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REQUIREMENTS AS OPERATIONAL METRICS? – CASE: FINNISH DEFENSE FORCES

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Abstract
The purpose of this paper is to study how requirements management could be utilized in connection to a service performance measurement system. Public private partnership (PPP) in Finnish Defence Forces' (FDF) catering operations is studied as a case example.
There are two research questions, which are studied: Firstly, do catering operations create KPI's, which enable inter- functional co-operation and service development? Secondly, do these KPIs support both efficiency and effectiveness of PPP catering operations?
Evidence from the previous studies on the subject indicates that there should be a single "power-by-the-hour" metrics unit, which enables a transparent follow-up of the performance-based operations. This research highlights requirements value in creation of economic efficiency and effectiveness from the end-user point-of view and reciprocal value creation between inter-functional service systems. This research's results show that focus on portion control can produce information, which enhances inter-functional co-operation between PPP stakeholders.

Keywords
requirements management, performance based logistics, catering operations, public private partnership.

Introduction

Role of privately operated, previously public functions have increased their importance in Europe during the last decade. Over the past 25 years there have been more than 1300 public private partnership (PPP) contracts in EU worth more than 5 million [1]. Purpose of the PPP is to reduce costs, enhance efficiency and transfer operational risk in the operations previously run by public entity by transferring these functions to a privately run entity/company [2]. PPP is a widely studied subject but still questions referring to responsibilities, overall roles of these profit generating enterprises and most of all management of the relationship causes debate. This debate reflects the ideological background of the debate participants and easily takes the focus out of the possible, proven benefits of the PPP [3]. This research highlights requirements value in creation of economic efficiency and effectiveness from the end-user point-of view and reciprocal value creation between inter-functional service systems.

In this paper there are two research questions, which are studied: Firstly, do catering operations create KPI's, which enable inter- functional co-operation and service development? Secondly, do these KPIs support both efficiency and effectiveness of PPP catering operations?

The purpose of this paper is to study how requirements management could be utilized in connection to a service performance measurement system. Two variables representing financial requirements and customer requirements have been chosen: financial value per dish or ingredient and energy value per dish or ingredient.

Concept of Key Performance Indicators (KPIs) was introduced by two Harvard professor Robert Kaplan and David Norton already 1992 [4]. Purpose of

the KPIs is to measure non-financial metrics and add them to the more traditional financial metrics while assessing company's results. A decision to use KPIs in the service operations' development is a quite natural one. Having said that, there are service specific features, which must be taken in to consideration.

According to [5], services are produced and consumed simultaneously. Therefore there is a real risk that predefined KPIs do not reflect the actual production/consumption process. KPIs in the form of requirements increase transparency and offer an unambiguous form of communications between stakeholders. More precise, but simple customer centric outcome metrics enable development of operations without compromising each stakeholders predetermined goals. This demands a structured mechanism to gather, collect and analyse these goals and use of requirements management can improve these processes. Further more, well-defined requirements contribute to the service operations management development relevant disciplines, such as strategic management, organizational behaviour and service marketing.

PPP requires a management model or an approach, which combines service production, transparent metrics in a form of requirements and interfunctional process management. Performance based logistics is a system, which focuses on the outcome of the service processes which value is always defined by the beneficiary of the service product [6, 7]. Outcome of the service processes should be in the form of pre-defined requirements. Results from the earlier researches indicate that requirements management enhances the overall effectiveness. Goal oriented requirements management steers sub-system development and management and reduces individual subsystem development at the cost of the common goal [8, 9]. Management model is scalable to other industries than one research here, but there must be a high contingent operations' awareness. Development requirements must be formed to suit existing operational production environment and process beneficiaries.

Public Private Partnership

A Public private partnership exists when a public authority is transferred to private sector. This authority transfer fulfils private and public outcomes previously offered by a public entity [10]. In PPP a long-term goal is to increase public service efficiency by using private service provider [1]. In PPP the whole life-cycle of the contract is linked to the several metrics such as quality of the service delivered and level of the service delivered [11]. These metrics should enable constant follow-up and development in a way, which can help to negotiate performance based contracts. Metrics should be transparent and both risks and rewards should be shared following the basic principles of the PPP, illustrated in the Table 1.

Table 1
Public Private Partnership.

Wang, 2009, p. 779 [12]	"... partnerships, involves a far more intensive interaction (or synergy), which requires strategic collaboration and inter-tangled action between the public and private parties from the very beginning of a project. In a partnership, two parties conduct joint decision making and specify the problem, solution, and product in the joint process."
Demirag et al., 2012, p. 1318 [2]	"... involves the public and private sectors sharing the risks and rewards on clearly defined projects financed by the private sector."

As reference [11] research's results showed, diversity in PPP has increased during the past years. Part of this change is also witnessed in Finland. A public entity, Finnish Defence Forces (FDF) has formed strategic PPPs with several private operators [13]. One of these strategic partners is Leijona Catering, which runs all the catering operations on behalf of the FDF.

In a PPP all financial rewards should be tied to any contract extension or renewal to contractor's achievement [14]. Controlling and monitoring process of the partnership should respect both parties and measures should be as neutral as possible. Efficiency should be measured in a way that the principle described by Doerr et al. (2005, p. 167) is met:

"Are purchasers sufficiently rational and careful, and the quality of the service sufficiently definable and measurable, that effective, informed consumer sovereignty can be exercised?" [15].

One should bear in mind that in their research by [16] bring to a readers attention a fact that benefits of privatization are not clear-cut.

