FROM QUANTIFICATION TO REDUCTION - IDENTIFICATION OF FOOD WASTE REDUCTION STRATEGIES IN PUBLIC FOOD SERVICES

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SUMMARY: Public sector food services are a major contributor to food waste generation in Sweden, with schools, preschools, elderly care homes, hospitals etc. producing approximately 70 000 ton of food waste per year. Sweden already has appropriate infrastructure for treating this waste to recycle nutrients and energy, but there is still great potential to move up in the waste hierarchy and prevent waste. A first step on the path to achieving waste reduction is to quantify the waste, in order to get useful statistics on which to base the design of waste-reducing actions. Since the municipality of Sala has already been investigated and analysed regarding the quantities of food waste it produces, this follow-up study investigated how the whole municipality can move from waste quantification to successful waste reduction. The material used comprised quantified volumes recorded by the municipal catering organisation in Sala from 2014 to 2017. These data were combined with interviews with managers and with staff in the kitchens that had achieved the greatest reduction in waste during the study period, in order to identify successful food waste reduction measures. From the results, two general tactics for waste reduction were identified; a trial and error tactic imposing the same actions on all kitchens, irrespective of their food waste volumes or potential problems, and systematic improvement of individual kitchens through actions based on their specific problems and conditions. Systematic improvement was found to be the most efficient for the individual kitchen, but since very few kitchens actually employed this tactic it had only minor effects on the whole organisation compared with the trial and error approach.

1. INTRODUCTION

Public sector food services are a major contributor to food waste generation in Sweden. According to the Swedish Environmental Protection Agency (2016), public food services, including schools, preschools, elderly care homes, hospitals etc., generate approximately 70 000 ton of food waste per year, which is roughly the same amount as all other food services such as hotels and restaurants combined. Since landfilling of organic waste is forbidden in Sweden (Ministry of the Environment and Energy, 2001), this food waste is mainly managed through anaerobic digestion, and to some extent through composting. In a global perspective this must be considered a fairly advanced waste management, but this recovery option is still far from the waste reduction strategy identified as the highest priority in the EU Waste Framework Directive (EC, 2008). Moreover, the environmental benefits of producing biogas are much lower than the potential benefits of preventing food waste or of using it for higher priority valorisation options and thereby replacing more resource-demanding products and services (Eriksson et al., 2015; Eriksson & Spångberg, 2017).

A first step in reducing food waste is to start quantifying it, in order to facilitate systematic improvement actions that lead to waste reduction. In a previous study (Eriksson et al., 2017), we quantified the food waste from 30 public sector food services in the municipality of Sala in Sweden. In this follow-up study, we investigated whether, and to what extent, waste quantification has led to concrete waste-reducing measures in the municipality. The objective of the present study was describe developments based on more recent quantifications, identify where major improvements have occurred and identify examples of actions taken that explain these improvements.

2. BACKGROUND

In the EU, about 90 Mt of food are wasted every year (EC, 2010). Food waste has been the focus of several studies and projects, but more research of better scientific quality is needed. To our knowledge, only Kallbekken et al. (2012, 2013) have used an experimental set-up aiming at reducing food waste. They tested nudging in 52 Norwegian hotels using two intervention groups (reduced plate size; or a sign stating that guests can help themselves more than once) and one control group. Each intervention resulted in food waste being reduced by approximately 20% ($p<0.001$).

Other studies have performed interventions in food services, but with inconclusive quantitative results in terms of waste reduction (WRAP, 2011; Barr, 2015; Björklund, 2015). In WRAP (2011), three interventions (improving familiarity and appreciation of school meals; improving the dining experience; and meals cooked to advance orders from the children) were tested in 39 schools and were found to lead to a 4% waste reduction, but this decrease was not significant. In Barr (2015), the LEAN philosophy (a systematic method for elimination of waste within manufacturing systems) was introduced to reduce overproduction and thereby food waste in public school canteens in Sweden, but the project was unable to demonstrate any reduction in food waste due to insufficient waste quantification. In a Swedish project study, Björklund (2015) tested ‘educational meals’ intended to raise awareness among pupils about sustainable development, including reduced food waste, but since food waste was not measured before the project, no statements regarding the effect could be made.

