

The BeerGame training as practice-oriented demonstration of the bullwhip effect

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ABSTRACT

The supply chain management problems can easily be demonstrated by the widely known BeerGame simulation. The problem is the implementation of the game especially in an industrial training situation or in formal education caused by the insufficiencies of the traditional forms of the game. In the Szabó-Szoba R&D Laboratory we developed an android software on the purpose of having an adaptable, entertaining and effective program, which can give real life experience about the nature of the bullwhip effect, inventory management challenges and create measurable results right away. We use the four perspectives of Balanced Scorecard performance measurement system for the most important part of the trainings: the discussion of outcomes and the team learning.

Index Terms— BeerGame, Balanced Scorecard, Bullwhip effect.

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1 INTRODUCTION

The BeerGame logistics management game is widely used to demonstrate the inventory imbalance problems in supply chains – in the frame of the game participants impersonate a four stage supply chain, and make their own decision about actual orders in every round according previous demands and expectations. The factory is responsible for production, and the other three collaborators for distribution towards the customer. The aim of the players is rather simple: each of the four traders has to fulfil incoming orders by forwarding the required units of beers to the partners in the chain with minimal total cost (the charge of inventory holding is 1, in the case of backlog the related cost is 2). Communication and collaboration are not allowed between supply chain stages. This game can be used in the formal education and on trainings as well to model real life situations and to highlight the difference between practice and theory by the learning-by-doing method.

2 THE BULLWHIP EFFECT

The bullwhip effect is a well-known phenomenon of coordination problems in traditional supply chains. It refers to the effect that the forecast and the actual consumption get separated by the insufficient information sharing. Shortages and huge inventory level shows the presence of the bullwhip effect. Even in the case of stable customer demand small changes in orders at the retail end tend to dramatically increase upstream the supply chain.

The term was first defined around 1990 when Procter&Gamble perceived erratic and amplified order patterns in its supply chain for baby diaper. The effect is also known by the names, whiplash or whipsaw effect. As a consequence of the bullwhip effect a range of inefficiencies occur throughout the supply chain:

1. excessive inventory throughout the whole supply chain;
2. insufficient or idle capacity;
3. product unavailability;
4. higher total supply chain cost;
5. loss of revenue;
6. inaccurate production plans.

While the effect is not new, it is still a timely and pressing problem in contemporary supply chains. Bullwhip creates unstable production schedules. This effect leads to inefficiencies in supply chains, since it increases the cost for logistics and lowers its competitive ability. Companies have to invest in extra capacity to meet the high variable demand. This capacity is then under-utilised when demand drops. Unit labour costs rise in periods of low demand, overtime, agency and sub-contract costs rise in periods of high demand. The highly variable demand increases the requirements for safety stock in the supply chain. Additionally, companies may decide to produce to stock in periods of low demand to increase productivity. If this is not managed properly this will lead to excessive obsolescence. Highly variable demand also increases lead-times. These inflated lead-times lead to increased stocks and ultimately the bullwhip effect. [1]

The trigger of the bullwhip effect can be traced by the lead time of information and material. A supply chain's reaction on a change in end customer demand is delayed firstly because it takes time to pass on information about the change to suppliers and secondly because these suppliers need time to adjust their capacities and deliveries. The longer a supply chain is unable to react on a changed demand, the heavier it needs to react as soon as this is possible. The bullwhip effect increases with longer lead times.

In addition to the lead time of information and material, the bullwhip effect is caused by other reasons:

- Demand forecast based on orders of the succeeding tier
- Historically oriented-techniques for demand forecast
- Batch ordering
- Price fluctuation
- Exaggerated order quantity in case of delivery bottlenecks

Commonly, demand amplification is mostly caused by some internal mechanism or event; it is not due to something external to the system. Although the customer demand may be extremely volatile, it is self-induced worsening of any situation. As bullwhip is a time-varying phenomenon, graphical representation of system behaviour is extremely helpful. The next figure shows specific demand amplification in a six month period.

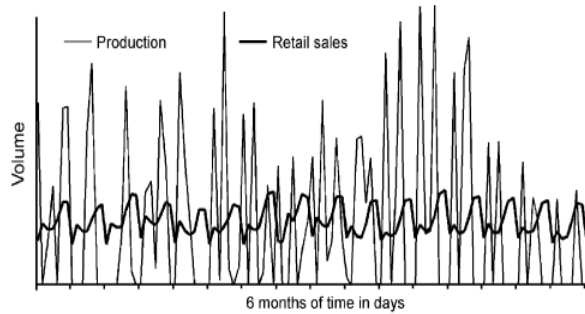


Fig. 1. Demand amplification typical of time series to be viewed through the “variance” lens. (Source: Potter, 2005).

Fig.1. Demand amplification typical of time series to be viewed through the “variance” lens (Porter, 2005) [2]

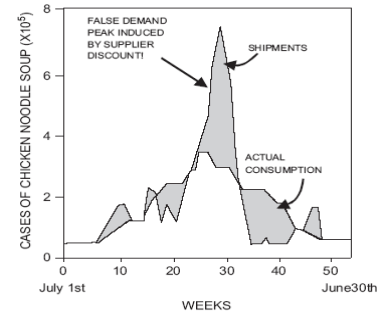


Fig. 2. Demand amplification of time series to be viewed through the “shock” lens. (Source: Fisher, 1997).

