

# Influencing Ordering Behavior with Modifiable Algorithm Suggestions to Reduce Food Waste

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## Abstract

Over the last decade science has shown that our world must become more sustainable. The current research tries to take part in this and establish more information about the matter of food waste and possible interventions to reduce it. Therefore, an online study was setup to investigate the question if employees that are responsible for ordering meals for larger events overestimate the amount of food needed and if they are susceptible for an intervention to reduce the amount of meals ordered. The research did not find a significant effect of larger events leading to larger overestimations. The intervention, which used default suggestions made by a fictive algorithm, was successful in altering the amount of food ordered by the participants. No interaction effect was found. This research provides a cost-effective intervention to help willing companies and institutes to reduce the amount of meals ordered in catering services and overcome algorithm aversion.

Keywords: modifiable default intervention, food waste, catering, algorithm

Over the last couple of decades science has shown that the world must become more sustainable. Pressing issues such as climate change, food security and shortages of water supplies have shown that it is important to be ingenious with our resources. On a global perspective, one third of the food produced for human consumption is wasted (Stenmarck, Jensen, Quested, & Moates, 2016). Statistics about food waste in Europe show that in 2013 approximately 88 million tons of food have been thrown away, which can be divided into 173 kilos per person (Stenmarck et al., 2016). These statistics also show that the primary food waste is done by personal households (53%). However, the current research will focus on a smaller but still important niche of food waste, which is food services (12%).

Food services are facilities that provide workers, students, and normal households with food from a centralized kitchen. Services like these include canteens, catering and delivery services. Centralizing the food production can be very useful in terms of efficiency, however, it can also have negative consequences. Especially, food waste is a factor that could be increased by a centralized kitchen. Ofei, Werther, Thomsen, Holst, Rasmussen, and Mikkelsen, (2015) interviewed food service professionals of a Danish hospital about the topic of food waste. The food service professionals explained that a lack of flexibility in portion size makes it harder to avoid food waste. Additionally, they indicated that determining the accurate number of meals that are needed for bigger groups of people is almost impossible

without ordering too much or too less food. Therefore, they rather order in excess amount of food to not run out of food during the meals. These two explanations show that the system that centralized kitchens are working with is prone to produce food waste.

A study of Sonnino and McWilliam (2011) studied food waste in a Welsh hospital and discovered that almost 60 % of the food produced by the hospital kitchen ended up in the trash bin. After conducting an analysis of the potential reasons behind this, they found out that there was a strong correlation between bulk services and higher amounts of food waste. If the kitchen prepared meals for many people at the same time, the highest amount of food losses arose. Food service employees struggle with determining the right amount of food that needs to be ordered to satisfy a larger group of people. In avoidance of running out of food and disappointing customers, higher amounts of food are ordered than necessary.

Ordering the right amount of food for a larger group of people seems to be a challenging task for food service professionals. To get a more accurate prediction for the amount of food that is needed to be ordered, a more sophisticated analysis needs to be done, than the assessment of a human being. These kinds of analysis are already done in other work areas in which waste reduction is targeted. Such as the Waste Reduction Algorithm (WAR) that is used in chemical manufacturing processes (Cabezas, Bare, & Mallick, 1999). The WAR was designed to analyze different models of chemical processes to reduce potential environmental impact. It has been proven to be an effective method in reducing waste and environmental impact. Hence, conducting an analysis of the patterns of food waste and constructing an algorithm that could give a more accurate prediction of what is needed for a bulk service order could help food service professionals improve their ordering behavior.

Even though research shows that evidence-based algorithms predict the future more accurately than human forecasters (Meehl, 1954; Subedi, 2013), humans often decide to rather trust the human forecaster more than the algorithm (Pahl & Van Swol, 2017). This phenomenon is known as algorithm aversion. This effect occurs because humans have a higher tolerance towards mistakes made by human forecasters than made by an algorithm. Could this mean that even if an algorithm would be constructed to reduce food waste, that food service employees would not trust the suggestions that are made by the algorithm? Dietvorst, Simmons and Massey (2015) showed in their study that it is possible to overcome this algorithm aversion by making the suggestions of the algorithm modifiable. Making the suggestion modifiable gave the participants the feeling of autonomy back and made them more satisfied with the algorithm itself.

