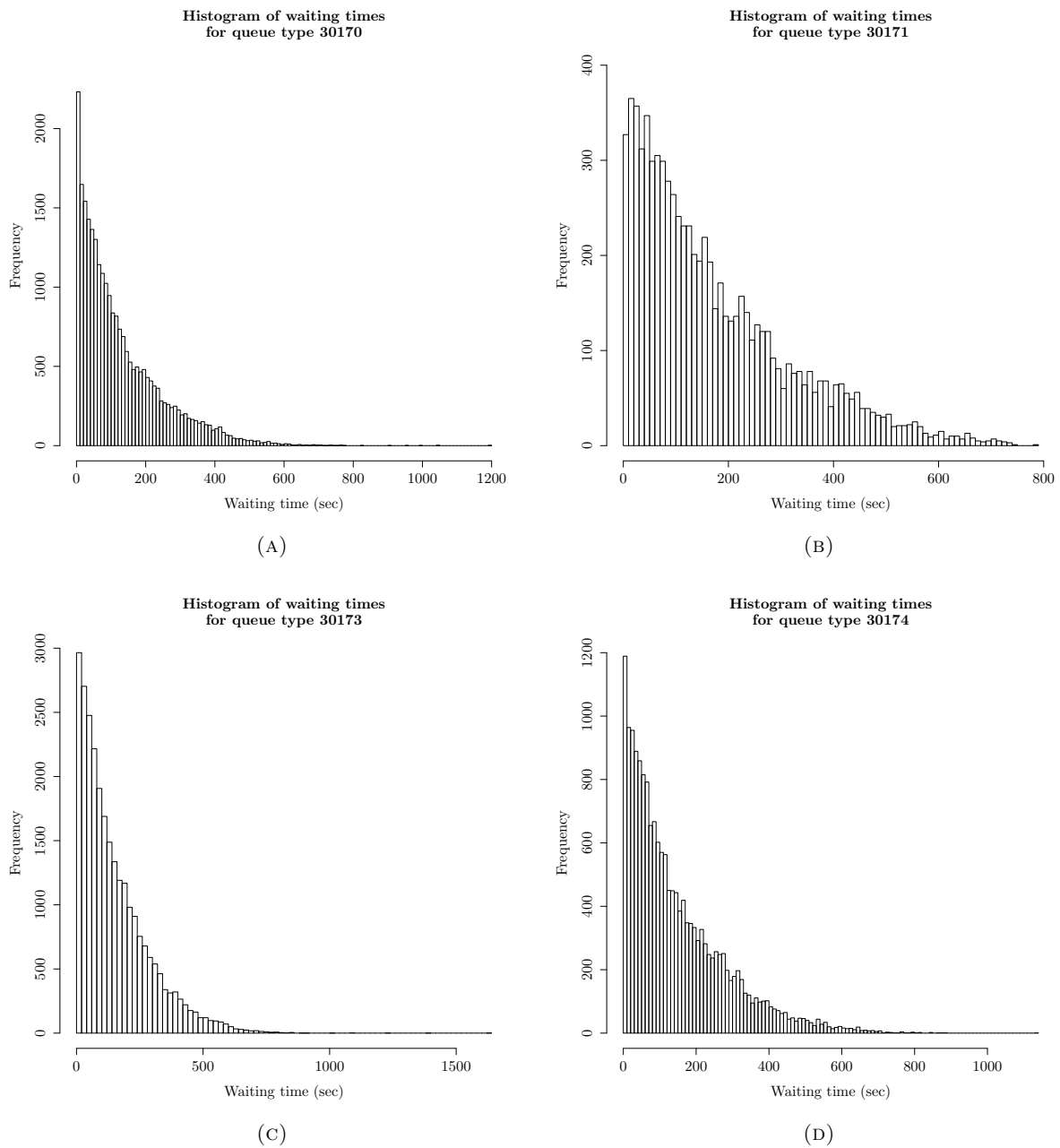


FIGURE A2: Waiting time distributions per queue line (A) 30170, (B) 30171, (C) 30173, (D) 30174.