Fig.2. Demand amplification of time series to be viewed through the “shock” lens – Fisher 1997 [2]

The previous figure is a typical example which illustrates how a major manufacturer “gambling” by offering a temporary discount severely disrupts the system both upstream and downstream. This causes a “shock” to the system forcing retailers to stock up rapidly, then run stocks down as they realise customer sales are relatively smooth. In this case we can easily catch the bullwhip-effect. [2]

3 BEERGAME

3.1 HISTORY

The beergame (or beer distribution game) was invented in the 1960s by Jay Forrester at MIT as a result of his work on system dynamics. The BeerGame has proven to be a very simple, yet effective experiential exercise for teaching the dynamics of marketing and logistics channels specifically and systems in general. Since then had been played all over the world by people at all levels, from students to presidents of big multinational groups. The purpose of the game was to show how the patterns we create in our relations with the world around us sometimes give unexpected and undesired results. This is an expression for what is called system dynamics. Jay W. Forrester in the USA first developed the ideas and theories behind this branch of science. The

game can represent how we (re)act in such trading situations, and how these situations lead us into standard ways of "thinking" that we accept without question, don't we? [3]

3.2 COMPARISON OF THE POSSIBLE GAME SOLUTIONS

3.2.1 PAPER BASED

In the previous chapter we introduced the process of the game based on the first and simplest form, the paper based BeerGame. For this version we will need a chart for each player and a delivery note between the pairs. The main advantage of this form is that it can be played almost everywhere, all the equipment we need is some paper and writing tool. The documentation is basically done by playing the game but after the last round it takes some time to digitalize and convert the results to an expressive, graphical form. If the players are tend to cooperate, then, the shifts are synchronized, and traceable. But there are some disadvantages also. Sometimes the game is hard to follow - even more if somebody plays for the first time - because of the complexity of the rules. In fact it can slow down the gameplay and give place to the mistakes. Unfortunately it is really hard to puzzle out the errors and to correct which can take away the fun.

3.2.2 BOARDGAME

It's an advanced form, this solution can be used infinitely, and this is a massive construction, but also portable. The design of the boardgame leaves less opportunities for making mistakes. The method of putting dowels in little holes gives the players the experience of actual material flow along the supply chain. Although it is a drawback at the same time as the other players will possess the information beside the orders about the inventory level and backlog of orders. It is uneasy to document the actual data. The players have to do all the work - fulfilling deliveries and register the orders - and it can lead to two outputs. Firstly, they are paying more attention to the material handling and less to the administration which will give fake results at the end, hence the discussion and the analyse and of the conclusion can end up wrong. Or they make too much effort to concentrate on both tasks and it will feel as difficult as the paper based form.

3.2.3 ON-LINE GAME

The on-line form of the BeerGame is a totally automated and simplified version. Excludes the probability of errors and the "not exactly following the rules" kind of behaviour. At the previous two method of playing the game allows the sabotage, like somebody orders eight units of beers, but the supplier delivers only four, although the inventory level would let the accomplishment.

Further advantage is that the administration is totally automated, the program computes everything the participants need. The only thing they have to do is decide the amount of beer they want to purchase. The data can be instantly transport into graphs and charts which quickens the discussion of the results.[5]

The main disadvantage is the virtuality. There is no actual material flow, so that it does not give a tangible experience of delivering beer. As on many field of life nowadays the virtuality also dispossess from personal contacts, common learning and team experience. The players cannot discuss their feelings sharing the thoughts and ideas.

3.2.4 BEERGAME, ON THE TABLETS

After we hold some BeerGame training with the traditional forms of the concept it became clear that for further experiments, analyse the results and applying the game in a training environment we need a better solution. For this we started to develop the BeerGame software for android devices in the Szabó-Szoba Laboratory. The purpose of this project is to join together the advantages of previous implementations. The game is continuously developed, but still it's in an initial phase, doesn't have all the functions we planned.

In the actual state of the software the processes at the different positions are totally synchronised; the documentation is automated but easy to follow. The opportunity of cheating or making accidental mistakes is out of the question. The results are immediately apparent, helps the discussion of experiences and better understanding the background of the bullwhip effect. The tablets are very practical and manageable and provide an excellent graphical appearance. The only drawback we found until now, that it's not really expressive in material handling. A solution for this can be the involving of other devices or better graphical visualization.

4 THE BEERGAME ON TABLETS IN TRAINING ENVIRONMENT

The game can be played by 4, 8, 12, 16 or 20 participants. The point is that the total number of the players should be divided by four, because this is the way to form the supply chains with the four stages. For the start we explain the rules and the main points of the game, the usual nature of the supply chains. Presenting the roles, the directions of material and information flows, the charge of inventory holding and the backlog.

The game is originally played with the paper based method, we kept all the rules and special properties of this form. Each group consists of four players, every player represents one segment of a market. These elements are the Retailer, the Wholesaler, the Distributor, and the Factory. The time period for the game is one week intervals round by round. Each week, each member of the distribution channel ships from their inventory to the customer, prepare a production or marketing plan and decide on the order amount. To make the game a bit more fun, the chain is responsible for the customer always gets the desired beer. There are some basic regulations which are ensuring that the game is working as it should and yet we have fun. These are the following:

- information must not be shared (ordered amounts, in stock amounts, shortages);
- everybody keeps contact only with their own customer and supplier
- communication takes place through the devices;
- the orders have to be fulfilled as soon as possible;
- the backlog of orders are cumulative and must be filled as soon as stock is available;
- the beer is in units, not in litter or barrel.

To simulate better the real life there is a delay built in the system: representing the lead time the shipment arrives two weeks later than the order is placed. The game begins in a balanced situation. Every player has 12 units of beer in stock, the customer orders in the first and second round are equally 4 units, so as the arriving shipments. In the third round arrives the amount of order based on the decision of the first round. [4]

They also need to be clear with the functions of the application, so we explain them step-by-step everything, for example the meanings of the abbreviations and the most important knowledge.

