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SUPPORTING LEAN CONCEPTS IMPLEMENTATION IN SMALL MEDIUM ENTERPRISES (SMEs): A CASE STUDY FROM THE ROMANIAN INDUSTRY

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ABSTRACT. This paper proposes a solution to the fundamental problem of maximizing productivity by reducing the costs in a small sized manufacturing company. The steps taken in tackling this commonly faced issue are prompted by the review of existing literature on Lean and Just in Time manufacturing, some of the concepts being first introduced at Toyota in the 20th century. The approached case study is based on a small manufacturing company of P.V.C. related products. Both qualitative and quantitative aspects are taken into account when analyzing the implementation of the proposed management process e.g. number of employees directly involved in the manufacturing process, relationship with suppliers, sales, inventories, incomes, expenses (up to 60 months of historic data). For providing an insight into expected future sales, this paper conducts a detailed time series analysis. In developing the forecasting model, three smoothing methods have been tested: simple moving average, autoregressive integrated moving average (ARIMA), and exponential smoothing. Also, different regression models have been considered e.g. simple linear and polynomial. Simple linear regression was considered to provide the best balance between model complexity and the accuracy of the predictions.

Key words: lean, just-in-time, time series analysis, forecasting, simple moving average (SMA), autoregressive integrated moving average (ARIMA), exponential smoothing

JEL Classification: C22

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Introduction

Striving for perfection in any manufacturing process implies a complex path of continuous improvement, minimizing errors, and a combination between great management and a well-trained, motivated workforce. Even though achieving perfection remains an unattainable objective, the most important aspect for any organization is the process, and steps taken, towards this strategic goal. This involves the proper research, knowledge, motivation and patience, but also a well thought out plan involving organizational, tactical and operational goals at each step, and going through the tiresome process of trial and error, using the feedback acquired in the purpose of gradually correcting the mistakes each step of the way.

Even though the philosophy of continuous improvement presents many advantages, its implementation represents a complicated path, especially in a small company with a hard to change culture. Several theoretical aspects must first be addressed and understood, such as: the foundation of Lean and Just in Time manufacturing and why it has worked so flawlessly for Toyota, means of eliminating costs, finding a way to reduce inventories as close to zero as possible, the relationship the company should have with its suppliers and so on.

Following a detailed research, a broad understanding of the company's culture and manufacturing process is required. Even though the method of Lean manufacturing can introduce many advantages, if the philosophy is not accepted by the management, or cannot be transferred to the employees, it will not be implemented. Change management can prove extremely problematic; for certain employees that have worked for a long time in a specific manner following strict rules or guidelines, change can definitely represent an impediment in their workflow.

For this step, qualitative and quantitative data is gathered through primary research. Ultimately, an analysis is made to find the optimum solution of implementing all of the research done within the company in a manner tailored for this specific organization. Furthermore, some forecasting models are developed using: simple moving average, autoregressive integrated moving average (ARIMA), and exponential smoothing.

Literature review

Improving the manufacturing process within a company has been an existing problem since the beginning of the first industrial revolution in the XVIII century to the present day. For solving this problem, solutions have been addressed by various companies through trial and error, with the scope of finding the perfect balance for optimizing manufacturing and reducing costs, according to the needs of each entity. This is precisely the problem that is addressed in this research, shaped according to the needs of the company.

The roots of the Toyota Production system date back to the beginning of the 20th century when the company first appeared, being funded by Sakichi Toyoda (Monden, 2012). Sakichi Toyoda was working at that time in a textile factory, in which he invented a motor-driven loom that was programmed to stop when a thread broke. In 1910 Toyoda visited the United States, where he became fascinated with the autonomation that he has seen at Ford Company, which in 1913 has introduced the serial production of its automobile from the time. In consequence, when Toyota Motor company has started its production, Kiichiro Toyoda has decided to implement the system witnessed in the United States, which marked the beginning of a well-lasting, prosper company (Monden, 2012).

Ever since the oil shock in 1973, a slow adoption process of Toyota Motor Corporation's J.I.T. system has started to appear in companies all over the world, due to its huge success in achieving its purpose, which is the elimination of waste through the improvement of various manufacturing related activities (Monden, 2012).

After Toyota's success in implementing „Lean", the concept has expanded to America when the opening of the joint venture between Toyota and General Motors occurred, and from that point it has expanded worldwide, impacting in one way or another on small ventures (Pearce et al., 2018), to giants such as Nike (Riddle, 2016) or Intel (Panat et al., 2014).

Reducing costs for the purpose of maximizing profit may be achieved through two main courses of action: the reduction of excessive inventory, or the reduction of excessive workforce. For the cost reduction process to achieve its maximum positive outcome, Toyota made it clear that all of the cost generating factors should be taken into account, not only the manufacturing ones. Those costs may also include sales costs, administrative costs, and capital costs (Monden, 2012).

