Detecting Customer Queue "at-risk" Behaviors Based on Ethograms to Minimize Overall Service Dissatisfaction

Magali Dubosson[1], Emmanuel Fragnière[1,2(✉)], Nathalie Junod[1], and Bettina Willaerts[1]

[1] HES-SO, Service Design Lab,
Le Foyer - Techno-Pôle 1, 3960 Sierre, Switzerland
magali.dubosson@hefr.ch, emmanuel.fragniere@hevs.ch,
nathalie.junod@hesge.ch, bwillaerts@gmail.com
[2] University of Bath, Bath BA2 7AY, UK

Abstract. Every service encounter corresponds to a "queue network" in which a system of waiting lines is connected to servers. We posit that each production service type (e.g., restaurant, airport) requires an adapted queue design in order to maximize attributes salient to customers (i.e., their primary elements of perceived value) in today's globalized service environment. While the queues have been studied from many angles, a scientific contribution based on a human ethology approach proposing the early identification of "at-risk" behaviors to regulate queue dynamics seems to be novel. To remedy this shortcoming, the large-scale food distribution sector has been chosen for the application of a naturalistic observation approach to describe in detail the behavior of customer queues. Sixteen immersion episodes were conducted in the months between May and June 2016. Using RQDA, we analyzed the immersion transcripts and identified typical customer queue behavioral patterns. Then, we developed an ethogram containing what we considered to be "at-risk" queue behaviors. This ethogram can ultimately be used as an anticipatory indicator in the context of feedforward management controls. Feedforward control, as opposed to classical feedback controls, is based on the early detection of risks and the implementation of mitigation before damage occurs. While this approach requires human attention and expertise (which can be labor-intensive), there is also potential for human ethology to assist managers with supportive or complementary automation. Indeed, the factual description of behaviors contained in our ethogram can easily be coded with modern technology like facial expression and body recognition technologies.

Keywords: Enterprise risk management · Human ethology · Service science
Waiting line management

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1 Context

For centuries humankind has shown no lack of imagination toward reducing distances; in particular, with the development cars, planes and even rockets. It must be observed, however, that queues still exist and are part of our daily lives. At the time of the instantaneousness of the Internet, the rule of "Anytime, Anywhere, Any device" takes on its full meaning, and customers seem less ready to wait. Indeed, according to a study conducted by IFOP (www.ifop.com - based on a sample of 1000 people aged 18 and over), no less than 30% of French consumers would abandon a purchase just because of a checkout queue. Consequently, "balking" or "reneging" behaviors and feelings of frustration and injustice have an impact in terms of costs for the company and can create a negative perception of the service offered to the client. The design of suitable queues therefore seems to be an element to be considered. In this paper we see how human ethology precepts can contribute to better queue management. Various queuing systems adopting the FIFO (First In First Out) logic have emerged alongside the traditional queue, which is known as the multiple-queue configuration. The serpentine queue also warrants mention. It is a single queue leading at the end to multiple servers. Another important type of file configuration, the queue with ticket-number, is also known as the virtual queue configuration. A first line leads to a ticket dispenser. Then, each client waits until his/her turn. More recently, the virtual ticket number has gained popularity thanks to the Internet where physical presence is not required anymore. This research aims to manage the annoyances associated with customer queues through human ethology methodologies. The queuing behaviors identified during immersions are collected in an ethogram, by sensorial qualification. On the basis of naturalistic observation, queue ethograms are established. The goal is then to be able, in real time, to prevent risks of overflow, general dissatisfaction, and also generally to promote a better perception of value offered by the final service. The entirety of the fieldwork, based on participative observations, was carried out according to the methods of human ethology in the food retail sector. A first "exploratory" field phase, including four immersions, allowed the observer to become familiar with the dynamics of the points of sale. In addition to a brief observation of the queues, the customer's purchasing context was also examined. The second "in-depth" field phase, consisting of sixteen immersion episodes (10 min each), enabled us to identify typical behaviors of clients in the queues. This inventory of behaviors was made possible thanks to the development of an observation grid and the processing of its data with the RQDA program. Thereafter, an ethogram was created to highlight certain behaviors identified as potentially "at risk". This paper is organized as follows. In Sect. 2, we propose a simple explanation about of queuing theory, as well as human ethology adapted to this context. In Sect. 3, we propose a brief literature review of queuing theory and related developments in the psychology of waiting lines. We also explain the main principles of human ethology in the context of customer queues. In Sect. 4, we present the methodology employed to gather data through naturalistic observation. In Sect. 5 we propose an ethogram of at-risk queue behavior based on fieldwork analysis. We conclude by indicating research limitations as well as further research directions.