A closely related concept to the idea of giving suggestions to humans to alter their

decision making is the idea of default interventions (Opel & Omer, 2015). A default intervention is designed to influence humans during the decision-making process by making one choice more salient than the other. This is done by already selecting one of the choices in advance, giving the decision maker the feeling that this is the best option because it was selected by the designer of the decision-making process. One example of the use of a default intervention can be found in the research of Egebark and Ekström (2016). They conducted an experiment at a university where the participants either saw a moral appeal or were nudged by the default intervention to print double-sided instead of single-sided paper. The default intervention just consisted of changing the settings of the printer from single-sided to double sided prints, while the moral appeal was displayed in a short message towards the participants. While the morale appeal had no significant effect on the printing behavior, the default nudge reduced paper use by fifteen percent.

This introduction has introduced three problems that are relevant for society as well as science itself. The first problem is that humans and the system that they are living in has to become more sustainable, which is visible in the amount of food that gets thrown away every year. Secondly, while other working areas already have established algorithms to determine the exact amount of resources needed to manufacture a product, to reduce leftovers, this has not happened yet in the food service industry. And lastly, even if an algorithm is programmed to aid food service professionals in their decision making, it is unclear if these take over the suggestions. The cue current research tries to shine light on the last problem by asking the question: Is it possible to alter ordering behavior of people who order food for larger groups by the help of modifiable suggestions made by an algorithm?

Several interviews were conducted with food service professionals and other employees that are part of the ordering system to get more insights into how the ordering system works at the institution and to be able to simulate it more realistically. The ordering system itself is an online platform where mostly secretaries fill in their order for larger group meetings, workshops and other events. The interviews also confirmed the previous established link between bulk service orders and overestimations of how much food is actually needed. As subjective answers are not as reliable as empirical data, this research also tries to confirm the findings of the study of Sonnino and McWilliam (2011) that food service workers overestimate the amount of food that is needed.

To investigate the questions, do people who order for larger groups overestimate the amount of food that is needed and are they susceptible to modifiable default suggestions made by an algorithm, an online research was set up. The ordering process for a small and a bigger

event were simulated. The participants were instructed that they will see several emails that will ask them to order for a larger group of people, either 20 or 40 people. Additionally, to make the ordering simulation more diverse, participants were presented with three different lunch types that are similar in size. These emails were displayed in two blocks which were displayed for every participant and counterbalanced. One block did not contain any suggestions or further instructions. The other block would display a message, instructing the participants about the default suggestions that were made by an algorithm to reduce food waste that they were free to take over or not. The algorithm was not an actual algorithm, the default suggestions were made up by the researchers and were smaller than the actual number of people that were supposed to come to the event. Lastly, the participants were asked three open-ended questions about their opinion towards the help of an algorithm and about suggestions to further reduce food waste.

Based on the research of Sonnino and McWilliam (2011) it can be hypothesized that the number of people that have signed up for an event has an effect on the amount of meals ordered for the event. It is predicted that the participants will make an overestimation for the amount of meals necessary for the bigger event, but not so much for the smaller event.

Based on the research of Egebark and Ekström (2016) it can be expected that default suggestions made by an algorithm may help to reduce the amount of food that is ordered. As suggested by the study of Dietvorst et al. (2015) making these suggestions modifiable will overcome the algorithm aversion because the participants will get their autonomy back. It can be predicted that less meals will be ordered for the condition where suggestions made by an algorithm are included.

Based on previous hypothesis it can be hypothesized that an interaction effect occurs, between the size of the event and the strength of the effect of the default options made by an algorithm. It can be predicted that the effect is stronger for the larger event than for the smaller event.

## **Methods**

### **Participants**

For this online study, 31 Dutch people participated. All of them were employees of the Radboud University that regularly order food at the Radboud catering service. Due to anonymity, other demographics were not assessed. Ten participants had to be excluded because they did not complete the survey, which leaves 21 participants. They were recruited

through email and participated voluntarily, thus no compensation was paid for the effort. Since the design was within-subjects, all participants completed all conditions.

