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Uncovering causes of stagnating product sales of a healthy snack: A system dynamics group model building project in a food processing company

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ABSTRACT

Product life cycle (PLC) analysis studies patterns of sales over time and the reasons behind those patterns. Such analysis can be challenging because of the interconnected effect of technical product characteristics, marketing mix elements, and the environment (e.g. competition, consumers). Moreover, employees from different functions have different backgrounds and perceptions about the origins of patterns, which constrains mutual understanding and hampers decision-making. The group model building (GMB) approach can be an effective method to support teams in solving complex dynamic problems, such as a PLC analysis of product sales. This study uses a GMB approach and presents a system dynamics model, which supported cross-functional collaboration in analysing causes of stagnating product sales in the PLC of a healthy snack product in a food processing company. Through multiple GMB sessions with the company team, a system dynamics model was developed, and several strategies were analysed. The model has proven useful in explaining the reasons behind the sales stagnation and in studying possible interventions. Moreover, GMB was successful in increasing participants' insight into the causes of the problem, improving communication, and creating a shared vision about the problem.

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Food industry; product life cycle; cross-functional team collaboration; group model building; system dynamics

1. Introduction

One of the main goals of food companies is continuous and fast development and launch of new food products. Products that succeed usually assure a big portion of the company's profit, while product failures represent substantial financial loss (Grunert & van Trijp, 2014; Owaga & Piller, 2006). Product management is usually handled by teams consisting of people from different functions (e.g. marketing, R&D, sales, production, and quality control) (Horvat et al., 2019; Luning & Marcelis, 2009). Researchers identified cross-functional team collaboration as one of the critical factors for the future success of products (Barczak et al., 2009; Edmondson & Nembhard, 2009). However, collaboration in cross-functional teams is very challenging (Jacobsen et al., 2014). People with different functions have different perspectives and sometimes have conflicting interests. This can cause less mutual understanding and difficulty in decision-making (Darawong, 2018; Sethi et al., 2001). Although people in a team initially tend to establish a consensus on product goals, they commonly perform actual activities in isolation from each other (Jacobsen et al., 2014). To overcome these challenges, teams are encouraged to meet frequently face-to-face (Jacobsen et al., 2014; Vennix, 1996). However, team meetings are not always properly structured, their purpose is not clear, the participation of attendees is not always of high quality, or one person dominates the conversation (Axtell, 2018). These common challenges in team collaboration can hinder food companies in developing strategies that would ensure successful product performance.

To support teams or groups of people in making informed collective decisions in organizations, the operations research, group decision and negotiation fields recommend the use of formal procedures and systematic approaches (Franco & Montibeller, 2010; Kilgour & Eden, 2010; Luoma, 2016). Group model building (GMB) is one such approach particularly aimed at structuring complex dynamic problems, such as product sales, with a group of stakeholders (Ackermann et al., 2014; Andersen & Richardson, 1997; Richardson & Andersen, 2010). GMB aims at

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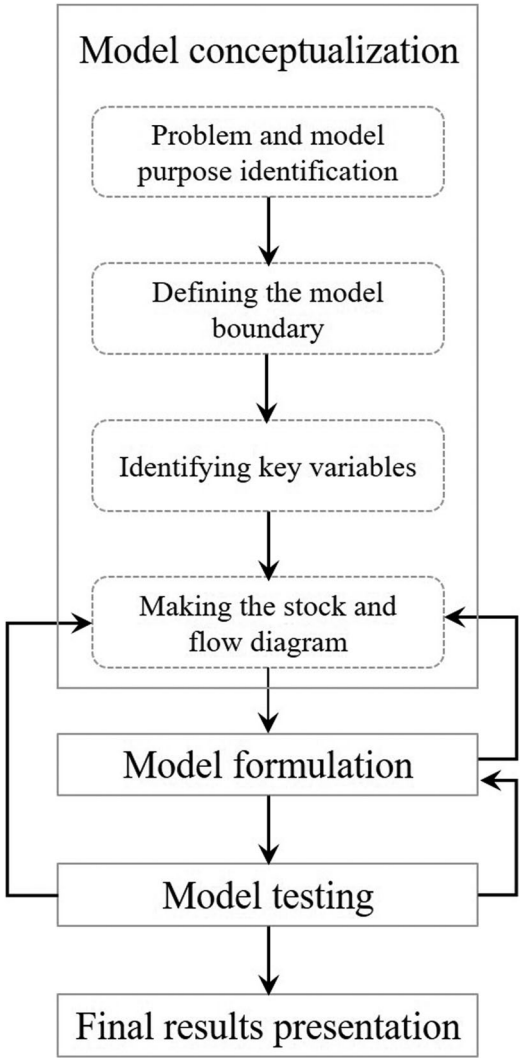

Figure 1. Stages of the group model building (GMB) process in this study, based on Vennix (1996) and Albin (1997). The arrows represent the progression through different GMB stages in this study.

uncovering elements of a complex system and their causal interrelations (Vennix, 1996). An outcome of GMB is a system dynamics (SD) simulation model to investigate strategies for tackling the problem (Richardson & Andersen, 2010; Vennix, 1996), which can be used to make informed future decisions. To develop a simulation model, one should use all existing information, such as conversations with subject-matter experts, observations of the system, looking into existing theories and relevant results from similar simulation studies, and finally, experience and intuition of the modellers (Law, 2015). GMB represents a highly structured approach to group conversations, based on scripts (i.e. Hovmand et al., 2013) with subject-matter experts to elicit model structure and relevant data. Eliciting information in GMB goes through a divergent, or a brainstorming phase, and a convergent phase where choices need to be made amongst many things (Vennix et al., 1992). An advantage of using groups can be their ability to recognize and reject incorrect solutions and solving problems that involve exploring courses of action (Vennix et al., 1992).

Group model building has been applied to various complex dynamic problems in multiple areas, such as policymaking, strategy development and implementation (e.g. Lane et al., 2019; Otto & Struben, 2004; Rouwette et al., 2016). Scott et al. (2016) reviewed applications of GMB in team decision making and almost all the studies provided evidence of the usefulness of GMB in better understanding of complex dynamic problems in group decision-making. Group model building has been applied to various problems in the food chain, such as food security (Baker et al., 2019; Mui et al., 2019), agriculture, food value chain improvement (Lie et al., 2017) and consumers' eating patterns (Gerritsen et al., 2019; Guariguata et al., 2020). Similarly, sales of various products have been explored in multiple system dynamics studies (e.g. electric cars (Deuten et al., 2020); industrial manufacturing (Miragliotta et al., 2009); fast-food chain (Georgiadis et al., 2005); poultry production (Minegishi & Thiel, 2000), online product sales (Yan et al., 2019). However, to the best of our knowledge, the use of a GMB approach in a consumer goods company in the context of assuring high sales of a processed food product has not been previously reported. It is expected that the GMB approach could overcome challenges in multidisciplinary team collaboration aimed at assuring food product success.

In this paper, we described a GMB project that aimed at supporting cross-functional team collaboration in a food company towards understanding the problem of unsatisfactory food product sales. The GMB approach was applied to the case of stagnating sales of a healthy fruit snack. The company had the product on the market for over four years at the moment of the study. The product's sales fluctuated in the first couple of years and levelled off in the subsequent years, leaving the company managers in the dark as to why their activities towards increasing the product's sales were not fruitful. We aimed at developing a dynamic hypothesis that could explain historical product sales behaviour. Moreover, we investigated the usefulness of this approach in supporting team collaboration in a multi-stakeholder situation in the food industry.

This study is positioned within the fields of system dynamics and food product management. It contributes to those fields by providing a detailed report on a project in the context of a problem that has not yet been explored within the framework of the system dynamics group model building. Furthermore, the study provides evidence of the success of applying a GMB approach to solve a common product management problem, i.e. understanding the underlying causes of food product sales behaviour on the market.

Table 1. Activities and scripts used in different stages of the GMB process.

