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THE MANUFACTURING COMPANY MICROWORLD AS A STRATEGIC MANAGEMENT TOOL. THE EFFICIENCY IN ORDER FULFILLMENT

The main objective of the research was to assess the usefulness of manufacturing company simulators as tools supporting leadership in strategic management. A management simulator was built on the convention of the Systems Dynamics method. The research was carried out in three production companies located in the Podkarpackie Voivodeship in Poland. Through meetings with leaders and workers, a simulation model of the system of basic processes of a manufacturing company was built. The resulting model was the basis for developing the architecture of the manufacturing company simulator (microworld). While working with the simulator, the main focus was on efficiency in order fulfillment. The research shows that it is possible to identify the norms controlling the system that directly affect changes in the above aspect of strategic management.

Keywords: System Dynamics, microworlds, simulation, strategic management, manufacturing company, mental models, Vensim.

1. INTRODUCTION

In the scientific literature, management simulators are often called microworlds. This is due to the fact that they to some extent reflect the surrounding system and allow for making strategically important decisions regarding this system. They make it possible to test various directions of activities supporting the development of the system and to find solutions to problems exist in the system.

This publication focuses directly on management simulators built in the System Dynamics method. The method was developed in the late 1950s by J. Forrester in the Massachusetts Institute of Technology. It is used to construct simulation models of complex systems and to discover and study their behavioral dynamics. It is largely associated with economic systems of any dimensions.

Currently, management simulators are one of the most important management tools used by modern learning organizations and practising the discipline of systems thinking (Senge et al., 2008). Senge distinguished three basic features of working with management simulators: looking into the future, discovering hidden strategic opportunities and discovering untapped opportunities for reinforcement (Senge, 2006). Thus, managers

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running organizations can experiment with different strategies of action and learn about the effects of possible consequences of their decisions and actions even in the distant future. In addition, the lack of external pressures, cost constraints and operating risks supports experimentation.

2. LITERATURE REVIEW

Complex simulation models of economic systems were maded based on the principles of Systems Dynamics before management simulators were created. The precursor of these models was Jay Forrester, who first presented a simulation model of a manufacturing company containing feedback interdependencies between streams of money, orders, materials, investments and personnel (Forrester, 1961). He used the DYNAMO software language. After him, the modeling of economic systems was also dealt by: Łukaszewicz (1975), Souček (1979), Sterman (2000), Śliwa (2001), Łatuszyńska (2015) and others.

Over time, more extensive computer software was developed to allow building and simulating economic systems, offering special tools for building models and simulators for managing them. These include: Microworld Creator (Diehl, 1992), Ithink ® (Kreutzer, 2018), Stella (Isee Systems, 2023), PowerSim (Powersim Software, 2023) and Vensim (Ventana Systems, 2023).

The use of a simulator as a tool supporting the discovery of strategic opportunities was indicated by Senge who emphasized that one of the applications of microworlds is the possibility of their use by teams immersed in conflicting views on complex issues (Senge, 2006). Śliwa also wrote that thanks to simulators the management staff has the opportunity to make their understanding of the organization more authentic and is given the opportunity to work together to create a coherent theory of organizational action (Śliwa, 2001).

During reviewing management simulators for managers connected with strategic management and described in the literature, it is worth paying attention to the following: Customer Claims Laboratory (Senge, 1989), which helps in systemic understanding of cost and quality issues in the insurance industry; the People Express Airline Simulator (SD Games, 2023), supporting the company's strategic activities for low-cost airlines; B&B Enterprises simulator, thanks to which the leadership of a production company can test business decisions in such areas as: product prices, marketing, production capacity, competition (Senge, 2006).

The vast majority of business management simulators are built in such a way that it is possible to examine specific problems that occur in the system. By understanding the sources of these problems, managers can develop different variants of solutions and test the effects of their implementation on the available simulator. Not only an innocent "game" can be an effective tool for solving problems, but also a tool for determining the main, long-term goals of the company and adopting such courses of action and allocating resources that are necessary to achieve them. This reflects the essence of strategic management (Koźminski, Piotrowski, 2005).

The main purpose of this article is to examine the possibility of using a production company management simulator in such aspects of strategic management as effectiveness in orders fulfilment.