## **Materials**

In total, 15 questions were included in the survey. The participants had to fill in the survey on a computer or laptop. To ensure that participants correspond to the target population, a closed-ended question was displayed that asked whether the person ordered food at the Radboud catering service before.

The simulation of the ordering website was constructed with Qualtrics and aimed to resemble the ordering portal from the Radboud Catering service. This can be seen in Appendix A.

Furthermore, an instruction paragraph was used to ensure that participants understood the study. This paragraph explained to them that the experiment will simulate an ordering process of the catering service of the university webpage. Furthermore, they were instructed that prewritten emails will be displayed, asking them to order for a certain number of people and a certain type of lunch. Three different lunch types were presented for either a smaller event (group of 20 people) or a bigger event (group of 40 people). For the intervention, a short message was constructed that told participants that default numbers were filled in based on the evaluation of an algorithm to reduce food waste. This message was displayed separately to the instructions and the exact wording of the message can be found in Appendix B. It also explained that participants are free to take this suggestion over or not. The default numbers that were filled in in the boxes were different for the lunch types and events. For the smaller event, the default number for the 'werklunch' was 16, for 'lunch sousa' 16, 'ham broodjes' 9 and for 'kaas broodjes' 8. For the bigger event, the default number for 'werklunch' was 34, for 'lunch sousa' 36, 'ham broodjes' 18 and 'kaas broodjes' 17.

The dependent variable of the current research was the 'amount of meals ordered', which corresponds the number that participants filled in the boxes when ordering. The smaller this score, the smaller the amount of meals ordered, hence the smaller the amount of food waste presumably.

Lastly, 3 open-ended questions were included at the end of the questionnaire, which were about the perceived effectiveness of suggested numbers and own ideas about reducing food waste.

## **Procedure**

The questionnaire was administered online by means of the survey platform Qualtrics (<http://www.qualtrics.com>). The participants were asked per mail if they order food at the Radboud catering service and if they would be willing to participate in the questionnaire. The questionnaire was only accessible via computer. Before they could actually start with the experiment, they were asked to read the information letter and sign the consent form and indicate whether they previously ordered food at the Radboud Catering Service. Subsequently the participants were instructed about the idea of the questionnaire, without mentioning food waste.

The two conditions (with suggestion of algorithm/without suggestion of algorithm) were counterbalanced across participants. After the reading the instructions either the short message was displayed that explains them about the default numbers and the algorithm or they are immediately forwarded to the first round of emails and tables to fill in. In both conditions, six trials were presented that asked to order for either 20 or 40 people and for 3 different types of lunches. After these were finished, three open-ended questions were displayed. Lastly, the participants were debriefed about the idea of the experiment. The duration of the whole procedure was around 10 minutes.

## **Data analysis**

The dataset consisted of twelve trials, six control without suggestions and six experimental with suggestions. To prepare the dataset only the variable 'ham broodjes' and 'kaas brodjes' had to be summed up. Additionally, a check for normality and homogeneity was conducted.

To analyse the first hypothesis that larger orders lead to larger overestimations, only the data of the condition without suggestions was investigated. Two means were calculated: The first mean was calculated by adding up the summary of meals ordered for each lunch type for the event with 20 people and then divided by three because there were three different lunch type to get a mean for each separate event. The exact same process was done for the events with 40 people to also get a better insight into the average amount of meals ordered for one event with 40 people. The assumption of homogeneity and normality were both violated; therefore, a Friedmans Test was conducted instead of a GLM repeated measures test. The dependent variables were the average amount of meals ordered for the events of 20 people without suggestions and the average amount of meals ordered for the event of 40 people, also without suggestions. The mean for the event of 40 people was divided by two to standardize it

to the mean of the event with 20 people, because otherwise it would not be possible to compare the means.