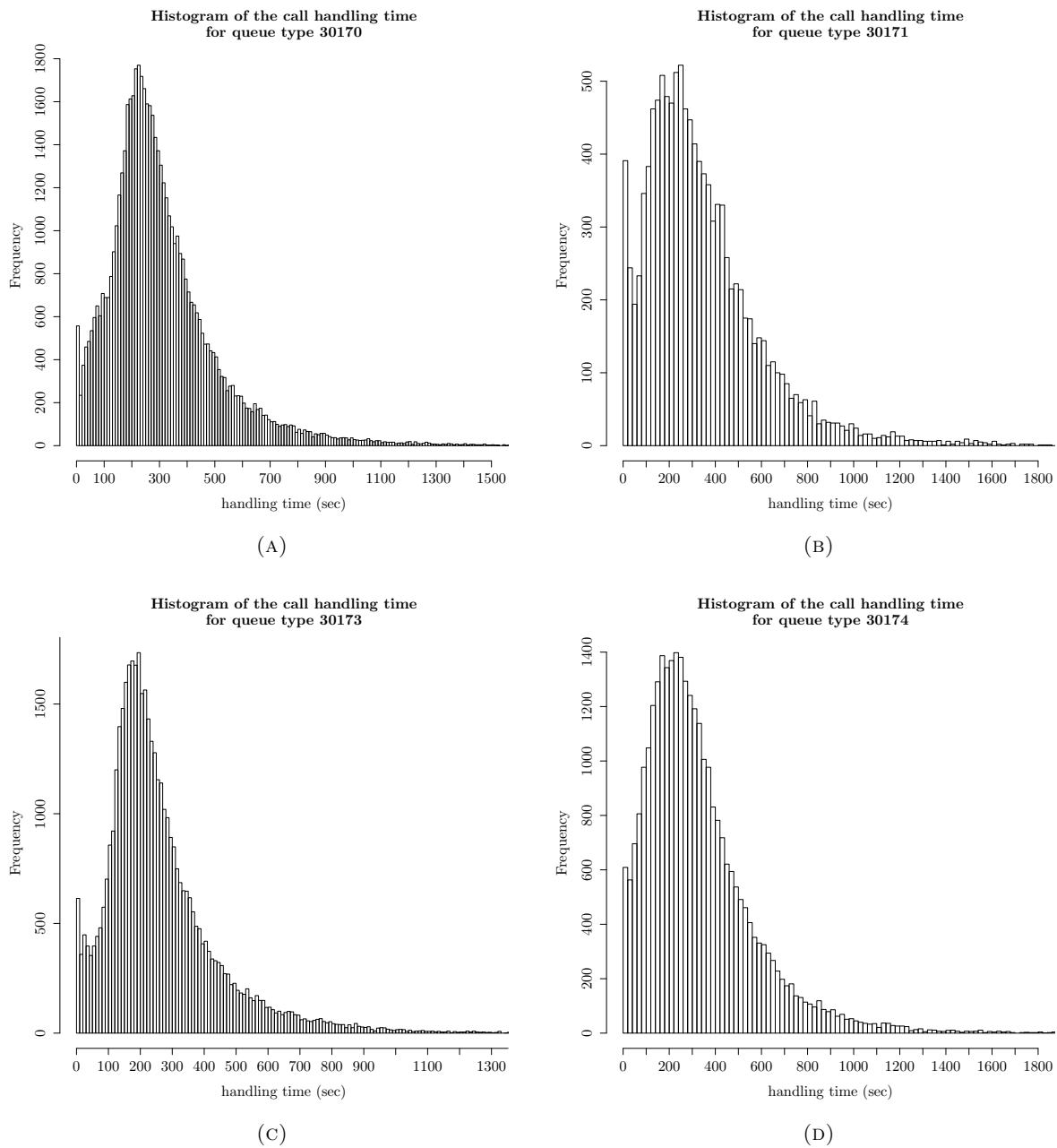


FIGURE A3: Service time distributions per queue line (A) 30170, (B) 30171, (C) 30173, (D) 30174.