Performance based logistics (PBL) – a service management model in a military context

Service as a research discipline is very fragmented and development of services requires a multidiscipline approach [9]. One of these approaches (in

military context) is PBL, a combination of several logistics function [17]. Each of these logistics functions/services and the whole service system requires a measurable outcome, a KPI. These intra-entity and inter-entity KPIs form the service system measurement network. Therefore management and development of a PBL system requires a goal given in the form of requirements and embedded network, as work by [4] and [18] shows.

In performance-based logistics (PBL) responsibility of the product/service system management is on a supplier of the system, unlike in the traditional end-user – supplier relationship [19]. In PBL according to Berkowitz et al. (2003, p. 5):

"...contractual mechanisms will include long-term relationships and appropriately structured incentives with service providers..., to support the end user's (warfighter's) objectives." [20].

In PBL a customer buys predetermined outcomes. These outcomes are dependent on and simultaneously vulnerable to outcomes of sub-systems. This interdependency is similar to the service systems and demands close co-operation among the whole supply chain [21]. A widely used example of the PBL is the case of Rolls-Royce. Rolls-Royce built a contract model in which a fixed price per flying hour covered all the maintenance and spare parts. This made it possible to predict the cost of the service and reduced the uncertainty of the purchaser [9].

Efficient PBL operations demand a completely transparent set of simple, realistic, consistent and easily quantifiable metrics [6]. They should support all the operations and take into account all the stakeholder groups participating to the service production [3]. Therefore a traditional customer centric service development perspective is not fully valid notwithstanding research by authors such as [5, 7, 22, 23].

In our case example FDF purchases an outcome of the service, provided by the catering operator Leijona Catering. There are two outcomes of this service purchase: firstly, FDF fills it's obligation according to national legislation to offer nutrition to every serviceman and secondly service supports the individual capabilities of a single serviceman by providing a necessary nutrition and energy [24]. These outcomes form the base for the service requirements.

Requirements management

Requirements are either qualitative or quantitative properties, characteristics, expectations of the product or behaviours of the product [25]. Use of requirements management in the service development is almost self-evident. Because a value of the service is defined by the beneficiary as described by [7] this value is evaluated not how something is done but what is the outcome of the obtained service. In PBL services are defined in terms of results rather than how results are achieved. Therefore there is a need to use standards, which measure performance a system must conform in a form of requirements [26, 27].

Research design

Evidence from the previous servication studies indicates, that there should be a single "power-by-the-hour" metrics unit, which enables a transparent follow-up of the operations [28]. Purpose of the empirical research was to find statistically valid KPIs, which would meet customer, buyer and end-user requirements. In the study catering operations were defined as a supporting function for the military. This notion gave a clear framework to catering services in a military capability development framework, as stated by [29]. Although catering operations function in a peacetime environment, it obviously has a significant role in the FDF during a crises situation. This is a fact, which simply can't be ignored while studying peacetime PPP between FDF and its partners. Research framework is illustrated in the Fig. 1.

The catering operations were studied in one food service unit for a time period of five days in February 2016. Before the data collection period a restaurant manager was interviewed, recipies of each meal were researched and standardised data collection methods were agreed. This reduced the research bias during the observation period.

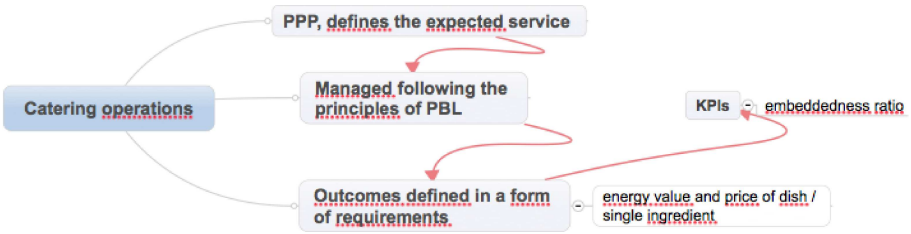


Fig. 1. Research design.

Case unit offers its services daily approximately to 700 customers, three times a day [30]. Of these 700 customers, 40 individuals were daily randomly chosen during each meal for measuring energy (kcal), realized financial value (euros) per dish and possibly produced plate waste also in kcal and euros.

A number of observations per meal was restricted due to the research environment and restricted time frame per meal. Only background information collected from the observed servicemen was their height and weight. These figures were collected for identification purposes and for the possible further analysis.

During the data collection process authors used minimum six research assistants to collect and measure empirical data. Each research assistant used precision scale which accuracy was guaranteed by using a standardised comparison weight. Each portion in the sample was weighted before and after consumption, component by component. Results were recorded by the author and transferred to the Excel spread sheet program for the further analysis.

During the observation period service provider offered 73 breakfast items, 69 lunch items and 63 dinner items. There were 11 to 15 articles served on each meal even without separation of the ingredients in the dishes. Separation of ingredients was not necessary, because service provider had calculated energy and monetary values per dish. Also, same items such as porridge, milk and bread were served during the observation period on various meals, but they were taken into consideration during the calculations due to the energy value and cost they created. In the first phase energy and financial value sums of each observations were calculated.

Altogether there were 2 (collection and waste)*600 observations (servicemen) and each of these observations had 11–15 articles as observation points. For the each individual observation point energy value and financial value was calculated and distribution and t-tests of these values were calculated using SPSS program. Results of these tests are illustrated in the Appendices 1 and 4. If a distribution did not follow the normal distribution a box-plot analysis was conducted. Purpose of this analysis was to find the possible outliers in the data set. Results of this analysis are illustrated in the Appendix 2.