The second hypothesis that default suggestions reduce the amount of meals ordered was investigated by calculating the mean of each type of event and with and without suggestions separately in the exact same manner as for hypothesis one. Additionally, the means were also divided by the number of people the participants were supposed to order for, to get more insights in the average amount of meals ordered per person. Both, the assumption of normality and homogeneity were not fulfilled, therefore the Friedmans Test was conducted to compare the mean ranks. The first analysis used the average amount of meals ordered for the events of 20 people with and without suggestions as dependent variable. The second analysis used the average amount of meals ordered for the event with 40 people with and without suggestions as dependent variable.

To test the interaction hypothesis, which stated that the effect of the intervention is stronger for different group events, a GLM repeated measures analysis was conducted with the means that were calculated to analyse the second hypothesis. Even though the assumptions of homogeneity and normality were violated a GLM repeated measures analysis was conducted, because this analysis is relatively stable with a within-subject design. The dependent variable was the average amount of meals ordered per event for each event. The independent variables were the size of the event and if suggestions were used or not.

## **Results**

The first hypothesis was rejected. The results showed that there was no significant main effect of larger events on larger amounts of meals ordered per event ( $\chi^2(1) 0,77, p = 0,782$ ). The average amount of meals ordered for the events of 20 people was 21.6508 ( $SD = 4.6013$ ) and for the event of 40 people 20.6905 ( $SD = 2.04823$ ), indicating that on average less food was ordered for the bigger event.

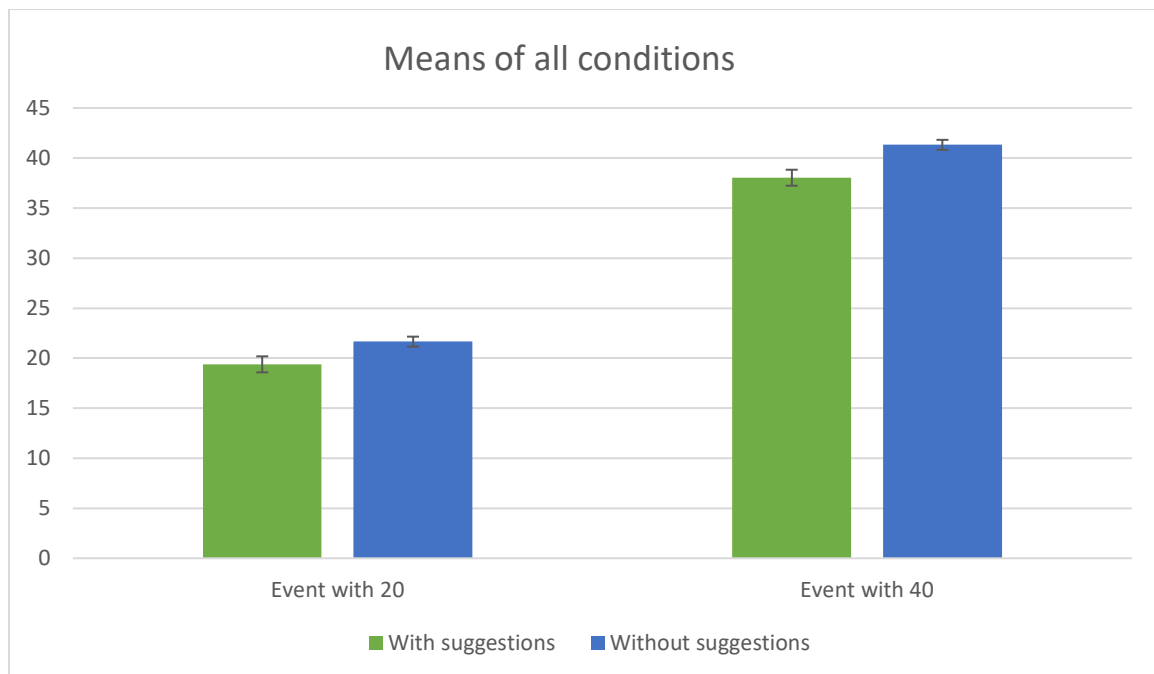
The second hypothesis was accepted. The results of the Friedmans Test show a significant main effect of default intervention with algorithm suggestions on the amount of meals ordered ((Smaller events:  $\chi^2(1) 5,556, p = 0,018$ ) (bigger events:  $\chi^2(1) 16,200, p = 0,001$ )).