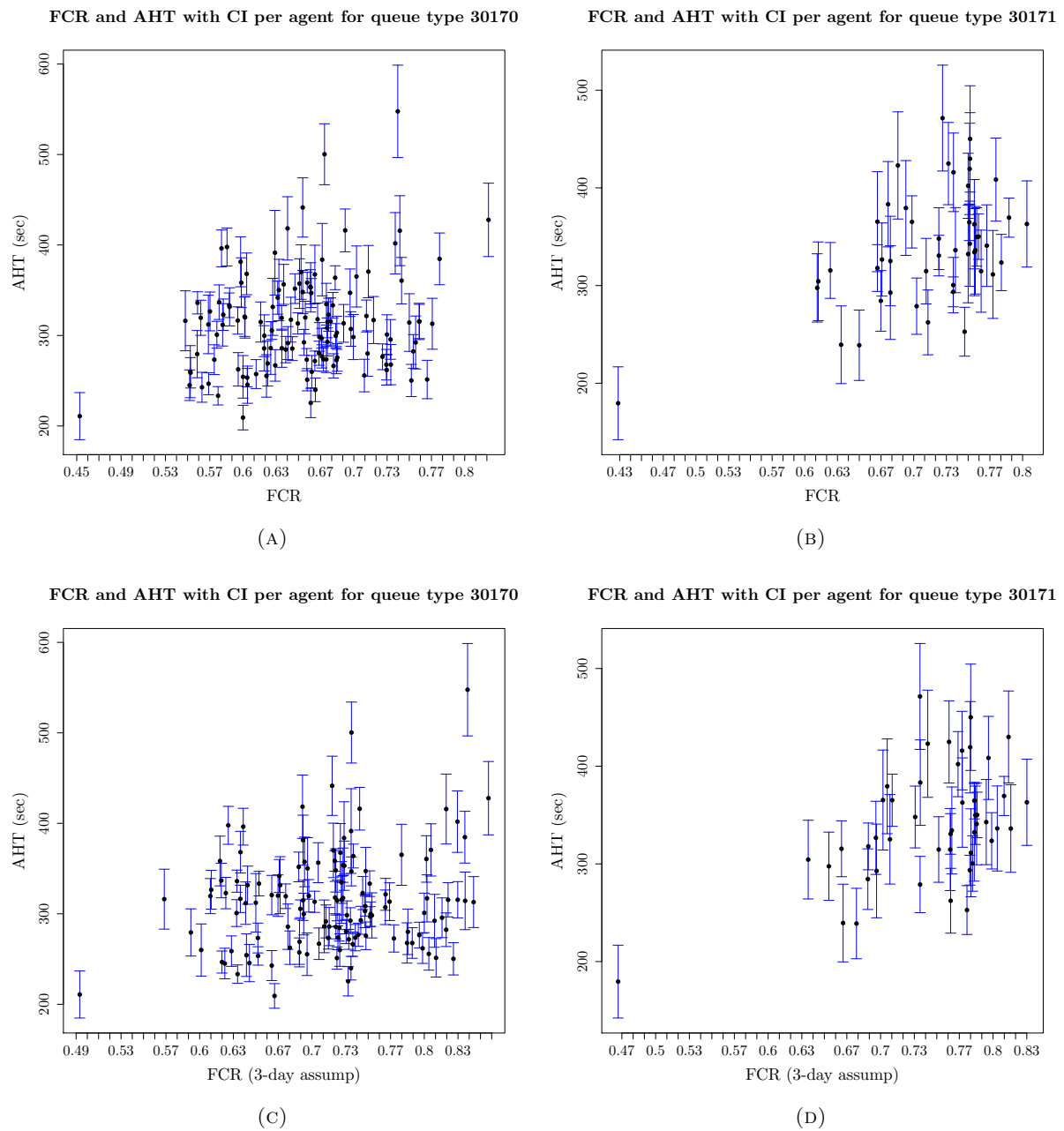


FIGURE A4: Relation between AHT with 95% CI and (A) FCR without assumptions made for agents from queue line 30170, (B) FCR without assumptions made for agents from queue line 30171, (C) FCR with 3-day reconnection assumption for agents from queue line 30170; (D) FCR with 3-day reconnection assumption for agents from queue line 30171.

