

Scenario

Food-Related Norovirus Outbreak in Southern Germany

Preliminary Events

An above-average number of gastroenteritis cases was registered in Baden-Württemberg, a federal state of Germany located in the southwest of the country. Many children in schools and day-care centres show symptoms including fever, diarrhoea and vomiting.

The responsible authorities (you!) have declared an outbreak and started an investigation. The number of cases and the fact that these appeared at the same time at different locations make a transmission via smear infection unlikely. The children have lunch in their educational institutions (schools, day-care centres) making a transmission via catering possible. Menus have been asked for as well as the methods of food preparation.

Due to information from public health authorities, noroviruses could be found in faecal samples from patients with gastroenteritis. Regarding the onset of the first symptoms and the incubation period of norovirus infections in humans, tracing activities were focused on menus eaten directly before the first symptoms became obvious.

The caterers are working closely together with you and have already sent hastily written menu names by fax. These might have contained viable pathogens because some ingredients had not been heated.

The objective is to find the contaminated food(s) and the pathogen responsible for the outbreak by tracing back the suspicious food items. If the product(s) and lot number(s) were able to be traced, they could be withdrawn from the market, minimising further spread of the pathogen as well as reducing the number of new cases.

Technical Note

The following example scenario is structured as a table with the following columns: DATE and STORY both depict the events of the fictitious outbreak. To investigate the outbreak certain TASKS need to be done. How this can be achieved with FoodChain-Lab is explained in the column WHAT TO DO IN FOODCHAIN-LAB. Options in KNIME and FoodChain-Lab are numbered in square brackets (e.g. [T15]) and can also be found in the screenshots. Data to be imported via Excel files can be found in the column FILES.

To “click” means to click with the left mouse button, to “right-click” means to click with the right mouse button and to “double-click” means to click twice quickly with the left mouse button.

Case definition

for an educational institution in Baden-Württemberg affected by a gastroenteritis outbreak:

- The educational institution (school, day-care centre) offers menus from external caterers for all children.
 - Catering is provided by an external caterer.
 - At least 10% of individuals (children, pupils) have fallen ill between 1. Sep and 7. Sep 2014 and show symptoms like diarrhoea or vomitus.
- OR
- At least 10 individuals* (children, pupils) have fallen ill between 1. Sep and 7. Sep 2014 and show symptoms like diarrhoea or vomitus.

* Including educational institutions not fulfilling the 10% criterion but with at least ten diseased individuals considers the fact that especially in grammar schools and secondary modern schools a substantial proportion of pupils does not eat the meals offered at school. This way schools with many pupils but with a small number of pupils affected can be included in the outbreak investigation.