The Toyota Production System follows the principle that waste should be completely eliminated in order to achieve maximum efficiency in the cost reduction process (Stevenson, W., 2012). It is essential to state that, if deciding to follow this course of action, a company may expose itself to a number of risks, especially if the company is a small-sized enterprise and the management does not possess the necessary technical and administrative skills. Excessive resources indeed represent a liability, but not being able to put a system into place that has a fail-safe may expose the company to risks such as not meeting production targets, increased lead times, not meeting demand, or damage in the relationship with both the customers and the suppliers.

All of those wastes create a chain reaction, from the first one to the last, sustaining a vicious cycle that is maintained with the use of extra resources in order to keep the manufacturing process going, while at the same time adding no extra value to the company.

In addition to waste issues, the risk of overloading/ over-working the machines and the workforce, should also be taken into consideration. In the case of the machinery, overloading may cause certain defects such as the machine to break down and cause delays, or electricity shortages. In the case of the workforce, overload may lead to tiredness, lack of motivation, and even the desire to quit in some extreme cases (Domingo, n.d.).

When implementing a lean system, a few concepts that have their origin in the Toyota Production System should also be taken into consideration, and will be discussed below.

For a further contribution to the planning and control process of the facility, the implementation of a pull system such as the Japanese Kanban system can be accounted for. In Japanese, the origin place of where this system was created, Kanban means a card and it consists in attaching one to each container in the output store, but the number of the cards is limited, which helps in limiting the maximum number of finished products in the system. When the container is withdrawn, the card is attached back to the scheduling board, and the process is repeated, controlling the quantities needed for the products (Matzka et al., 2009).

The Kanban system further contributes to the maintenance of Just in Time manufacturing through a series of factors. Firstly, by implementing it the smoothening of production occurs by fluidizing the workflow and reducing the time necessary for a process. Furthermore, the jobs are standardized, requiring less workforce and reducing costs but also in this way every employee knows how to flawlessly complete each job assigned to them and less training per employee is required. The setup time is also reduced due to the fact that the production process is standardized, less processes requiring special attention. An improvement in the activities will also be noticed, as well as the design in the machine layout and in the end, making it possible for the concept of automation described above to be implemented (Matzka et al., 2009).

To have a clear understanding of what a Kanban card is, Monden's description is an accurate one, stating that "it is a card that is usually placed in a rectangular vinyl envelope" (Monden, 2012). He further describes that there are two types of Kanbans that are used: a withdrawal one, and an ordering one, depending on the type of activity. The withdrawal Kanban is used to dictate the quantity that needs to be withdrawn from the subsequent process, while the production-ordering one is used to dictate the quantity that needs to be produced by the preceding process (Monden, 2012).

The Japanese concept of Kaizen embraces the idea of continuous improvement in the standard way of work, a factor that each employee can and should be encouraged to contribute to. The employees who form the standard workforce are the ones who directly contribute to the manufacturing process and the quality of the output, so they should be the ones who come with new ideas when it comes to identifying the flaws, and help in improving the manufacturing process (Chen, 2001).

Jidoka represents the concept of autonomation and using it separates the individual human activity from machine cycles, enabling each worker to attend several machines of different types that work at the same time. In turn, the output of each machine represents the input for the next one (Stevenson, 2012).

The pillars of the Toyota Production System are Just in Time and autonomation, which, combined flawlessly, can give any production-based company the necessary to gain the competitive advantage (Baudin, 2007). With the help of J.I.T. the necessary units are produced in the necessary quantity at the necessary time, resulting in the elimination of two types of waste: excessive quantities produced, and excessive time used for a process. This is a necessary step that must be taken for the inventories to be reduced as close to zero as possible. Even though this implementation sounds great in theory, an error related to anything taking part in the manufacturing process, such as in the assembly line, may have a significant negative impact within the company. This is where the concept of Jidoka (autonomation) comes in, which basically stops the defective units from a previous process to continue taking part in the assembly and disrupts the process that follows (Monden, 2012).

Another strategy of implementing lean manufacturing can be empathized through Rother and Shook's (2003) five step process of a lean:

1. Find a sensei (a teacher whose learning you can borrow).
2. Seize (or create) a crisis to motivate action across your firm.
3. Map the entire value stream for all of your product families.
4. Pick something important and get started removing waste.

Scientific research & Methodology

In order to understand how a company operates, and furthermore, to have a perspective on the possibility of implementing such a complex system can only be achieved through an internal insight of how the company works through the eyes of the management of the company by conducting a primary research. Two primary data collection methods were used for the gathering of data. Firstly, a phone interview has been conducted to receive a first-hand perspective over the operations of the company. During this interview information regarding the set-up of the company, the suppliers, the customers, and other general information was provided. The purpose behind the phone interview was to gain an actual insight within the company, form a perspective regarding its culture, get to know the management, its employees, and its assets.