3. MATERIALS AND METHODS

In order to build a production company management simulator, the research was carried out in three Polish companies operating in the Podkarpackie Voivodeship. The aim of the

research was to collect empirical material for the construction of a simulation model, which was the basis for the management simulator. Two enterprises from the small sector and one from the medium enterprise sector were selected.

The small business sector was represented by the Najlepszefoto.pl company. The company has been operating on the photographic market for several decades. The company's clients are professional photographers from Poland and Europe, photography enthusiasts and people for whom photography is a passion and hobby. The research focused on the photobook which is a combination of a traditional book with the concept of a photo album. Its production takes place only for a special order. The production cycle lasts 4 days. After this time, the finished photo book is sent to the customer.

Another company from the small business sector was the Gamma company. The company agreed to the research but wished to remain anonymous. The company has been operating since 1996. It produces, among others, professional silicone matrices and steel matrices for pad printing used for decorative marking of glass and plastics. The research focused on silicone stamps production. They are used mainly for marking plastic products. The production of stamps takes place only for the special orders and it is a unit production.

The third company that the research was carried out was Alfa which also requested anonymity. It is a medium-sized clothing company. The scope of its activity includes sewing elegant men's trousers for the Polish and foreign markets. Customers are primarily other clothing companies, clothing stores and wholesalers as well as individual customers. The research focused on the production of black trousers. The production of this type of trousers is mass.

3.1. Methodology of building the simulation model

In the initial stage of the research, meetings with the leaderships and workers of enterprises were organized. Talks were about what problems they most often encounter while managing the enterprise, how they deal with them and what they would expect from working with a management simulator. The research also focused on elements related to strategic management responsible for effectiveness in orders fulfillment, rational management of raw materials and workforce as well as the financial result of the company's activity.

After many discussions, the following parts of the simulation model were adopted: Orders, Production and Sales, Stocks of Raw Materials A, Stocks of Raw Materials B, Labor, Revenues and Costs – Figure 1.
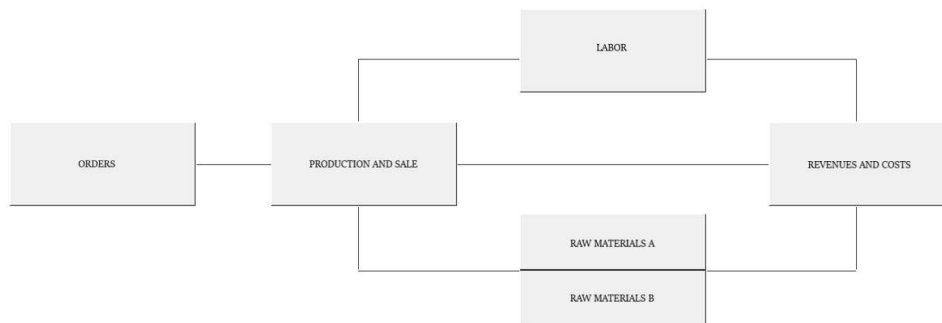

Figure 1. Parts of simulation models

Source: Own elaboration.

In the next step, variables for each part of the simulation model were defined and linked together to create dependency diagrams. Diagrams showed direct and indirect cause-and-effect relationships between the variables. Thanks to that, it was possible to discover the types of feedback loops that had a direct impact on the dynamics selected model variables.

Then, the dependency diagrams of each part were converted into simulation models. Individual variables were presented as mathematical variables and constants. Also, necessary coefficients have been added. Stocks, flows and auxiliary (information) variables as well as mathematical relationships between them were indicated. The models were built in the Vensim DSS program and the mathematical apparatus was presented using mathematical functions and expressions available in it. Both individual dependency diagrams and simulation models of individual parts have been presented in articles (Baran, 2013) oraz (Baran, Stecko, 2013, 2014, 2015, 2016).

The last step was to link the individual parts of the model into one main model which was validated. The following validation methods were adopted:

- assessment of the correctness of the choice of modeling boundaries, the correctness of the model structure and the consistency of the adopted parameter values (model constants) in comparison with available knowledge about the modeled system;
- test of the correctness and consistency of variable units adopted in the model;
- statistical analysis which the ability of the model to reproduce the actual behavior of the system was estimated;
- test of the model's work under imposed extreme conditions.