These results were compared to the figures, which form the base for the contract between FDF and a service provider. After the comparison authors studied a change to create an "embeddednes ratio", which would act as a single "power-by-the-hour" – figure. This ratio would be built using the following variables if current metrics did not provide adequate information about efficiency and effectiveness of catering operations:

a = taken portion or ingredient calculated by the monetary value, €;

b = taken portion or ingredient calculated by the energy value, kcal;

c = predetermined monetary value of a portion or ingredient, €;

d = predetermined energy value of a portion or ingredient, kcal;

e = plate waste by energy value, kcal;

f = plate waste by monetary value, €;

g = number of customers informed in advance;

h = actual number of customers.

Results

There were two research questions studied: Firstly, do catering operations create KPI's, which enable inter- functional co-operation and service development? Secondly, do these KPIs support both efficiency and effectiveness of PPP catering operations?

Two variables representing financial requirements and customer requirements were chosen: financial value per dish or ingredient and energy value per dish or ingredient.

These variables represented efficiency and effectiveness, respectively. Results indicate that there is a need to improve both areas. This could lead to reduced costs, enhanced efficiency and transfer operational risk in the operations previously run by the public entity.

Efficiency

Efficiency was researched by calculating variables measuring service provider's ability to produce predemanded amount of dishes for the predetermined financial value. These figures are strongly affected by the information given by the service buyer in the form of number of expected customers.

During the research period alterations of the manpower figure were between +6% to −19%, where a negative number indicates that the actual number of customers was smaller than announced.

Second computed metrics, which affected efficiency was a plate waste created by each customer. Rationale behind this figure was that if there was no plate waste, service provider managed to offer its products efficiently. Thus, service offering was created in a manner, which was efficient, because customer (end-user) requirements in the form of energy (there was right amount food) and taste (no left-overs) were met.

Role of plate waste was found to be almost insignificant. None of the daily observations followed the normal distribution. Amount of zero plate waste varied between 24–34 observations per meal and total amount of plate waste in kcal is very small. Results of plate waste t-tests and t-test of distribution are illustrated in the Appendix 3. Actual figures from the sample are illustrated in the Table 2.

Third computed efficiency metrics concerned the monetary value of meals, calculated by the mean sum of all ingredients each serviceman collected from the self-service line. An alarming notion was, that there were only three meals, which met predetermined financial values. Overall results are illustrated in the Table 3.

Table 2
Amount of plate waste created by the sample.

		Plate waste (kcal) created by 40 servicemen	Offered energy/ 40 servicemen	Offered – plate waste [kcal]	% difference
Monday	Breakfast	1034	36160	35126	2.86
	Lunch	756	35680	34924	2.12
	Dinner	1278	38000	36722	3.36
Tuesday	Breakfast	347	34040	33693	1.02
	Lunch	359	42800	42441	0.84
	Dinner	776	41480	40704	1.87
Wednesday	Breakfast	3799	32360	28561	11.74
	Lunch	2852	58560	55708	4.87
	Dinner	3360	38960	35600	8.62
Thursday	Breakfast	1985	34760	32775	5.71
	Lunch	1049	48040	46991	2.18
	Dinner	1383	34640	33257	3.99
Friday	Breakfast	744	31240	30496	2.38
	Lunch	1516	46000	44484	3.30
	Dinner	3445	52000	48555	6.63

Table 3
Mean financial value per meal, predetermined, difference and confidence interval (CI), values calculated as the difference between predetermined and actual in euros.

		Mean financial value [%]	Difference, Pre vs. mean [%]	CI** [%]
Mon	Breakfast	54	46	3.2
	Lunch	84	16	4.3
	Dinner	94	**6*** **	1.0
Tue	Breakfast	59	42	4.2
	Lunch	81	19	1.6
	Dinner	103	**−3*** **	3.8
Wed	Breakfast	68	32	10.3
	Lunch	57*	43	3.0
	Dinner	91	9	11.1
Thu	Breakfast	57	43	6.2
	Lunch	85	15	3.8
	Dinner	91	9	6.2
Fri	Breakfast	49	51	4.0
	Lunch	70	30	4.3
	Dinner	112	**−12*** **	8.8
		% from the pre-determined	Pre vs. mean [%]	

* – distribution was not normal, ** – confidence interval mean financial value taken,
*** – predetermineated financial value met

Effectiveness

Effectiveness of the operations was calculated by the energy provided to the servicemen. Overall results are illustrated in the Table 4. Again, drastically only one meal met or exceeded the predetermined energy levels. A "Difference" variable from these effectiveness observations should be multiplied by the amount of actual customer and divided by the number of predetermined energy level, in order to follow production *efficiency* and to control over production.

For the further statistical analysis a one-sample T-test was run. Its results illustrated in the Appendix 4 show the confidence interval, which should be taken into consideration when comparing results.

When all the variables were added up and converted to monetary values, the total difference during the five day observation period was as high as €5147,12. This amount takes into account energy value not consumed and a mistakes in manpower figures. Kcal to € conversion is illustrated on a Table 5.

Table 4
Mean energy taken, predetermined energy, difference and confidence interval.