The BeerGame system has two main parts: the server and the clients. The server program is running on a PC, and it provides the communication between the clients using TCP/IP. The clients are running on android platform. These client tablets are used by the players, the server is controlled by the trainer or lecturer.

When a client is connected to the server, the server sends a list from the available roles and the player has to choose from the roles: Factory, Wholesaler, Distributor and Retailer. The server can handle 5 groups of players, so it's suitable for quite big team to play BeerGame. After the choice, the server registers the client to one of the groups, where the chosen role is still free. The game starts for the groups separately when every role is taken.

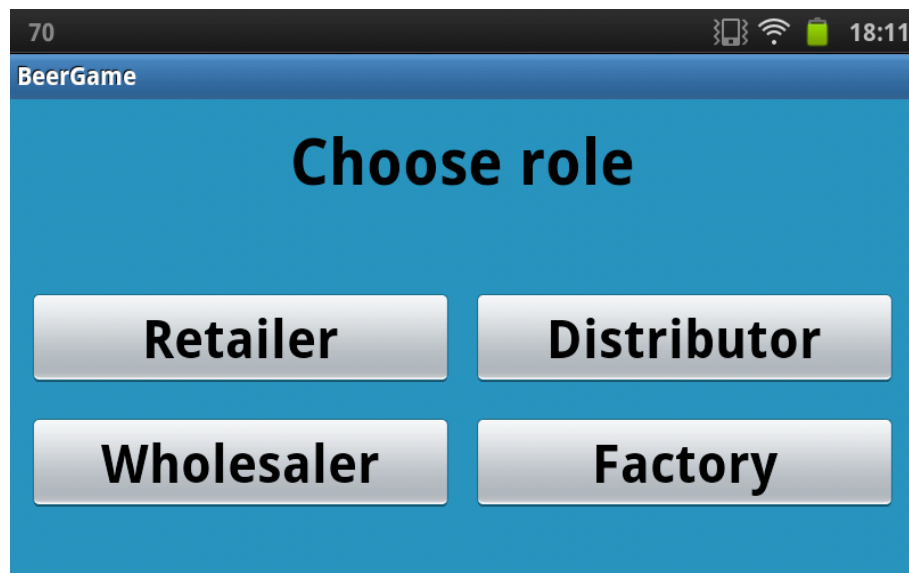


Fig. 3. Starting screen

The server reads the orders of the customer from a file, and sends it to the retailer. In every round, the players have to provide the ordered quantity and the client program sends this to the server. When every player's decision is arrived, the server calculates the changes according to the rules, and sends the new status back to the clients. During the game, the server logs the players' actual inventory information, and save them to „.csv” files. The game ends when the server reaches the end of the file containing the customers' orders at the 24th round.

Below we can see the main screen of the game:

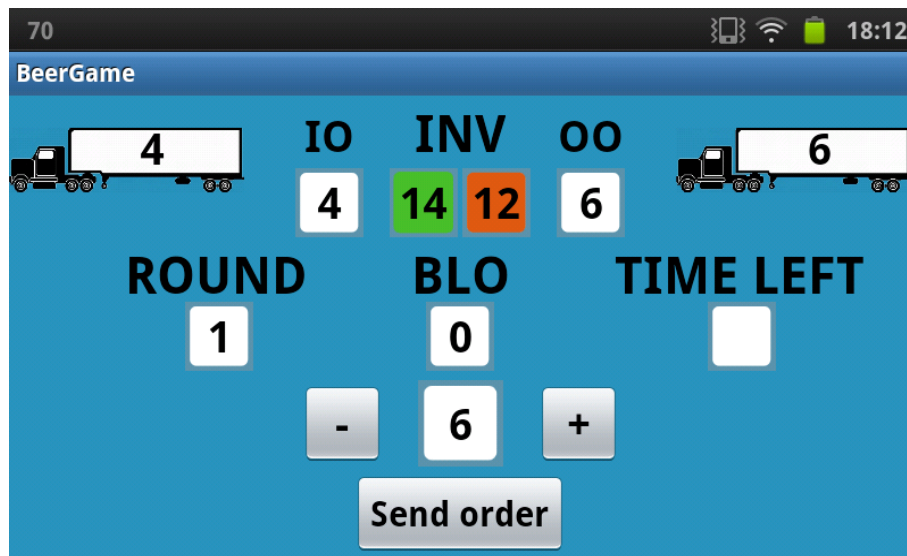


Fig.4. Client platform of the BeerGame on tablet

1. Outgoing shipment
 - The amount of delivered orders from stock
2. IO – Incoming Order
 - Amount of received order from the customer
3. INV – Inventory Level
 - Green background – Actual stock
 - Orange background – Previous stock
4. Outgoing Order
 - The quantity of the user's order from the previous round.
5. The amount of incoming deliveries
6. The counter of the rounds.

7. BLO – Backlog of order

- The quantity of undelivered beer

8. The user can raise or reduce the order amount in each round

9. Time left until the ordering decision can be made

In the game every boxes are automatically filled by the software, the only thing the player need to decide, which role do they want to play and then round by round the amount of the outgoing order. It makes the gameplay faster and easier, they can not fail the administration.

