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The Impact of Cooperativeness Supply Chain Performances*

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In this paper we analysed the relation between cooperativeness as a personality trait of participants in a supply chain and the bullwhip effect. We explored the possibility of change participants' cooperativeness but we also showed the learning process of engineering students. In order to teach our students about behavioural causes of the bullwhip effect and to increase their awareness about the influence of their cooperativeness on decision making in the supply chain, we simulated decision making in the beer game performed by four groups of engineering students. The beer game is a role-play simulation game that lets students (or managers as well) experience typical coordination problems of supply chains. Participant cooperativeness is determined using a Social Value Orientation (SVO) questionnaire, applied before playing the game to classify them into cooperative and uncooperative ones and after playing the game to investigate changes of cooperativeness. Participants were assigned randomly to one of the two situations: a chain with and without sharing information. The experiment conducted twice – firstly with 20 engineering students, and secondly with other 22 engineering students. The results, showing lower costs within the team with cooperative behaviour tendencies and permission to share relevant information, point to the importance of the further study of the behavioural causes. Students realized that their behaviour influences the behaviour of others and how that can change the results of the team. After playing the game students filed SVO questionnaire again, and we showed that students who shared information increased their cooperativeness scores, while cooperative participants who couldn't share information decreased their cooperativeness scores, so we found that students can learn cooperativeness to achieve better supply chain results.

Keywords: bullwhip effect; cooperativeness; social value orientation; supply chain; learning

1. Introduction

It is a well-established fact that when participants (suppliers, manufacturers, distributors, wholesalers, retailers) exclusively consider their interests in a supply chain regardless of the impact of their actions on others and the whole chain, the bullwhip effect occurs due to the lack of coordination. This effect is initially described in Forrester's work [1] to be defined lately as systematic ''irrational behaviour of players'' or ''misperception of feedback'' [2, 3]. The bullwhip effect explains the phenomenon of gradually amplifying variations in buyer's demand along the line of the chain from retailer to manufacturer. It is mainly a consequence of the distortion of information within the chain. The retailer happens to interpret the small amount of variation in the buyer's order as the tendency of the demand to expand, which makes him enlarge the request. The higher the position in a chain one has, the higher the rise in demand is. A typical example is ordering more for planned promotions. If a wholesaler interpreted this augmentation as constant growth and increases his demands from the supplier accordingly, he would be facing the problem of overstock once the period of the promotion ends. The consequences of the bullwhip effect are not only the costs of inventory holding, but backlog costs as well. These outcomes significantly aggravate chain performances.

Contemporary scholars [4, 5] classify the causes of bullwhip effect as operational (structural) and behavioural. Operational causes are more comprehensively studied [6–11]. As a matter of fact, behavioural causes refer to bounded rationality of the decision maker, particularly on the wrong account of feedback and time delays. There are five groups of behavioural sources of the bullwhip effect.

1. The first group occurs if the decision makers believe that their suppliers and customers would make the wrong decisions. In that case, they may drop the balance strategy to provide stocks for the case of a non-optimal behaviour of partners. The uncertainty caused by the internal actions of partners in a supply chain can be labelled as coordination risk [4].
2. The second group considers not only the doubt of participants that the others would obey the rules of fair play but also the disbelief that they would even be able to apply them. In that case, the participants could not anticipate the behaviour of others, because they have limited knowledge or lack of trust in the motives and cognitive abilities of their partners [4]. Cognitive constraints of participants initiate the bull-

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whip effect in the third group of factors when participants act as there are oscillations in demand even when there are none [2, 12].

3. People find it difficult to simultaneously monitor and reflect on their inventory, inventories in progress, how much has been ordered, what the unmet demand is, and how much to order. It happens that orders are prepared based on the discrepancy between the targeted and the current level of backlog, disregarding the requested amount of products that have not yet arrived.
4. Many authors [12–16] showed that even when all participants know what the optimal ordering policy is and demand is constant and well known, the majority of participants still neglect current orders (underweight the supply line). It forms the fourth group of causes.
5. Finally, some personality traits could have an impact on decision-making style, and it refers to the fifth category of causal bullwhip effect factors. In that context, work of Ruel and associates [17] analyse the relationship between risk-taking tendency, ambiguity, self-efficiency and locus of control, with decision-making and performance.

It is well known that cooperation and collaboration are important in the supply chains, but there are no researches about the influence of cooperativeness as a personality trait on bullwhip effect. If we define cooperativeness as a willingness to cooperate and cooperation as ''voluntarily arrangement in which two or more entities engage in a mutually beneficial exchange instead of competing'' [18] the first goal of this study is to investigate relations between cooperativeness as a personality trait and bullwhip effect and to add one more personal characteristics on the list given in [17].