2 Queuing and Human Ethology

It was in the beginning of the 20th century that the Danish engineer Agner Krarup Erlang (1878–1929) developed the mathematical theory of waiting lines (called queuing theory). His mathematical models were applied for the first time to assessing the very long queues of white-collar workers who wanted to take skyscraper lifts to their offices. Erlang was not only interested in quantitative models to evaluate waiting time and queue length, but also in the perception of time spent in the queue (qualitative aspects, such as talking with a colleague, reading a newspaper or enjoying a bagel and a coffee, may create the impression that the perceived wait time is shorter than the actual wait time). Unfortunately, today, the two approaches (quantitative and qualitative) are too often treated separately. On the one hand, quantitative approaches coupled with Monte-Carlo simulation techniques now allow computers to calculate a range of indicators to manage the queue from an essentially operational point of view. For example, when wait times in the queue are considered too long, these models can accurately assess the number of additional cashiers needed in order to return to a reasonable wait time. On the other hand, qualitative approaches allow us to grasp behavioral aspects of the queue. The most studied behaviors are: a priori impatience ("balking") and a posteriori ("reneging"), which lead to the abandonment of the queue if it is perceived as too long, as well as the passage from one queue to another ("Jockeying") in order to reduce the waiting time. For example, jockeying is a typical behavior of the traditional queue and typically creates feelings of injustice within the queue. The serpentine queue eliminates the possibility of "jockeying" on the other hand. However, it is subject to more frequent abandonment behaviors when the queues are very long. The same applies to the queue with ticket-number. First, we consider the traditional queue that consists of several queues each leading to a counter. Next, we consider the single line leading to several cashiers, also called serpentine, which consists of a single queue leading to several cashiers. The last queue configuration we consider is the queue with ticket, also called the virtual queue. A first line leads to the ticket dispenser. Then, people take their places in the waiting room and go to a specific window as soon as the electronic bulletin board invites them. All three queue configurations apply the so-called FIFO (First In First Out) rule. The term "human ethology", is defined as the study of human behavior without relying on questions or discussion but through sole observation from the outside. Eibl-Eibesfeldt [1] is known to be the first scientist to have systematically explored human ecosystems with methods and concepts of animal ethology. In the 1970s, he created a repertoire of the most universal human behaviors. Basic facial and gestural expressions, appearing to be found in all human societies, have thus been categorized. He also highlighted the invariance of certain behaviors such as frowns related to the expression of anger or in opposition, eyebrow shrugging (frowning), as a sign of friendly welcome. The energy leading to a given behavior is put in place by two different triggering systems that can be seen as the dual causes of behaviors:

- Behavior of endogenous origin (internal stimulations). This is defined very well through the notion of drive, referring to everything that is of physiological origin.

- Behavior of exogenous origin (external stimulations). The exogenous origin concerns the environment and includes the spatio-temporal dimensions proper to it, but also the presence and activities of other individuals or groups of individuals.

These fundamental aspects are part of a "stimulus-response" pattern of cause and effect. Still, in order to understand the notion of behavior, a theoretical contribution can be made with regard to innately acquired behaviors. In the majority of cases, these are closely intertwined in the behaviors observed. Indeed, these coexist in our brain and are dictated by two parts of the brain. In the case of innate behaviors, they are located in the paleo-cortex (reptilian brain), while the acquired behaviors find their seat in the neo-cortex. We can thus define two main types of behaviors:

- Inborn Behaviors. Innate behaviors are dependent on the hereditary heritage of the species and are registered in the genes. These are all instinctive behaviors. Among these are the expression of emotions, a baby's instinctive behaviors, walking, and basic social recognition or communication behaviors. These are dictated by the reptilian brain.
- Acquired Behavior. The acquired behaviors result from various learning and experiences acquired during the ontogenesis of the individual.