GMB stage	Script name or activity	Purpose	Product	Source
Model conceptualization				
Problem definition and model purpose identification	No specific script used Group meeting with participants and individual interviews	To identify a relevant dynamic problem and to define the purpose of the SD model. To increase familiarity with the participants and assess their connection to the identified problem.	Problem definition and model purpose	Vennix (1996)
Defining the model boundary	Model boundary elicitation	To list stakeholders relevant for the problem and strategies that the participants have tried in the past or would want to employ in the future.	Key stakeholders and key strategies	Hosseinichimeh et al. (2017), Eden and Ackermann (1998)
	Dots	To select the stakeholders and strategies that are the most important for the participants.		Hovmand et al. (2013)*
Identifying key variables	Graphs over time	To elicit model variables and their reference modes (graphs of behaviour over time).	Key variables and their reference modes	Hovmand et al. (2013)*
	Dots	To select the variables that are the most important for the participants.		Hovmand et al. (2013)*
Making the stock and flow diagram	Concept model	To introduce the process and the symbolism of building a system dynamics model.	Stock and flow diagram	Hovmand et al. (2013)*
	Causal mapping with the seed structure	To quickly elicit causal structures in a stock and flow diagram.		Hovmand et al. (2013)*
	Transferring group ownership from one image to another	To move from a structure developed through group discussions in a GMB session to a cleaner version created by the modeller after the GMB session.		Hovmand et al. (2013)*
Model formulation	Parameter booklet	To collect numerical data for model parameters.	SD model that can be simulated	Hosseinichimeh et al. (2017)
	Nonlinear functions elicitation	To estimate table/look up functions for model variables.		Ford and Sterman (1998)
Model testing	What-if analysis	To test how large changes in selected model variables affect the model behaviour. If the existing model behaviour does not correspond to participants' expectations, the information that participants provide about the causes of the expected model behaviour are used to further improve the SD model.	Improved SD model	Rizzi (2018)
Final results presentation	No specific script used Group meeting with participants	To present interesting solutions to the problem, in the form of model runs.	Simulated scenarios	–

*Detailed description of the procedure of executing the scripts is available from Scriptapedia: https://en.wikibooks.org/wiki/Scriptapedia

2. Method

2.1. Stages of the GMB process

In this study, the GMB process consisted of the following stages: model conceptualization, model formulation, model testing, and presentation of results (Figure 1), following the principles of Vennix (1996) and Albin (1997). Table 1 shows the list of scripts that were used to structure the GMB sessions.

2.2. GMB process in this study

2.2.1. The participating company

The company participating in the GMB project is a young small food company situated in Europe. The company produces fruit-based processed products. In total, six company participants attended the GMB sessions and two modelling team members were present (see Table 2). Table 3 shows an agenda of the GMB sessions.

2.2.2. Model conceptualization stage

In the first GMB session, the aim was to define the model boundary and to identify key model variables. The scripts "Model boundary elicitation" and "Graphs over time" were used (see Table 1). The second GMB session, which occurred two days after the first one, aimed at making the initial stock and flow diagram (SFD). To start eliciting causal structures in the SFD, the seed structure as used (see Supplementary material), which was built based on the elicited key variables, stakeholders, and strategies from the first session. The overall SFD was built through group discussions, based on the script

Table 2. Profiles of participants in the GMB sessions and their attendance.

Participant profile	Attendance
Company participants	
Company director	Initial group meeting, individual interview, 4 GMB sessions
Marketing manager	Initial group meeting, individual interview, 4 GMB sessions
Sales representative	Initial group meeting, individual interview, 4 GMB sessions
Sales representative	Initial group meeting, individual interview, 4 GMB sessions
Quality assurance manager	Individual interview, 2 GMB sessions
Production manager	2 GMB sessions
Modelling team	
University researcher – facilitator and modeller	Initial group meeting, individual interviews, 4 GMB sessions
Researcher in private sector – modeller and helper	3 GMB sessions

"Causal mapping with seed structure" (Hovmand et al., 2013) and the guidelines set by Vennix (1996).

2.2.3. Model formulation and testing stages

The first author performed the SD model formulation in Vensim software away from GMB participants, based on the guidelines set by Sterman (2004). The model parameters were based on numerical data, which was partially provided by participants (e.g. marketing budget, market share, product sales, maximum product discount, the chronological entrance of the product in new points of sales, dates of new product launches, consumer quality complaints). Other parameters were from participants' assumptions and outcomes of the "Parameter booklet" script (Hosseinichimeh et al., 2017). Nonlinear functions were estimated together with participants according to the protocol set out by Ford and Sterman (1998).

Model validation was partially performed with participants, and partially by the authors. Structure assessment test aimed at validating if the model's structure was consistent with the existing knowledge of the system and if the level of aggregation and decision rules in the model is appropriate (Sterman, 2004). To assure the validity of the model structure, this information was elicited in the group model building sessions 1-3 directly from the participants (e.g. Model boundary elicitation and Dots, Graphs over time and Causal mapping with the seed structure scripts; see Table 1 for details). When the participants were lacking an understanding of certain concepts, the relevant literature on system dynamics modelling of consumer behaviour was consulted (i.e. classification of consumers into potential, non-loyal and loyal (Warren, 2008)). The model structure that was adapted based on the literature was validated with participants in the third GMB session in a group discussion. The what-if analysis was also performed with participants (e.g. Rizzi, 2018) to explore how large changes in model variables affect the model behaviour. If the model behaviour did not correspond to participants' expectations, information from the discussion about potential causes of the mismatch was used to further improve the model structure. Details of the what-if analysis can be found in the supplementary material.

Validation tests performed by the authors were dimensional consistency, behaviour reproduction, and parameter sensitivity analysis (Sterman, 2004). Dimensional consistency was performed with the Vensim function "unit check". Behaviour reproduction test to examine if the model base run reproduces historical sales of the product was performed by the first author by calibrating the model's base run behaviour to the actual data (see supplementary material). Calibration was performed with the Vensim function Optimize. The details of specific settings of the Optimize function and parameters that were calibrated are listed in the supplementary material. The fit was also assessed qualitatively with participants. Sensitivity analysis was performed to assess if uncertain parameters, when changed, lead to large changes in the model base run behaviour and if the sensitivity is behavioural or numerical (Horvat et al., 2020). Sensitivity analysis was performed with the Vensim function Sensitivity (for details see supplementary material).

2.2.4. Presenting results

In the **fourth GMB session** in November 2018, the process ended by presenting various simulated scenarios, which aimed at increasing participants' understanding of the modelled problem, i.e. probable causes of the stagnating sales of their product (Vennix, 1996).

2.2.4.1. Post-test survey to assess the usefulness of the GMB. The usefulness of GMB in supporting cross-functional team collaboration was measured using a post-test survey (see Supplementary material). We used the questionnaire developed by Rouwette (2011), which evaluates participants' improvement in communication, shared vision and extent of insights gained, and commitment to conclusions resulting from participation in the GMB sessions.

3. Results

3.1. Conceptualized model

3.1.1. Identified problem related to product success in PLC

In the initial group meeting, the company owner stated that the sales of the company's oldest product have not been growing as expected. Figure 2 shows

Table 3. The public agenda of the group model building (GMB) sessions.

No.	GMB session 1	GMB session 2	GMB session 3	GMB session 4
1	Participants introduction	Review of the 1st session	Review of the 1st and the 2nd session	Review of the past sessions
2	Problem introduction	Model structure elicitation	Presentation of the system dynamics model behaviour	Presentation of simulated scenarios
3	Hopes and fears	Model review	What-if exercise	Exercises – participants use the model interface
4	Key stakeholders elicitation	Next steps and closing	Presentation of the stock and flow diagram on consumer buying behaviour	Closing the session
5	Strategy elicitation		Validation of the stock and flow diagram on consumer buying behaviour	Post-test survey
6	Concept model presentation		Nonlinear graphs exercise	
7	Graphs over time exercise		Parameter elicitation exercise	
8	Next steps and closing		Next steps and closing	

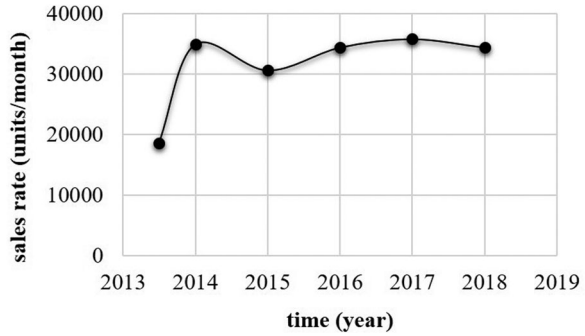

Figure 2. Reference mode of product sales showing average monthly sales of the product from year 2013 to 2018.

that the product's sales fluctuated in the period between 2013 and 2016 and levelled off around 35 000 product units sold per month in subsequent years. Although each year the company increased marketing budget, the company managers did not know why this increase in the budget did not translate into increased product sales. The consensus was established for the GMB process to be aimed at increasing the company participants' understanding of why the problem of stagnating product sales occurred. Therefore, GMB sessions focused on uncovering the dynamic hypothesis to develop a stock-and-flow system dynamics model that could explain historical sales behaviour.

3.1.2. Defined boundary

In the stage of "Defining the model boundary", participants elicited the key stakeholders (Figure 3) and strategies (Figure 4). The most voted external stakeholders (outside of the company) were clients (five votes), consumers (four), and suppliers of raw materials (three). The most voted potential strategies were conducting a large-scale market survey with consumers (five), more communication with consumers (i.e. more marketing activities) (four votes), improvement of sales planning (four votes), easy to open packaging (four votes), improvement of conditions of storing the final product (four votes), and more meetings with internal team (three votes). The modelling team used this information to design the seed structure and determine major discussion points in the second GMB session.