In most scientific studies of food waste the measurement period has been short, ranging from two days to about a month (Barton, 2000; Engström et al., 2004; Sonnino et al., 2011; Martin et al., 2014; Byker et al., 2014; Katajajuuri et al., 2014; Betz et al., 2015). In a survey in Sweden, only half the participating schools measured their waste for at least one week per

semester (School Food Sweden, 2013). A literature review by Møller et al. (2014) as part of the EU-FUSIONS project found that quantification periods are very seldom longer than a year. This may lead to inconclusive results and makes it impossible to investigate long-term effects.

There is strong justification for focusing on lowering food waste within the public sector in general, and in school restaurants in particular. Food service organisations, i.e. restaurants within the public sector such as schools, are large producers of food waste (Goonan et al., 2013) and municipalities need knowledge and support if they are to lower their waste (Boij, 2013). With a few exceptions, it is obvious that the literature does not contain data for long quantification periods combined with waste reduction measures. Even in our previous study (Eriksson et al., 2017), the full potential of the data was not exploited for this purpose. However, in Sala municipality there has been a change in how waste quantification is conducted, a change that was not captured in the more static middle period analysed in Eriksson et al. (2017).

Sala municipality started to conduct food waste measurements according to the current method back in spring 2014. It started with 15 kitchens participating in food waste quantification, measuring waste in different categories and number of portions served. The number of kitchens participating in quantification gradually increased to cover all kitchens within the municipal area by autumn 2015. Since then, all kitchens in Sala have continued to participate in waste quantification. The number of quantification days has undergone a similar change, starting with 5 days per semester in spring 2014 to autumn 2014 and expanding to around 20 days per semester from spring 2015. By spring 2015, all the participating kitchens had also started to measure how much food they produced and served.

The first quantification periods involved only half the total number of kitchens and data were only collected for a brief time. However, Sala municipality established the ambition to follow up on food waste in all kitchens and to provide more reliable statistics, which is why the number of kitchens was increased, as well as the number of quantification days in each period.

Since autumn 2015 onwards, the numbers of kitchens and quantification days have remained more or less the same, with minor changes in participating kitchens due to rearrangement of the organisation increasing or decreasing the number of kitchens.

Various measures for reducing waste have been tested. During autumn 2015, the municipality took away the third lunch option in kitchens serving three alternatives, in order to see what impact this action would have on overall food waste. During spring 2016, a “kitchen’s alternative” option was introduced into the menu, in order to give the kitchens more flexibility to handle their overproduction by making leftovers on a regular alternative. The municipal authority also encouraged the kitchens to try local actions based on their own knowledge, as an complementary measure to reduce food waste in individual kitchens.

3. MATERIAL AND METHOD

3.1 Description of the study material and data collection

The material for this study comprised data on public catering services in Sala municipality, representing all kitchens managed by the municipal public catering department. The material differed to some extent from that presented in Eriksson et al. (2017) in that the period covered by the data was spring 2014-spring 2017, compared with autumn 2014-spring 2015 in Eriksson et al. (2017). However, quantifications were still only conducted for lunches, although preschools serve snacks and sometimes breakfast, and elderly care homes serve breakfast and dinner. The quantification periods were selected by managers at Sala municipal authority, in order to find periods in the middle of the semester with full activity in the kitchens, resulting in

just a few days' interruption due to external activities or holidays. Thus the selection of quantification periods might have had an influence on the results and they might not necessarily be representative of the rest of the year. The other difference is that some of the data gaps present in the material analysed in Eriksson et al. (2017) have now been filled, which means that the results covering the same period are to some extent different.

The food waste quantified was categorised into three main categories and several sub-categories. Waste from beverages was not recorded or quantified. The main data collection was performed by the kitchen staff using electronic scales (of any sort available in the kitchen), pen and paper for making notes and an Excel spreadsheet to report the mass of food waste. A new way of reporting mass of food waste and information about number of portions served was introduced during the quantification period for spring 2017, which focused on collecting the information manually via an internet service (Matomatic, 2017) as an alternative to paper and pen or Excel spreadsheets. Seven of the kitchens used this alternative for data collection.