The software basically performs the steps of the paper based game, keep the books, send the orders, keeps track of the inventory and the backlog of orders. The calculation method of the in stock amount is quite simple, has to be counted as shown below:

$$(\text{previous in stock amount}) - (\text{amount delivered to the customer}) + (\text{amount received from the supplier}) = (\text{new in stock amount})$$

Generally the players by the paper based game get confused in this calculation – despite of using only positive and integer numbers. Furthermore if the backlog comes in: depending on the ordered amount it is possible that the player hasn't got enough units of beer in stock to fulfill the demand, the rest they should record as backlog. Remember, it has to be positive, because a negative shortage means an in stock amount. If we have a shortage and the next order is also more than we can send, than the shortages had to be accumulated. On the other hand, as soon as we have enough beer in the inventory, we have to send the actual incoming order and the backlog of orders too. All these additional tasks are difficult to follow and accomplish for the first time, plus making the decisions and the calculations at the same time. The application automatically perform these functions, the players only need to decide on the ordered amount on their own. This decision is based on the players' expectations, mentality, and feelings. After every decision

(order) arrived to the server it does a quick calculation about all the variables and sends back to the clients simultaneously.

However there is a difference in the role of the factory. There is a little bit of real life condition built into the game, a bit of production delay. The “Factory” player schedules into production instead of ordering and this is where the delay is. There is a two round long delay in the production. This means that when the amount is scheduled in production, it only comes back as the “finished product” three rounds later. The first three amounts of the finished product are the consequences of previous decisions have been made by the previous imaginary factory owner. These quantities are like the first orders for the other players. This delay makes the whole game a little more lifelike. It also slows the reaction time of the whole supply chain, and is capable of generating huge in stock amounts and shortages throughout the chain.

Fortunately the BeerGame software does all this tasks so the players are in a really comfortable situation: they only have to make the decisions and send to the server. The game lasts for 24 round. This is long enough to see the trends and the challenges, also short enough to not get bored. By this time every participant gets some experience about managing a supply-chain, can observe the difficulties, possibilities, typical tricks and some coincidences. That’s the time when they can share the feelings, experiences and some information with each other by the lead of the trainer. This discussion is very important in the aspects of recognition and learning.

Typical observations:

- ⤴ the evolved shortage spreads along the chain
- ⤴ usually the factory has the biggest shortage and the retailer has the least
- ⤴ at the half of the gameplay (10-12th round) each of the participants gets frustrated by the appearing backlogs and makes the decisions in panic – worsening the situation
- ⤴ the period with the shortages is followed by a period with high inventory level
- ⤴ the bullwhip effect emerges without exception

The time frame usually lets an other round. In this case the participants are more experienced, they can focus on the discussed and relevant details, they configure some kind of tactic regarding

to the consequences. In the second game they usually feel themselves confident and assume that the bullwhip effect at this time won't upset the balance. But it does - in all cases.

That's where the real work starts. We give them the recorded data so that they can make a presentation about the results of the game. For the analysis we give them a frame, the balanced scorecard measurement approach which is really effective in evaluation of the performance of supply chains.

The game as we can see is quite simple, easy to understand the tasks and the functions. A great advantage is that from the server we can get instantly the results, so after the game the experiences immediately can be discussed. On the next figures we can see how the bullwhip effect shows up in each player's performance.

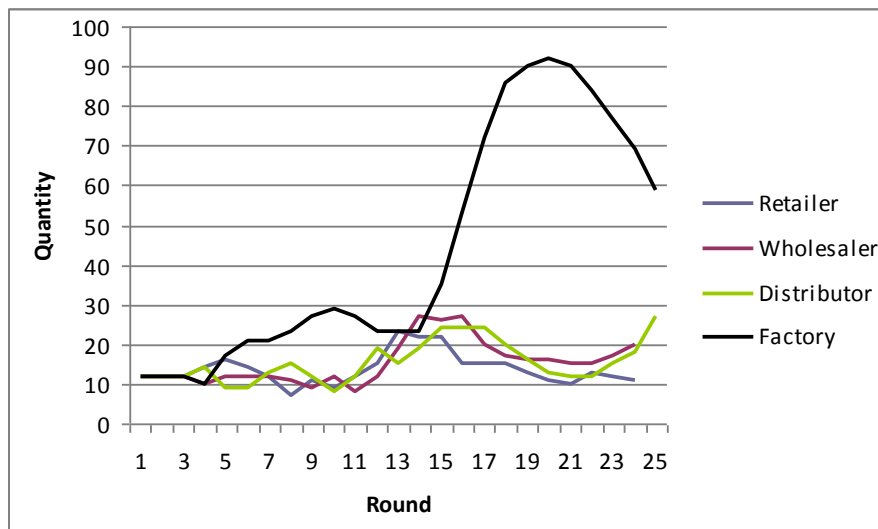


Fig.8. Inventory levels

The graph below represents the outgoing shipments. It clearly highlights the first reason of the bullwhip effect, which is the demand forecasting based on orders of the succeeding tier: each participant tries to keep a safety stock. These stocks simply accumulate and become a reason of the extremely high inventory level at the Factory (fig.8.).