3.1.3. Identified key variables

Table 4 shows elicited key variables, which include marketing budget, the temperature in the factory, competitors selling healthy products, points of sales, and the number of company's products.

3.1.4. The formalized stock and flow diagram (SFD)

Figure 5 shows a sector diagram of the conceptualized SFD after the first two GMB sessions, consisting of the stock and flow backbone of the model and the model sectors affecting the flows. The backbone of the model represents the product's path from the factory (the stock of "packaged product") to the points of sales ("product in the points of sales" stock). The production rate of the packaged product is determined by the "production planning" sector. The client sales rate depends on the stock of the packaged product and the "points of sales" sector of the diagram. Points of sales (e.g. supermarkets, gas stations) represent the number of sales places in which the product is available to the consumers on the market. The sector "product quality" (see Figure 5) depicts the occurrence of product defects (e.g. the deficient sensory quality of the product), which can affect "consumer sales rate". This sector was included since in summer months, due to high temperatures and lack of air-conditioning in the factory, the undesirable sensory quality of packaged products occasionally occurs. If this goes unnoticed by the quality assurance department, packages containing a product of undesirable quality reach the consumers, which can negatively influence their future buying behaviour.

At the end of the second GMB session, the sectors "production planning", "product quality", and

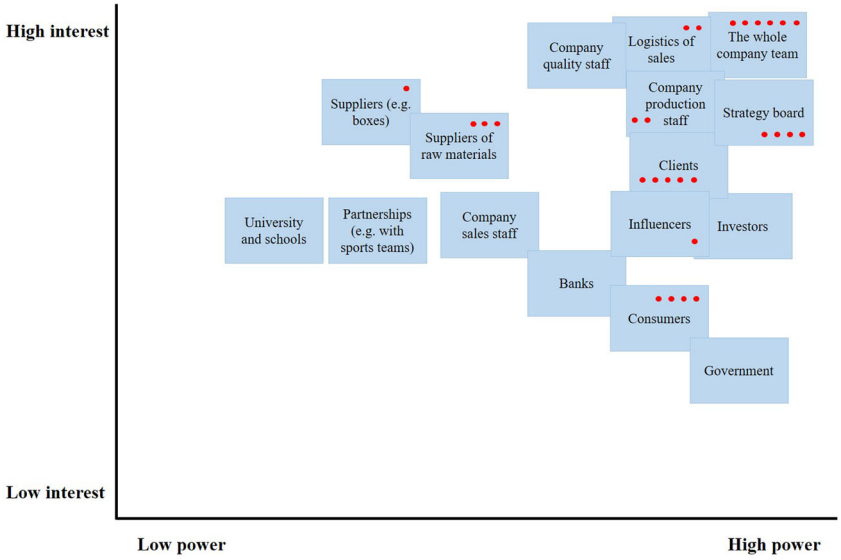

Figure 3. Power-interest grid of stakeholders, elicited with the stakeholder elicitation portion of the "Model boundary elicitation" script. GMB participants positioned stakeholders in the grid based on stakeholder's power to affect the defined problem, and their interest, which implies stakeholders' stake or involvement in the defined problem. Red dots represent participants' votes for the most important stakeholders.

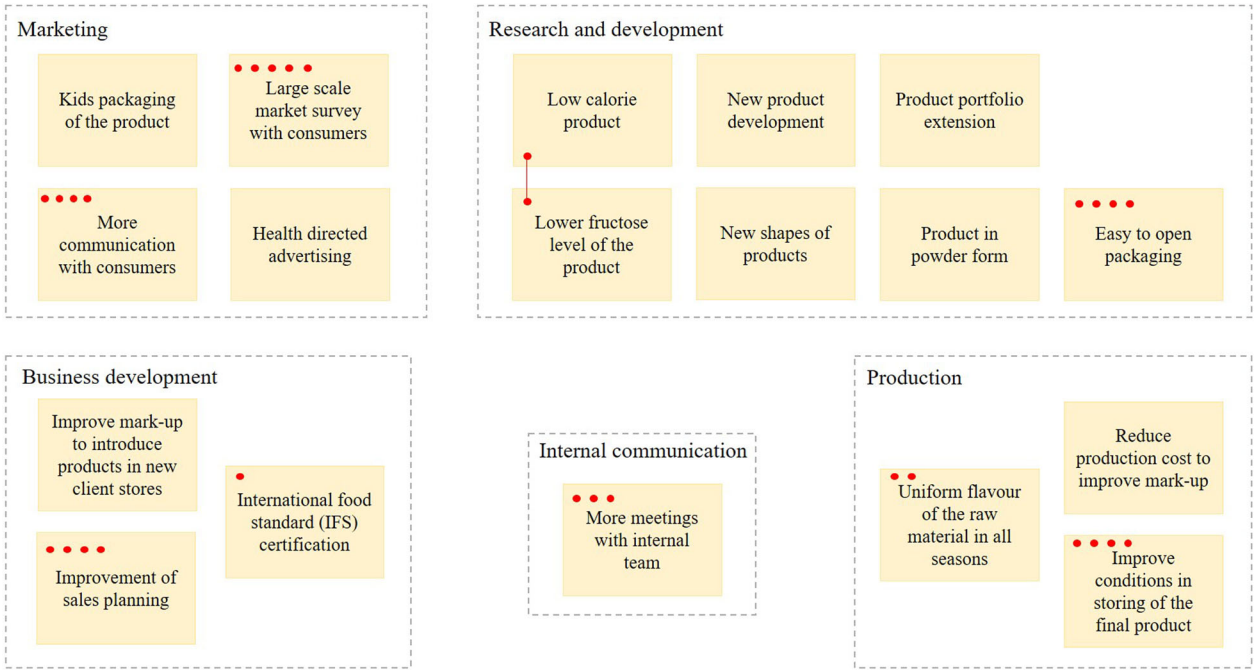

Figure 4. Strategies elicited with the strategy elicitation portion of the "Model boundary elicitation" script, categorized by themes. Red dots represent participants' votes for the most important strategies, in relation to the defined problem. A line between the dots means a participant gave one vote to two strategies.

"points of sales" were represented with a higher level of detail compared to the sectors depicting company's "marketing activities" and "competition" on the market. After this session, the modelling team formalized and simulated the model structure (Figure 5). However, this structure was not able to explain the causes of stagnating product sales. Product quality problems would occur only on rare occasions and in small amounts. Moreover, there was no evident problem in production planning or in entering the points of sales. In the second session, the participants acknowledged that unexplored model sectors (i.e. marketing activities and competition) could have a substantial effect on consumer sales rate. However, their lack of understanding of how those sectors affected the sales rate did not allow for clear mapping of causal structures. Consequently, the modelling team decided to search for theories that would be able to explain the causes of the sales problem within the marketing activities and competition sectors.

For the third GMB session, the facilitating team developed a new SFD based on existing theories of consumer buying behaviour, which could potentially

Table 4. Key variables elicited with "Graphs over time" script, their description, and the total number of votes each variable received from participants.

Variable name	Description	Votes
Marketing budget	Represents the amount of money allocated for marketing activities each year.	5
Temperature in the factory	Represents the temperature within the production facilities, which is especially problematic in warm months since the space is not air-conditioned.	5
Competitors selling healthy products	Represents all the competitors on the market whose products fall into the category of healthy food.	4
Points of sales	Represents all the places where the company's product can be bought (e.g., supermarkets, gas stations, vending machines).	4
Number of products	Represents the total number of company's products on the market	3

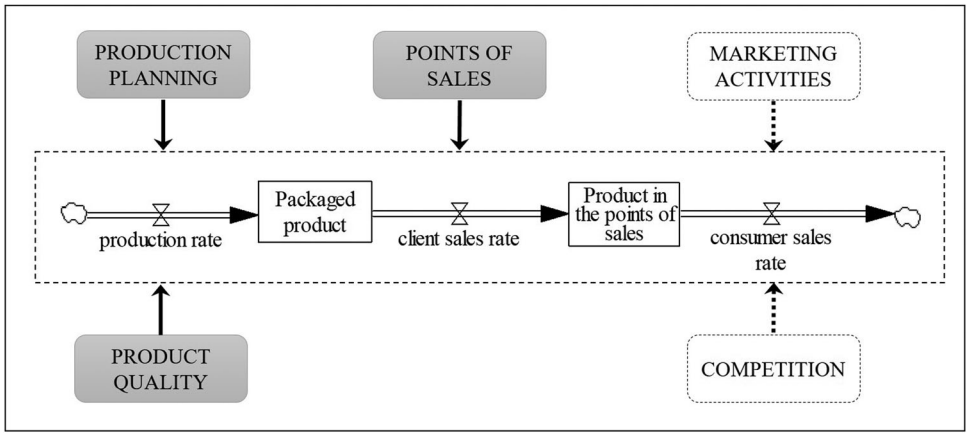

Figure 5. Sector diagram consisting of the stock and flow backbone of the model and various sectors affecting the flow rates. The sector boxes in grey represent the structures that were developed completely after the second meeting, while the white boxes represent the structures that remained unfinished.

capture the company's impact on product sales through marketing activities, and the effect of competition (e.g. Schepers et al., 2004; Warren, 2008). To minimize the negative impact of introducing a literature based SFD on participants' model ownership; all elements of the presented SFD were extensively discussed in that GMB session. Firstly, the facilitator addressed each stock and flow and their causal connections to validate if suggested dynamic hypotheses corresponded to their consumers, which they confirmed. Moreover, it was discussed which marketing activities affected consumers to move from one stock to another. Figure 6 depicts the main part of the new SFD showing consumer buying behaviour, validated by the GMB participants in the third GMB session.