There are a lot of papers about using simulation games in education to teach students to understand a complex concept such as bullwhip effect and about consequences of their behaviour but also about the importance of teamwork, trust, cooperation and collaboration [19–24]. The most popular is beer game developed by Sloan School of Management at the Massachusetts Institute of Technology. Authors in [22] simulated beer game and concluded that the bullwhip effect is lower if participants start with hands-on experience, and then they are allowed to cooperate and to formulate team strategies. That implies that training may improve individuals' knowledge but it can improve supply chain performance only if players are allowed to communicate and share their knowledge. In [19] they used computerized Beer Game for teaching students how different parameters affect supply chain costs. In the paper [21] authors developed multiplayer interactive computerized beer game and then compared results of playing that game with the results of playing a board game. Players who played the board game achieved significantly better results than those who played the computerized version in the same conditions. They also found that players who played the board game before playing the computerized game achieved significantly better results than those who played only the computerized game. Authors in [24] presented the use of Supply Chain Simulator – ''computer gaming/simulation application'' to teach students about the functioning of supply chains but advanced students could also learn how to design and develop supply chain scenarios based on real or imaginary situations. They concluded that gamification develops students' analytical abilities in a fun gaming environment. In [20] authors played Cider Game for simulating supply chain with students, and applied the constructivist learning approach. They found that, depending on whether the game is played individually by the student or whether decisions are made as a team, learning differences exist. When students make decisions as a team, they have better solutions due to the cooperative and constructivist learning approach carried out. Authors in [23] applied simulation-based training to compare two approaches of group interaction – (1) pure cooperative or competitive and (2) mixed. They showed that a mixed approach for interaction group is better than a pure approach, and also if a mixed approach is used, it is better to start with competitive interaction and then move to cooperative interaction. When teacher wants to encourage a certain behavior (cooperative in this case) and to discourage another behavior considered to be negative (competitive in this case), it is better to first gain experience with the negative behavior.

Authors [25, 26] highlighted the important role of socialization processes in the development of relationships within supply chains. They define socialization as the level of interaction between, and communication of, various actors within and between organizations, which leads to the building of personal familiarity, improved communication, and problem-solving. Wubben et al. [27] showed that the expression of some emotions can affect people to responded more cooperatively than when they don't have information about other people's emotions. Beekman et al. [28] found that conflict increases cooperation within groups when there is a history of conflict between two groups but decreasing cooperation between groups. Socialization efforts lead to improved communication in the relationship, but there are other factors that are influencing the effectiveness of such efforts.

"Shadow of the past moderates the relationship between socialization and communication quality. If there are negative past experiences, the shadow of the past limits the positive influence of socialization on communication quality." [29]. Authors [30] found that close relationships are not always positive because they provide the opportunity to act opportunistically for both partners and systematically cheat each other. Still, they think that relationships with commitment, joint goal setting, and successful creation of returns for both companies can outperform stable relationships that have gone through a period of decline.

In this study, the bullwhip effect is viewed from the perspective of participant willingness to cooperate. This is a preliminary experiment conducted to determine personal characteristics that impact the bullwhip effect. These results should help in forming a clearer picture of personal characteristics relevant to the behaviour in supply chains. There is an idea to test whether an inclination towards cooperativeness could influence on the bullwhip effect phenomenon. As a matter of fact, the majority of research unequivocally proved that collaboration improves performance in the supply chain [23, 29, 31–41]. As different authors differently define collaboration within this context, we had to specify the term in the manner in which we are going to observe it. We believe that collaboration could be defined by a cooperative strategy of supply chain partners and our primary goal is to analyse whether there is an effect of cooperativeness as a personal characteristic on supply chain performance. Further [32] in their endeavours to determine factors that promote collaboration emphasized trust, dependence, long-term relationship, information, and resource sharing. In this paper, we try to define cooperativeness by measuring the so-called social value orientation.

At the same time, we research behaviour of the participants in the supply chain and the possibility to increase their cooperativeness through socialization by playing the simulation game in small groups. As it is become well known that students playing beer game are able to realize that they behaviour influence the logistic decisions of others, we wanted to research if students can realize how their level of cooperativeness can change costs of the whole supply chain and if it is possible to increase cooperativeness of the participants in the supply chain, so that is the second goal of this study. The purpose of this research is to improve ways to educate engineering students.