Main objectives of the study:

- Get an insight regarding of how the company was formed
- Find what are the fixed and variable assets behind the manufacturing system
- Which are the company's suppliers
- What is the company's relationship with its suppliers
- In what manner do the employees receive special training to do their jobs
- Which are the company's clients.

Following the phone interview, more data was solicited through email, including quantitative data such as the company's sales, inventories, number of employees, and orders. Over 60 months' worth of data was sorted and analyzed to offer an insight into the company. One of the most important objectives of the interview was the gathering of data regarding the company's sales, which had to be evenly split on each month for a period of at least five years, serving as the basis of the forecasting models: the classical decomposition model, and the exponential smoothing model. The secondary objectives involved data gathering regarding the company's number of employees, number of clients, inventory value, income, expenses, and profit.

A Just in Time manufacturing system's main purpose is achieving maximum profit through the reduction of costs, and the maximization of productivity. When analyzing a microenvironment of small to medium companies that have the primary focus on manufacturing, they may not be aware of the potential uses of a J.I.T system (Knol et al., 2018). To find the most appropriate means to implement such a complex system, first of all, an overview of the company's management and of its orders must be forecasted. At this point, the subject of analysis will represent order management, the relationship with the suppliers, the payment and quantity of the orders.

In this paper several forecasting models have been adopted. In order to achieve reliable forecasts several approaches and methods have been tested: classical decomposition method, autoregressive integrated moving average model (ARIMA), and the exponential smoothing model. The forecasting models that were used for the analysis will be described.

In the model of classical decomposition, the time series is decomposed into four main components: trend, cyclicality, seasonality and irregularities (Dewhurst, 2006). Two types of models tested that exist within the technique of classical decomposition are the multiplicative and additive models (Ostertagová et al., 2012). For the purpose of this research, the methodology used will be based on the multiplicative model.

The model is split within four main components (trend, seasonality, cyclicality, and the irregular component), which are based on the following formula:

$$Y_t = TR_t \times SN_t \times CL_t \times IR_t$$

The components mentioned above have the following interpretation:

- Y_t – Value of the time series in the period t
- TR_t – Trend component in the period t
- SN_t – Seasonal component in the period t
- CL_t – Cyclical component in the period t
- IR_t – Irregular component in the period t

The data used for the model is selected on the monthly basis, and the moving average is then calculated on the respective period. Afterwards, a centered moving average is calculated using the formula

$$CMA_k = (MA_k + MA_{k+1}), \text{ for the period } k.$$

Exponential smoothing forecasting methods is the one most commonly used, making its first appearance in the 1950's, and it was developed by Brown and Holt (Ostertagová, 2012), who were trying to create a forecasting model for inventory-controlled systems, and its use is essential for predicting the minimum inventory levels that can be achieved, in order for a company not to suffer due to shortages of raw materials.

The method became so popular due to its simplicity, ease of use, and due to the minimal requirements for data storage and computing. The premise of the model is the level of a time series should fluctuate about a constant level or slowly change over time (Ostertagová, 2012).

The equation of the model is:

$$y(t) = \beta(t) + \varepsilon(t)$$

Significance:

- β(t)- takes a constant at time t and may slowly change over time
- ε(t)- random variable that describes the effect of stochastic fluctuation

When performing an estimation, using all past observations is essential. However, going further back in the past, a down-weighting older observation is a factor to take into consideration, due to the declining correlation.

Taking this into account, the equation of the simple exponential smoothing takes the following form:

$$F_{(t+1)}=\alpha y_t+(1-\zeta)*F_t$$

Significance:

- y_t - series value at time t
- F_t - Forecast value of the variable at time t
- F_{t+1} - Forecast value at the time t+1
- α - smoothing constant

The model is based on an initial forecast, an actual value, and a smoothing constant. (Ostertagová, 2012)

The autoregressive integrated moving average (ARIMA) model represents an alternative approach to the exponential smoothing model in the area of time series forecasting, providing alternative approaches in solving the problem. While ARIMA models focus on the autocorrelations in the data, exponential smoothing has its basis on a description of the trend and seasonal components. (Hyndman et al., 2018)

An ARIMA model has three main components at its core. The first one is the autoregressive (AR) time series model which is correlated to the past observation of the dependent variable in the forecast of future observations. The first-order autoregression model (AR (1)) is represented by the following formula:

$$y_t=ay_{t-1}+\varepsilon_t$$

Significance:

- y_t - the dependent variable,
- a - a parameter, y_{t-1} is a lagged dependent variable
- ε_t - the random or white noise term which represents a shock which cannot be explained.