		Mean energy taken +/− CI** [kcal]	Predetermined Energy [kcal]	Difference Pre vs. mean [kcal]	CI** +/−
Monday	Breakfast	657	904	247	73.844
	Lunch	723	892	169	72/50
	Dinner	857*	950	93	79.953
Tuesday	Breakfast	534*	851	317	61.828
	Lunch	714	1070	356	73.892
	Dinner	797	1037	240	78.247
Wednesday	Breakfast	551	809	258	58.425
	Lunch	1065	1464	399	105.097
	Dinner	773	974	201	72.522
Thursday	Breakfast	512	869	357	52.010
	Lunch	966	1201	235	82.567
	Dinner	640	866	226	51.1631
Friday	Breakfast	438	781	343	66.970
	Lunch	812	1150	338	63.927
	Dinner	1405	1300	−105***	130.023

* –distribution was not normal, ** – confidence interval mean energy taken, *** – predeterminated energy value met

Table 5
Kcal converted to monetary values.

		Average difference between pre-announced and actual consumption [kcal]	Number of servicemen using the service	Total difference in kcal	Pre-announced kcal/whole meal [kcal]	Total difference in pre-announced meals	Pre-announced monetary value/meal all ingredients [€]	Total financial effect [€]
Monday	Breakfast	247	933	230451	904	255	0.94	239.70
	Lunch	169	684	115596	892	130	1.82	236.60
	Dinner	93	648	60264	950	63	1,17	73.71
Tuesday	Breakfast	317	749	237433	851	279	1.15	320.85
	Lunch	356	619	220364	1070	206	1.50	309.00
	Dinner	240	614	147360	1037	142	1.37	194.54
Wednesday	Breakfast	258	706	182148	809	225	1.28	288.00
	Lunch	399	612	244188	1464	167	2.84	474.28
	Dinner	201	748	150348	974	154	2.64	406.56
Thursday	Breakfast	357	779	278103	869	320	0.96	307.20
	Lunch	235	661	155335	1201	129	0.9	119.97
	Dinner	226	723	163398	866	189	1.39	262.71
Friday	Breakfast	343	824	282632	781	362	0.82	296.84
	Lunch	338	550	185900	1150	162	1.39	225.18
	Dinner	**−105**	195	**−20475**	1300	**−16**	1.37	**−21.92**
								3733.22

Conclusion

In the best-case situation efficiency and effectiveness figures could be used to create an "embeddedness ratio". If the optimal situation were met a figure would indicate three things. Firstly, portions' energy and monetary value would match the planned and bought outcome. Secondly, no plate waste would be created, indicating good end-user value of the provided service. Thirdly, production process would be efficient, because no over production would exist. This figure would function as a single "power-by-the-hour" – figure and give a transparent and objective base for PPP development following PBL principles.

Even without a new ratio, results clearly indicate that there is a need to streamline operations and alter the principal foundation of the contract. Based on the results it can be concluded that catering operations create KPI's, which would enable inter-functional co-operation and service development with the help of "embeddedness ratio". This KPI would support both efficiency and effectiveness of PPP catering operations better than currently used individual metrics.

Current metrics are not simple, realistic, consistent and easily quantifiable and therefore they do not serve PBL purposes in the PPP between FDF and Leijona Catering.

Service provider followed its own efficiency and sales margin by each individual meal. In PBL framework this figure should be compared to the served energy value and if predetermined energy values are not met, a service provider should return an agreed amount of compensation. This is not possible if the financial deviations are not specified. Only three meals met predetermined financial value indicating overpricing of served meals.

Efficiency was affected by the FDF's own inefficiency too. Currently FDF uses only headcount of the servicemen as a base of its efficiency metrics. Duty officers inform catering unit the manpower figures calculated in the companies. Rapid changes in the training program, calculation mistakes and other human errors make this figure highly unreliable. In order to specify this figure, catering unit calculates used trays after each meal and gives a deviation figure in percentages. Both of these methods are vulnerable to inaccuracies and malpractice.

Used percentage figure told very little about efficiency in the terms of requirement set by FDF. Demand fluctuation in the observed catering unit was large. In the Monday morning restaurant served 933 servicemen and on the Friday dinner there were only 195 customers. On the other hand this Friday dinner had the largest percentage deviation in the informed and actual customer number. Therefore the actual difference calculated by the number of customers (43 individuals) is obviously smaller despite a significantly larger percentage figure (−19%) compared e.g. to Monday breakfast 103 individuals and −10%. Manpower alterations increase the overproduction of dishes reducing efficiency significantly.

Effectiveness of the operations was researched studying the energy values of the served dishes. Only one meal reached or exceeded the predetermined energy value. This has imminent effect to the efficiency due to the over production of food. It can be stated that in the PBL framework the service provider does not meet the service buyers or end-users' objectives.

While going through the conclusion, one has to bear in mind that this research was limited to an individual business unit within a single industry. Having said that results are very much in line with the previous researches. Examples by [31, 32] indicate both benefits of PBL and possible limitations of it which are similar to our results.

Limitations of the study

Limitations of study relate to the nature of the case study. Firstly, this study represents only one individual garrison at the capital area of Finland. Secondly, the observed food service unit is located closely to the commercial foodservices. There is a risk that consuming behavior outside the service hours makes generalization of the results more difficult. Thirdly, there is always a risk that case study in the closed environment affects the individuals, whose behavior is monitored and studied. Fourthly, a closed environment, such as garrison makes it difficult to generalize these results to the purely commercial environment.

Author used data triangulation in order to minimize all described but still possible limitations.