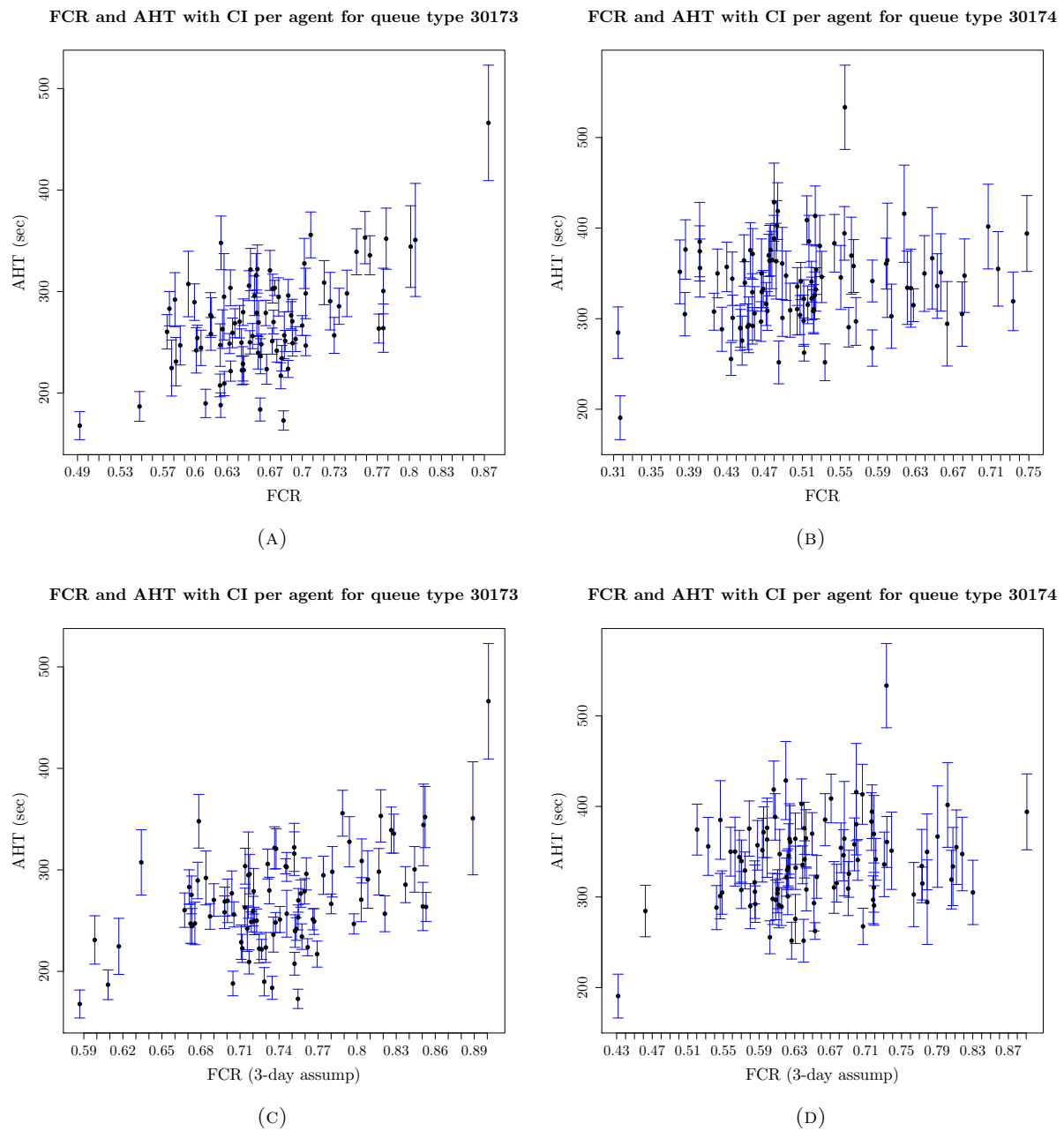


FIGURE A5: Relation between AHT with 95% CI and (A) FCR without assumptions made for agents from queue line 30173, (B) FCR without assumptions made for agents from queue line 30174, (C) FCR with 3-day reconnection assumption for agents from queue line 30173; (D) FCR with 3-day reconnection assumption for agents from queue line 30174.