Take the example of escalators in London. It is known that users are placed on the right side of the escalator one after the other so that the people pressed for time can take the left side. This behavior has been learned and is not innate. Let us take another example of queuing behavior that is no longer learned, but is innate. A given queue system is configured as a traditional queue (multiple queues in parallel). We know that as 90% of people are right-handed, the right queues have a natural tendency to fill more strongly than those on the left. It is as if most of us are driven by our right hand (this is the case when we shop). Now that these basic notions directly related to behavior have been developed, we can clarify what we mean by:

- Typical behavior of queues. One of the objectives of this work is the observation of typical behaviors of queues. By this we mean observing typical behavioral patterns that occur repeatedly in queues during field observations. [2] provides an example of a naturalistic observation approach employed to understand skiers' behaviors in cable cars queues in order to improve their overall satisfaction.
- At-risk queue behaviors. Once observing the set of standard behaviors of queues, one of the tasks will be to highlight the at-risk behaviors. By the notion of risk behaviors we mean behaviors that may have a negative impact on the issuer of the behavior or on its direct or indirect environment and which can also impact the image of the service provider.

3   Literature Review

Below is an overview of research that takes into account some behavioral aspects of queues. Maister [3] was one of the first authors to discuss the psychology of queues. [4] emphasized the importance of the control process and the announcement of wait times

in order to maintain a sense of justice in the queue. [4] proposes a variety of stress reduction mechanisms, such as providing clients with a wait-time forecast, or offering clients fast-pass options. These practical suggestions can help managers reduce perceived waiting time, improve the customer's waiting experience, and generally improve the management of the queue. [5] demonstrates that some elements, such as music or queue structure, if properly managed, can have a positive impact on perception of service expectation and satisfaction. The paper concludes with a comprehensive model, including all the elements that the authors judge to affect overall perceptions of service expectations. [6] shows that music or perfume can reduce the level of discomfort during a wait. The overall satisfaction level of the service therefore increases with the insertion of external stimuli during a queue. [7] highlights the importance of the relationship between the structure of the queue and the attitudes of clients. The authors suggest that individuals who wait in a serpentine queue system are more awakened than those waiting in a multiple queue system (i.e. traditional).

The authors also question the perceived anxiety about whether the service will be delivered according to expectations. [8] developed an econometric model to explain wait in services. The authors show that some independent variables such as the human factor and visual elements have a significant influence on the perception of clients' expectations. [9] describes waiting as a psychological experience. The authors of this paper find that the traditional queue can produce a sense of injustice, even if from an objective point of view there is no inequality. The authors showed that when the client perceives the service provider has control over the wait time, longer wait times will be more unpleasant. [10] examines the difference between actual wait times and wait times as perceived by the consumer, based on a case study. It becomes clear that there are different ways to reduce this difference, and that depending on the emotional state of clients, the perceived wait time may be longer or shorter. It is important to note that with the advent of new technologies and the Internet, qualitative research has also focused on the perception of waiting for online services with, for example. [11] studied the wait time tolerated when consulting websites. [12] highlighted through their study that a service involving a feeling of discrimination can lead to frustration and a sense of helplessness to the client. Finally, Hall [13], who developed proxemics, used to say that individuals tend to create an emotionally strong zone around themselves, which may also be described as an individual perimeter of security, like a bubble.

4   Methodology

There are two types of approaches in ethology to collect data: naturalistic observation and experimental manipulation. The naturalistic observation is made in a natural environment or in a reconstitution of it. Experimental manipulation is carried out in the laboratory and attempts to control all induced variables. Here, we solely employ naturalistic observation as an exploratory approach to discover behavioral patterns related to customer queues. The working tools used in naturalistic observation are primarily paper/pencil, but also photos, videos or even voice recordings. The basics of inquiry are always based on the following three precepts: to remain at a descriptive level, to determine what is observed and to develop an ethogram (catalog of behaviors in a