The second component is represented by the moving average (MA) model, including past observations of the white noise process in the forecast of future observations of the dependent variable. The first-order MA model (MA (1)) is represented by the following formula:

$$y_t=b\varepsilon_{t-1}+\varepsilon_t$$

Significance:

- b - the parameter
- ε_t and ε_{t-1} - the forecast error and the lagged forecast error, respectively.

The combination of the two models MA and AR generates the ARMA model, which is stationary. If the data used is nonstationary, a third component has the purpose of converting the data to achieve stationarity through the process of differentiating (integrating (I)) the original series, which according to Rohrbach and Kiriwaggulu (2001), and Nau (2018) is represented by the following formula:

$$y'_t=y_t-y_{t-1}$$

Significance:

- y'_t - the future consumption
- y_t and y_{t-1} - the original series and lagged original series, respectively (Mgaya, 2019)

Case study

The analyzed company was founded in 2001, it's domain of activity being centered around the fields of construction, execution and installation of P.V.C. and aluminum joinery, carpentry maintenance and repair services. Among the assets of the company there is a production hall and a warehouse, two transport vehicles, and machineries used in the production of aluminum and P.V.C. joinery products. The acquisition of insulated glass is made from a local company near Deva city. The profiles and accessories are provided by two different companies, one for P.V.C. materials and, respectively, for aluminum.

The company usually handles its stock by keeping it to a minimum, using, in practice, a "Just in Time" operating process, but without the awareness of the concept. The company only stocks white materials, which are the ones which exhibit the highest demand. When the company receives customized orders, which require the use of different colored materials, the management orders the specific materials after receiving the order.

The number of customers for the past five years is captured in Table 1, which indicates a rather constant customer base. However, the company's revenue has increased over the years, so, even with approximately the same number of clients, it is noticeable that the size of the individual orders has increased.

Table 1. Number of clients for the past 5 years

Clients		
Year	**Legal Entities**	**Phisical Entities**
2015	30	72
2016	46	75
2017	41	93
2018	35	77
2019	38	102

Source: Compiled by authors based on the data from the company

The company's suppliers are two local manufacturers from Hunedoara county, with which it has a steady and lasting relationship, and does not focus on finding better alternatives or even taking any other options into account. Its current objective represents the expansion of its client base. At the beginning of each year, the company gets a 5% to 7% loyalty discount from both suppliers, if the payment is made in 30 days. If the company manages to complete the payment in 2 to 3 days, it gets an additional 5% to 7% discount.

The enterprise is aware of the negative effects waste can have, and keeps it to the lowest possible level. The company is mainly concerned with the negative effects that was can generate on their direct costs, but they are also conscious of their environmental impact. Any waste that occurs from any stage of the manufacturing process is thoroughly collected, and recycled, giving the company the possibility of regaining a part of their losses through the income collected from recycling.

An advantage that may be considered is the relatively small size of the company, which will make the implementation of the process much easier, offering both the management and the workforce a more direct perspective of the advantages that these processes have to offer. In addition, the relatively reduced amount of processes and machineries involved in manufacturing also represent an advantage, reducing the difficulty of implementation that would be required in a larger, more complex company.

Analysis

A Just in Time manufacturing system's main purpose is achieving maximum profit through the reduction of costs, and the maximization of productivity. When analyzing a microenvironment of small to medium companies that have the primary focus on manufacturing, they may not be aware of the potential uses of a J.I.T system. Even though the analyzed company, is making use of certain lean concepts, they are not aware and do not analyze their implications.

To find the most appropriate means to implement such a complex system, first of all, an overview of the company's management of its orders must be foreseen. At this point, the subject of analysis will represent order management, the relationship with the suppliers, the payment and quantity of the orders. The purpose of this study is to carry a quantitative analysis of the company's sales in the past 5 years.

Upon a first visual inspection of the sales data, presented in Figure 1, no seasonal patterns can be identified. Nevertheless, classical decomposition models and ARIMA models will be generated to test this aspect. Using the classical decomposition model, the study will be conducted from the perspective of the company's trend and seasonality, with the use of the moving average method on three, six and twelve months, and the result were compared.

The best results, for smoothing out the data, when the classical decomposition method is employed, are obtained for MA3. However, as it can be observed from Figure 2, the approach does not provide a good model, indicating a very low coefficient of determination R^2=0.2069 on the deseasonalized data. The other models build using the classical decomposition approach also generated poor results on the deseasonalized data: MA (6) generated an R^2 of 0,0984 and MA (12) an R^2 of 0,1098, on the deseasonalized data. As previously mentioned ARIMA models were also tested.