As social value orientation is based on concern for others in the decision-making processes, we could mention research results that observe supply chains from the perspective of the social exchange theory and the perception of organizational justice and its impact on organizational outcomes [43–45]. Also, the value system has its cultural background, and studies that connect organizational culture and supply chain effectiveness are very valuable, suggesting the aspects of behaviour that promote performance [46] and socially responsible supply chain management [47]. Nevertheless, we are interested in an individually expressed phenomenon. For example, Yamagishi and colleagues [48] found that the pro-sociality observed across different games were related to the general measures of prosocial value orientation and perceiving the game situations.

Concretely, in our study, we've controlled the cooperativeness of participants (by categorizing them according to the score on the SVOQ) engaged in simulated beer game to gain insight into the very process of collaboration.

Our experimental design combines two factors within two categories: situational – cooperation strategy by allowing communication and competitive strategy with no communication whatsoever, and personal – categorizing participants into cooperative and uncooperative, based on their social value orientation. Four groups of participants were engaged in beer game simulation of a supply chain. The main goals of this study are (1) to investigate relations between cooperativeness and bullwhip effect, (2) to research if it is possible to increase the cooperativeness of the participants in the supply chain, i.e., if students can learn behaviours that decrease bullwhip effect.

2. Method

2.1 Social Value Orientation

Social value orientation (SVO) studies individuals' orientation towards social values, explaining how much people care about others in their decisions. The main purpose of SVO is to determine the readiness of the decision-maker to sacrifice their interests for the benefit of others [49].

Although the traditional economy is based on the premise that the decision-maker is a rational being (homo economicus) who tends to maximize his/her score expressing indifference toward the results of other participants, there is a lot of examples that contradict this idea. Decision-makers have different human qualities, varying from egoism to altruism. All those characteristics influence the decision-making process. When making decisions, people are often encouraged to take into consideration the impact of their decisions on the other members of society.

The SVO questionnaire is often used to assess the individual aspect of cooperativeness [50]. The pro-

blem of selecting one out of the two warranted money distributions could be for example the option A: both decision maker and another person gain 85$, and the option B: decision maker gains 100$ and another person 50$ [49]. In both cases, the decision-maker gains a certain sum, but the other person (partner), who is unknown and is going to stay unknown to him, obtains an amount of money dependent on this decision but this is not strategic decision-making as it is in the game theory because the decision-maker is the only one who has control over the payment. The decision is a one-shot and anonymity protects it from the influence of pressure, reciprocity, reputation issues, etc. A rationally driven decision-maker would choose option B because it brings him a 15$ higher payoff than option A, although in this case, the other person gains 35$ less. Nevertheless, it is confirmed experimentally that option A is preferred in 40% of the cases [49]. This kind of behaviour is called social preference, social motives, or social value orientation. The existence of positive social value orientation shows that his benefit may not be the only criterion for the decision-maker.

Liebrand gave taxonomy which shows different possible orientations and motivation of the decision-makers [50 according to 49]. The majority of decision-makers tend to [49, 51, 52]:

- *Individualists* – maximize payoff for self – (weight on own outcome: 1, weight on other's: 0),
- *Prosocial* – maximize the joint payoff or minimize the difference between payoffs – (1:1),
- *Competitive* – maximize the positive difference between self and the other's payoff – (1:–1),
- Sometimes, decision-makers tend to maximize the payoff of others (*Altruists*) – (weight on own outcome: 0, weight on other's:1).

According to Liebrand there are several non-typical orientations that are very rarely present in practice:

- *Sadistic* – minimize the other's payoff – (0:–1),
- *Sadomasochistic* – minimize the joint payoff or minimize the difference between payoffs – (–1:–1),
- *Masochistic* – minimize the payoff to self – (–1:0) and,
- *Martyr* – maximize the negative difference between the other's and self payoff – (–1:–1).

There are different ways to measure social orientation [49]. One approach is to use The Ring Measure, as in this study. This method uses a series of pairs of payoff and estimates the SVO score based on the choices made. It is followed by calculating the angle, as explained in the work of Murphy and colleagues [49, 51] that determines the SVO orientation of the decision-maker. For example, if the angle were 45 degrees, the person is of prosocial orientation, as shown in Fig. 1.