Figure 6 shows that there is a stock of "potential consumers" on the market who are interested in the product that the company is selling. The company acquires "new potential consumers" when the product enters new points of sales. There is a continuous competition for "potential consumers" between the company and its competitors. By investing in marketing activities (e.g. discount campaigns, advertising in supermarket fliers and on social media, sharing product samples, and launching new products), the company increases the chance of winning "potential consumers". If the company succeeds in winning potential consumers, those people first become "non-loyal consumers". With a certain delay, a fraction of "non-loyal consumers" may become "loyal consumer". "Loyal consumers" monthly buy more units of the product than the "non-loyal consumers". Figure 6 also shows that some "non-loyal consumers" do not become loyal, and after a certain delay they go back to being "potential consumers". Moreover, Figure 6 reveals that a fraction of "loyal consumers" is lost after a delay of a few months, because they start buying fewer product units. Participants stated that this happens particularly if "loyal consumers" buy a product of lower quality.

3.1.5. Simulated scenarios presented to the GMB participants

In the fourth GMB session, the team presented and discussed simulations of various model scenarios, representing the main activities that the company undertakes to move consumers from one stock to another. The aim was to increase participants' understanding of the causes of stagnating product sales. These scenarios included: 1) product discount campaigns, 2) entrance of a similar new company's product on the market (i.e. the effect of

Table 5. Formulations of the stock and flow variables of the Vensim model* (see stock and flow diagrams in Figure 6 and in the Appendix).

Variable name	Unit	Formulation
Potential consumers	People	= ∫ competition consumers forgetting rate + "non-loyal consumers forgetting rate" + new potential consumers-competition winning potential consumers-winning potential consumers dt + [0]
Loyal consumers	people	= ∫ winning loyal consumers-losing loyal consumers - losing loyal consumers due to quality issues *dt* + [initial delay 1 throughput* delay in losing loyal consumers]
"Non-loyal consumers"	people	= ∫ losing loyal consumers + losing loyal consumers due to quality issues + winning potential consumers - "non-loyal consumers forgetting rate" *dt* + [initial delay 2 throughput * delay in consumers forgetting]
Consumers of competing products	people	= ∫ competition winning potential consumers-competition consumers forgetting rate *dt* + [initial delay 3 throughput* delay in competition consumers forgetting]
new potential consumers	people/Month	= people per shop*change in points of sales
winning potential consumers	people/Month	= Potential consumers*fraction of consumers of the product
winning loyal consumers	people/Month	= "Non-loyal consumers"/delay in winning loyal consumers
losing loyal consumers	people/Month	= DELAY N((winning loyal consumers - losing loyal consumers due to quality issues), delay in losing loyal consumers, initial delay 1 throughput, delay 1 order)
losing loyal consumers due to quality issues	people/Month	= quality complaints factor* Loyal consumers
"non-loyal consumers forgetting rate"	people/Month	= DELAY N (winning potential consumers, delay in consumers forgetting, initial delay 2 throughput, delay 2 order)
competition winning potential consumers	people/Month	= Potential consumers*fraction of consumers won by competing products
competition consumers forgetting rate	people/Month	= DELAY N (competition winning potential consumers, delay in competition consumers forgetting, initial delay 3 throughput, delay 3 order)
sales rate	units/Month	= products bought by loyal consumers* Loyal consumers + "products bought by non-loyal consumers"* "Non-loyal consumers"

*time step/dt: 0.0078125, integration: RK4 Auto, initial time: 6 months, final time: 96 months, units for time: Month.

cannibalization), and 3) product quality issues, to show the effect on average monthly sales (as shown in Figures 7–9). Since the company adapts its product strategy every three months, months were selected as the model's time unit. The presented model's base run time horizon was 72 months; consistent with the existing historical sales data from the middle of 2013 until the middle of 2018 (see Figure 2). Future scenario runs were presented for subsequent 24 months.

Figure 7 shows the results of the product discounts scenario. The blue line represents the base run, showing the model behaviour when no product discount has been applied. The company never applies more than a 20% discount on the price. Therefore, the base run is compared to the model behaviour when a 20% price discount is applied for 3 months (red line), and 12 months (green line), both starting from January 2019. Based on participants' assumptions, when there is a product discount of 20%, non-loyal and loyal consumers will buy 20% more units of the product than usual. Moreover, when there is a 20% discount, there is also a 5% higher chance of winning potential consumers. Figure 7 shows that there is an immediate increase in sales during discount months, as a direct result of both non-loyal and loyal consumers buying more product units. When there are no discounts, the sales rate drops sharply.

Figure 8 shows the results of the second scenario when a new similar company's product appears on the market. This scenario was presented because one of the company's strategies has been to launch line extensions, e.g. different flavours of healthy food snacks. When that happens, a fraction of consumers of the old product will decrease, because some of the potential consumers will start choosing the new product. With a slight increase in the fraction of lost potential consumers (0.4%), the company would experience a small loss of sales of the old product. However, this effect would be more pronounced with a higher loss of potential consumers (2.5%). In this case, the sales of the old product would not recover. The decrease of 0.4% was based on participants' assumptions from the results of the nonlinear functions script and the 2.5% fraction was assumed based on the decrease in the product sales when the company had new products entering the market in the past. The 2.5% loss of potential consumers could be an overestimation since the drop in actual sales could have been caused by various other factors (e.g. competition winning consumers, a company entering fewer points-of-sales, less successful marketing activities). However, the participant's assumption (0.4%) might also be unrealistic since no concrete data exist. Nevertheless, with this scenario, the participants could see the sensitivity of the system to new product introductions and the need for careful consideration of potential product cannibalization effects.

Figure 9 shows the model behaviour when a product with sensory quality issues appears on the market. According to participants, this would mainly affect losing loyal consumers, who would