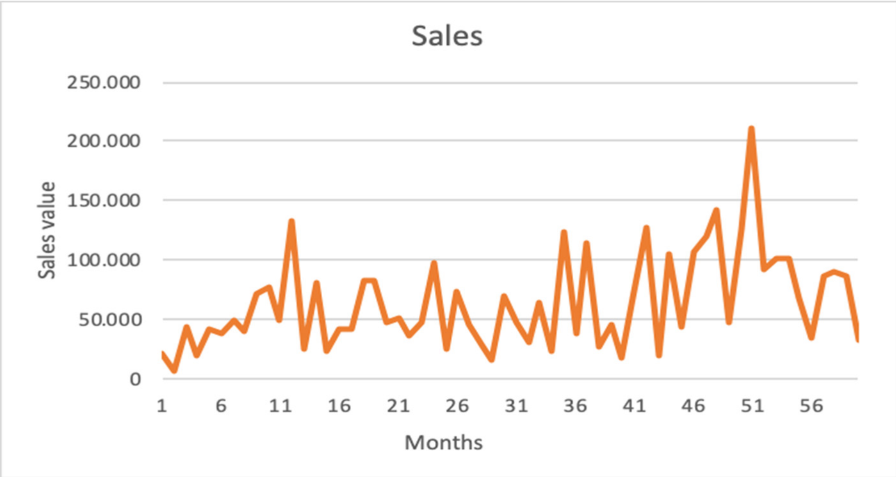

Figure 1. Sales Plot
Source: authors' own calculations

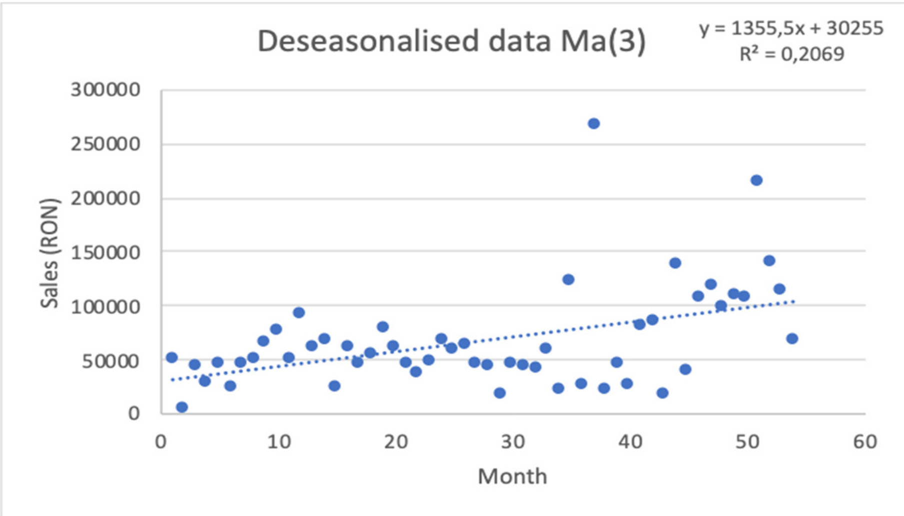

Figure 2. Deseasonalized data
Source: authors' own calculations

The Autoregressive Integrated Moving Average (ARIMA) model was also tested using three different moving average windows: 3 months, 6 months, and 12 months respectively. The last 6 months, representing 10% of the dataset, were included in the testing set, and the remaining 54 observations were employed to build the models. Certain error measurements (mean absolute error, mean squared error, and mean absolute percentage error) are presented in Table 2. The errors are strictly computed on the testing set. As it can be observed, as in the case of classical decomposition model, the moving average with a window of 3 months (MA3) exhibits the lowest errors.

Table 2. Forecasting errors for the ARIMA MODELS

	ARIMA (3)			ARIMA (6)			ARIMA (12)		
Data Point	MAE	MSE	MAPE	MAE	MSE	MAPE	MAE	MSE	MAPE
55	67.592,23	4.568.710.043,04	0,998	67.581,42	4.567.113.693,40	0,9982	67.638,71	4.574.994.779,33	0,9990946
56	33.841,01	1.145.213.957,82	0,996	33.861,36	1.146.524.361,17	0,9969	33.937,52	1.151.755.243,39	0,9991027
57	86.215,18	7.433.057.952,15	0,998	86.254,51	7.439.667.491,04	0,9987	86.316,39	7.450.519.596,95	0,9994488
58	90.339,78	8.161.275.705,90	0,999	90.345,67	8.162.160.480,91	0,9989	90.412,88	8.174.488.345,50	0,9996117
59	86.668,45	7.511.420.450,74	0,999	86.674,28	7.512.258.398,74	0,9986	86.733,91	7.522.770.901,03	0,9992731
60	32.508,56	1.056.806.525,29	0,996	32.501,17	1.056.261.385,59	0,9954	32.575,71	1.061.176.582,31	0,997694
SUM:	**397.165,22**	**4.979.414.105,82**	**0,998**	**397.218,42**	**4.980.664.301,81**	**0,9978**	**397.615,11**	**4.989.284.241,42**	**0,9990375**

Source: authors' own calculations

The forecasts for the testing set are depicted in Figure 3, along with the upper and lower bounds of the 95% confidence interval. As it can be observed, as in the case of classical decomposition models, the ARIMA model does not provide reliable forecasts. The values predicted for the testing set are quite far from the actual sales, as it can be observed from Table 3, or inferenced from the error measurements presented in Table 2.