2.2 Beer Game

The bullwhip effect in a supply chain is often illustrated by a beer game. The beer game is widely played for learning of bullwhip effect. It

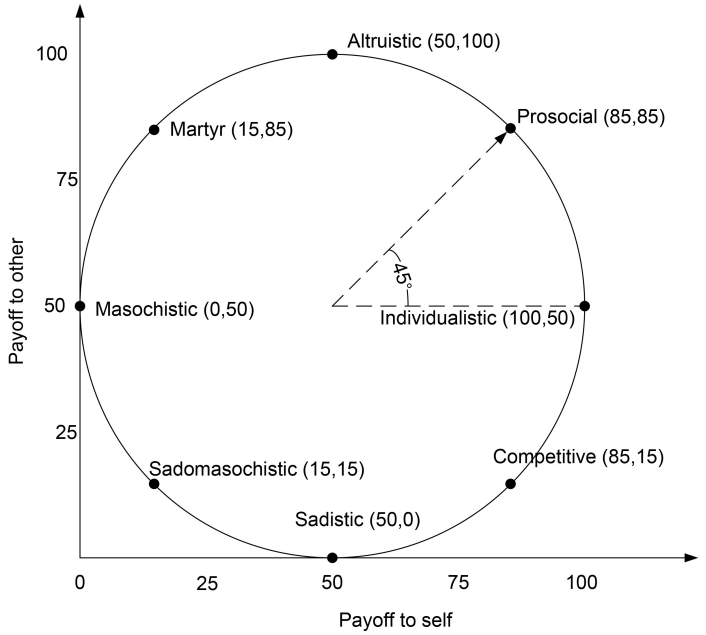

Fig. 1. The example of assessing social orientation by The Ring Measure (adapted from [49]).

was created as a part of research in industrial dynamics in the early sixties by the Sloan School of Management at the Massachusetts Institute of Technology, to simulate the performance of a supply chain with one participant in each phase [53]. Teams are consisted of four roles: Retailer, Wholesaler, Distributor and Factory. Retailer buys beer from the Wholesaler. The Wholesaler strives to satisfy the Retailer's demands from the stock. Unsatisfied order remains as a backlog. The retailer orders from Wholesaler who orders from Distributor, who orders from Manufacturer. Two weeks (two iterations of the simulation) are required for the product to pass from one participant to the other. Inventory holding costs are 0.50$ per case per week, and backorder costs are 1$ per case weekly. At the beginning every participant has 12 cases of beer in stock, and the initial demand is 4 cases in every phase. In the first few weeks, participants learn about mechanisms of filling in the purchase order, creating backorders and so on, and during that period demand is constant – 4 cases weekly. In the first three weeks, the participants can order only 4 cases per week. At the beginning of the fourth week, participants can order an unlimited amount of beer, though it is pointed out that the demand of the buyer could vary. One of his tasks is to forecast the demand and to purchase accordingly. The total duration of the game is 50 weeks of simulation, but the desired effects are evident much earlier. Every participant has accurate local information (about his inventory, backorders, some of the supplies placed from his direct supplier each week and some of the supplies he provided to the other participant), but he has no insight into global information. Communication between participants is not allowed.

2.3 Participants and Procedure

In our experiment, we simulated the functioning of a supply chain by playing a partly modified and customized beer game. The participants in the supply chain were engineering students on elective courses of Supply chain management at Faculty of Organizational Sciences, University of Belgrade. They already had some basic knowledge about supply chains and the bullwhip effect. The main purpose was learning about the bullwhip effect and cooperation in the supply chain. Because we have small groups of students, we conducted an experiment twice with two different groups of students – firstly in the 2013 year [54] and secondly in 2018. There were 20 of them in the final sample in the first experiment and 24 in the second, but two students are excluded from the experiment because of the inconsistency of answers on SVOQ. Firstly, they filled out an SVO questionnaire, and it showed that there were no sadistic respondents in the whole sample and only two of them were altruistic. Altruistic, prosocial, and individual respondents with altruistic, prosocial, and individual value orientation with scores near prosocial were classified into a cooperative one, and competitive and individualist people with scores inclined toward the competitive were categorized into uncooperative subsample. Then, both groups were randomly divided into two subgroups, subjected to two situational conditions. Consequently, we got four subsamples consisting of two categories of students based on their individual proclivity toward cooperation. Considering the interactional (communicational) circumstances they were submitted to two different game rules. Those groups were uncooperative with information exchange not allowed (UN), cooperative with information exchange not allowed (CN), uncooperative with information exchange allowed (UI), cooperative with information exchange allowed (CI) as it is shown in Table 1 for 1st experiment and in Table 2 for 2nd experiment.