Individual tests confirmed the correctness of the simulation model's work.

3.2. Methodology of building the simulator of managing a production company

During the next stage were determined: the number of views of the simulator, the functions by individual views, view content, the order views appear, interactions between views. Then, the main menu was developed and the arrangement of elements' individual views was planned.

The designed simulator was built similarly to the simulation model in the Vensim DSS program using: text mode, graphical interface and "screen definition" dialog boxes. Validation of the correctness of work of the management simulator was carried out using the integration test between the simulation model and the simulator interface, the boundary conditions test, modular integration tests and the acceptance test. The revealed discrepancies have been corrected.

4. RESULTS

The following showed empirical materials from one of the surveyed companies, Najlepszefoto.pl, which agreed to make them public. The research was divided into two stages. At the initial stage, the inflow of orders for photobooks based on historical data was assumed and the dynamics of the behavior of the variables responsible for effectiveness in orders fulfilment were checked. In subsequent studies, norms (constants of the model) controlling the variables responsible for that strategic goal were sought.

4.1. Orders based on historical data

At the initial stage of the research, the inflow of orders for photobooks based on historical data was assumed (Figure 2).

At the beginning of the research period, the number of orders was assumed to be 150 pieces/week. In the fourth week, a sharp increase in orders to 450 units was assumed, which was maintained for the next 4 weeks. It resulted in the increased interest in photobooks during the Holy Communion period. From eight week, a gradual decrease in the volume of orders was assumed until the end of the research period. The longest delay in the production system was 12 weeks, so the research period was twice as long as the longest delay in the system – i.e. 24 weeks.
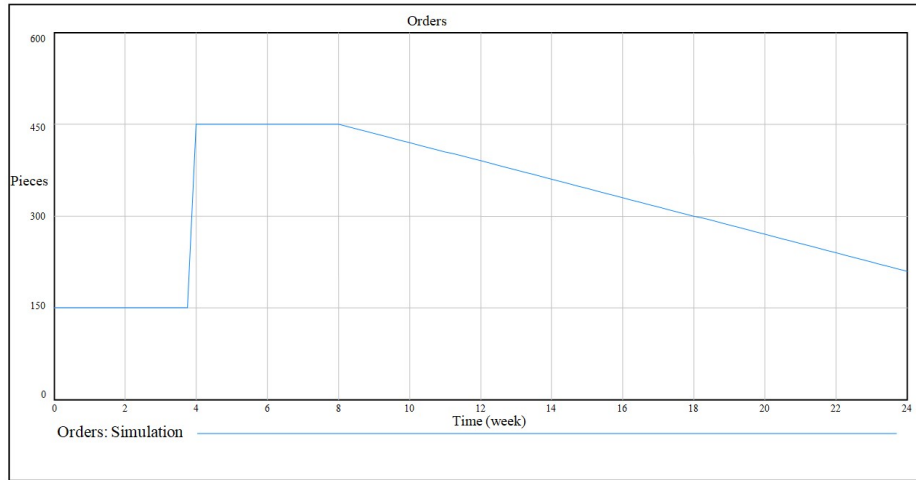

Figure 2. The run of orders

Source: Own elaboration.

The table below shows the values of the model constants used to simulate the model.

Table 1. Values of the model constants

No.	Constans of the Model	Value
1	Orders	[(0,0)-(24,200)], (0,150),(24,150) [Piece]
2	Value of the one-time increase in orders	2 [Piece]
3	Time of the one-time increase in orders	4 [Week]
4	The slope of the line of a linear increase or decrease in orders	-0.1 [1/ Week]
5	End time of a linear increase or decrease in orders	24 [Week]
6	Start time of the sine wave of orders	8 [Week]
7	Time of the one cycle in sine wave	1 [Week]
8	Turn on the production under orders	1
9	Manufacturing cycle time	0.68 [Week]
10	Time to adjust the volume of production in progress	0.17 [Week]
11	Time to correct for overdue production	0.085 [Week]
12	Planned delivery delay	0.68 [Week]
13	Time to adjust stock levels of raw materials A	0.17 [Week]
14	Time to prepare a raw materials A for usage	0.04 [Week]