Recommendation for the future research

Further empirical research on the use of embeddedness ratio would increase transparency and reduce misinterpretations between stakeholders. For further studies authors recommend analysis, which would concentrate on identifying possible cluster centers from the vast amount of collected data. Cluster analysis run on all the individual cases (customers), each answer responding to individual ingredients served in the form of requirements would help

to create more efficient and effective PPP. Also nutritional values and environmental effects of the food production could be researched using the vast empirical data. Purely customer centric survey would increase customer perspective and possibly gain service provider's efficiency and effectiveness due to better customer satisfaction. These issues were outside the scope of this research but they can't be neglected in the future research.

Appendix 1

Test of normal distribution, kcal and monetary value of **taken** meals.

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of VAR00003 is normal with mean 0,578 and standard deviation 0,21.	One-Sample Kolmogorov-Smirnov Test	,200[1,2]	Retain the null hypothesis.
2	The distribution of VAR00004 is normal with mean 657,016 and standard deviation 230,89.	One-Sample Kolmogorov-Smirnov Test	,200[1,2]	Retain the null hypothesis.
3	The distribution of VAR00005 is normal with mean 1,516 and standard deviation 0,44.	One-Sample Kolmogorov-Smirnov Test	,200[1,2]	Retain the null hypothesis.
4	The distribution of VAR00006 is normal with mean 723,679 and standard deviation 226,69.	One-Sample Kolmogorov-Smirnov Test	,200[1,2]	Retain the null hypothesis.
5	The distribution of VAR00007 is normal with mean 1,096 and standard deviation 0,33.	One-Sample Kolmogorov-Smirnov Test	,200[1,2]	Retain the null hypothesis.
6	The distribution of VAR00008 is normal with mean 857,432 and standard deviation 250,00.	One-Sample Kolmogorov-Smirnov Test	,200[1,2]	Reject the null hypothesis.
7	The distribution of VAR00009 is normal with mean 0,675 and standard deviation 0,28.	One-Sample Kolmogorov-Smirnov Test	,200[1,2]	Retain the null hypothesis.
8	The distribution of VAR00010 is normal with mean 534,832 and standard deviation 193,32.	One-Sample Kolmogorov-Smirnov Test	,200[1,2]	Reject the null hypothesis.
9	The distribution of VAR00011 is normal with mean 1,217 and standard deviation 0,37.	One-Sample Kolmogorov-Smirnov Test	,200[1,2]	Retain the null hypothesis.
10	The distribution of VAR00012 is normal with mean 714,498 and standard deviation 231,05.	One-Sample Kolmogorov-Smirnov Test	,200[1,2]	Retain the null hypothesis.
11	The distribution of VAR00013 is normal with mean 1,412 and standard deviation 0,50.	One-Sample Kolmogorov-Smirnov Test	,200[1,2]	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is ,05.

[1] Lilliefors Corrected

[2] This is a lower bound of the true significance.

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
21	The distribution of VAR00023 is normal with mean 0,821 and standard deviation 0,29.	One-Sample Kolmogorov-Smirnov Test	,200[1,2]	Retain the null hypothesis.
22	The distribution of VAR00024 is normal with mean 966,902 and standard deviation 258,17.	One-Sample Kolmogorov-Smirnov Test	,200[1,2]	Retain the null hypothesis.
23	The distribution of VAR00025 is normal with mean 1,256 and standard deviation 0,35.	One-Sample Kolmogorov-Smirnov Test	,200[1,2]	Retain the null hypothesis.
24	The distribution of VAR00026 is normal with mean 648,444 and standard deviation 159,98.	One-Sample Kolmogorov-Smirnov Test	,200[1,2]	Retain the null hypothesis.
25	The distribution of VAR00027 is normal with mean 0,404 and standard deviation 0,23.	One-Sample Kolmogorov-Smirnov Test	,200[1,2]	Retain the null hypothesis.
26	The distribution of VAR00028 is normal with mean 438,172 and standard deviation 209,40.	One-Sample Kolmogorov-Smirnov Test	,200[1,2]	Retain the null hypothesis.
27	The distribution of VAR00029 is normal with mean 0,966 and standard deviation 0,31.	One-Sample Kolmogorov-Smirnov Test	,200[1,2]	Retain the null hypothesis.
28	The distribution of VAR00030 is normal with mean 812,390 and standard deviation 199,89.	One-Sample Kolmogorov-Smirnov Test	,200[1,2]	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is ,05.

[1] Lilliefors Corrected

[2] This is a lower bound of the true significance.

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
12	The distribution of VAR00014 is normal with mean 797,864 and standard deviation 244,66.	One-Sample Kolmogorov-Smirnov Test	,200[1,2]	Retain the null hypothesis.
13	The distribution of VAR00015 is normal with mean 0,874 and standard deviation 0,30.	One-Sample Kolmogorov-Smirnov Test	,200[1,2]	Retain the null hypothesis.
14	The distribution of VAR00016 is normal with mean 551,914 and standard deviation 182,68.	One-Sample Kolmogorov-Smirnov Test	,200[1,2]	Retain the null hypothesis.
15	The distribution of VAR00017 is normal with mean 1,613 and standard deviation 0,62.	One-Sample Kolmogorov-Smirnov Test	,200[1,2]	Reject the null hypothesis.
16	The distribution of VAR00018 is normal with mean 1 020,890 and standard deviation 328,62.	One-Sample Kolmogorov-Smirnov Test	,200[1,2]	Retain the null hypothesis.
17	The distribution of VAR00019 is normal with mean 2,389 and standard deviation 0,70.	One-Sample Kolmogorov-Smirnov Test	,200[1,2]	Retain the null hypothesis.
18	The distribution of VAR00020 is normal with mean 773,364 and standard deviation 226,76.	One-Sample Kolmogorov-Smirnov Test	,200[1,2]	Retain the null hypothesis.
19	The distribution of VAR00021 is normal with mean 0,554 and standard deviation 0,19.	One-Sample Kolmogorov-Smirnov Test	,200[1,2]	Retain the null hypothesis.
20	The distribution of VAR00022 is normal with mean 512,726 and standard deviation 162,62.	One-Sample Kolmogorov-Smirnov Test	,200[1,2]	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is ,05.