Cases, aggregated by Educational Institution

Educational Institution	Name	Street	House Number	Postal Code	City	Federal State ¹⁾	Cases	First Symptoms	Laboratory Test Result	Confirmed Cases? (Y/N)-	Lunch by Caterer? (Y/N)	Name of Caterer	Caterer's Principal Office	Establishment Capacity (No. of Children)
School	Primary school 01	Heuweg	1	72417	Jungingen	BW	18	01/09/2014		Y	Y	Caterer 1	Burladingen	146
School	Primary school 02	Lichtensteinweg	1	72393	Burladingen	BW	22	02/09/2014		Y	Y	Caterer 1	Burladingen	173
School	Primary school 04	Stilfriedstraße	1	72379	Hechingen	BW	27	01/09/2014	Norovirus	Y	Y	Caterer 1	Burladingen	187
School	Primary school 05	Steinbeisstraße	1	72501	Gammertingen	BW	12	01/09/2014		Y	Y	Caterer 1	Burladingen	83
School	Primary school 06	Sonnenhalde	1	72532	Gomadingen	BW	22	03/09/2014		Y	Y	Caterer 2	Engstingen	109
School	Primary school 07	Stuttgarter Straße	1	72574	Bad Urach	BW	18	04/09/2014		Y	Y	Caterer 2	Engstingen	108
School	Primary school 08	Emil-Mörsch-Weg	1	72555	Metzingen	BW	31	03/09/2014		Y	Y	Caterer 2	Engstingen	128
School	Secondary modern school 01	Brunnenstraße	1	72417	Jungingen	BW	20	01/09/2014		Y	Y	Caterer 1	Burladingen	181
School	Secondary modern school 02	Gammertinger Straße	1	72379	Hechingen	BW	15	02/09/2014	Norovirus	Y	Y	Caterer 1	Burladingen	106
School	Secondary modern school 03	Europastraße	1	72501	Gammertingen	BW	28	02/09/2014	Norovirus	Y	Y	Caterer 1	Burladingen	175
School	Secondary modern school 04	Siemensstraße	1	72818	Trochtelfingen	BW	24	01/09/2014	Norovirus	Y	Y	Caterer 1	Burladingen	166
School	Secondary modern school 05	Auf dem Graben	1	72574	Bad Urach	BW	12	03/09/2014		Y	Y	Caterer 2	Engstingen	103
School	Secondary modern school 06	Orfweg	1	72555	Metzingen	BW	17	03/09/2014		Y	Y	Caterer 2	Engstingen	116
Day-care centre	Day-care centre 01	Weilbachstraße	1	72417	Jungingen	BW	25	01/09/2014	Norovirus	Y	Y	Caterer 1	Burladingen	149
Day-care centre	Day-care centre 03	Panoramastraße	1	72393	Burladingen	BW	31	02/09/2014		Y	Y	Caterer 1	Burladingen	180
Day-care centre	Day-care centre 04	Tübinger Straße	1	72379	Hechingen	BW	19	01/09/2014		Y	Y	Caterer 1	Burladingen	191
Day-care centre	Day-care centre 05	Friedrich-Wolf-Weg	1	72379	Hechingen	BW	16	01/09/2014		Y	Y	Caterer 1	Burladingen	96
Day-care centre	Day-care centre 06	Eichertstraße	1	72501	Gammertingen	BW	24	01/09/2014		Y	Y	Caterer 1	Burladingen	146
Day-care centre	Day-care centre 07	Kapelleschweg	1	72818	Trochtelfingen	BW	24	01/09/2014		Y	Y	Caterer 1	Burladingen	168
Day-care centre	Day-care centre 08	Sperberweg 28	1	72829	Engstingen	BW	24	03/09/2014		Y	Y	Caterer 2	Engstingen	145
Day-care centre	Day-care centre 09	Bannholz	1	72532	Gomadingen	BW	18	04/09/2014		Y	Y	Caterer 2	Engstingen	140
Day-care centre	Day-care centre 10	Eichbergstraße	1	72813	Sankt Johann	BW	32	03/09/2014		Y	Y	Caterer 2	Engstingen	122
Day-care centre	Day-care centre 11	Schillerstraße	1	72574	Bad Urach	BW	24	04/09/2014		Y	Y	Caterer 2	Engstingen	115
Day-care centre	Day-care centre 12	Im Altweck	1	72585	Riederich	BW	10	03/09/2014		Y	Y	Caterer 2	Engstingen	67
Day-care centre	Day-care centre 13	Bachstraße	1	72585	Riederich	BW	31	03/09/2014		Y	Y	Caterer 2	Engstingen	124
Day-care centre	Day-care centre 14	Wangstraße	1	72813	Sankt Johann	BW	36	03/09/2014		Y	Y	Caterer 2	Engstingen	132
School	Grammar school 01	Gammertinger Straße	1	72379	Hechingen	BW	18	01/09/2014	Norovirus	Y	Y	Caterer 1	Burladingen	110
School	Grammar school 02	Hechinger Straße	1	72501	Gammertingen	BW	19	02/09/2014		Y	Y	Caterer 1	Burladingen	110
School	Grammar school 03	Schillerstraße	1	72818	Trochtelfingen	BW	18	01/09/2014		Y	Y	Caterer 1	Burladingen	152
School	Grammar school 04	Stuttgarter Straße	1	72574	Bad Urach	BW	33	04/09/2014		Y	Y	Caterer 2	Engstingen	176
School	Grammar school 05	Im Millert	1	72555	Metzingen	BW	11	03/09/2014		Y	Y	Caterer 2	Engstingen	92

1) BW – Baden-Württemberg

Catering Menus on Outbreak Days
(First Forwarding by Kitchens)