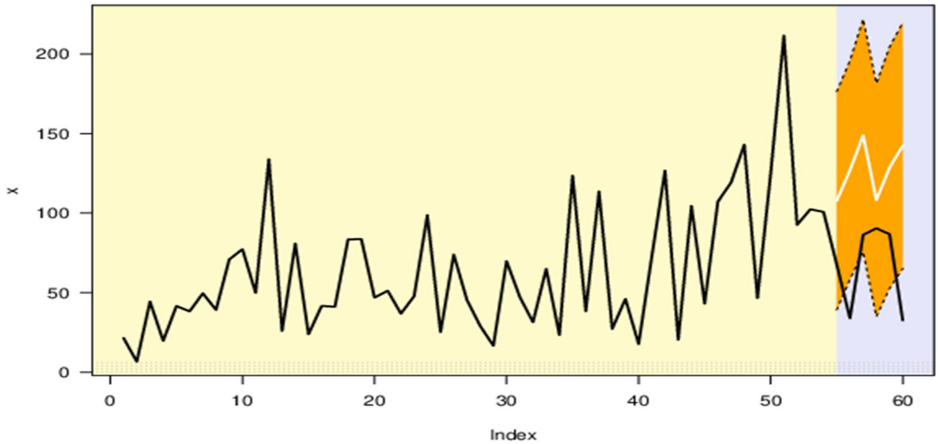

Figure 3. ARIMA model - Three-months testing period
(Figure generated using Wessa (2016); Source: authors' own calculations)

Another indication of the poor quality of the ARIMA models, is given by the wideness of the 95% CI. As it can be observed both visually from Figure 3, or from the data in Table 3, the confidence intervals generated for the forecasts are extremely wide. Moreover, even with such wide margins for the upper and lower bounds of the CI, it can be observed that for months 56 and 60, the actual values are actually outside the generated CI.

Table 3. ARIMA Model - Three-months model, confidence interval

Data Point	Y[t]	F[t]	95% LB	95% UB
55	67,700	107,7664	39,1873	176,3454
56	33,968	126.99	58,3050	195,6751
57	86,364	148,8160	75,7457	221,8863
58	90,448	108,2208	34,9723	181,4694
59	86,797	128,5487	52,7228	204,3746
60	32,651	142,4392	65,1897	219,6887

Source: authors' own calculations

The poor results obtained by both classical decomposition and ARIMA are an indication that the variation in the sales does not follow a seasonal pattern that can be captured. As it was also indicated by management, the variations in sales are irregular, being dependent on rather circumstantial factors such as export orders. The highest irregularities have started to appear after month 35, the period in which the outsourcing began. For smoothing out the irregularities in the sales, and exponential model was developed.

In order to generate a robust exponential smoothing model, different damping factors have been tested. The damping factor is a corrective value that is employed that minimizes the fluctuations in the sales data (Dewhurst, 2006). Given the high variation in sales, a rather large value for the damping factor was necessary to smooth out the irregularities. Also, two different trend-lines were employed for generating the forecasts: linear and polynomial of order 2.

Table 4. Coefficient of determination for different model structures

	Coefficient of Determination (R2)		
	α=0,3	α=0,6	α=0,8
Linear	0,319	0,498	0,697
Polynomial (grade 2)	0,326	0,166	0,708

Source: authors' own calculations

In the case of forecasting models, as the model complexity increases so does the model accuracy; however, a balance must be sought between the two objectives (Savan, 2015). Given these considerations, the exponential smoothing damping factor of 0.8 with a linear trend line was selected for the forecasts. As it can be observed from both Table 4, acceptable coefficients of determination can only be obtained with a damping factor of 0.8 (0.697 and 0.707). As expected, the polynomial provides a slightly better fit than the linear trend line. However, since the increase in R^2 is not justifying the increase in the model complexity, the linear model was selected for forecasts (see Figure 4).