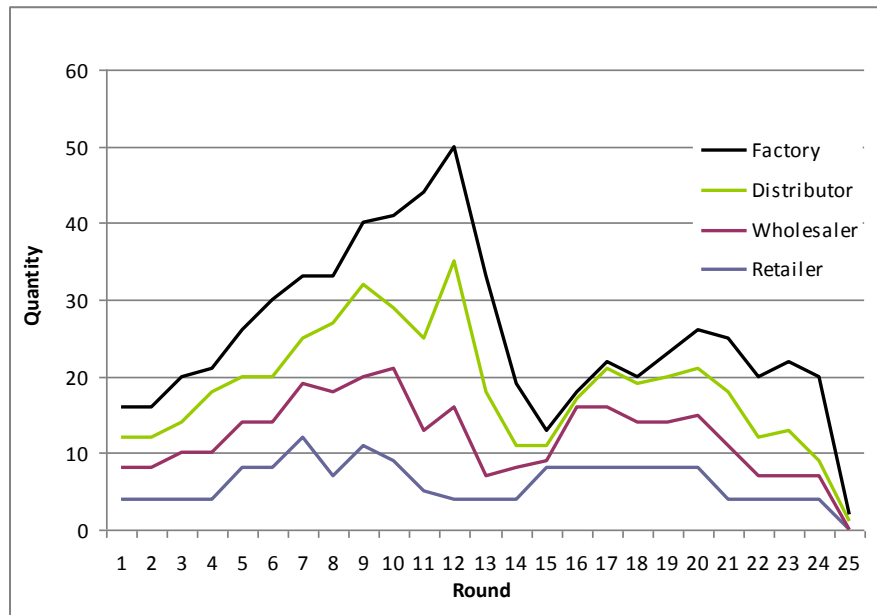


Fig.9. Outgoing shipments

The next picture shows the outgoing- and incoming orders. These more or less meet each other (for example the outgoing order of the Distributor equals the incoming order of the Factory). On both graphs appears another reason of the bullwhip effect, which is the lead-time. Clearly traceable the response to the customer's moves delayed in time.

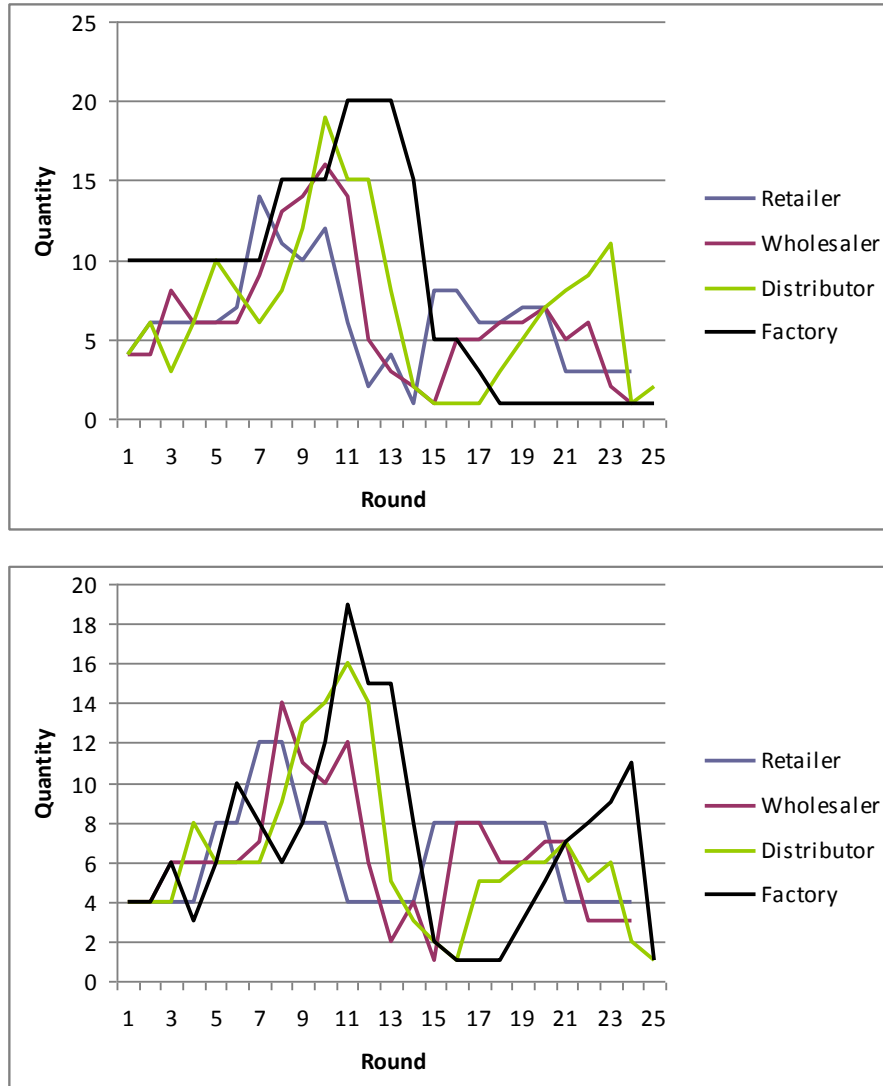


Fig.10. Outgoing- and incoming orders

Finally the next figure illustrates the shortage at the participants. We can see again a reason of the bullwhip effect, which results in supply problems. The inappropriate inventory management multiplies through the distribution channel, a small shortage can increase significantly as it passes by to the end of the chain.

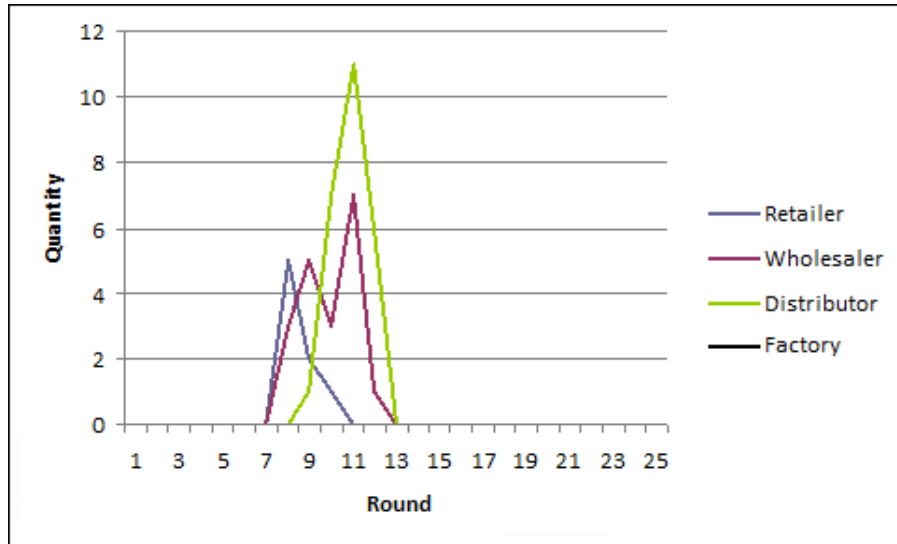


Fig.11. Shortages

5 THE BALANCED SCORE CARD SYSTEM AS PERFORMANCE MEASUREMENT APPROACH

We had to realize that the traditional efficiency measures by themselves – because they are considering mostly the financial parameters of production processes – are inadequate in providing a complete and useful overview of organizational performance (in our case it means the performance of the whole distribution channel as a system).