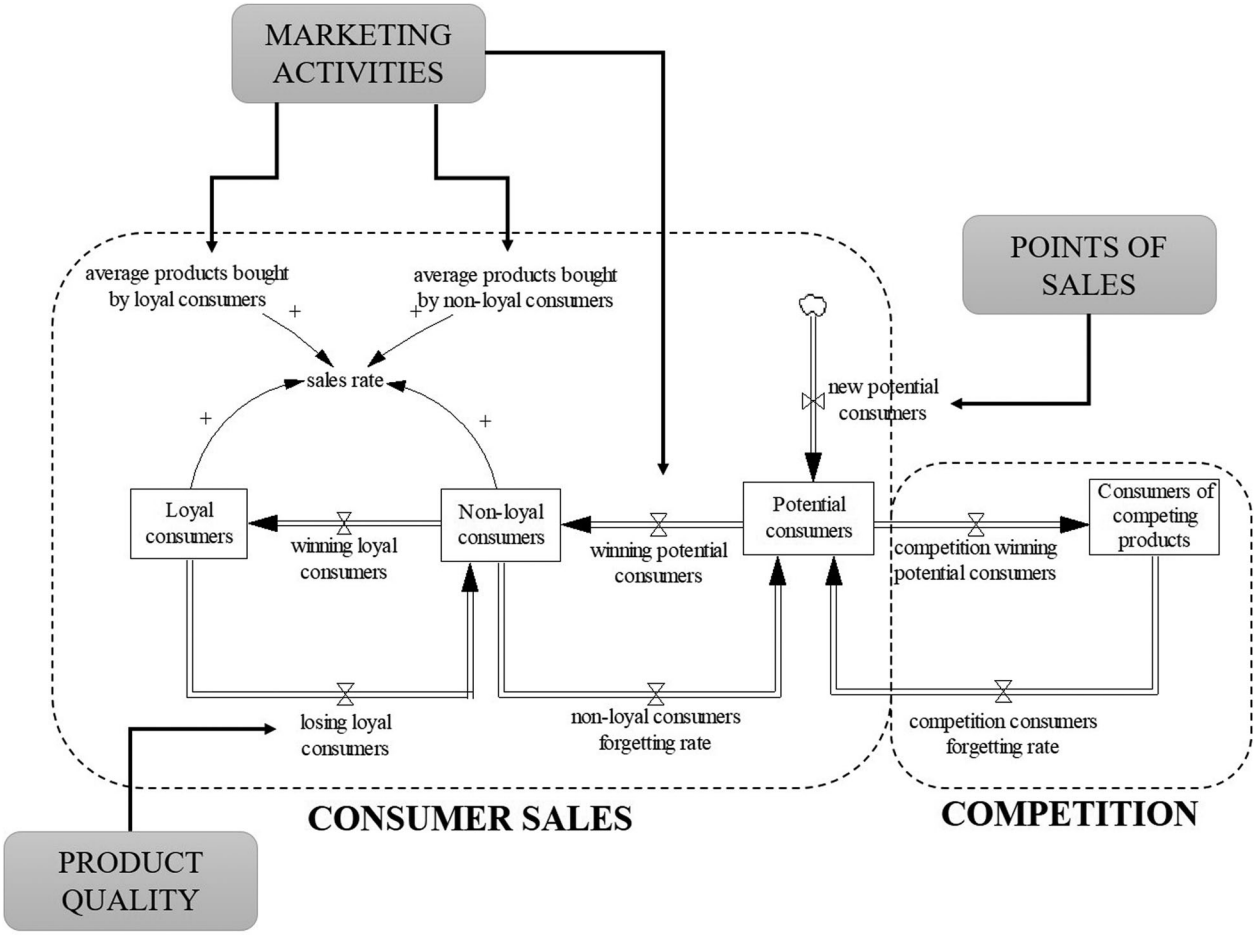

Figure 6. Main parts of the stock and flow diagram (SFD) depicting consumer buying behaviour, developed for better understanding of the effect of marketing activities, competition, and product quality on product demand. See Table 5 for formulations of variables and Supplementary material for the complete SFD.

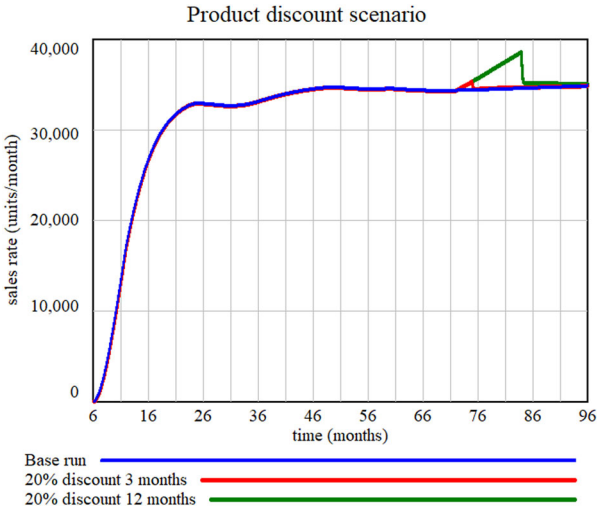

Figure 7. Scenario showing sales rate of a healthy fruit snack when there is a 20% product price discount for 3 months or permanently. Product discount causes loyal and non-loyal consumers to buy 20% more product units, and there is a 5% higher fraction of winning non-loyal consumers.

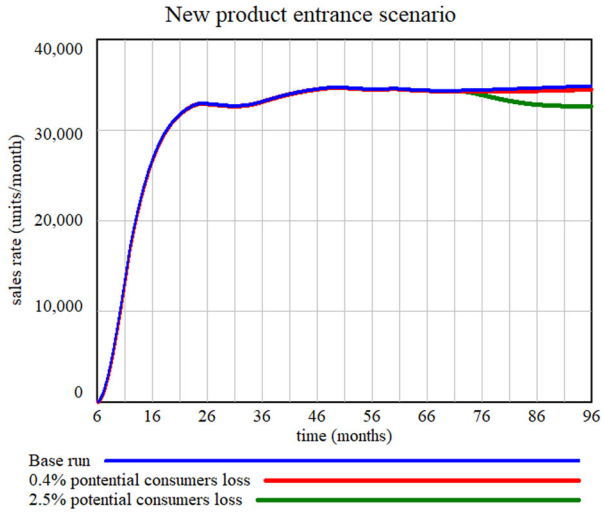

Figure 8. Scenario showing sales rate when a new company's product enters the market, which causes 0.4% or 2.5% loss of potential consumers.

start buying fewer product units. Based on company's consumer complaints data and participants assumptions on the frequency of consumers complaining, it is assumed that 1% of loyal consumers would buy faulty products, which would cause them to stop being loyal. Figure 9 shows that there is a small drop in product sales rate if quality issues occur for a short period, such as two months. However, longer quality-related problems, i.e. 12 months, could have a more serious impact on product sales, which will have negative consequences on

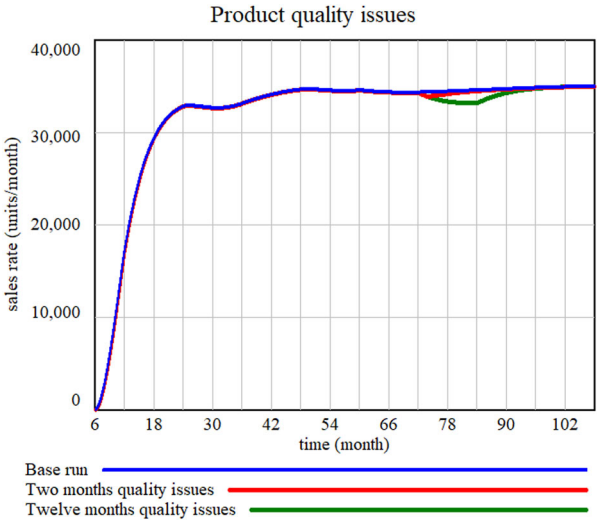

Figure 9. Scenario showing sales rate when there are sensory quality issues with the product for two or 12 months, which causes the loss of loyal consumers.

product sales even after the quality issues will have been resolved, but will eventually recover. This recovery supports participants' claim that they do not lose consumers permanently. Since the company usually does not have serious quality issues for periods longer than a few weeks, the deficient quality was probably not the cause of stagnating product sales. Nevertheless, the company must try to avoid long periods of lowered product quality.

3.2. Results of the post-test survey

Table 6 shows the results of the post-test survey. The participants agreed that the GMB approach generated better communication, more insight, and better-shared vision of the problem, compared to the usual meetings in which they discussed similar problems. Although the results in Table 6 show that commitment was scored the lowest, participants stated that they support the conclusions that were drawn during the modelling process, and that they would try to convince others in the company of their importance. Participants stated that the use of the SFD made communication about the problem clearer and it gave them more understanding of the feedback processes that play a role in the problem. Most of the participants appreciated the GMB sessions as they gave them an opportunity for an open and extensive discussion of the problem as a team. While some participants felt that the sessions required too much of their time, others stated that they would have liked even more time to discuss the problem, to test the model and to perform scenario exercises. These results complement findings in past studies where the same aspects of GMB projects within the public sector were tested through distributing a post-test survey (e.g. Rouwette, 2011; Vennix & Scheper, 1993)

4. Discussion

4.1. An expansion of participants' worldview

The GMB approach in this study was used to increase a company's understanding of their problem of stagnating sales of a healthy fruit snack. The GMB participants started with a supply-push view of the problem. This resulted in the model shown in Figure 5, which largely focused on production, product quality, and client (points of sales) issues. In this first phase, participants could not say much about how their marketing activities affected their consumers, although they found the development of marketing strategies very important. One sales representative stated that they do not even collect sales data for most of the points of sales. On the other hand, the marketing manager revealed that they perform marketing activities because they think these affect consumer sales, but the participant did not know how. This revealed their truncated view of the problem situation. Participants were looking for a familiar explanation for stagnating sales, such as occasional product quality deficiency or the lack of points of sales to enter the market. Introduction of the model in Figure 6 drew the discussion away from production and client sales aspects towards consumer orientation. This aspect, which was initially hidden from their truncated view of the problem, allowed simulation of their sales problem. This shift from production-driven to consumer-driven product management has been recognized as one of the factors in assuring product success in food systems (Meulenberg & Viaene, 2005). Consumer orientation of a company implies that the company's activities need to be focused on satisfying consumers' needs (Davčik & Rundquist, 2012; Horvat, 2019). GMB sessions increased participants' understanding of the mechanisms by which they can influence consumer sales, which provides an opportunity to improve future strategies by using that newly acquired knowledge.