Each group represented one team simulating one supply chain according to the established rules. Since the sample consisted of students, the game was renamed into a water supply game. To analyse the participant's cooperativeness in the simulation of supply chain performance, we modified the penalty and storage costs. The weekly inventory costs per product unit were: for retailer 0.5, for wholesaler 1, for distributor 1.5, and for manufacturer 2. Costs that were a consequence of unsatisfied demand per product unit weekly were: for retailer

Table 1. Groups for 1st experiment

	Information exchange not allowed	**Information exchange allowed**
Uncooperative	UN1: 4 participants (female)	UI1: 6 participants (5 female, 1 male)
Cooperative	CN1: 5 participants (3 female, 2 male)	CI1: 5 participants (3 female, 2 male)

Table 2. Groups for 2nd experiment

	Information exchange not allowed	**Information exchange allowed**
Uncooperative	UN2: 6 participants (3 female, 3 male)	UI2: 5 participants (4 female, 1 male)
Cooperative	CN2: 6 participants (2 female, 4 male)	CI2: 6 participants (female)

2.5, for wholesaler 2, for distributor 1.5, and for manufacturer 2.

We expected that more cooperative participants (classified in the appropriate category) with lesser unit inventory costs and higher unit costs of unmet demand from their suppliers would accept more backlogs to minimize total chain costs. Also, two groups played by the traditional beer game rule saying that each participant possesses only local information. Two other groups were allowed to exchange whatever information they wanted. The game lasted for 23 simulated weeks. Studies show that students are usually preoccupied with making sure that they follow the rules of the game, so they have no time to develop an effective strategy [41]. For this reason, the time was not limited, and the duration of the game was about 1.5 hours.

We also expected that the students would be more ready to cooperate after the beer game simulation and learning about the situation and about other participants. After playing the game students filled out an SVO questionnaire again, but a little bit modified. They answered questions not about unknown persons, but about partners from the same team.

2.4 Results

After 23 simulated game weeks, total costs for groups and individual participants were estimated and are given in Fig. 2. In the first experiment group UN1 had total costs of 5411.5 with 449 costs of the retailer, 939 from the wholesaler, 1633.5 of the distributor and 2390 owed to the manufacturer. Slightly better results were found in CN1 group. Total costs were 4263. Retailer costs in this group were 397.5 wholesaler 519, distributor 1219.5 and manufacturer 2646. Compared to the previously given groups, subsamples where information sharing was allowed accomplished better results. As it was expected, the superior result was within the cooperative group that shared information. Group UI1 had overall costs of 2904.5. Retailer costs were 503, wholesaler costs were 665, distributor had costs of 859.5 and manufacturer of 877. At the same time, group CI1 had merely 1369 amount of overall costs, with 425 goes on the retailer, 279 on the wholesaler, 237 on the distributor and 428 on the manufacturer. In the second experiment group UN2 had total costs of 5522, with 954.5 costs of the retailer, 1235 from the wholesaler, 1457 of the distributor and 1875.5 owed to the manufacturer. Slightly better results were found in CN2 group. Total costs were 4381. Retailer costs in this group were 289.5 wholesaler 914, distributor 1123 and manufacturer 2054.5. Subsamples where information sharing was allowed accomplished better results. The superior result was within the cooperative group that shared information in this experiment. Group UI2 had overall costs of 2855.5. Retailer costs were 490.5 wholesaler costs were 655, distributor had costs of 840, and manufacturer of 870. At the same time, group CI2 had merely 1286.5 amount of overall costs, with 232 goes on the retailer, 292 on the wholesaler, 334.5 on the distributor and 428 on the manufacturer.

After playing game the most players said that they felt frustrated and helpless [16, 53, 54]. In our experiment the same feelings reported uncooperative teams who couldn't share information (UN). They blamed their teammates, creators of the game, and the customer, i.e., teachers. The rest of the teams were satisfied with the possibility of immediately seeing the results of their decisions, and it fits with the conclusions of some other authors [20].

During the experiment, we kept track of communication between members of teams.

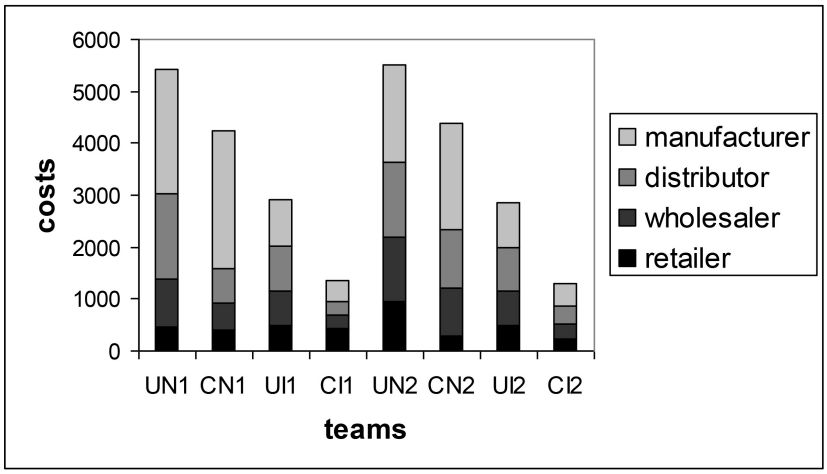

Fig. 2. Supply chain costs per team.