certain context). The research was carried out with customers attending supermarkets. The framework for large-scale food retailing was chosen for several reasons. Indeed, this sector is represented by large players daily engaged in a major competitive battle. Offering essential goods, these places have become essential and have to cope regularly with the large flow of customers. The clients waiting in line were observed by a unique person (one of the authors of this paper) according to the methods of human ethology. The idea of an ethological approach consists in a direct observation, with an outside and non-interactive observer, of the different behaviors encountered within the human species, here of the clients. Ethology, whose general characteristics have been developed in the previous section, seems to be a relevant and meaningful discipline for the researcher who wishes to understand the ecosystem of queues with the intention of describing related behaviors in a precise manner. The objectives mentioned in the preceding point can be achieved by the following three human ethological precepts: staying at a descriptive level; determining what is observed; developing an Ethogram. The subjects observed are the customers making their purchases in the selected outlets and who take part in a queue to pay a cashier for what they have bought. The observer is part of the group of customers waiting in line so as to be able to collect precise information concerning the queues and ensure that the observer is not encumbered by a visual obstacle. It is a participatory approach. The proximity to the group allows for better listening to the environing noise. Typically, the quality of the observations gathered depends on the mode of recording. Indeed, if the use of a video camera makes it possible to view the events later and to have a very fine screening, this technique offers only a two-dimensional view of the events and often requires additional lighting. Moreover, this type of equipment can have a disruptive role, especially with humans. A less expensive and simpler technique is used in this research: paper and pencil. It is well accepted in the field of ethology that paper and pencil are a relevant approach to make live observations and remain quite valid without requiring the intervention of more complex tools [14]. So, in sum, here are the main characteristics of the fieldwork undertaken for this study. We worked in two different locations (a small store and a large store). In both cases, queue configurations corresponded to the traditional line system; that is, multiple queues. The sampling technique adopted was "centration successive" (focal sampling): observation began as soon as the client entered the queue and continued until the client left the queue [15]. Sixteen immersion episodes (eight per store) were conducted, at 10 min each, on four Saturday afternoons (known to be four busy days). An observation grid containing pre-identified categories of queue behaviors was developed during a preliminary phase conducted in several commercial centers before the 16 formal immersion episodes. The transcripts of the 16 immersions episodes were encoded in the RQDA software (RQDA - R package for computer assisted qualitative data analysis) that allowed the grouping of similar data by coding the data in categories. This was used to produce tables containing typically observed queue behaviors.

In this case, there the two supermarkets observed will remain anonymous. This type of approach allows an in-depth understanding of the behaviors of individuals in relation to the complexity of the environment. Practically, the overall research design can be summarized in the three following phases:

Phase 1: Pre-immersion. The first step consists of a phase of exploratory observation or reconnaissance observation carried out according to unstructured sampling techniques. In this case, the most important and interesting elements were observed in the supermarket. This first exploratory stage allows for control of the environment studied, but also a familiarization of the observer with the main lines of behavior of the clients in the context of a queue, which allows a first "slimming". At this stage, it is the purchasing context of the customer that is taken into account and not just the queue item leading to a cash register. The advantage of this approach is not to carry out a reductive analysis limited only to the observation of the individual when he/she is in the queue, but rather to adopt a more global approach integrating the aspects related to the context in which the client has previously evolved.

Phase 2: In-depth Phase. The second phase consists of field observation work focusing on the behaviors present in the queues. This phase is possibly based on certain points highlighted during the previous phase, the exploratory phase. With regard to observations in the checkout queues, the client is considered observable for the typical behavior of the queues from the moment that the client goes to a queue until he/she leaves the cashier after collecting and paying for his/her purchases. Once these sixteen immersion episodes were completed, accurately collected and described observations were encoded into the computer for processing. The encoding and analysis of the data from the observation grids was carried out from the data processing system "RQDA-R package for computer assisted qualitative data analysis." Indeed, this software allows for the regrouping of similar data thanks to the coding of the data.

Phase 3: Realization of the Ethogram. Before developing this third step, it was first necessary to develop the term ethogram in order to have a complete understanding of the chosen methodology. Let us first recall that the ethological method differs from other methodological approaches, in particular by the importance it places upon the descriptive phase of the observation. This step involves the development of an ethogram that can also be seen as a repertory comprising the characteristic behaviors of an individual within a specific framework. In this inventory, behaviors are classified or deconstructed according to previously established behavioral categories. The implementation of an ethogram involving various risk behaviors allows for the implementation of appropriate managerial recommendations.