The lack of the company's consumer orientation was also visible in the lack of consumer data to formulate the model parameters. This did not jeopardize the project's success due to the carefully designed GMB project plan that allowed for extensive discussions, which made calibration and validation of the model easier since the project team could directly approach participants to assure that the model is a good representation of their problem. Furthermore, the participants were able to estimate parameter values based on their experience and

Table 6. Results of the post-test survey.

Compared to usual meetings in which you discussed similar problems, group model building sessions:	Mean*	Mode*
generate more insight	4.25	4
result in better communication	4.25	4
generate better shared vision	4.25	4
generate insight more quickly	4	4
generate shared vision more quickly	3.75	4
generate more commitment	3.5	**
generate commitment more quickly	3.25	3

*5 - strongly agree; 4 – agree; 3 – neither agree, nor disagree; 2 – disagree; 1 - strongly disagree.
**Two participants agree (4), and two participants neither agree, nor disagree (3).

their assumptions became a valuable source for model calibration.

4.2. The likely causes of stagnating sales of the healthy snack

The graph of the problem in Figure 2 indicated that the sales of a healthy food snack might be stagnating, which was further reinforced by SD model simulations. Model simulations in Figures 7–9 showed that the sales rate moves towards a steady state unless consumers are triggered by company's activities that affected the sales rate positively (e.g. product discounts) or negatively (e.g. the launch of a new product). This behaviour is in line with literature on product life cycle management, which explains that non-durable products, such as food products, often have a cycle-recycle sales curve (Kotler, 2003; Midgley, 1981), with multiple consecutive cycles of growth and decline in sales (Kotler, 2003). In the first cycle, strong product promotion leads to the consumers' initial buying decision. However, only part of the initial buyers continues buying the product regularly until the next cycle of strong promotion (Midgley, 1981). This explanation corresponds to the SFD in Figure 6, where only a small number of consumers becomes loyal, while others go back to the stock of potential consumers until they are triggered again into buying the product. It also corresponds to the GMB participants' statements that their consumers want to try new products, instead of being loyal to only one.

Another possible cause of problems with the sales of the healthy snack product comes from the literature on product cannibalization. Cannibalization represents "the extent to which one product's consumers are gained at the expense of consumers of other products of the same company" (Guide & Li, 2010, pg. 551). Launching new products is an important strategy to sustain company growth (Barczak & Kahn, 2012) and some of the GMB participants stated that more new products need to be launched to improve the overall sales of the company. However, the model simulations in Figure 8 suggest that launching new products might not always be the best strategy as it might affect the sales of existing products. This is particularly relevant when it causes consumers to switch from buying an older product to buying a new product (Srinivasa et al., 2005). The model behaviour indicates that even small market share loss (e.g. 2.5%) resulting from product cannibalization causes a substantial decrease in sales in the long-term. Consumers who are not loyal are particularly susceptible to switching between similar products (Meredith & Maki, 2001). According to the scenario in Figure 7, a bigger portion of consumers of the product in this study belongs to non-loyal consumers. Moreover, cannibalization is especially likely to occur when a newer product is a line extension, i.e. when the two products fulfil the same consumer need and attract the same consumer segments (Guide & Li, 2010; Meredith & Maki, 2001). This is particularly relevant here since product line extensions have been the main type of company's new product introductions.

4.3. The usefulness of the GMB approach in supporting team collaboration in this study

The GMB approach in this study was successful in increasing participants understanding of the potential causes of stagnating sales of their product, and it was useful in supporting team collaboration. Before the GMB started, participants indicated a low frequency and quality of communication between the team members. GMB sessions in this study were particularly successful in improving team communication, and in generating insight and shared vision. Participants stated that the best features of the meetings were group interaction and discussing the problems. The first positive impact of the GMB on cross-functional team collaboration was accomplished already early in the process. After the second GMB session, the company increased communication frequency by scheduling weekly meetings between technical and marketing personnel, which is an important element of cross-functional team collaboration (Stewart-Knox & Mitchell, 2003).

On the other hand, GMB's usefulness in increasing commitment to the solutions was somewhat lower. The commitment of the participants in facilitated modelling sessions can be enhanced by allowing participants to co-construct an SD model, which contributes to achieving ownership over results (Rouwette, 2011). In this GMB process, the perceived ownership could have been lower for two main reasons. Firstly, the authors suggested the consumer structure in Figure 6. Secondly, there was

unequal participation throughout the GMB process, as two participants only joined the first two GMB sessions. The fact that not all participants joined all the sessions was also stated by participants as one of the disappointing features of the sessions. Potential reasons for the lack of contribution by some participants could be a lack of interest combined with more pressing work issues and a geographical distance (the factory and the headquarters of the company where the sessions were held are 100 km apart).

4.4. Contribution of the paper to the field of strategy

The study focused on increasing understanding of the underlying causes of stagnating healthy snack sales by employees of a small consumer-goods company and it contributes to the pool of research on the use of participatory SD in small food firms. Small firms usually employ one or a few people who deal with business strategy, which can hinder their full understanding of the underlying causes of the problem since their mental models may not be complete (Torres et al., 2017). Through the process of model development and simulation, managers build an understanding of the problem they are facing (Kunc, 2012). This study showcased the process of uncovering and expanding mental models of participants employed in a small company, taking them from a state of partial understanding of the underlying causes of their sales problem to a completely new knowledge of dynamic hypotheses representing behaviour of consumers who contribute to product sales. Such process can have positive implications for their future strategic decision making (Torres et al., 2017). The relevance of SD as a rehearsal tool prior to implementing strategies has also been recognized by Dyson et al. (2007). Furthermore, the paper presented how participatory system dynamics, as one of the soft OR tools (O'Brien, 2011), can provide strategic development support in a situation when a company may be lacking market data as one of the important strategic resources to meet their objectives (Kunc & O'Brien, 2019).

5. Conclusions and future work

The group model building approach presented in this study was successful in improving team-collaboration and in uncovering possible causes of stagnating sales of the company's healthy food product. The model simulations indicated that external influence (e.g. promotion, discounts), influence the product sales to go through multiple consecutive cycles of increased and decreased sales. Cannibalisation of the healthy food product by launching similar new products could be another threat to the growth of product sales. The GMB approach in this study was assessed by the participants as more successful in increasing the understanding of the problem of stagnating product sales, compared to the similar meetings where this problem was discussed. GMB supported team collaboration by increasing participants' insight into the causes of the problem, by improving communication among them and by creating a shared vision about the problem.

The sales problem was conceptualized from multiple perspectives (i.e. marketing, sales, production, and quality). Future model improvements could involve conceptualizing the effect of social media promotion, elaborating product quality to involve various product attributes (e.g. texture, packaging), and further expanding the competition sector. Improvement could be made by collecting more accurate consumer data by performing extensive consumer research. Furthermore, similar models of other company's products could be built to study the effect of the company's strategies on the combined sales of the company's products.

Lastly, the usefulness of a GMB approach in supporting team collaboration to understand the problem of stagnating sales of a food product was appraised based on four factors (insight, communication, shared vision, and commitment). Future research could move towards uncovering if any other factors are important in supporting team collaboration and investigate the mechanisms through which these factors lead to positive outcomes after GMB. Moreover, different study designs (e.g. pre- and post-test survey, and a follow-up survey after some time has passed from the last GMB session) could show the extent of cross-functional team collaboration improvement from the beginning to the end of the GMB process and the extent of the resilience of improvement in team collaboration due to the GMB process.

Disclosure statement

No potential conflict of interest was reported by the author.

References

Ackermann, F., Franco, L. A., Rouwette, E., & White, L. (2014). Special issue on problem structuring research and practice. *EURO Journal on Decision Processes*, *2*(3–4), 165–172. https://doi.org/10.1007/s40070-014-0037-6

Albin, S. (1997). *Building a system dynamics model part 1: Conceptualization*. Massachusetts Institute of Technology.

Andersen, D. F., & Richardson, G. P. (1997). Scripts for group model building. *System Dynamics Review*, *13*(2), 107–129. https://doi.org/10.1002/(SICI)1099-1727(199722)13:2<107::AID-SDR120>3.0.CO;2-7

Axtell, P. (2018). 5 Common Complaints About Meetings and What to Do About Them. *Harvard Business Review*. Retrieved December 18, 2018, from https://hbr.org/2018/06/5-common-complaints-about-meetings-and-what-to-do-about-them.