- Students in UN teams blamed each other from the beginning to the end of the experiment. They said: "You don't understand!", "You are monopolists!", "What is this?!", "You don't order enough!", "You don't produce enough!". . .
- Students in CN teams started in the same way as UN students but during the game, they realized that they should cooperate, and they started to communicate in a more polite manner.
- Students in UI teams also started with blaming each other: "Mind your own business!" After a few simulated weeks, they started to blame some third person: "Customer is crazy!", "Manufacturer is lazy!". . . In the end, they started to learn that their behaviour influence the behaviour of others and how that can change the results of the team. They realized that they make mistakes too: "I made mistake, sorry."
- Students in CI teams from the beginning communicate politely. They didn't blame each other; they only blamed the customer at the beginning.

Although the UI groups had information about the actual demand on their disposal, some of the supplies on the stock of the next participant, and about the current backlog, there is one fundamental difference between them and the CI groups. Cooperative participants agreed that if they have lower inventory costs, they will order more to decrease the costs of the next participant. They also agreed that participants, whose backorder weekly costs per case were lower, should order more to lower the costs of an adjacent participant. Due to this rule, total costs were significantly lower when compared to the other groups. Nevertheless, these results were not typical for a beer game, as it happened that the retailer had more expenses than wholesaler and the wholesaler from the distributor. Only the manufacturer had higher expenses that were characteristic of the beer game. Despite the fact that the retailer accepted the highest expenses of backlogging, at the end of the game, his costs were nearly the same as in the groups where there was no agreement about this rule. It imposed a reasonable question why a participant would agree to pay expenses instead of the other with higher expenses. This situation could be solved if they divided their costs, but the important thing is that those expenses belong to the participant with the lowest expenses.

Although there was an idea that the participants would be more ready to cooperate after the beer game simulation, results indicate that different groups have different results. Each participant could gain total score between –112.5 and 112.5 degrees on the questionnaire. In the Tables 3, 4, 5 and 6 were given results of SVO questionnaire for CN, UN, CI and UI groups respectively in the first experiment and second experiment.

In Figs. 3 and 4 are shown cumulative results for all four groups of participants.

Both groups with information exchange allowed had expected results – the participants became more

Table 3. Results of SVO questionnaire for cooperative group with information exchange not allowed

1st experiment					**2nd experiment**				
CN		**Before**		**After**	**CN**	**Before**		**After**	
Particip.	**Degree**	**SVO**	**Degree**	**SVO**	**Particip.**	**Degree**	**SVO**	**Degree**	**SVO**
1	45.00	Prosocial	35.97	Prosocial	1	84.29	Altruist	50.71	Prosocial
2	82.63	Individualistic	66.32	Prosocial	2	21.18	Individualistic	37.49	Prosocial
3	21.68	Individualistic	39.13	Prosocial	3	45.00	Prosocial	7.56	Individualistic
4	45.00	Prosocial	22.25	Individualistic	4	28.72	Prosocial	14.04	Individualistic
5	82.23	Altruist	45.00	Prosocial	5	11.66	Individualistic	37.63	Prosocial
					6	1.32	Individualistic	23.96	Prosocial
Average	55.31		41.73			32.03		28.56	

Table 4. Results of SVO questionnaire for uncooperative group with information exchange not allowed

1st experiment					**2nd experiment**				
UN		**Before**		**After**	**UN**	**Before**		**After**	
Particip.	**Degree**	**SVO**	**Degree**	**SVO**	**Particip.**	**Degree**	**SVO**	**Degree**	**SVO**
1	–7.20	Individualistic	–18.43	Individualistic	1	–45.00	Competitive	13.24	Individualistic
2	5.33	Individualistic	5.33	Individualistic	2	–36.03	Competitive	33.69	Prosocial
3	–13.42	Individualistic	–14.42	Individualistic	3	–28.93	Competitive	2.20	Individualistic
4	5.33	Individualistic	4.40	Individualistic	4	–4.82	Individualistic	7.37	Individualistic
					5	–80.54	Sadist	–31.26	Competitive
					6	–38.66	Competitive	15.12	Individualistic
Average	–2.49		–5.78			–39.00		6.73	