5 Findings

The analysis of the immersion transcripts has provided many detailed insights regarding queue behaviors. In this section, we present a summary of this analysis. Then, we illustrate the method by which we developed an ethogram of "at-risk" queue behaviors based on this analysis, which is in turn intended for decision-making purposes. There are several scenarios for arriving in a traditional queue. Some customers go directly to the cashier closest to them as soon as they leave the department, even if it is not the fastest queue. The majority of this type of customer is often distracted by a ringing mobile phone, a telephone conversation, listening to music, or sending messages. Other customers mark a brief stop with a head swing from left to right in order to

choose the queue they want to take part in (more marked in the large store). In the majority of cases, the client will take part in the queue that includes the fewest clients or the queue that is shortest in length. Some customers make detours without pause and head to a particular check-out counter. There are also customers who simply follow the customer who precedes them. The fluidity of the queue decreases during periods of high attendance at the check-out counter. In the off-peak period, too many check-out counters are open. The opening of an extra check-out counter is not always clearly communicated, and some customers are not even aware of it. Indeed, the green lights above the check-out counters are not very visible, and some cashiers do not systematically offer oral invitation to the customer to go to a newly opened queue when this is the case. Regarding specific observations conducted in the small store, arrival in the queue was sometimes more complex. The client did not always understand whether it was a single or multiple queues leading to several check-out counters. The queues took on the movement of an accordion, and their "rhythm" was dependent on the different periods of business activity and client behavior. Indeed, it has been often observed that the client moved from a "rest" state to an "active" state within the same queue. The customer took action to deposit his/her goods on the carpet, on receipt of goods as soon as they had been scanned, and also when paying for his/her purchases. The customer thus went through several implicit stages and was solicited periodically. Various behaviors can be observed at different stages of the same queue and for the same client. Most of the time, the client seems lonely, but some social behaviors may also appear. Various external events animated the ecosystem of the queue positively as well as negatively. No major incidents were noted. The customer often seemed to be "watching his/her back," looking at the moves of his/her eyes to the left and to the right. This was especially the case when a certain safety zone (in terms of distance between people) was not respected. Some clients also prepared their wallet, payment card, vouchers, etc., in advance. The shape of the traditional queue was generally a straight line. However, when an unforeseen element had to be taken into account, it became immediately more disordered. Signaling was good but did not easily allow the customer to leave the queue for one reason or the other (being regularly cluttered with shopping carts or shopping baskets of customers and thus making it difficult to maneuver). The client then had to clear a path to leave the queue. In Table 1, we present a formalized way of describing queue behavioral patterns based on our analysis along with frequencies (i.e., subjective probabilities). Then, based on formalized tables such as Table 1, we developed an ethogram (see Table 2) containing queue behaviors that we consider to be at-risk behaviors in terms of the overall service value perception. There are several forms of ethograms. However, most include a first column with the name of a typical behavior, followed by a column describing this behavior more accurately.

The value of our approach is really related to the logic of a preventive control (see below) in which mitigation triggers are based on the ethogram. The last methodological element used in this research project was preventive control (feedforward control) [16] for addressing human risks [17]. Preventive control allows the indicators coming from the ethogram to trigger the "mitigations" necessary to reduce emotional risks in the queue. According to the IIA (Institute of Internal Auditors, www.theiia.org), control means any action taken by management, the board or other parties to enhance risk

Table 1. Extract of inventoried behaviors ranked according to their frequency.

Category	Description of observed behaviors	Frequency
Reneging	The customer informs the cashier of being in a hurry and leaves the line without completing his/her purchases. The client leaves the queue because it does not advance fast enough and observes the other queues.	Rare
Overtaking	The customer leaves the line without informing the customers he/she plans to return later, then passes in front of the other customers.	Rare
Surveillance	The client seems to open his eyes and stretch his head to the left to assess the progress of the queue. The client keeps his/her bust straight. Customer turns head from left to right. The customer observes the maneuvers of the previous customer.	Likely

Table 2. An ethogram describing "at-risk" queue behaviors.