Baker, P., Brown, A. D., Wingrove, K., Allender, S., Walls, H., Cullerton, K., Lee, A., Demaio, A., & Lawrence, M. (2019). Generating political commitment for ending malnutrition in all its forms: A system dynamics approach for strengthening nutrition actor networks. *Obesity Reviews*, *20*(S2), 30–44. https://doi.org/10.1111/obr.12871

Barczak, G., Griffin, A., & Kahn, K. B. (2009). Perspective: Trends and drivers of success in NPD practices: Results of the 2003 PDMA best practices study. *Journal of Product Innovation Management*, *26*(1), 3–23. https://doi.org/10.1111/j.1540-5885.2009.00331.x

Barczak, G., & Kahn, K. B. (2012). Identifying new product development best practices. *Business Horizons*, *55*(3), 293–305. https://doi.org/10.1016/j.bushor.2012.01.006

Darawong, C. (2018). Dynamic capabilities of new product development teams in performing radical innovation projects. *International Journal of Innovation Science*, *10*(3), 333–349. https://doi.org/10.1108/IJIS-07-2017-0060

Davčik, N., & Rundquist, J. (2012). An exploratory study of brand success: Evidence from the food industry. *Journal of International Food & Agribusiness Marketing*, *24*(1), 91–109. https://doi.org/10.1080/08974438.2012.645747

Deuten, S., Vilchez, J. J. G., & Thiel, C. (2020). Analysis and testing of electric car incentive scenarios in the Netherlands and Norway. *Technological Forecasting and Social Change*, *151*, 119847. https://doi.org/10.1016/j.techfore.2019.119847

Dyson, R., Bryant, J., Morecroft, J. W., & O'Brien, F. (2007). The strategic development process. In F. O'Brien, & R. Dyson (Eds.), *Supporting strategy: Frameworks, methods, and models*. Wiley.

Edmondson, A. C., & Nembhard, I. M. (2009). Product development and learning in project teams: The challenges are the benefits. *Journal of Product Innovation Management*, *26*(2), 123–138. https://doi.org/10.1111/j.1540-5885.2009.00341.x

Ford, D., & Sterman, J. (1998). Expert knowledge elicitation for improving mental and formal models. *System Dynamics Review*, *14*(4), 309–340. https://doi.org/10.1002/(SICI)1099-1727(199824)14:4<309::AID-SDR154>3.0.CO;2-5

Franco, L. A., & Montibeller, G. (2010). Facilitated modelling in operational research. *European Journal of Operational Research*, *205*(3), 489–500. https://doi.org/10.1016/j.ejor.2009.09.030

Georgiadis, P., Vlachos, D., & Iakovou, E. (2005). A system dynamics modeling framework for the strategic supply chain management of food chains. *Journal of Food Engineering*, *70*(3), 351–364. https://doi.org/10.1016/j.jfoodeng.2004.06.030

Gerritsen, S., Renker-Darby, A., Harré, S., Rees, D., Raroa, D. A., Eickstaedt, M., Sushil, Z., Allan, K., Bartos, A. E., Waterlander, W. E., & Swinburn, B. (2019). Improving low fruit and vegetable intake in children: Findings from a system dynamics, community group model building study. *PLoS One*, *14*(8), e0221107. https://doi.org/10.1371/journal.pone.0221107

Grunert, K. G., & van Trijp, H. C. M. (2014). Consumer-oriented new product development. In N. K. van Alfen (Ed.), *Encyclopedia of agriculture and food systems* (2nd ed., pp. 375–386). Academic Press.

Guariguata, L., Rouwette, E. A. J. A., Murphy, M. M., Saint Ville, A., Dunn, L. L., Hickey, G. M., Jones, W., Samuels, T. A., & Unwin, N. (2020). Using group model building to describe the system driving unhealthy eating and identify intervention points: A participatory, stakeholder engagement approach in the Caribbean. *Nutrients*, *12*(2), 384. https://doi.org/10.3390/nu12020384

Guide, V. D. R., & Li, J. (2010). The potential for cannibalization of new products sales by remanufactured products. *Decision Sciences*, *41*(3), 547–572. https://doi.org/10.1111/j.1540-5915.2010.00280.x

Horvat, A. (2019). *Systems thinking in managing the success of food products: exploring the potential of a system dynamics approach*. Wageningen University.

Horvat, A., Behdani, B., Fogliano, V., & Luning, P. A. (2019). A systems approach to dynamic performance assessment in new food product development. *Trends in Food Science & Technology*, *91*, 330–338. https://doi.org/10.1016/j.tifs.2019.07.036

Horvat, A., Fogliano, V., & Luning, P. A.(2020). Modifying the Bass diffusion model to study adoption of radical new foods–The case of edible insects in the Netherlands. *PLoS One*, *15*(6), e0234538. https://doi.org/10.1371/journal.pone.0234538

Horvat, A., Granato, G., Fogliano, V., & Luning, P. A.(2019). Understanding consumer data use in new product development and the product life cycle in European food firms – An empirical study. *Food Quality and Preference*, *76*, 20–32. https://doi.org/10.1016/j.foodqual.2019.03.008

Hosseinichimeh, N., MacDonald, R., Hyder, A., Ebrahimvandi, A., Porter, L., Reno, R., Maurer, J., Andersen, D. L., Richardson, G., Hawley, J., & Andersen, D. F. (2017). Group model building techniques for rapid elicitation of parameter values, effect sizes, and data sources. *System Dynamics Review*, *33*(1), 71–84. https://doi.org/10.1002/sdr.1575

Hovmand, P. S., Rouwette, E. A. J. A., Andersen, D. F., Richardson, G. P., & Kraus, A. (2013). Scriptapedia 4.0.6. In Eberlein, R. & Martínez-Moyano, I. J. (Eds.), Proceedings of the 31st International Conference of the System Dynamics Society. System Dynamics Society.

Jacobsen, L. F., Grunert, K. G., Søndergaard, H. A., Steenbekkers, B., Dekker, M., & Lähteenmäki, L. (2014). Improving internal communication between marketing and technology functions for successful new food product development. *Trends in Food Science & Technology*, *37*(2), 106–114. https://doi.org/10.1016/j.tifs.2014.03.005

Kilgour, D. M., & Eden, C. (2010). Introduction to the handbook of group decision and negotiation. In D. M. Kilgour, & C. Eden (Eds.), *Handbook of group decision and negotiation* (pp. 1–7). Springer.

Kunc, M. (2012). Teaching strategic thinking using system dynamics: Lessons from a strategic development course. *System Dynamics Review*, *28*(1), 28–45. https://doi.org/10.1002/sdr.471

Kunc, M., & O'Brien, F. A. (2019). The role of business analytics in supporting strategy processes: Opportunities and limitations. *Journal of the Operational Research Society*, *70*(6), 974–985. https://doi.org/10.1080/01605682.2018.1475104

Lane, D., Husemann, E., Holland, D., & Khaled, A. (2019). Understanding foodborne transmission mechanisms for Norovirus: A study for the UK's Food Standards Agency. *European Journal of Operational*

Research, *275*(2), 721–736. https://doi.org/10.1016/j.ejor.2018.11.070

Law, A. M. (2015). *Simulation modeling and analysis* (5th ed.). McGraw Hill Education.

Lie, H., Rich, K. M., & Burkart, S. (2017). Participatory system dynamics modelling for dairy value chain development in Nicaragua. *Development in Practice*, *27*(6), 785–800. https://doi.org/10.1080/09614524.2017.1343800

Luning, P. A., & Marcelis, W. J. (2009). *Food quality management: a technological and managerial principles and practices*. Wageningen Academic Publishers.

Luoma, J.(2016). Model-based organizational decision making: A behavioral lens. *European Journal of Operational Research*, *249*(3), 816–826. https://doi.org/10.1016/j.ejor.2015.08.039

Meredith, L., & Maki, D. (2001). Product cannibalization and the role of prices. *Applied Economics*, *33*(14), 1785–1793. https://doi.org/10.1080/00036840010015769

Meulenberg, M. T. G., & Viaene, J. (2005). Changing agri-food systems in Western countries: A marketing approach. In W. M. F. Jongen, & M. T. G. Meulenberg (Eds.). *Innovation in agri-food systems* (pp. 87–124). Wageningen Academic Publishers.

Midgley, D. F. (1981). Toward a theory of the product life cycle: Explaining diversity. *Journal of Marketing*, *45*(4), 109–115. https://doi.org/10.1177/002224298104500414

Minegishi, S., & Thiel, D. (2000). System dynamics modeling and simulation of a particular food supply chain. *Simulation Practice and Theory*, *8*(5), 321–339. https://doi.org/10.1016/S0928-4869(00)00026-4

Miragliotta, G., Brun, A., & Soydan, I. A. (2009). Coordinating multi-business sales through management simulators. *International Journal of Production Economics*, *121*(2), 533–549. https://doi.org/10.1016/j.ijpe.2006.10.006

Mui, Y., Ballard, E., Lopatin, E., Thornton, R. L. J., Pollack Porter, K. M., & Gittelsohn, J. (2019). A community-based system dynamics approach suggests solutions for improving healthy food access in a low-income urban environment. *PLoS One*, *14*(5), e0216985. https://doi.org/10.1371/journal.pone.0216985

O'Brien, F. (2011). Supporting strategy: A survey of UK OR/MS practitioners. *Journal of the Operational Research Society*, *62*(5), 900–920.