Table 5. Results of SVO questionnaire for cooperative group with information exchange allowed

1st experiment					**2nd experiment**				
CI		**Before**		**After**	**CI**	**Before**		**After**	
Particip.	**Degree**	**SVO**	**Degree**	**SVO**	**Particip.**	**Degree**	**SVO**	**Degree**	**SVO**
1	37.57	Prosocial	45.00	Prosocial	1	45.00	Prosocial	45.00	Prosocial
2	29.85	Prosocial	37.30	Prosocial	2	24.23	Prosocial	26.57	Prosocial
3	37.49	Prosocial	29.86	Prosocial	3	15.19	Individualistic	37.41	Prosocial
4	35.22	Prosocial	39.97	Prosocial	4	12.99	Individualistic	45.00	Prosocial
5	42.18	Prosocial	84.92	Altruist	5	11.58	Individualistic	12.53	Individualistic
					6	7.65	Individualistic	13.82	Individualistic
Average	36.46		47.41			19.44		30.05	

Table 6. Results of SVO questionnaire for uncooperative group with information exchange allowed

1st experiment					**2nd experiment**				
UI		**Before**		**After**	**UI**	**Before**		**After**	
Particip.	**Degree**	**SVO**	**Degree**	**SVO**	**Particip.**	**Degree**	**SVO**	**Degree**	**SVO**
1	0.00	Individualistic	29.83	Prosocial	1	–37.72	Competitive	71.11	Altruist
2	0.00	Individualistic	1.82	Individualistic	2	–37.15	Competitive	–11.58	Individualistic
3	–37.57	Competitive	15.69	Individualistic	3	–37.57	Competitive	–22.66	Competitive
4	–7.56	Individualistic	45.00	Prosocial	4	0.00	Individualistic	23.68	Prosocial
5	–64.98	Competitive	–7.13	Individualistic	5	–27.15	Competitive	35.43	Prosocial
6	1.32	Individualistic	14.56	Individualistic					
Average	–18.13		16.63			–27.92		19.20	

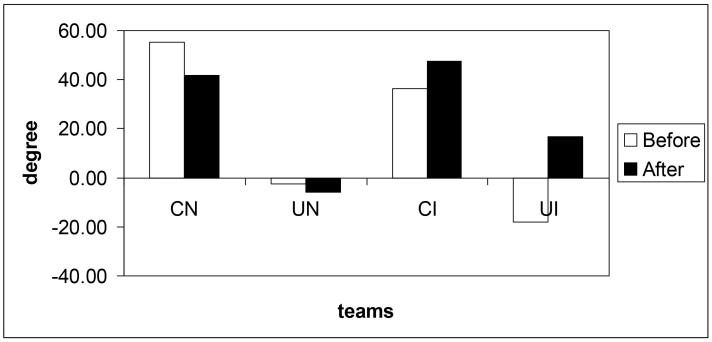

Fig. 3. Cumulative results for all four groups of students in the first experiment.

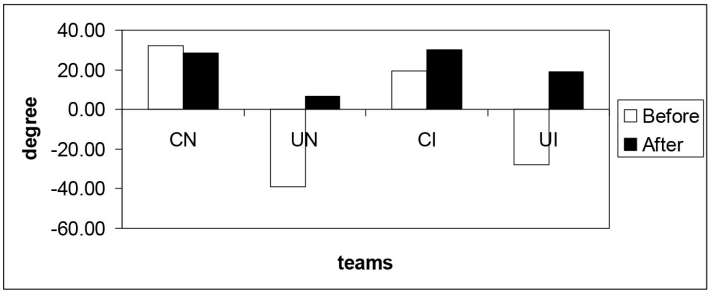

Fig. 4. Cumulative results for all four groups of students in the second experiment.

ready to cooperate after the beer game simulation. The cooperative groups with restriction of information sharing (CN) showed the decrease of average cooperativeness and became even less ready to cooperate. The uncooperative group with no information sharing opportunity (UN) showed a decrease of average cooperativeness in the first experiment, but an increase in the second. It is probably correlated with expectations because cooperative groups with restriction of information

sharing expressed their disappointment caused by a lack of cooperation. The uncooperative group with no information sharing had lower expectations, so some of them were disappointed, but some were even positively surprised.

3. Discussion

Scholars identified a group of behavioural causes of the bullwhip effects, recognizing personal characteristics of participants as a relevant factor of this phenomenon [17]. One of the main personal variables that researchers consider refers to the level of readiness for cooperation and collaboration. Previous research showed that cooperation is in correlation with supply chain performance [29, 31–41]. In this paper, we tried to understand the effects of situation alleviating cooperation in interaction (with cooperativeness as an individual trait) on the effectiveness of the supply chain.