[1] Lilliefors Corrected

[2] This is a lower bound of the true significance.

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
29	The distribution of VAR00031 is normal with mean 1,535 and standard deviation 0,44.	One-Sample Kolmogorov-Smirnov Test	,200[1,2]	Retain the null hypothesis.
30	The distribution of VAR00032 is normal with mean 1 405,306 and standard deviation 406,56.	One-Sample Kolmogorov-Smirnov Test	,200[1,2]	Retain the null hypothesis.

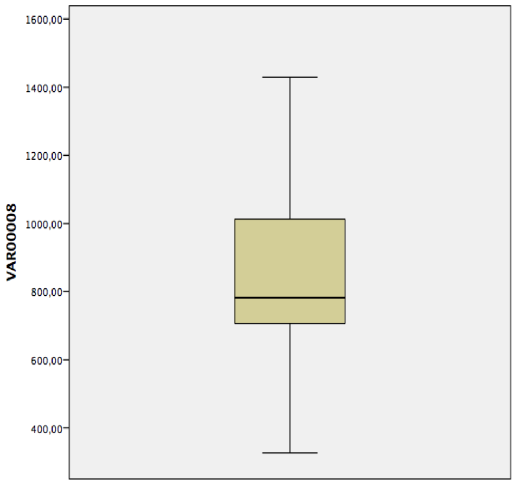
Asymptotic significances are displayed. The significance level is ,05.

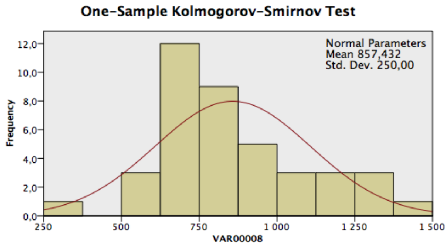
[1] Lilliefors Corrected

[2] This is a lower bound of the true significance.

Appendix 2

Test of outliers, observations which did not follow normal distribution.



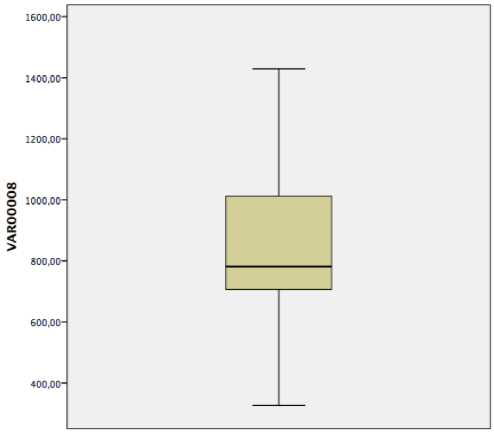


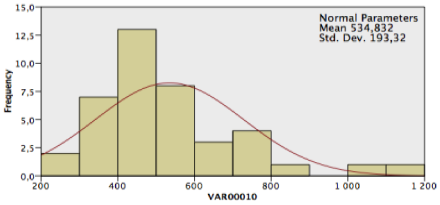
One-Sample Kolmogorov-Smirnov Test

Total N		40
Most Extreme Differences	Absolute	,159
	Positive	,159
	Negative	-,088
Test Statistic		,159
Asymptotic Sig. (2-sided test)		,012[1,2]

[1] Lilliefors Corrected

[2] This is a lower bound of the true significance.



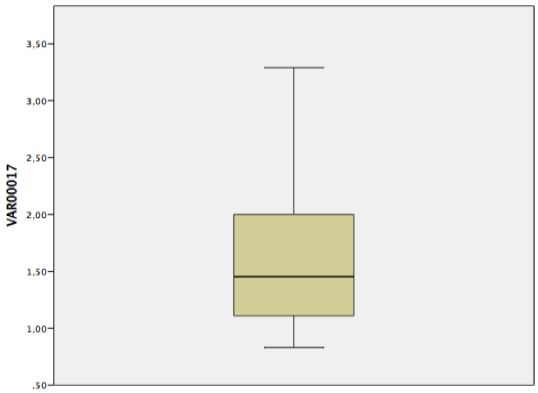


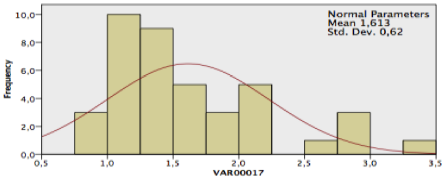
One-Sample Kolmogorov-Smirnov Test

Total N		40
Most Extreme Differences	Absolute	,167
	Positive	,167
	Negative	-,098
Test Statistic		,167
Asymptotic Sig. (2-sided test)		,006[1,2]

[1] Lilliefors Corrected

[2] This is a lower bound of the true significance.





One-Sample Kolmogorov-Smirnov Test

Total N		40
Most Extreme Differences	Absolute	,171
	Positive	,171
	Negative	-,102
Test Statistic		,171
Asymptotic Sig. (2-sided test)		,005[1,2]

[1] Lilliefors Corrected

[2] This is a lower bound of the true significance.