Caterer 1

Menu 1 on 1st September 2014

Pasta with ground beef and
tomato sauce

Vanilla pudding with strawberries

Menu 2 on 3rd September 2014

Potato soup with bread

Fruit yoghurt

Caterer 2

3/9/14

Menu 1

Semolina pudding with
strawberry compote

Menu 2

Turkey goulash with
rice

Fruit quark

Workshop FoodChain-Lab

DATE	STORY	TASKS	WHAT TO DO IN FOODCHAIN-LAB	FILES
08 Sep 2014	Caterers 1 and 2 provided a list of schools and day-care centres having received lunches. Moreover, these were entered into our Excel template for FoodChain-Lab.	Import the delivery lists of both caterers into the FoodChain-Lab-Database. They give information about schools and day-care centres who received menus from this caterer.	<p><u>Data import into the database</u></p> <ul style="list-style-type: none">Choose Food-Lab → Open DB Gui... [K2] in the menu to open the internal FoodChain-Lab database.In the database window click the Table import [DB1] button in the upper-left corner.<ul style="list-style-type: none">A dialogue opens. Choose the files indicated in the FILES column. To select several files press Ctrl on the keyboard while selecting them with the mouse. Click on Open to import the caterer information into the database.A windows pops up saying "Import successful!" → click OK.Close the database window. <p><u>Establish a new KNIME workflow</u></p> <ul style="list-style-type: none">Right-click on LOCAL [K3] in the KNIME Explorer and choose New KNIME Workflow...Enter a name and click Finish. The empty workflow can be seen in the workflow area which is in the centre of the KNIME desktop.	Start_Tracing_Caterer 1a.xlsx Start_Tracing_Caterer 2.xlsx

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			<p><u>Use data from the FoodChain-Lab database in a KNIME-Workflow</u></p> <ul style="list-style-type: none">• To be able to see all FoodChain-Lab nodes click in the Node Repository [K7] on the small arrow next to the node group FoodChain-Lab [K8].• Drag the Supply Chain Reader [K10] node out of the Node Repository and drop it in the workflow area. This node has access to the internal database.• Right-click on the node to open its context menu and choose Execute [K5] to load the database entries into the workflow. That the node has been successfully executed is shown by the traffic light changing from yellow (= configured, ready to be executed) to green (= executed).• Imported data can be viewed as tables in the outports of the node. The Supply Chain Reader has three outports: Stations, Deliveries and Delivery Relations. These are represented by three arrows on the right of the node [K4] and can also be found in the context menu (right-click on the node) [K9].	

DATE	STORY	TASKS	WHAT TO DO IN FOODCHAIN-LAB	FILES
08 Sep 2014		Have a look at the graph in the Tracing View. If you zoom out far enough you will be able to see two clusters.	<p><u>Inspect the delivery network with the Tracing View node</u></p> <ul style="list-style-type: none"> • Drag the Tracing View [K11] node from the Node Repository [K7] into the workflow and connect the first outport of the Supply Chain Reader with the first inport of the Tracing View. Connecting the ports is done as follows: Click the outport and – while still pressing the left mouse button down – drag a line to the inport. Also connect the second and the third outport of the Supply Chain Reader with the second and the third inport of the Tracing View. The inports are on the left of the node [K6]. • The traffic light of the Tracing View changes from red (= no data available) to yellow (= configured, ready to be executed). • Double-click the Tracing View to inspect the delivery network. • The editing mode Transforming [T10] allows you to drag the network into the preferred position while Picking [T11] enables selecting one or many stations and deliveries. Details of stations and deliveries may be viewed by double-clicking on them. Zooming is always possible, either by clicking the "+" or "-" buttons [T9] or by turning the mouse wheel. 	