Table 1 (cont.). Values of the model constants

No.	Constans of the Model	Value
15	Time maintaining inventory of raw materials A	2 [Week]
16	Minimum stock of level of raw materials A	400 [Set]
17	Raw materials A used per unit of production	1 [Set/ Piece]
18	Turn on Raw materials B inventory	1
19	Time to adjust stock levels of raw materials B	3 [Week]
20	Time to prepare a raw materials B for usage	0.02 [Week]
21	Time maintaining inventory of raw materials B	12 [Week]
22	Minimum stock of level of raw materials B	400 [Set]
23	Raw materials B used per unit of production	1 [Set/ Piece]
24	Time to adjust to the required number of workers	2 [Week]
25	Coefficient of required supply and storage workers	0.04
26	Coefficient of required sales workers	0.04
27	Average productivity	19 [Piece / Week /Person]
28	Coefficient of inexperienced workers productivity	0.7
29	Coefficient of inexperienced workers leaving work	0.06
30	Average of inexperienced workers notice period	1 [Week]
31	Gaining experience time	4 [Week]
32	Coefficient of experienced workers leaving work	0.02
33	Percentage of additional workers	20
34	Average notice period	4 [Week]
35	Average cost of a inexperienced worker	450 [PLN/ Week / Person]
36	Average cost of a experienced worker	650 [PLN/ Week / Person]
37	Average cost of a raw materials A	75 [PLN/ Set]
38	Average cost of a raw materials B	15 [PLN/ Set]
39	Utilities per unit of production	1 [PLN/ Piece]
40	Average price of the finished product	180 [PLN/ Piece]
41	Indirect costs	4000 [PLN/ Week]

Source: Own elaboration.

The values of constants were adopted in accordance with conducted empirical research. The simulation of the model was carried out, supplemented with the above values of constants. The simulation step was 0.0078125. The dynamics of changes in selected variables of the simulation model are presented in the graphs shown in Figure 3.

The results showed that in the first four weeks, the company Najlepszefoto.pl delivered the ordered photobooks to customers in accordance with the incoming orders. From the fourth week, due to the surge in orders, there was a backlog of photobooks production and thus a backlog of deliveries. The largest backlog occured in the second half of the fourth week – 72 pieces. In the fifth week, the backlog declined to 15 pieces, in the sixth week to 7 pieces, and from the seventh week to the end of the research period, it was about 2–3 pieces.
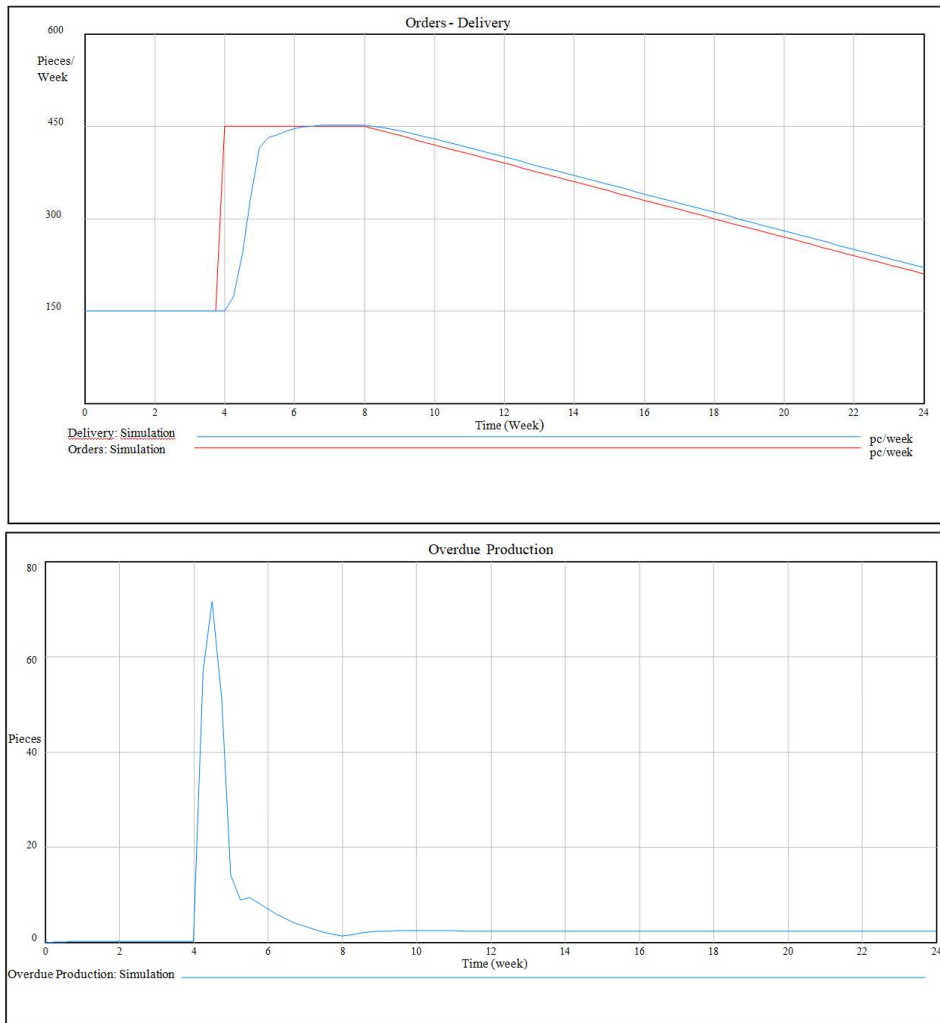
Figure 3. The run of Orders – Delivery and Overdue Production vabiables