We observed the behaviour of four different groups; two of them consisted of cooperative members, and two of them categorized into non-cooperative ones, according to the Social Value Orientation questionnaire. They engaged in a simulation of beer game (called water game because the sample consisted of students) and they have divided again into further two groups bounded by different rules. Two teams (one cooperative and one uncooperative) engaged in a classic beer game with no communication between participants, and two teams (one cooperative and one uncooperative) followed the rules of free sharing of information. Because of the small size of the sample we repeated the experiment after a few years with new groups of participants to check and verify our conclusions. The significance of cooperativity for successful coordination in the supply chain is a well-known fact. The first goal of this study was to investigate relations between cooperativeness as a personal characteristic and we showed that cooperative players make lower bullwhip effect than uncooperative, i.e., they make lower costs in the supply chain.

The second goal of this study was to investigate if students can realize how their level of cooperativeness can change the costs of the whole supply chain and if it is possible to increase cooperativeness. In this study, we showed that it is possible to change the cooperativeness of the participants in the supply chain. For that purpose, Social Value Orientation questionnaire was applied before and after playing the game. Before the game students answered questions about unknown persons, and after about partners from the same team. Although we expected the overall amplification of the cooperative tendencies after the beer game simulation, it turned out that the results were dependent on conditions in which the game was played. Groups that were given the opportunity to share information enlarged their cooperativeness, but cooperative groups that had no chance to share information were even more reduced their cooperativeness. An uncooperative group with no information sharing opportunity showed a small decrease in average cooperativeness in the first experiment, but a significant increase in the second. Some previous research showed that there is an association between the presence of cooperative, trust-generating mechanisms of trust, the absence of competitive, trust-inhibiting mechanisms of trust, and team performance [55]. There were possibilities that the circumstances in which information was hidden provoke distrust between participants and decrease their agreeableness with consequently reducing their willingness to cooperate. Previous research showed that more agreeable members perform better and that communication and cohesion help to translate the agreeable tendencies of team members into better team performance [56]. It is also connected with expectations because cooperative students with restriction of information sharing expressed their disappointment caused by a lack of cooperation. Uncooperative students with no information sharing had lower expectations, so some of them were disappointed, but some were not.

3.1 Possible Limitations and Future Research

One of the limitations of using beer game simulation is that the results based on individual characteristics of students may not truly capture the behaviour of a company [19]. On the other hand, companies consist of people with their characteristics.

This paper presents a double experiment with small samples (20 and 24 participants). Therefore, the results are statistically insignificant, but they indicate the need for further analysis with a larger sample. Nevertheless, there is an idea to continue research in the direction (or maybe inspire some other researchers) of a further explanation of the phenomenon.

4. Conclusion

In this paper we analysed the relation between cooperativeness of participants in a supply chain and the bullwhip effect. We explored the possibility of change participants' cooperativeness but we also showed the learning process of engineering students.

Studies in the domain of behavioural factors in a supply chain are particularly less common from those engaged with operational causes of the bullwhip effect. The main purposes of this paper are to

provide evidence that higher cooperativeness as a personality trait of the participants in a supply chain has a positive effect on the overall costs and to prove that cooperativeness can be changed and learned and that engineering students can realize how their level of cooperativeness can change results of the whole supply chain. It was shown that the higher cooperativeness of participants in the supply chain had a positive impact on the overall costs of the chain, which means that expenses were lower when participants express a higher level of cooperation. As a matter of fact, cooperative students together found ways to accomplish better results through negotiation, sharing important information, searching and finding mutual benefit, and establishing agreements and common rules. They were really satisfied with the possibility of learning during the game, make their own decisions, and seeing the results of their decisions.

We also showed that it is possible to change cooperativeness but direction of those changes depends on conditions. By sharing information between participants in the group we can increase cooperativeness but if groups have no chance to share information, they can even decrease their cooperativeness if they are disappointed by behaviour of other participants.

These results give a scientific foundation for integrating the elements of personal preference for cooperation and altruistic traits of participants into an equation of an effective supply chain. Because of an SVO questionnaire, measuring prosocial behaviour is free of charge and easy to administer, there is a suggestion to implement it when selecting the participants in real supply chains. Also, we suggest creating agreeable conditions to influence on cooperativeness of participants in existing supply chains. On the other hand, these experiments could be used and we use it for teaching engineering students about supply chains but also for learning and increase cooperativeness. It could improve ways to educate engineering students as well as other students who learn about the supply chain.

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