DATE	STORY	TASKS	WHAT TO DO IN FOODCHAIN-LAB	FILES
08 Sep 2014	Caterers 1 and 2 delivered lunches to 30 schools and day-care centres. In all educational institutions several children had symptoms of gastroenteritis.	Have a look at the data set in the Tracing View and set "Weight" = 1 for all schools and day-care centres to indicate that disease cases were registered there. Additionally, add a legend.	<p>Set the weight of a station</p> <ul style="list-style-type: none"> Choose editing mode Picking [T11]. Open the context menu [T2] via right-click in the Tracing View, then choose Set Selected Stations [T7]: <ul style="list-style-type: none"> Property [T3] = Type of business Value [T4] = Educational institution (choose in the drop-down menu) → OK. Selected stations are now highlighted in blue. Afterwards right-click → station selection → show properties → set all weight → 1.0 → OK → OK If you would like to deselect the selected stations or deliveries click somewhere into the empty space in the Tracing View window. By double-clicking on an Educational institution you will see the new weight 1.0 in the upmost cell. Mark institutions with disease cases red via right-click → Set default highlighting [T8] → OK. To show the Legend click on Activate below Show Legend [T12] in the grey menu bar at the bottom of the Tracing View window. Click OK [T14] to save the current view status of the Tracing View node and to close the node. To save all changes of the workflow permanently you need to press the save button in KNIME [K1]. 	

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DATE	STORY	TASKS	WHAT TO DO IN FOODCHAIN-LAB	FILES
09 Sep 2014	You notice, that in the list on page 4 of this scenario script are more educational institutions with gastroenteritis cases than in the excel sheets of the caterers. You ask the two day-care centres and get to know that they received meals from Caterer 1. This caterer confirms having provided meals also to these institutions and sends an additional Excel sheet to you.	Import the additional delivery list for Caterer 1.	<ul style="list-style-type: none"> Import the delivery list into the database as before (Choose Food-Lab → Open DB Gui... [K2]...see above). Reset the Supply Chain Reader with right-click on this node → Reset and execute the node again to import the new data sets from the database into the workflow. Open the Tracing View. If the graph is not well-arranged, open the context menu with a right-click and choose a layout from Apply Layout [T5], for example Fruchterman-Reingold. Zoom until you can see both clusters. Set "Weight" = 1.0 for the two newly added educational institutions. Close the Tracing View with OK. 	Start_Tracing_Caterer 1b.xlsx
09 Sep 2014	Data from two caterers have been imported. We know now which caterer provided menus to which day-care centre or school. Now, we need to know the ingredients of the menus and who supplied these to the caterers.	Generate an Excel document to collect the menu ingredients and suppliers. The generated files concerning the caterers can be completed either by local food inspectors or by the caterers themselves.	<ul style="list-style-type: none"> Open the DB GUI Click on the icon Generate backward tracing templates for missing data [DB3]. Choose for which business types templates should be generated (default = all) [DB5]. To find knowledge gaps it is best to keep all boxes ticked. You are asked for an output folder for the templates. Choose or create a folder and click Open. A message will be displayed as soon as the templates have been created in the chosen folder. 	
09 Sep 2014	While you are tracing the food chain, interviews are conducted: Children from schools and day-care centres are asked which menus they have eaten on the days of disease onset.			
10 Sep 2014	A day later the menus including food component suppliers are provided.	Import the completed backward tracing templates.	<ul style="list-style-type: none"> Use the table import in the DB GUI as before. 	Backtrace_request_Caterer 1_complete.xlsx Backtrace_request_Caterer 2_complete.xlsx

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DATE	STORY	TASKS	WHAT TO DO IN FOODCHAIN-LAB	FILES
10 Sep 2014	The list of ingredients of the menus from Caterer 2 is faulty: Because of a missing lot number it is not possible to import the Excel file. After half an hour and several phone calls with contact persons who cannot help the answer is finally known by one of the employees: The lot number of the pepper is 113.	<p>Enter the lot number into the Excel sheet, save it and import both completed backward tracing templates into the FoodChain-Lab database.</p> <p>Note: Note: In order to be able to analyse new data immediately you might want to invent a lot number and import the data sheet into FoodChain-Lab. Later, when you receive the correct answer, you can change the lot number directly in the database.</p> <p>The lot number can also be corrected in the next backward tracing step by the responsive local authority.</p>	<ul style="list-style-type: none">Import the corrected Excel file. You will get a confirm message stating the successful import.	Backtrace_request_Caterer 2_complete2.xlsx
10 Sep 2014	Mistakes can always slip in. The missing information makes you suspicious and you check all the data collected in the database.	A similarity search is recommended after importing data into the database. Investigate for faulty addresses or duplicate entries. Correct the mistakes.	<p><u>Similarity search in the FoodChain-Lab database</u></p> <ul style="list-style-type: none">After the data import click the button Similarity Search [DB2] in the database window. Tick Station, Product, Lot and Delivery [DB6], keep the default settings and click OK.Duplicate entries can be merged as follows: right-click the ID to be deleted and enter a new ID (one of the other data set(s)).Check one message after another and close each by clicking OK.Please have in mind that the algorithm searches for small differences. These do not need to be mistakes, but may also be desired differences between two similar data sets.Close the database window.	