Otto, P., & Struben, J. (2004). Gloucester Fishery: Insights from a group modeling intervention. *System Dynamics Review*, *20*(4), 287–312. https://doi.org/10.1002/sdr.299

Owaga, S., & Piller, F. T. (2006). Reducing the risks of new product development. *MIT Sloan Management Review*, *47*(2), 65–71.

Richardson, G. P., & Andersen, D. F. (2010). Systems thinking, mapping, and modeling in group decision and negotiation. In M. D. Kilgour, & C. Eden (Eds.), *Handbook of group decision and negotiation* (pp. 313–324). Springer.

Rizzi, S. (2018). What-if analysis. In L. Liu, & M. T. Özsu (Eds.), *Encyclopedia of database systems* (2nd ed.). Springer-Verlag.

Rouwette, E. A. J. A. (2011). Facilitated modelling in strategy development: Measuring the impact on communication, consensus and commitment. *Journal of the Operational Research Society*, *62*(5), 879–887. https://doi.org/10.1057/jors.2010.78

Rouwette, E. A. J. A., Bleijenbergh, J., & Vennix, J. (2016). Group model-building to support public policy: addressing a conflicted situation in a problem neighbourhood. *Systems Research and Behavioral Science*, *33*(1), 64–78. https://doi.org/10.1002/sres.2301

Schepers, H., van Henten, E., Bontsema, J., & Dijksterhuis, G. (2004). Tactics of quality management and promotions: Winning consumers for fresh exotic produce. In H. J. Bremmers, S. W. F. Omta, J. H. Trienekens, & E. F. M. Wubben (Eds.), *Dynamics in chains and networks* (pp. 566–580). Wageningen Academic Publishers.

Scott, R. J., Cavana, R. Y., & Cameron, D. (2016). Recent evidence on the effectiveness of group model building. *European Journal of Operational Research*, *249*(3), 908–918. https://doi.org/10.1016/j.ejor.2015.06.078

Sethi, R., Smith, D. C., & Park, C. W. (2001). Cross-functional product development teams, creativity, and the innovativeness of new consumer products. *Journal of Marketing Research*, *38*(1), 73–85. https://doi.org/10.1509/jmkr.38.1.73.18833

Srinivasa, S. R., Ramakrishnan, S., & Grasman, S. E. (2005). Identifying the effects of cannibalization on the product portfolio. *Marketing Intelligence & Planning*, *23*(4), 359–371. https://doi.org/10.1108/02634500510603465

Sterman, J. D. (2004). *Business dynamics: Systems thinking and modelling for a complex world* (International Edition). McGraw-Hill.

Stewart-Knox, B., & Mitchell, P. (2003). What separates the winners from the losers in new food product development? *Trends in Food Science & Technology*, *14*(1–2), 58–64. https://doi.org/10.1016/S0924-2244(02)00239-X

Torres, J. P., Kunc, M., & O'Brien, F. (2017). Supporting strategy using system dynamics. *European Journal of Operational Research*, *260*(3), 1081–1094. https://doi.org/10.1016/j.ejor.2017.01.018

Vennix, J. A. M. (1996). *Group model building: Facilitating team learning using system dynamics*. John Wiley & Sons, Ltd.

Vennix, J. A. M., Andersen, D. F., Richardson, G. P., & Rohrbaugh, J. (1992). Model-building for group decision support: Issues and alternatives in knowledge elicitation. *European Journal of Operational Research*, *59*(1), 28–41. https://doi.org/10.1016/0377-2217(92)90005-T

Vennix, J. A. M., & Scheper, W. (1993). Group model-building; what does the client think of it? In E. Zepeda & J. A. D. Machuca (Eds.), *Proceedings of the 11th International Conference of the System Dynamics Society* (pp. 534–543). System Dynamics Society.

Warren, K. (2008). *Strategic management dynamics*. John Wiley & Sons, Ltd.

Wu, J., Teng, J.-T., & Skouri, K. (2018). Optimal inventory policies for deteriorating items with trapezoidal-type demand patterns and maximum lifetimes under upstream and downstream trade credits. *Annals of Operations Research*, *264*(1–2), 459–476. https://doi.org/10.1007/s10479-017-2673-2

Yan, Q., Zhou, S., Zhang, X., & Li, Y. (2019). A system dynamics model of online stores' sales: Positive and negative E-WOM and promotion perspective. *Sustainability*, *11*(21), 6045. https://doi.org/10.3390/su11216045

Appendix 1

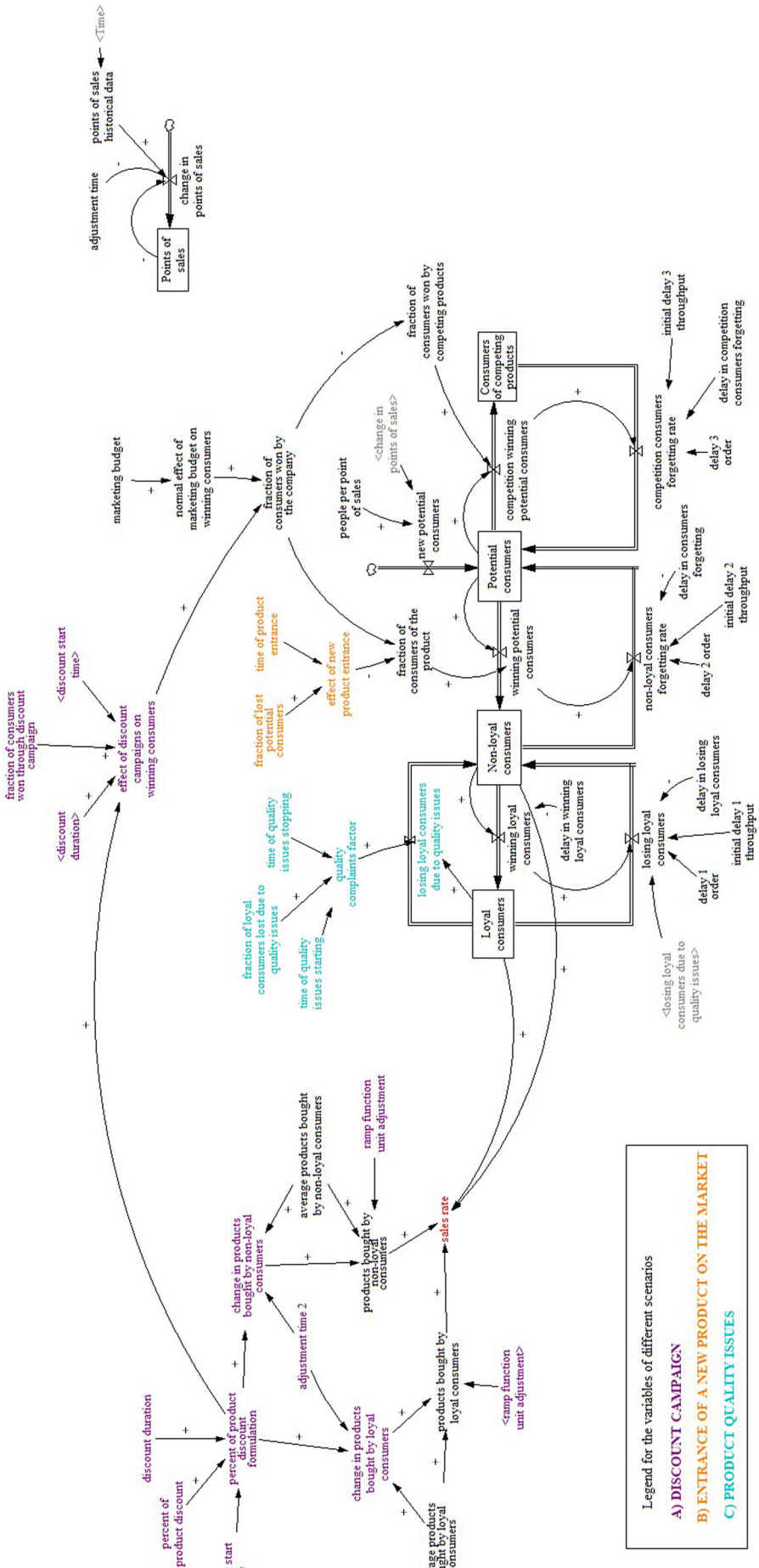

Figure A1. Complete stock and flow diagram of the partial model structure presented in Figure 6 of the manuscript.