Category	Behavior	Description of expected behaviors
Distraction	Looking around	The client observes how the queue is moving. The client stares at the service provider.
Boredom	Getting impatient	The client glances at his watch repeatedly. The client taps fingers on the conveyor belt. The client taps foot on the ground.
	Switching lines	The client leaves his queue and takes part in another queue.
Dissatisfaction	Giving up	The client abandons the queue and leaves the store.
Frustration	Assaulting	The client verbally assaults another client because the latter misunderstands the signaling of the queue.
	Avoiding	The client returns to the end of the queue without complaining.
Nervousness	Getting upset	Under queue pressure, the client frowns.
	Fussing	The client scratches his head. The client plays with his car keys. The client actively searches in his bag.

management and increase the likelihood that established objectives and goals will be achieved. Control corresponds to an essential part of management and is comprised of four critical components: planning, organization, employee involvement and control (assuring the first three components). Risk control is a three-step process: 1. Definition of the objective; 2. Measuring the achievement of the target within the time limit; 3. The managerial corrective phase (do nothing if goal is reached, reconsider objective if too ambitious, set up risk mitigation treatments to increase the likelihood of achieving the objective). When control is corrective (i.e. feedback control), the managerial corrective phase is triggered on the basis of an objective measurement of the achievement

of the result; hence afterwards. When the control is anticipated (i.e. feedforward control), the actual measurement of the achievement of the result is replaced by a forecast of it. The actions of the corrective phase can therefore be taken more quickly, even before the deadline for achieving the target has been reached. A feedforward control can be presented as a process in three steps, as in the following example implementing the ethogram:

(1) Determining an objective related to the customer queue (e.g., maintaining a "relaxed" queue during rush hours);
(2) Analyzing indicators from the ethogram (e.g., diagnosis of too much nervousness in the queue);
(3) Triggering "mitigation" according to the level of the indicators (e.g., distributing glasses of water and orange juice in order to lower the "emotional temperature" and to get back to normal state).

Risk controls are easily programmed, thanks to their linear structure. However, the feedforward control compared to the feedback control is trickier since the anticipative indicators usually come from an expert. In our case, it would come from the ethogram, so it could be automated.

6   Conclusion and Further Research

The purpose of this research is to identify early signals to avoid a sudden increase of emotional temperature related to recurrent annoying experiences when waiting in line. The originality of this work is that at-risk queue behaviors were studied through human ethology. Ethology is the study of the behavior of living things (animal or human) in their "natural ecology". This discipline focuses on all of the factors that induce certain behaviors (stimuli, innate, learned…). Through naturalistic observation, we attempted to identify the typical behavior of customer queues: it was accomplished through observation of typical behaviors of queues occurring several times during our field observations. In view of this, the objectives set out in this paper were to observe different queues and to inventory the various behaviors, in order to be able to detect risk behaviors typically associated with waiting lines. Thanks to this early detection of at-risk behaviors, managers are able to implement adapted solutions to return the queue to a normal state. The fieldwork took place as follows: identification of the different types of queues, identification of analyzed behaviors, and grouping of these in an ethogram by sensorial qualification. Once these steps were completed, various emotional and physical mitigation tools were proposed. While we discovered that some clients were easily distracted, our observations also pointed out that not only can impatient behavior have a contagious effect on the rest of the queue, it may also lead to other risk behaviors such as change of queue or abandonment. Faced with these results, various managerial recommendations have been put in place to improve the management of queues. These include taking into account the context in which the customer makes his purchases, as well as the design of a single, personalized queue that meets the needs of the company. The organization of training seminars in human ethology to better understand customer behavior [18] also complements the proposed solutions, in

order to better know and manage the problematic object of this study. Finally, we show how preventive controls (feedforward controls) based on at-risk queue behavior ethograms can be easily implemented to practically mitigate the typical physical and emotional responses observed in the queues in order to avoid too sudden a climb in "emotional temperature". The main limitations of this work are that naturalistic observation corresponds to exploratory research and that the ethogram produced is not validated. So, our findings cannot be generalized. Nevertheless, this approach has enabled us to discover things that we are personally experiencing every day, and that if well addressed in a practical manner could improve the lives of customers. We intend in the future to study more collective behaviors, and not just individual behaviors observed in the queue, such as mimicry, contagion or crowd effects. Moreover, it would also be interesting to study the possible occurrence of new behaviors following the massive introduction of digitization in many outlets. This work could be complemented by a comparison between digital and traditional. We also intend to develop a research collaboration with an institute specializing in facial expression and body recognition technologies in order to automate our approach.

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