For better understanding the relations not only on the operational, but also on tactical and strategic levels the use of Balanced Score Card measurement system is widely accepted: it is operating on the financial, marketing (customer-related), operational (internal-business processes) and strategic dimensions (learning and growth).

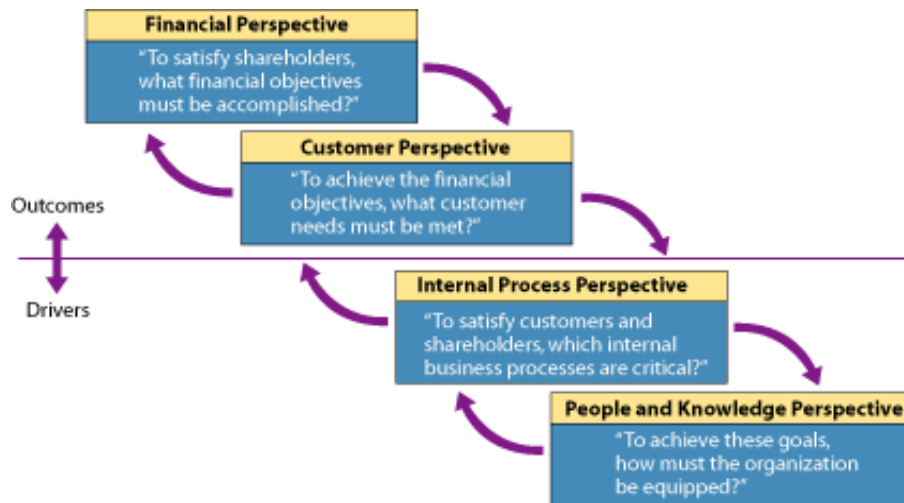


Fig.5. The perspectives of the Balanced Scorecard [6]

With other words the typical BSC consists of four perspectives - financial and non-financial measures to guide implementation and evaluation: financial, customer, internal/process, and learning/innovation, in addition focuses both on the short- and long-term objectives of the organization.

The **financial** perspective of course is the basic of the BSC measurement system, but this is the easiest to create exact numbers from which we can jump to a conclusion, and so it has lots of common attribute with the typical measurements systems. Also the truth is that the managers will always want to see clearly the data, trends, graphs, and use every possible instrument to learn where the company is heading to, be aware of the risk assessment and cost-benefit data. This is why it's colligated with the other three perspectives, to see the whole picture.

The next most important factor is the **customer**, to specify, the customer satisfaction. The management has to realise that the future of the company depends on the orders. Applying indicators on customer satisfaction may show hidden problems before our partner changes supplier. A possible way to separate our customers in different groups, and rate their different needs, then the customer service can get closer and closer to the needs based on this.

To reach successes the **internal business processes** must be continuously improved and examined. It makes easier to the employees to perform their tasks, minimise the possible mistakes and the managers can see the quality of the production or services. The problem with this perspective is that it requires very profound knowledge about every tiny detail of the internal business processes, so it can not be developed by an outsider consultant or expert.

The last perspective is the **innovation and learning**. It both means the training of the associates and the self development of the company. With this nowadays technical improvement speed no one can afford to miss out these aspects. The employees have to be updated and also evaluated during their work. It's a good way if the company has a collective data base of specialised knowledge. The level of technical developments can be measured by adequate metrics (physical and quality indicators).

Because of the complex background and numerous triggers of the bullwhip effect we need to look deeper into the phenomenon. The performance measurements are necessary for knowing the details of the different areas, but not enough to see through the whole system/coherences. The four balanced perspectives of the BSC are helping us in this. [7]

The most important goal in a supply chain is to serve the customer. If the customers can not get the goods they need then look for another distributor which can fulfil the demand. We need to optimise the internal processes to satisfy our customers as well as we can, which is related to the second point of view of the Balanced Scorecard approach. To reach the highest possible customer service level a distribution channel needs optimal processes (inventory management, forwarding optimization etc.), that requires the internal business perspective. Also the business environment is in constant changing, prices, customers, preferences, purchasing power, most of the circumstances are differing from day to day. The whole chain has to prepare to several possible outcomes, need to have a scenarios in sake of proper behaviour in each cases. These models have to be improved continuously based on the experiences, this if how the system can learn and develop.

The Balanced Scorecard perspectives are not subordinated to each other, all of them should be considered, only, the measure is not the same in the different cases.

I would demonstrate with some concrete example, how we employ the four BSC perspectives in the BeerGame supply chain simulation environment:

Financial perspective

We can generate the most obviously measurable indicators in this area. We can exactly calculate the inventory holding cost and the penalty in case of shortage. We can also easily say the growth in the certain customer's orders, which refers our next perspective.

Examples:

- Lot of capital tied up in inventories
- Frequency and amounts of out-and in stores
- Storage costs depend on the size of the warehouse and the storage technology

In our trial gameplay the inventory levels moved quite simultaneous. Increase at one players stock caused the raise at the others. In this case quite natural that the retailer had the lowest and the factory owned the highest stock, so the parallel lowest and highest inventory holding costs.