Source: Own elaboration.

4.2. Timely deliveries of ordered photobooks

Next, the focus was on the study of which variables (for the purposes of the publication they were called control variables) affected the size of the backlog in production (which might also affected the volume of deliveries of finished photobooks to customers). The analysis in the "Simulation Synthesis" window on the built simulator was used here. During the analysis, it was noted that four control variables had the greatest impact on the amount of the backlog: "Manufacturing cycle time", "Planned delivery delay", "Time to correct for overdue production" and "Time to adjust to the required number of workers". The first two control variables were related to technology used in the company, so their values were not changed. Therefore, the other two control norms were used for the study.

Their values were changed to check what impact they had on the volume of overdue production as well as on the values of such variables as: "Delivery of finished products to customers" and cumulative "Gross profit". The simulation results obtained during the changes the "Time to correct for overdue production" are summarized in Table 2. The gray column presents the results for the adopted value of that variable in the company.

Table 2. Different values of "Time to correct for overdue production" variable

	Week	Time to correct for overdue production [Week]				
		0.105	0.085	0.063	0.042	0.021
Overdue Production [Piece]	0	0,00	0,00	0,00	0,00	0,00
	1	0,23	0,21	0,19	0,14	0,06
	2	0,26	0,20	0,12	0,07	0,08
	3	0,24	0,21	0,17	0,12	0,04
	4	0,28	0,23	0,15	0,10	0,04
	5	26,55	14,20	3,25	0,00	0,00
	6	9,88	7,05	4,24	2,03	0,00
	7	4,79	3,28	1,93	0,98	0,12
	8	2,06	1,34	0,75	0,38	0,08
	9	2,89	2,29	1,69	1,15	0,58
	10	3,02	2,44	1,82	1,23	0,62
	11	2,97	2,40	1,78	1,19	0,59
	12	2,91	2,36	1,75	1,16	0,58
	13	2,88	2,33	1,73	1,15	0,57
	14	2,87	2,32	1,72	1,14	0,57
	15	2,86	2,31	1,72	1,14	0,57
	16	2,86	2,31	1,71	1,14	0,57
	17	2,86	2,31	1,71	1,14	0,57
	18	2,86	2,31	1,71	1,14	0,57
	19	2,86	2,31	1,71	1,14	0,57
	20	2,86	2,31	1,71	1,14	0,57
	21	2,86	2,31	1,71	1,14	0,57
	22	2,86	2,31	1,71	1,14	0,57
	23	2,86	2,31	1,71	1,14	0,57
	24	2,86	2,31	1,71	1,14	0,57
Delivery [Pc./Week]	0	150,00	150,00	150,00	150,00	150,00
	1	149,80	149,82	149,85	149,90	149,98
	2	149,96	150,00	150,03	150,02	149,95
	3	149,99	149,98	149,96	149,98	150,00
	4	149,97	149,99	150,01	150,00	150,03
	5	404,02	415,21	420,19	411,63	397,70
	6	447,63	446,12	443,74	440,77	438,08
	7	453,14	451,83	450,24	448,68	447,20
	8	452,65	451,79	450,88	450,12	449,40
	9	442,91	442,64	442,46	442,41	442,43
	10	429,61	429,53	429,51	429,53	429,55