Appendix 3

T-test and test of distribution for **plate waste** values.

One-Sample Test

	Test Value = 0					
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Mon, *B, €	3,694	39	,001	,03125	,0141	,0484
Mon, B, kcal	4,007	39	,000	25,84925	12,8003	38,8982
Mon, *L, €	2,276	39	,028	,04350	,0048	,0822
Mon, L, kcal	2,006	39	,052	18,89725	−,1601	37,9546
Mon, *D, €	1,837	39	,074	,00550	−,0006	,0116
Mon, D, kcal	2,121	39	,040	31,94950	1,4814	62,4176
Tue, B, €	2,428	39	,020	,02875	,0048	,0527
Tue B, kcal	2,664	39	,011	8,67575	2,0896	15,2619
Tue, L, €	2,456	39	,019	,01450	,0026	,0264
Tue, L, kcal	2,705	39	,010	8,96725	2,2611	15,6734
Tue, D, €	2,010	39	,051	,02600	−,0002	,0522
Tue, D, kcal	2,265	39	,029	19,39025	2,0736	36,7069
Wed, B, €	4,485	39	,000	,14675	,0806	,2129
Wed B, kcal	4,483	39	,000	94,98600	52,1253	137,8467
Wed,L, €	2,968	39	,005	,06175	,0197	,1038
Wed, L, kcal	3,465	39	,001	71,30575	29,6791	112,9324
Wed, D, €	4,630	39	,000	,33650	,1895	,4835
Wed D, kcal	5,209	39	,000	84,00050	51,3855	116,6155
Thu, B, €	3,041	39	,004	,04500	,0151	,0749
Thu, B, kcal	2,888	39	,006	49,62525	14,8654	84,3851
Thu, L, €	2,222	39	,032	,02000	,0018	,0382
Thu, L, kcal	2,388	39	,022	26,23675	4,0164	48,4571
Thu, D, €	3,049	39	,004	,06550	,0221	,1089
Thu D, kcal	3,046	39	,004	34,57125	11,6152	57,5273
Fri, B, €	2,140	39	,039	,01725	,0009	,0336
Fri, B, kcal	2,940	39	,005	18,60850	5,8078	31,4092
Fri, L, €	2,458	39	,019	,03600	,0064	,0656
Fri, L, kcal	3,142	39	,003	37,90875	13,5052	62,3123
Fri, D, €	2,956	39	,005	,08850	,0280	,1490
Fri, D, kcal	3,127	39	,003	86,11950	30,4181	141,8209

*B – breakfast, L – lunch, D – dinner.

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of VAR00001 is normal with mean 0,031 and standard deviation 0,05.	One-Sample Kolmogorov-Smirnov Test	,000[1]	Reject the null hypothesis.
2	The distribution of VAR00002 is normal with mean 25,849 and standard deviation 40,80.	One-Sample Kolmogorov-Smirnov Test	,000[1]	Reject the null hypothesis.
3	The distribution of VAR00003 is normal with mean 0,044 and standard deviation 0,12.	One-Sample Kolmogorov-Smirnov Test	,000[1]	Reject the null hypothesis.
4	The distribution of VAR00004 is normal with mean 18,897 and standard deviation 59,59.	One-Sample Kolmogorov-Smirnov Test	,000[1]	Reject the null hypothesis.
5	The distribution of VAR00005 is normal with mean 0,006 and standard deviation 0,02.	One-Sample Kolmogorov-Smirnov Test	,000[1]	Reject the null hypothesis.
6	The distribution of VAR00006 is normal with mean 31,950 and standard deviation 95,27.	One-Sample Kolmogorov-Smirnov Test	,000[1]	Reject the null hypothesis.
7	The distribution of VAR00007 is normal with mean 0,029 and standard deviation 0,07.	One-Sample Kolmogorov-Smirnov Test	,000[1]	Reject the null hypothesis.
8	The distribution of VAR00008 is normal with mean 8,676 and standard deviation 20,59.	One-Sample Kolmogorov-Smirnov Test	,000[1]	Reject the null hypothesis.
9	The distribution of VAR00009 is normal with mean 0,014 and standard deviation 0,04.	One-Sample Kolmogorov-Smirnov Test	,000[1]	Reject the null hypothesis.
10	The distribution of VAR00010 is normal with mean 8,967 and standard deviation 20,97.	One-Sample Kolmogorov-Smirnov Test	,000[1]	Reject the null hypothesis.
11	The distribution of VAR00011 is normal with mean 0,026 and standard deviation 0,08.	One-Sample Kolmogorov-Smirnov Test	,000[1]	Reject the null hypothesis.