Inventory holding cost	$\sum INV \times 0,5\text{€} = TIC$
Shortage cost	$\sum BLO \times 1 \text{ €} = TSC$
Total cost	$TIC + TSC = TC$
Global total cost	$GTC = TC_R + TC_W + TC_O + TC_F$
Average total cost	$ATC = \frac{GTC}{4}$
Absolute deviation	$\partial_{INV} = \frac{\sum x_i - \bar{x} }{n}$
Squared deviation	$\partial^2_{INV} = \frac{\sum (x_i - \bar{x})^2}{n}$
Fig. 6. Equations used for Financial perspective	

We can see on the following picture the costs of each participant, the global and average total costs. We can conclude from the first game to the second all the cost decreased on their half.

Financial Perspective					
Retailer	Wholesaler	Distributor	Factory	Global Total Cost	Average Total Cost
12	12	12	12	48	12
12	12	12	12	48	12
12	14	10	12	48	12
13	12	13	11	49	12,25
10	10	14	8	42	10,5
8	7	14	6	35	8,75
14	7	12	2	35	8,75
27	12	6	8	53	13,25
30	22	16	28	96	24
28	34	60	64	186	46,5
18	60	134	101	313	78,25
26	92	237	176	531	132,75
38	115	242	266	661	165,25
39	150	234	203	626	156,5
60	154	201	104	519	129,75
56	117	102	45	320	80
64	59	16	65	204	51
59	59	15	87	220	55
51	59	19	98	227	56,75
45	57	19	98	219	54,75
47	51	21	96	215	53,75
47	47	21	96	211	52,75
43	47	21	96	207	51,75
759	1209	1451	1694	5113	1278,25

Retailer	Wholesaler	Distributor	Factory	Global Total Cost	Average Total Cost
12	12	12	12	48	12
12	12	12	12	48	12
16	7	14	11	48	12
19	12	8	9	48	12
20	9	22	3	54	13,5
20	9	31	29	89	22,25
16	4	51	51	122	30,5
8	21	75	80	184	46
5	45	110	92	252	63
13	68	130	58	269	67,25
20	78	82	46	226	56,5
49	31	82	42	204	51
53	47	38	28	166	41,5
55	48	19	26	148	37
53	42	19	26	140	35
51	36	19	26	132	33
49	30	19	26	124	31
45	26	21	24	116	29
41	22	21	24	108	27
35	20	21	24	100	25
31	20	21	24	96	24
27	20	21	24	92	23
23	20	21	24	88	22
673	639	869	721	2902	725,5

Fig.7. Financial data of the supply-chain (first play upper, second play lower)

Customer (satisfaction)

In this case customers are mostly the trading partners, who order from our inventory. We can see their satisfaction, when we consider for example the “lifespan” of the relationship. If we have old partners with a long-term relation and common history, we should be doing something well. We can think about more concrete tools here.

For example:

- How much late we can afford with the delivery of an order?

- How many times do we have to compensate, until the customer does not choose another supplier?
- How do we behave in the case of a missing product?
- Do we monitor the order amounts?
- What do we conclude from the orders gradient?
- Do we look for the underlying reasons in case of fluctuation in the orders?

The different inventory management strategies affect differently the relation with the customer. In our first try everybody had their own tactic for satisfying the demand. The high safety stock at the Factory was the best solution in this aspect but it conflicts with other goals.

Maximum Backlog of orders	$BLO_{\max} = X_{i\max}$
Average shortage	$AS = \frac{\sum BLO}{n}$
Maximum delay	$x_i, x_{i+1}, \dots x_j = BLO > 0 = (j - i + 1)_{\max}$
Average delay	$\frac{\sum BLO}{n_i}$
Absolut deviation of order fluctuation	$\partial_{IO} = \frac{\sum x_i - \bar{x} }{n}$
Squared deviation of order fluctuation	$\partial_{IO}^2 = \frac{\sum (x_i - \bar{x})^2}{n}$
Fig. 8. Equations used for Customer perspective	

On the tables below we can see the significant decreases in the average and maximum shortages also.

[illegible]

Fig.9. Backlog of orders (first play upper, second play lower)

Internal

The internal processes of distribution channels contain lots of components. Forecasting, human and material resource planning, production and shipment scheduling can largely influence the efficiency of the company, and globally the performance of the chain. Usually there is not only one possible optimal way to fulfil the demand. Furthermore sometimes not possible to find the real optimum; just use any good solutions close to it.

Based on the experiences we can say it's a good way to treat the whole supply chain as one system. If we consider globally the factors maybe we can get closer to the best solution. A lot of question entails related to the internal processes:

- How much information do we share with the partners?
- Do we discuss our trading plans with our supplier?
- Are we able to manage a common inventory or trading plan with the others?
- How efficient is our capacity utilisation?
- Do we have idle resources in the shipments?
- What kind of forecasting method leads to the optimal resource allocation?
- What is the ideal safety stock level?

In the game we all played huge attention on not sharing any information to see what will happen. The expectation was fulfilled, we finally created the bullwhip effect without any efforts (some managers may deliberately mislead the partners).

Learning

This part should show us, how fast we can comply with new techniques, trends, and the fluctuation of the customer demands. Some adequate indicators can measure for example the technical or infrastructural development of the company. Yet there are some aspects of progression in the business life which can be really affective but uneasy to evaluate.