Table 2 (cont). Different values of "Time to correct for overdue production" variable

	Week	Time to correct for overdue production [Week]				
		0.105	0.085	0.063	0.042	0.021
Delivery [Pc./Week]	11	415,11	415,08	415,07	415,08	415,07
	12	400,22	400,21	400,20	400,19	400,18
	13	385,23	385,22	385,21	385,21	385,20
	14	370,22	370,21	370,21	370,21	370,20
	15	355,21	355,21	355,20	355,20	355,20
	16	340,20	340,20	340,20	340,20	340,20
	17	325,20	325,20	325,20	325,20	325,20
	18	310,20	310,20	310,20	310,20	310,20
	19	295,20	295,20	295,20	295,20	295,20
	20	280,20	280,20	280,20	280,20	280,20
	21	265,20	265,20	265,20	265,20	265,20
	22	250,20	250,20	250,20	250,20	250,20
	23	235,20	235,20	235,20	235,20	235,20
	24	220,20	220,20	220,20	220,20	220,20
Gross Profit [PLN]	0	0,00	0,00	0,00	0,00	0,00
	1	3807,53	3807,35	3807,06	3806,61	3806,04
	2	7605,25	7606,42	7608,44	7611,65	7615,04
	3	11412,81	11415,45	11418,13	11419,41	11422,40
	4	15220,03	15222,05	15224,41	15228,09	15229,60
	5	18466,96	18459,55	18451,90	18230,98	17139,73
	6	32056,23	31588,63	30775,22	29442,41	26792,65
	7	46751,43	45863,04	44466,58	42409,79	38802,18
	8	61643,83	60436,75	58617,49	56047,66	51740,55
	9	76310,77	74884,06	72775,33	69848,64	65040,71
	10	90272,61	88694,49	86380,66	83190,66	78001,30
	11	103452,91	101760,66	99287,84	95888,57	90393,34
	12	115863,74	114082,38	111483,41	107916,75	102177,02
	13	127536,04	125684,46	122985,41	119285,63	113351,81
	14	138497,27	136590,33	133812,05	130007,02	123919,63
	15	148766,66	146816,11	143975,25	140087,08	133878,56
	16	158356,17	156371,25	153481,11	149527,08	143223,28
	17	167272,41	165260,48	162331,53	158325,94	151946,73
	18	175518,61	173485,34	170525,86	166479,70	160041,14
	19	183095,66	181045,67	178062,17	173984,13	167498,91
	20	190003,31	187940,20	184937,80	180834,75	174312,81
	21	196240,63	194167,16	191149,91	187027,28	180476,50
	22	201806,27	199724,66	196695,78	192557,73	185984,33
	23	206698,73	204610,80	201572,78	197422,67	190831,53
	24	210916,63	208823,73	205778,61	201619,03	195013,95

Source: Own elaboration

The next table (Table 3) presents the results of the simulation for the previously selected variables after changes the "Time to adjust to the required number of workers".