The mass of each category was reported together with the mass of food prepared (for which measurement started in spring 2015). For the latter, only one unit of the food prepared was weighed and the other units were assumed to have the same mass. For sauces and soups, the volume was quantified and translated to mass with the assumption that all food served had a density of 1 kg/dm^3.

To estimate the number of portions served, the number of plates used by guests was counted every day. It is possible that some guests used more than one plate, but this was considered a minor source of error. The internet service (Matomatic, 2017) used by seven of the kitchens for reporting data was also used for analysing the data for all kitchens after importing all the Excel spreadsheets into the same database. This quantification tool was primarily used to generate figures and key statistics that were communicated back to the kitchen staff, but it also generated a database with all quantified data used in the present study.

3.2 Analysis

There are two quantification measures that have always been used in the quantifications, waste quantification and number of portions served. These two measures are fairly exact and easy to measure compared with quantification of mass of food served, which is estimated and extrapolated as described above and also not performed throughout all quantification periods. This study therefore focused on the key statistics derived from the data collected on waste quantification and number of portions served, i.e. waste per portion.

In the collected data, there were some missing values. Cases with missing values were excluded from the relevant parts of the analysis, i.e. only days with complete data were included in the calculation of waste per portion. Waste per portion was calculated individually for kitchens, but also aggregated for the whole municipality, giving key statistics on the average waste per portion per kitchen and also the waste per portion for the whole municipality per quantification period. To determine the range of performance of all kitchens, the maximum and minimum waste per portion per quantification period were calculated.

3.3 Identification and impact of actions

One of the waste-reducing measures that was implemented in spring 2015 was feedback of the data to the kitchens. This feedback was provided in the form shown in Figure 1, with a set of diagrams presenting different results structured in a printable sheet sent out to each kitchen. The kitchen staff were then expected to analyse the data, identify their individual problems and take actions appropriate for their specific conditions (and corresponding to their level of interest and engagement). However, the staff did not receive any specific training in data analysis or

improvement management to conduct this work and were not given any kind of incentive or recompense to perform this additional task.

Figure 1: Example of the feedback diagram from a single school canteen visualising food waste quantification that was sent to individual kitchens (since the figure is in its original form, the text is in Swedish). The top graph shows waste per portion for each day, together with number of portions served. The lower left diagram shows the percentage waste for each category of meal in relation to mass served, and the lower right diagram waste per portion for each semester during 2015-2016.

To identify the actions the management team took on an overall level, the manager in the relevant municipal department were interviewed about the kind of food waste-reducing actions they took, and when. The effect of these actions was analysed by comparing the average waste per portion for the semesters in which the action was implemented with the corresponding value in previous semesters.

Waste-reducing actions in individual kitchens were identified by comparing the mean value of waste per portion for the last two quantification periods with that in all previous periods. The kitchens with the greatest relative decrease in waste in comparison with previous periods were identified (Table 1). Staff in the two kitchens with the greatest decrease in waste during both semesters were interviewed to identify what actions they had taken, and why. The effect of the actions was then analysed using the same method as for the whole organisation, i.e. by comparing the waste per portion in the semester with the measure implemented with the waste per portion in semesters without the measure.

Table 1: Kitchens in Sala municipality with the greatest relative decrease in waste in comparison with the mean value of previous periods

Kitchen	Relative reduction, autumn 2016	Kitchen	Relative reduction, spring 2017
Björkgården elerdly care	-23%	Möklinta primary school	-26%
Ösby secondary school	-24%	Ösby secondary school	-31%
Ekeby Elderly care	-29%	Klockarbo pre school	-33%
Salbo pre school	-39%	Varmsätra primary school	-34%
Västerfärnebo pre school	-40%	Salbo pre school	-63%

4. RESULTS AND DISCUSSION

On average, 72.4 g waste per portion served was wasted in the municipality as a whole during all quantification periods. This is lower than the average reported in our previous study (75 g waste per portion) (Eriksson et al., 2017). The data cover five more quantification periods, falling both before and after the quantification periods in the previous study. Another contributing factor was the correction of some faulty data after the previous study. However, since the present study also relied on data collected by users, some caution is needed when interpreting the results. In this case, more data altered the results and gave more findings regarding the change in the key statistic, waste per portion.