DATE	STORY	TASKS	WHAT TO DO IN FOODCHAIN-LAB	FILES
10 Sep 2014	<p>Obviously, several component suppliers delivered products / ingredients to both caterers. Which of these may have been contaminated with the pathogen?</p> <p>Noroviruses could be detected in some cases (see page 4), but not in any food item, yet. Noroviruses are known to stay intact in poorly heated or non-heated foods. As the virus was ingested via salad, berries, raw vegetables and also bivalve molluscs in past outbreaks, these foods are of special interest when screening the ingredients lists.</p>	<p>Visualise the delivered foods in the Tracing View. Are there any foods which were sent to both caterers? In these food items the supplier might have delivered the agent as well. For an easier tracing of foods label the arrows with the food name.</p>	<ul style="list-style-type: none"> Reset and execute the Supply Chain Reader, if you have not done so after the last data import into the database. Tracing View: deactivate Join Deliveries [T13], if appropriate, to display one arrow per delivery. Open the Tracing View by double-clicking the node. If the graph is not well-arranged, open the context menu with a right-click and choose a layout from Apply Layout [T5], for example Fruchterman-Reingold. <p><u>Highlighting the flow of products / ingredients in the Tracing View</u></p> <ul style="list-style-type: none"> Right-click for context menu → Delivery Highlighting [T6] → Edit → Add: <ul style="list-style-type: none"> Type = Apply to all Name = Food items Deselect "Use Color" Label = Name OK To close the Highlight Condition List click OK 	
10 Sep 2014	<p>From caterers 1 and 2 you learn that vanilla pudding, fruit quark and frozen strawberries were not heated.</p>	<p>Set these products "observed" one after another and have a look at the forward and backward trace. Please keep in your mind that despite affirmation the menus might not have been heated enough to kill noroviruses. In this case additional suppliers and products might be the source of the pathogen. Due to their supply relationships and the delivered foods, which of the suppliers could have delivered products contaminated with noroviruses? What are your next steps? Tracing? Sampling? In which company would you take samples first?</p>	<p><u>Mark deliveries "observed"</u></p> <ul style="list-style-type: none"> Right-click → set selected deliveries: <ul style="list-style-type: none"> Property = Name Value = e.g. "Frozen Strawberries" (select in drop-down menu or start typing and choose from the suggestions) OK Afterwards, right-click → delivery selection → show properties → set all observed = true → OK → OK You could also define "Observed" by double-clicking on an arrow and activating "Observed" <p>For comparison, repeat this procedure with the other suspicious products. Before observing another product click "Reset Observed" [T1] and mark the next product as described above.</p> <ul style="list-style-type: none"> Close the Tracing View with OK. 	

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DATE	STORY	TASKS	WHAT TO DO IN FOODCHAIN-LAB	FILES
11 Sep 2014	<p>You have the strong suspicion that <i>Frozen Fruit Sales</i>, the company who produced bags of frozen strawberries, might be the key to the gastroenteritis outbreak. Both caterers received frozen strawberries with the same lot number. You examine the whole company, take samples and ask for the supplying strawberry farms. Also, the other recipients of the strawberries are of interest.</p> <p>In the evening, the samples are sent to the laboratory.</p>	<p>Export backward tracing templates for the suppliers, fill in the information you receive from <i>Frozen Fruit Sales</i> in the appropriate file. In this case both forward and backward tracing information is provided at the same time. Use the sheet "ForwardTracing_Opt" to fill in the recipients of frozen strawberries with Lot No. 108.</p>	<ul style="list-style-type: none"> • Open the DB GUI • Click on the icon Generate backward tracing templates for missing data [DB3] and export templates for "Suppliers" as described above. <p>To do in Excel or Libre Office Calc: Open the file "<i>Backtrace_request_Frozen Fruit Sales.xlsx</i>", which is one of the files you just generated.</p> <ul style="list-style-type: none"> • Stations sheet: Fill in the missing stations. If you enter stations which are already in this sheet, this might cause an error message when you import the sheet into the database. • BackTracing sheet: Into lines 23, 24 and 25 enter the strawberry deliveries with lot numbers, dates, quantities and supplier. Please do not forget to choose the lot number of frozen strawberries (Lot No. 108) in column "A" for each row. • ForwardTracing_Opt sheet: Complete lines 3, 4 and 5 to state to which recipient Lot No. 108 was delivered. <p>To do in KNIME</p> <ul style="list-style-type: none"> • Open the DB GUI • Import the completed backward tracing template for <i>Frozen Fruit Sales</i>. • We will have a look at the trace in a moment. But for now we will stay in the database window. 	<p>Frozen Fruit Sales Strawberries in and out.docx</p>