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
12	The distribution of VAR00012 is normal with mean 19,390 and standard deviation 54,15.	One-Sample Kolmogorov-Smirnov Test	,000[1]	Reject the null hypothesis.
13	The distribution of VAR00013 is normal with mean 0,147 and standard deviation 0,21.	One-Sample Kolmogorov-Smirnov Test	,000[1]	Reject the null hypothesis.
14	The distribution of VAR00014 is normal with mean 94,986 and standard deviation 134,02.	One-Sample Kolmogorov-Smirnov Test	,000[1]	Reject the null hypothesis.
15	The distribution of VAR00015 is normal with mean 0,062 and standard deviation 0,13.	One-Sample Kolmogorov-Smirnov Test	,000[1]	Reject the null hypothesis.
16	The distribution of VAR00016 is normal with mean 71,306 and standard deviation 130,16.	One-Sample Kolmogorov-Smirnov Test	,000[1]	Reject the null hypothesis.
17	The distribution of VAR00017 is normal with mean 0,336 and standard deviation 0,46.	One-Sample Kolmogorov-Smirnov Test	,000[1]	Reject the null hypothesis.
18	The distribution of VAR00018 is normal with mean 84,000 and standard deviation 101,98.	One-Sample Kolmogorov-Smirnov Test	,000[1]	Reject the null hypothesis.
19	The distribution of VAR00019 is normal with mean 0,045 and standard deviation 0,09.	One-Sample Kolmogorov-Smirnov Test	,000[1]	Reject the null hypothesis.
20	The distribution of VAR00020 is normal with mean 49,625 and standard deviation 108,69.	One-Sample Kolmogorov-Smirnov Test	,000[1]	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is ,05.

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
21	The distribution of VAR00021 is normal with mean 0,020 and standard deviation 0,06.	One-Sample Kolmogorov-Smirnov Test	,000[1]	Reject the null hypothesis.
22	The distribution of VAR00022 is normal with mean 26,237 and standard deviation 69,48.	One-Sample Kolmogorov-Smirnov Test	,000[1]	Reject the null hypothesis.
23	The distribution of VAR00023 is normal with mean 0,066 and standard deviation 0,14.	One-Sample Kolmogorov-Smirnov Test	,000[1]	Reject the null hypothesis.
24	The distribution of VAR00024 is normal with mean 34,571 and standard deviation 71,78.	One-Sample Kolmogorov-Smirnov Test	,000[1]	Reject the null hypothesis.
25	The distribution of VAR00025 is normal with mean 0,017 and standard deviation 0,05.	One-Sample Kolmogorov-Smirnov Test	,000[1]	Reject the null hypothesis.
26	The distribution of VAR00026 is normal with mean 18,608 and standard deviation 40,03.	One-Sample Kolmogorov-Smirnov Test	,000[1]	Reject the null hypothesis.
27	The distribution of VAR00027 is normal with mean 0,036 and standard deviation 0,09.	One-Sample Kolmogorov-Smirnov Test	,000[1]	Reject the null hypothesis.
28	The distribution of VAR00028 is normal with mean 37,909 and standard deviation 76,30.	One-Sample Kolmogorov-Smirnov Test	,000[1]	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is ,05.

[1] Lilliefors Corrected

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
29	The distribution of VAR00029 is normal with mean 0,088 and standard deviation 0,19.	One-Sample Kolmogorov-Smirnov Test	,000[1]	Reject the null hypothesis.
30	The distribution of VAR00030 is normal with mean 86,120 and standard deviation 174,17.	One-Sample Kolmogorov-Smirnov Test	,000[1]	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is ,05.

[1] Lilliefors Corrected

Appendix 4

One sample T-test, difference between announced monetary values and actual energy.

One-Sample Test

	Test Value = 0					
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Mon, *B, €	17,261	39	,000	,57750	,5098	,6452
Mon, B, kcal	17,997	39	,000	657,01600	583,1724	730,8596
Mon, *L, €	21,979	39	,000	1,51550	1,3760	1,6550
Mon, L, kcal	20,190	39	,000	723,67875	651,1798	796,1777
Mon, *D, €	21,098	39	,000	1,09625	,9912	1,2013
Mon, D, kcal	21,692	39	,000	857,43225	777,4789	937,3856
Tue, B, €	15,514	39	,000	,67525	,5872	,7633
Tue, B, kcal	17,497	39	,000	534,83175	473,0039	596,6596
Tue, L, €	20,666	39	,000	1,21725	1,0981	1,3364
Tue, L, kcal	19,558	39	,000	714,49775	640,6054	788,3901
Tue, D, €	17,799	39	,000	1,41225	1,2518	1,5727
Tue, D, kcal	20,625	39	,000	797,86425	719,6172	876,1113
Wed, B, €	18,462	39	,000	,87350	,7778	,9692
Wed B, kcal	19,107	39	,000	551,91375	493,4887	610,3388
Wed,L, €	16,543	39	,000	1,61325	1,4160	1,8105
Wed, L, kcal	19,648	39	,000	1020,89000	915,7928	1125,9872
Wed, D, €	21,466	39	,000	2,38910	2,1640	2,6142
Wed D, kcal	21,570	39	,000	773,36350	700,8410	845,8860
Thu, B, €	18,018	39	,000	,55425	,4920	,6165
Thu, B, kcal	19,940	39	,000	512,72600	460,7163	564,7357
Thu, L, €	17,942	39	,000	,82100	,7284	,9136
Thu, L, kcal	23,687	39	,000	966,90200	884,3347	1049,4693
Thu, D, €	22,951	39	,000	1,25650	1,1458	1,3672
Thu, D, kcal	25,636	39	,000	648,44350	597,2804	699,6066
Fri, B, €	11,142	39	,000	,40350	,3302	,4768
Fri, B, kcal	13,234	39	,000	438,17150	371,2018	505,1412
Fri, L, €	19,585	39	,000	,96650	,8667	1,0663
Fri, L, kcal	25,705	39	,000	812,39028	748,4633	876,3173
Fri, D, €	22,184	39	,000	1,53500	1,3950	1,6750
Fri, D, kcal	21,861	39	,000	1405,30650	1275,2831	1535,3299

*B – breakfast, L – lunch, D – dinner.

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