Table 3. Different values of "Time to adjust to the required number of workers" variable

	Week	Time to adjust to the required number of workers [Week]			
		3	2	1	0.51
Overdue Production [Piece]	0	0,00	0,00	0,00	0,00
	1	0,26	0,21	0,12	0,05
	2	0,36	0,20	0,11	0,08
	3	0,26	0,21	0,13	0,09
	4	0,30	0,23	0,14	0,10
	5	72,92	14,20	0,00	0,00
	6	15,04	7,05	0,00	0,00
	7	5,97	3,28	0,00	0,00
	8	2,14	1,34	0,00	0,00
	9	2,49	2,29	1,41	0,00
	10	2,47	2,44	2,11	0,00
	11	2,40	2,40	2,29	0,00
	12	2,35	2,36	2,33	0,00
	13	2,33	2,33	2,32	0,00
	14	2,32	2,32	2,32	0,61
	15	2,31	2,31	2,31	1,60
	16	2,31	2,31	2,31	2,05
	17	2,31	2,31	2,31	2,22
	18	2,31	2,31	2,31	2,29
	19	2,31	2,31	2,31	2,31
	20	2,31	2,31	2,31	2,31
	21	2,31	2,31	2,31	2,31
	22	2,31	2,31	2,31	2,31
	23	2,31	2,31	2,31	2,31
	24	2,31	2,31	2,31	2,31
Delivery [Pc./Week]	0	150,00	150,00	150,00	150,00
	1	149,77	149,82	149,92	149,98
	2	149,91	150,00	149,98	149,97
	3	150,05	149,98	149,99	149,98
	4	149,97	149,99	149,98	149,99
	5	367,00	415,21	393,97	384,83
	6	460,77	446,12	437,23	435,15
	7	458,80	451,83	447,09	446,62
	8	454,65	451,79	449,34	449,23
	9	443,70	442,64	441,55	442,70
	10	429,89	429,53	428,91	429,63
	11	415,18	415,08	414,79	415,07
	12	400,23	400,21	400,09	400,17
	13	385,22	385,22	385,18	385,19
	14	370,21	370,21	370,20	369,53

Table 3 (cont.). Different values of "Time to adjust to the required number of workers" variable

| | Week | Time to adjust to the required number of workers [Week] | | | |
		3	2	1	0.51
Delivery [Pc./Week]	15	355,21	355,21	355,20	354,34
	16	340,20	340,20	340,20	339,69
	17	325,20	325,20	325,20	324,96
	18	310,20	310,20	310,20	310,10
	19	295,20	295,20	295,20	295,16
	20	280,20	280,20	280,20	280,19
	21	265,20	265,20	265,20	265,20
	22	250,20	250,20	250,20	250,20
	23	235,20	235,20	235,20	235,20
	24	220,20	220,20	220,20	220,20
Gross Profit [PLN]	0	0,00	0,00	0,00	0,00
	1	3807,86	3807,35	3806,62	3806,67
	2	7602,92	7606,42	7612,20	7613,76
	3	11408,63	11415,45	11418,64	11421,11
	4	15219,17	15222,05	15226,84	15228,80
	5	18199,82	18459,55	17956,77	15496,67
	6	32181,43	31588,63	29060,88	24590,12
	7	47319,74	45863,04	42360,32	36520,33
	8	62200,78	60436,75	56372,94	49495,39
	9	76707,08	74884,06	70531,48	62903,83
	10	90485,55	88694,49	84149,96	76015,48
	11	103495,50	101760,66	97091,01	88577,97
	12	115761,18	114082,38	109329,93	100549,93
	13	127314,64	125684,46	120874,37	111927,17
	14	138180,31	136590,33	131738,03	122693,00
	15	148373,45	146816,11	141931,80	132770,75
	16	157902,38	156371,25	151462,22	142218,84
	17	166770,55	165260,48	160332,23	151042,66
	18	174978,56	173485,34	168542,13	159227,56
	19	182525,45	181045,67	176090,70	166761,61
	20	189409,28	187940,20	182976,06	173637,41
	21	195627,70	194167,16	189195,88	179850,20
	22	201178,47	199724,66	194747,77	185396,55
	23	206059,23	204610,80	199629,52	190273,78
	24	210267,95	208823,73	203839,06	194479,67

Source: Own elaboration.