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DATE	STORY	TASKS	WHAT TO DO IN FOODCHAIN-LAB	FILES
12 Sep 2014	Caterer 3 received the same frozen strawberry lot as Caterers 1 and 2. You ask Caterer 3 to which educational institutions lunches were delivered.	Generate a forward tracing template, import the completed delivery list from Caterer 3 and have a look at the trace.	<ul style="list-style-type: none"> Click on the icon Generate forward tracing templates for missing data [DB4] and select only the caterers. Select an output folder for the templates. <p>To do in Excel or Libre Office Calc:</p> <ul style="list-style-type: none"> Have a look at the template for <i>Frozen Fruit Sales</i>. <p>To do in KNIME</p> <ul style="list-style-type: none"> Import the completed forward tracing data sheet into the database. Close the database window Reset and execute the Supply Chain Reader to get the imported data into the workflow. Open the Tracing View. Again, mark the frozen strawberries “observed” (see above). 	Forwardtrace_request_Caterer 3_Caterer 3 completed.xlsx
12 Sep 2014	According to the trace, the two additional educational institutions should have reported gastroenteritis cases. However, two quick phone calls later you know that nobody is ill. You interview Caterer 3 again and learn that the fruits were processed to strawberry purée and boiled. By boiling the strawberry purée Caterer 3 has obviously inactivated the included noroviruses and prevented the spread of the disease.	Change the network status so that educational institutions connected to Caterer 3 are not predicted to have gastroenteritis cases.	<p><u>Telling FoodChain-Lab that the pathogen has been inactivated in a station</u></p> <ul style="list-style-type: none"> Double-click the station “Caterer 3”. <p>Activate the checkbox Kill contamination [T15].</p>	

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DATE	STORY	TASKS	WHAT TO DO IN FOODCHAIN-LAB	FILES
13 Sep 2014	<p>From the interviews with children you learn that the majority of cases have eaten menu 1 from Caterer 1 or menu 1 from Caterer 2. Both menus contained frozen strawberries, so the current assumption that these fruits might be contaminated is backed.</p> <p>Menu ingredients are tested for noroviruses. In the kitchen of Caterer 1 noroviruses could be detected in a closed bag of frozen strawberries with the Lot No. 108. Caterer 2 used the same lot, but unfortunately, he could not provide a retained sample.</p> <p>Frozen strawberries sampled at <i>Frozen Fruit Sales</i> showed a contamination in one sample, but the signal was very weak and could not be confirmed in a repeated test run.</p> <p>However, it is essential to prevent additional disease cases. Evidence is strongest for frozen strawberries with Lot No. 108. The supplier is asked to withdraw this lot from the market.</p>			

Final Remark

It remains unclear how the frozen strawberry lot became contaminated. One suggestion is, that an ill staff member and poor hygiene in the company *Frozen Fruit Sales* might be the reason. Another one might be that one of the three strawberry farmers has delivered contaminated fruits and that during the washing procedure in *Frozen Fruit Sales* the noroviruses were spread onto all strawberries. Unfortunately, no strawberries were kept as retained sample by *Frozen Fruit Sales*.

Disclaimer

This scenario was inspired by the Norovirus outbreak in Germany in 2012. However, all stations and deliveries are fictitious. If there is by chance any similarity to existing food businesses, this was not intended.