### **Table 2.**

*Means, standard deviations, Minimum, Maximum and Mean Rank for amount of meals ordered for the smaller and bigger events without suggestions*

Variables	Measurements						
	<u>M per event</u>	<u>M per person</u>	<u>SD</u>	<u>Minimum</u>	<u>Maximum</u>	<u>Standard error</u>	<u>Mean rank</u>
S. E. with suggestions	19.3810	0.9691	3.0190	16.33	26.67	0.6588	1.26
S. E. without suggestions	21.6508	1.0825	4.6013	18.33	40.00	1.0041	1.74
B. E. with suggestions	38.0317	0.9508	1.5983	35.00	40.00	0.3488	1.07
B. E. without suggestions	41.3180	1.0323	4.0965	38.67	53.33	0.8939	1.93

*Note.* S. E. stands for smaller event and B. E. stands for the bigger event.



*Figure 1.* Average amount of meals ordered for event of 20 people with and without suggestions and for the event of 40 people with and without suggestions and standard error.

Looking at figure 1 it is visible that participants ordered less meals on average if they had default suggestions, which confirms the prediction that the participants are influenced by the default suggestions.

The last interaction hypothesis was rejected as well. The interaction effect of the size

of the event and with or without suggestions was insignificant ( $F(1, 20) = .576, p = .457$ ). This implies that the effect of the intervention did not change significantly if the event was for a larger group of people compared to a smaller group of people.

## **Discussion**

The current study aimed to investigate whether a default option suggested by an algorithm would make it possible to reduce the amount of meals that are ordered for a larger group of people. This was done by conducting an online experiment, in which participants went through a simulated ordering process. In the experimental condition default suggestions were used, supported by the information that these were produced by an algorithm. In the control condition no suggestions were made. The first hypothesis could not be confirmed. The main effect of the default suggestions made by an algorithm showed a significant effect on the amount of meals ordered. The interaction hypothesis was also rejected.

In contrast to the study of Sonnino and McWilliam (2011) and the research of Ofei et al. (2015) that indicated that food service employees overestimate the amount of meals necessary for larger groups, this study could not confirm these findings. It is important to note that without suggestions the participants ordered approximately the same amount of meals as people were coming to the event. This could imply that the participants rely more on the information given by the ordering emails instead of their own intuition. Furthermore, the research by Sonnino and McWilliam (2011) compared much larger events than the current study. It could be that the relatively small size of the events of the current research could not replicate the same effect as for much larger events.

The second hypothesis based on the study of Egebark and Ekström (2016) was confirmed by successfully implementing default suggestions made by an algorithm that led to a significant change in the ordering behaviour of the participants. The current study suggests that suggestions made by an algorithm could be effectively implemented in the ordering system of a catering service by using modifiable default suggestions. These findings could be useful for companies that want to shift from human forecaster to algorithms and influence their employees to take over the suggestions of the algorithm.

The research of Dietvorst et al. (2015) predicted that making suggestions made by an algorithm modifiable would decrease the aversion towards these suggestions. This study could confirm this prediction and was able to overcome algorithm aversion by making the suggestions made by the algorithm modifiable. It is important to mention that three participants answered in the open-ended question that they did not like the suggestions, but

still took them over. This means that even though some resistance towards algorithm suggestions was present, the intervention still had an effect. This replicates the study of Dietvorst et al. (2015) and adds additional knowledge towards overcoming algorithm aversion.

The interaction effect of the two main effects was found to be non-significant. This implies that the participants did not order significantly less food for larger groups when default suggestions by algorithm were present. The non-significant interaction effect could be a result of the first main effect also not being significant.

### **Limitations and future research**

The rather small number of participants (N=21) could give the conception that the current study did not have a high statistical relevance. However, the current study had a within-subject design which has a high statistical power and typically requires less participants. Furthermore, the sample of 21 participants is also a relatively high percentage of the total population of employees at the Radboud University that order food regularly (N ≈ 60). Because this study was done with employees of the Radboud University and based on the ordering system of the Radboud University it is important that it cannot yet be generalized to other ordering systems. Therefore, future research should try to replicate this study in a field setting with other food services or centralized kitchens at other universities.