- Peak management – treat the accumulated stock
- Don't panic – strategy in case of shortage
- IT systems – sequential improvement is necessary in every field of company governance including the product tracking, customer-supplier relationship management, inserting new methods in operational processes, development of corporate culture

For examination of the learning perspective we chose to apply a linear regression on the difference of the incoming and outgoing order for each participant, based on the following equation:

$$\Delta_{IO,00} = |IO_i - OO_i|$$

On the following graphs we can see that the most of the participants have a negative tendency which means the quantity of incoming and outgoing orders gets closer and closer.

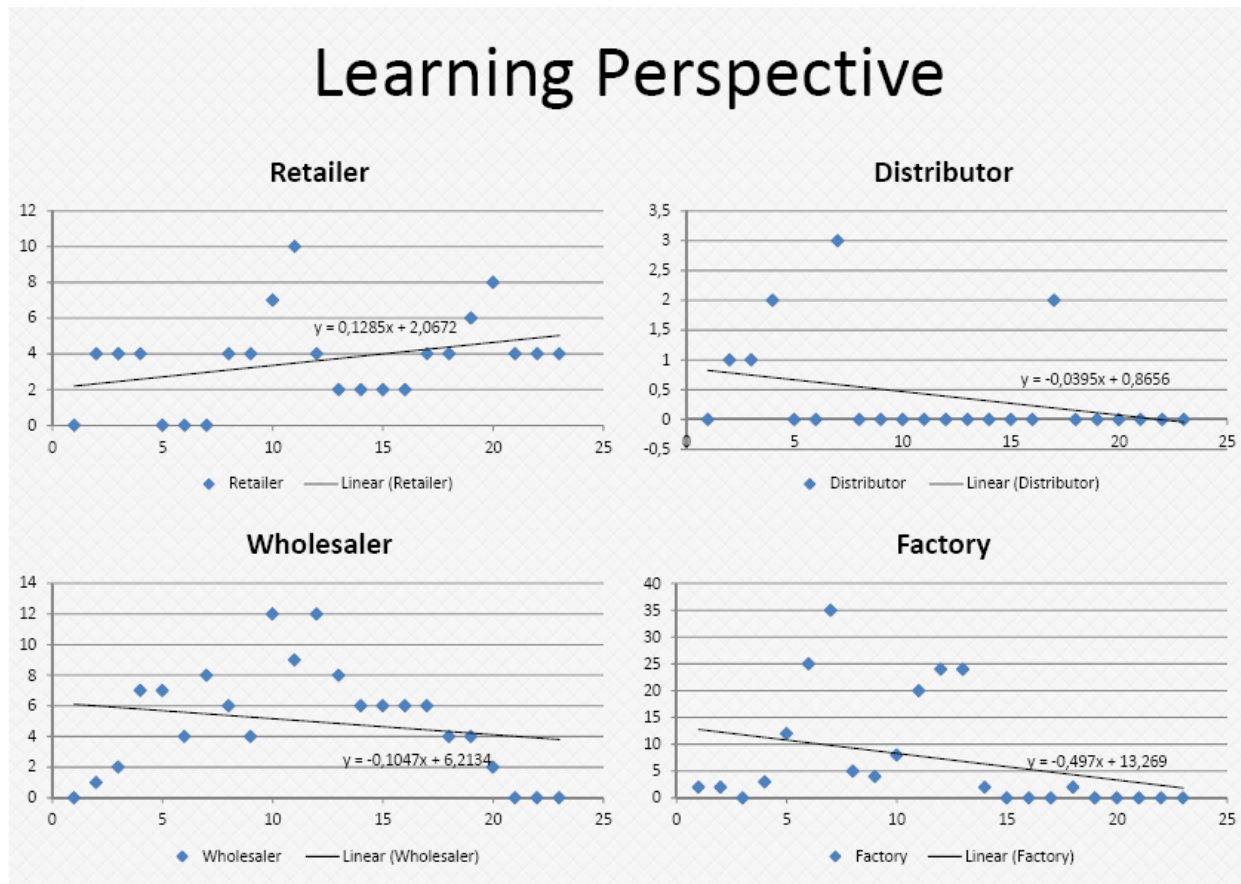


Fig.8. Linear regression of the difference between incoming and outgoing orders in the first game

So using the BSC method can highlight many new factors in performance measurement. Leading a business by the specific and measurable goals can highlight the strong and weak fields. It is important to emphasize: we would not say exact, optimal solutions, just offer ideas what increases the performance of the system and what we should consider in the practice. It is one thing, that we know the Balanced Score Card principles in theory, in our model we try to apply it for a distribution channel simulation.

6 SUMMARY

In our essay we have presented an overview about the bullwhip effect, and gave a proper description about the phenomenon. In the frame of the continuous research on the field of bullwhip effect in Szabó-Szoba Laboratory we were focusing on the development of an appropriate classroom-type and training-type BeerGame environment. The BeerGame is a quite simple but representative tool for simulation. We examined the traditional paper based, board-game and on-line versions on the basis of educational features – as a result we highlighted the critical factors what the new Android based system has to provide. We have created the first version of BeerGame in Android software environment. The trial version performed well for the first time the results are encouraging but also draws attention to a lot of features we need to reconsider.

According to our goals we applied the Balanced Scorecard performance measurement module in the BeerGame environment. We have collected some real life examples that might be useful building in the performance evaluation. Extending the aspects of the bullwhip effect can be seen the information sharing overall lowers the inventory level trough the supply chain, so on the contrary, without integration and cooperation the global efficiency reduces, wastage of manpower and material increases and the unsatisfied customer demand rises. The proper information sharing can substitute the accumulated stock in the distribution channels. Otherwise, many actors afraid of sharing any information with supply chain partners, they keep it as “business secret”.

The BeerGame in this new form might help the better understanding of the processes in a supply chain and helps to admit the importance of looking behind the consequences and finding an optimal solution.

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