At the start, the managers just wanted to have underlying data on how much food was wasted and it took a year before they started to work with feedback and present the data to the different kitchens. Since then, feedback has been presented to the kitchen staff every semester. In order to try and reduce food waste, common actions were later implemented for all kitchens, and the managers also encouraged all kitchens to find their own food waste-reducing actions.

Overall, the quantification periods in Sala municipality can be divided into different phases: i) start of quantification, when the methodology was being developed and kitchens started to participate; ii) quantification with feedback, when the kitchens started to get back the results from their data collection; iii) implementation of common actions set by the managers; and iv) implementations of actions by individual kitchens. This is an interpretation of the periods presented in Table 2 and highlights how long it takes from starting to quantify food waste to actually see measures being implemented at different levels.

Table 2: Change in amount of food waste per portion over time and information on actions introduced by managers and individual kitchens

Period	Waste/portion (g)	Number of quantification days	Number of kitchens	Action implemented by managers	Successful actions taken by individual kitchens
Spring 2014	74.0	5	15		
Autumn 2014	70.1	5	21		
Spring 2015	75.9	22	23	Feedback	
Autumn 2015	72.8	20	30	Fewer lunch options	
Spring 2016	71.9	19	30	Flexible lunch option	
Autumn 2016	71.3	20	31		Making lunchboxes, optimised portion size
Spring 2017	71.4	19	30		Making lunchboxes, optimised portion size

Through first quantifying and later making extensive quantifications and providing feedback, the municipal authority has been slowly but surely decreasing food waste per portion for the municipality as a whole (Table 2). Several factors can explain this slow but steady progress. One is greater awareness of the issue of food waste among staff as a result of the feedback provided, another is implementations of general solutions set by the public catering managers at the municipal authority level. One such solution was to reduce the number of lunch options served, which was implemented in autumn 2015, and to some extent lowered the total waste per portion for the whole municipality. Another action set by the managers was to allow kitchens to serve a “kitchen’s option” (i.e. leftovers), which was implemented during spring semester 2016. However, this action did not have a marked impact and only lowered the total waste per portion by a fraction compared with the previous quantification period. The managers were trying to find ways to reduce the food waste, but since they did not have full insights into conditions in every kitchens and since individual kitchens responded very differently to the various attempts, the managers tried different approaches and examined the effects. This top-down tactic to implementing food waste-reducing actions can be categorised as a trial-and-error approach, since it focuses on general improvements that are later evaluated, but does not set out to solve a specific problem in a specific kitchen.

Figure 2 provides information about the maximum and minimum amount of waste per portion recorded per semester in the participating kitchens. The area between the lines in the diagram shows the range of performance for kitchens in the municipality in terms of waste per portion. As can be seen, starting with a fairly large spread it narrows down over time. It should be borne in mind, however, that the first two quantification periods did not have as comprehensive data as the following periods, which makes the results for the first two periods less resilient. For example, the abnormally high maximum value for autumn 2014 was caused by a kitchen that had an exceptionally bad week or erroneous data. This emphases the value of longer quantification periods in order to smooth out such fluctuations.