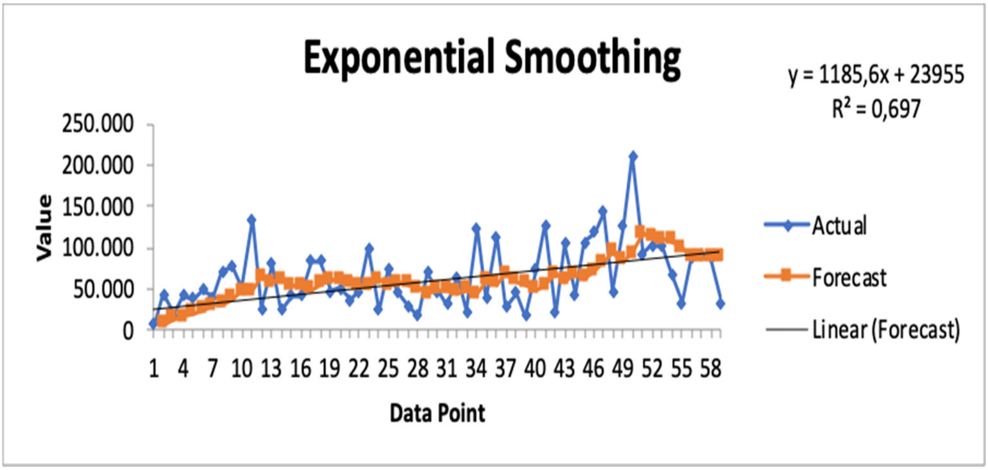

Figure 4. Exponential smoothing model
Source: authors' own calculations

As expected, the model will be influenced by the irregular variations. As it can be observed in Figure 4 and Table 5, there are months in which the offered forecasts are quite far from the actual data: as in the case of the ARIMA models is the case of months 55 and 60. However, as we concluded that no seasonal patterns or any other constant patterns can be extracted, the above developed model is considered the best for the given data.

Table 5. Forecasting errors - linear trend

Linear Trend					
Data Points	Y[t]	F[t]	MSE	MAPE	MAE
55	67.700	89163,00	460.660.369,00	0,317031019	21463
56	33.968	90348,60	3.178.772.056,36	1,65981512	56380,6
57	86.364	91534,20	26.730.968,04	0,059865222	5170,2
58	90.448	92719,80	5.161.075,24	0,025117194	2271,8
59	86.797	93905,40	50.529.350,56	0,08189684	7108,4
60	32.651	95091,00	3.898.753.600,00	1,912345717	62440
SUM:			**1270101236,53**	**0,676011852**	**154834**

Source: authors' own calculations

Further discussion

According to JIT principles, the reduction of costs and improvement of productivity is achieved through the elimination of waste (Monden, 2012). In the case of excessive production resources, three types of waste are taken into account. The excessive workforce represents the first one, and, taking into account the ratios, it is not a type of waste present in the analyzed company. The company has, currently, 5 employees, 4 of them working directly in the production department. The total workspace is of 380 square meters, which leads to a ratio of 76 square meters per employee, which leads us to consider a different kind of waste. With an average of 76 square meters/employee, after discussions with the management, it was identified as generating an unnecessary cost that can be reduced.

The existing inventories do not represent a major impediment, since the factory only stocks white and grey materials, which are the most commonly used, and order the custom materials when they are needed. Also, the issue that arises using this method is that the company mainly focuses on a naive forecasting method, together with an analysis of the trend from the previous year, when stocking up.

The small-sized enterprise does not make use of a fully automated production process. Orders are being handled by the employees on an as needed basis. This can be also be seen as an advantage, when it comes to the objective of avoiding overproduction, which can be kept at a minimum.

Finally, another potential type of waste is represented by the unnecessary capital investment. This waste is also, currently, kept to a moderate amount, the only impediment being the large storage space, leading not only to higher expenses with rent, but also to increase expenses with utilities and other indirect costs. An extra warehouse of 140 square meters was built in 2017, the time in which the company has started exporting 35% of its products. The extra space may have been needed due to the volume of orders increasing, but the number of employees decreased by 1 in that period. Due to the small workforce, especially in the production department, the extra space cannot be used to its maximum capacity (Monden, 2012).

The use of an accurate forecasting method, hiring new employees or reducing the workspace are aspects to be taken into consideration when making use of a JIT manufacturing system. The implementation of JIT philosophy must start from the top management, and be accepted by all the employees, including those involved in the production process (Monden, 2012). The business owner has started the company over 20 years ago after the fall of communism, before being a production worker himself in a similar factory. Due to his age, experience and paradigms, which he has followed after opening his own company, he has a rather rigid mindset regarding how the manufacturing process should be functioning. In order for the management to be open to embrace such an idea, the information must be transmitted in the form of a well thought out suggestion and not give the idea that the managers' current way of thinking is doubted in any way (Walleigh, 1986). Clear advantages need to be illustrated in order to convince him; a change is beneficial. At the same time, he must find a way to transfer this way of thinking to his employees, which are more or less in the same situation as he is, but with no management experience.