5. DISCUSSION

The results showed that the gradual reduction of the "Time to correct for overdue production" by one hour (from the initial value of 4 hours) would reduce the amount of backlog production in individual weeks and a single increase in this time would increase

the volume of outstanding production. The volume of deliveries of finished photobooks to customers would also change. To the fourth week, the supply would be 150 pcs/week. In the fifth week, during reducing the "Time to correct for overdue production" by one hour, the weekly delivery would increase by 5 items but further reduction would cause the volume of deliveries to decrease. Interestingly, in weeks 6, 7 and 8, during increasing the "Time to correct for overdue production" by one hour would result in a slight increase in the volume of deliveries. This is related to the "Current capacity" values, which would take on larger values due to the feedback from "Production backlog", increasing "Production start required", which affects the "Current capacity". In the following weeks, changes to the "Time to correct for overdue production" would not affect the volume of deliveries of finished photobooks to customers.

During analyzing the sales revenues and total costs, it was observed that the accumulated gross profit would decrease after 6 months along with the decrease in the "Time to adjust for overdue production". With a base value of 0.085 per week, it would amount to PLN 208823,73. After reducing the "Time to correct for overdue production" by one hour – it would fall to PLN 205778,61. After reducing by two hours - it would fall to PLN 201619,03; reduced by three hours, it would amount to PLN 195013,95. Interestingly, increasing the "Time to correct for overdue production" by one hour would result in an increase in cumulative gross profit to PLN 210916,63.

The gradual reduction of "Time to adjust to the required number of workers" from the base value (equal to 2 weeks) would result in a decrease in the volume of overdue production. Reducing the variable by 1 week would completely eliminate the backlog of production in weeks from the first to the eighth, while assuming that the "Time to adjust to the required number of workers" would be 3 days – it would be possible to eliminate the backlog of production in the first thirteen weeks. Increasing the variable by 1 week would result in an increase in the backlog of production in each of the studied weeks.

Reducing the "Time to adjust to the required number of workers" would not, however, affect the increase in the volume of deliveries of finished photo books to customers. There would be no difference in the volume of deliveries in the weeks when order volumes were stable. In the weeks when orders would increase, the gradual reduction of the "Time to adjust to the required number of workers" would also result in a gradual reduction in the volume of deliveries. Increasing the variable by 1 week from the base value, initially would not change the volume of deliveries, but in the "critical" weeks, in which there was an increase in orders, it would slightly increase the amount of finished photobooks that can be delivered to the customer (especially in weeks six, seven and eight). This would result, as in the case of "Time to adjust for overdue production", from the feedback effect, which by increasing the "Time to adjust to the required number of workers" would increase the amount of "Overdue production", which, subsequently affecting "Start production required" (Baran, Stecko, 2016).

As a result of changes in sales revenues and total costs, the cumulative gross profit after 6 months and after increasing the "Time to adjust to the required number of workers" by 1 week from the base value would increase by PLN 1444,22. Reducing the "Time to adjust to the required number of workers" would result in a loss of PLN 4984,67 in the case of a decrease of 1 week and a loss of PLN 14344,06 in the case of a decrease of 1.5 weeks.

6. CONCLUSIONS

The final results presented that the use of a management simulator built in the convention of the Systems Dynamics method can help in strategic management in terms of timely deliveries of ordered photobooks to customers as well as the financial result in the company. By changing the "Time to adjust for overdue production" from a base value of 0.085 weeks to a value of 0.105 weeks (i.e. 5 hours), the company would increase the volume of deliveries of finished photo books to customers in "critical" weeks and increase the final gross profit by PLN 2092,90 from the profit base. By increasing the "Time to adjust to the required number of workers" by 1 week from the base value (2 weeks), the company would also slightly improve the volume of finished goods deliveries and increase gross profit by PLN 1444,22.

Interesting observation resulting from the conducted research was a noticeable change in the mental models of the company leaderships. While working with the simulator, they learned the complexity of the system they manage and realized that there are feedback loops in the system that they had no idea about them before. This contributed to changing the mental models they used and to searching for new, creative solutions to existing problems in the company system.

Working with a management simulator allows to conduct research with a much wider range than shown in this article. In further research, it would be worth focusing on other control norms that control the company's system, which directly affect the key processes in the company. The simulation model could be developed with further variables that affect various aspects of management and thus improve the company's operations.

In the summary, tools currently offered by the Systems Dynamics method, together with systems thinking and the computer approach, can be used in the strategic management of a company. They allow the company to determine a course of action that will ensure its current and future position in the environment in accordance with the adopted general strategy and the company's mission.

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