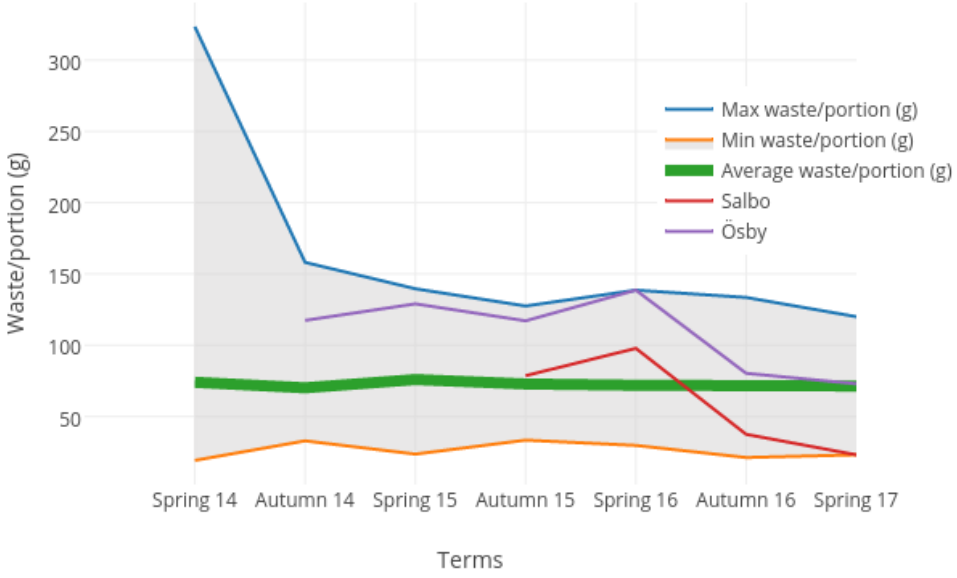

Figure 2: Change over time in the maximum, minimum and average food waste per portion in all kitchens, and in two individual kitchens.

Figure 2 also shows the average waste per portion for the whole municipality and for two kitchens that took the step of implementing their own actions in combination with the actions set by management to reduce food waste. Those two kitchens shared one vital characteristic, in that they found a major cause of food waste in their specific kitchen and implemented a solution suitable for their specific conditions. We categorised this type of strategy as systematic improvement, since the actions were based on some type of problem definition for the individual kitchen. The specific problem was then solved by implementing a solution designed to fit within the specific conditions and opportunities in the kitchen, and it was possible to quantify the effect using subsequent waste quantification data.

The actions that the kitchens took in autumn 2016 had a strong impact on their waste per portion (Figure 2). In the case of Ösby, which decided to make lunchboxes from overproduced food and sell it to students, it went from being the kitchen which had the most waste per portion in spring 2016 to close to the municipality average in the succeeding period. Its situation is quite unique, however, since it is the only boarding school within the municipality, so it would not be easy for other kitchens to copy its action and expect similar results. However, it should be possible for other kitchens to find similar alternative uses for their leftovers.

Salbo, a small preschool, showed a similar trend in waste reduction to Ösby, but the reason in its case was a change of personnel in the beginning of autumn 2016, with the new staff being very committed to food waste reduction. They introduced a new way of working which included very accurate calculation of portion sizes and the number of pupils/staff present every day. The staff had not looked at the results from previous quantification periods when they started quantification in autumn 2016, but still managed to perform very well, achieving slightly above the minimum waste per portion for autumn 2016. In spring 2017 they managed to perform even better and ended up with the lowest waste per portion within the whole municipality.

Despite the encouragement from management to try out their own solutions, only two of 30

participating kitchens managed to find feasible solutions that successfully reduced their food waste for more than a single quantification period. Feedback on food waste is a good start for problem analysis, but it is obviously not enough for most kitchens to find suitable food waste-reducing actions. More help is needed in order to find measures that work individually for the broader spectrum of kitchens. One solution could be to implement faster feedback loops when using an internet service as the data collection tool and to require all kitchens to use this way of reporting data. This would allow the kitchens to get feedback in real time, instead of once per quantification period. Other alternatives could be to introduce pay rises for kitchen staff who contribute to reducing waste, in order to incentivise a wanted behaviour. However, this needs to be investigated further in terms of its efficiency.

5. CONCLUSIONS

Two waste-reducing strategies were identified in this study, a trial-and-error approach in which general measures were introduced from above and a systematic improvement approach where individual kitchens identified their own problems and solved these based on their opportunities discovered through feedback from food waste quantification.

Proper food waste quantification in terms of complete datasets, which act as the foundation for feedback to each kitchen, can help food service organisations reduce their food waste. Feedback is essential for individual kitchens to identify solutions to their specific food waste situation, but most kitchens also need help in designing suitable food waste-reducing measures. General solutions for reducing food waste have an effect, but the greatest potential lies in resolving the specific problems and exploiting the opportunities of every single kitchen. Feedback is important to give kitchens an indication of how they are performing over time and to raise awareness of how to address their specific problems and the action they need to take to minimise their food waste.

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