First of all, top management has to accept the idea that any kind of inventory leads to inflexibility, unused assets, and decreased liquidity overall. This issue may be addressed through reducing the stock of common materials to almost 0, which represent the most of their inventory and try and implement the same strategy used for the custom materials which are bought only when a custom order has been placed, with a lead time of maximum 30 days. This strategy leads to a different challenge: the relationship with the suppliers, which represents another source of inflexibility. Having only two suppliers and not exploring other possibilities, will affect the company's way of operating, due to the fact that no other variables are taken into consideration, and the suppliers are the ones dictating the conditions for purchasing the raw materials. However, this inflexibility is counterbalanced by the loyalty and discounts the company receives for exclusivity; this being the main reason management decided to operate with such a low supplier base.

Deciding on increasing the supplier base represents a strategic decision, which must be carefully analyzed. First of all, a market research of potential suppliers followed by the solicitation of a few collaboration offers should be carried. Secondly, a forecast should be made of the future costs compared to the decrease in inventory and potential productivity growth. Up until this point, the management will have minimum costs of research and may be the starting point for new opportunities to come up. Finally, a decision must be taken to maximize the balance between the financial advantages of having a small supplier base and the flexibility provided by the higher number of suppliers.

Literature suggests that for implementing JIT in SMEs, a well-defined plan and set of objectives must be defined (Malik, 2012). Based on the existing literature and in close collaboration with management we developed the implementation plan presented below.

Strategic goal:

- The implementation of a Just in Time manufacturing system.
- SMART Objectives (based on the framework proposed by Tosi et al. (1970)):
- Get the JIT concept to be accepted by the top management by systematically presenting the potential benefits of the concept within the next 4 months.
- Transfer the acceptance of the concept from top management to the employees in order to be implemented in the direct manufacturing process within the next 6 months.
- Set up an Enterprise Resource Planning system in order to integrate all the data of the company into a unified system within the next year.
- Develop a strategy of waste reduction within the company through the minimization of excessive inventory within the next year.
- Test the concept after implementation in order to evaluate the success of the project.
- Develop a strategy of continuous control in order for JIT to properly function in the long term, after testing is finished.

The achievement of these objectives should be closely monitored through the acknowledgment of specific key results for each objective. The objectives presented in Table 6 were developed in collaboration with management and taking into account existing JIT literature (Malik, 2012).

Table 6. Company objectives

Objective	**Key result**
Acceptance of the concept by top management	Taking the first step towards implementation
Acceptance of the concept by employees	The direct manufacturing process will be done in a Just in Time manner
Set up of an Enterprise Resource Planning system	Having all the company's data and processes centralized in one system
Development of a waste reduction strategy	The decrease of the inventory level
Concept testing	Deciding if the concept is ready for long-term implementation
Development of a continuous control strategy	Having a sustainable, long-term, Just in Time manufacturing system

(*Source*: Malik, 2012)

Conclusions

The implementation of the Lean philosophy in the manufacturing process within an SME can generate a series of advantages e.g. increased productivity, reduced costs, but also raises a number of challenged. Risk management represents a key success factor in the final result. For example, the minimization of inventories may not only have the effect of reducing waste, but it could also generate a series of disadvantages: an increase in lead time, shortages, and a disruption in the manufacturing process. A balance must be achieved when taking strategic decisions for optimal inventory levels and optimal supplier base.

The development of a quantitative forecast models is useful for the implementation of JIT manufacturing. Through the carried research an illustration of how forecasting can be employed to support decision making was provided. The selected forecasting models are not intended to be extrapolated to all SMEs, certain companies might exhibit seasonal or even cyclical patterns, which were not identified within the analyzed datasets. In the analyzed case study, the company did not experience any constant pattern, exhibiting a high degree of irregularities. As a result, models such as classical decomposition models and ARIMA did not provide reliable solutions. Given the nature of the data, the exponential smoothing was selected to eliminate some of the irregularities; a high damping factor was needed to generate a smooth data set.

Another important decision required for model building, concerns the balance between the model complexity and model accuracy. After eliminating the irregularities in the data (through exponential smoothing) a trendline was fitted to the 60 data-points. Obviously, as model complexity is increased, there is an implicit increase in model accuracy. For the analyzed dataset, a simple linear regression offered a good model fit (on the smoothed-out data set).

It must be noted that the analysis carried on the testing set (10% of the data) indicated high error measurements for the forecasts. This result was anticipated given the high variation in the data. Moreover, it could be expected that these circumstances would apply to many SMEs, which through the characteristics of their businesses will face high variations and irregularities in sales. In the case of the company being analyzed, the underlying cause of fluctuations was identified, by management, as being the orders for export. The orders received for export have large lead times and usually require high quantities (implying high sales values), but, as opposed to local orders, they are highly irregular.

Based on the existing literature, the results, and the discussions carried with the management, a set of objectives and steps were proposed. Also, a series of potential improvement areas were identified: optimizing the warehouse per worker ratio, increasing the supplier base, and including forecasting for decision support. It must be highlighted that for implementation full collaboration is required from top management.

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