Another limitation is that from the results of the study one can only conclude that the amount of meals ordered can be reduced with the default intervention. Even though this suggests that also less food could be wasted because of this, no empirical data about actual food waste could be collected. The study was done during the COVID-19 pandemic and the researchers were therefore not able to collect actual empirical data. Future studies could replicate this study in a field setting and verify if reducing the amount of meals ordered reduces food waste.

To summarize the findings of this study: Implementing modifiable default suggestions that are supported by an algorithm successfully lowered the amount of meals ordered by the participants. Even though science has not yet developed algorithms to reduce food waste this research sheds light into how humans could be nudged to be more likely to take over suggestions made by such an algorithm. This is especially important, because increasingly more algorithms take over the job of human forecaster (Harvey, Smith, Goulding, & Branco Illodo, 2020); Velásquez-Barrios et al., 2019) and many humans have shown to have an aversion towards the suggestions of these algorithms (Prah & Van Swol, 2017). Companies

and institutions that aim to reduce food waste could make use of this simple and cost-effective intervention to potentially lower the amount of resources wasted.

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## Appendices:

### Appendix A

Instructions about the simulated ordering process, emails composed to ask the participants to order for the fictive events and the ordering table with and without suggestions:

#### Instructions:

De procedure tijdens het experiment is zoals die wordt gevolgd:

De hele procedure probeert een levensecht bestelproces te simuleren. Daarom krijgt u een e-mail te zien waarin u wordt gevraagd om eten te bestellen voor een groep mensen. Daarna ziet u een tabel met voedselopties van het Radboud-menu.

Op basis van de e-mail plaatst u de voedselkeuze die u bestelt zoals u dat in het **echt** zou doen.

De hele procedure duurt ongeveer 15 minuten.

#### Translation

The procedure during the experiment is as followed:

The whole procedure tries to simulate a lifelike ordering process. Therefore, you will receive an email asking you to order food for a group of people. Then you will see a table of food options from the Radboud menu.

Based on the email, you place the food choice you order as you would in real life.

The whole procedure takes about 15 minutes.

Email for event of 20 and 40 people:

Hallo,  
zullen we een bijeenkomst hebben waar **20 mensen** zich aanmelden. Kun je de **werklunch** voor ons bestellen. Bedankt.

Met vriendelijke groet,  
Mr. Jansen

#### Translation

Hello ,we'll have a meeting where 20 people will sign up. Can you order the working lunch for us. Thank you.Yours sincerely,

Mr. Jansen

Hallo,  
 zullen we een bijeenkomst hebben waar **40 mensen** zich aanmelden. Kun je de **werklunch** voor ons bestellen. Bedankt.

Met vriendelijke groet,  
 Mr. Jansen

Translation

Hello, we'll have a meeting where 40 people will sign up. Can you order the working lunch for us. Thank you. Yours sincerely,

Mr. Jansen

Ordering table with suggestion

	Hoveelheid			
	Werklunch	Lunch Sousa	Ham broodjes	Kaas brodjes
Hoveelheid	<input type="text" value="16"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>

Ordering table without suggestion

	Hoveelheid			
	Werklunch	Lunch Sousa	Kaas broodjes	Ham broodjes
Hoveelheid	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>

Translation:

Hoveelheid = Amount

Werklunch, Lunch Sousa, Kaas broodjes and Ham broodjes are the different lunch types

## Appendix B

### Instructions about the suggestions made by an algorithm:

De volgende 6 tabellen bevatten **suggesties** die door een algoritme worden gedaan. Dit algoritme is ontworpen om **voedselverspilling** te verminderen en om slechts zoveel te bestellen als nodig is.

U kunt deze suggesties overnemen, maar dat hoeft niet.

### Translation

The following 6 tables contain suggestions made by an algorithm. This algorithm is designed to reduce food waste and to order only as much as necessary.

You can take these suggestions on board, but you don't have to.