The Effect of COVID-19 on Production Plan (Case Study: Automotive Parts Industry)

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Abstract

This paper will discuss the importance of preparing the change of production plan during and the effect of COVID-19 pandemic using linear forecasting (FORECAST.LINEAR). Many manufacturing companies are in shock because of the pandemic, from the uncertainty of government regulation and the scarcity of raw material. In addition, not only about a pandemic or epidemic, but can be a monetary crisis or other kind of uncertainties. And, adjusting the production level severely affects the supply chain, since these companies also need to adjust their production level. In the planning process, we need to know how are the customer demand to ensure the production. To forecast the customer demand, we use linear forecasting. The method we used for acquiring the data for covid lockdown are all on public domain. As for the company data, we acquire it by asking the company with the requirement that we shouldn't publish the company name in regards of company privacy. From this study, we hope a better way to adjust production level including preparing for every uncertainty could be used for better decision making in forecasting the production plan and could be used for shifting production plans when adjusting to government regulation and customer demand.

Keywords
COVID-19, Production Plan, Government Regulation, Production Level

1. Introduction
The production plan is the next step after we made a strategic business plan. The reason we need a strategic business plan because we need to achieve enough quantities of each product group, desired inventory level, the resources needed, and the availability of resources on each period (Introduction to Material Management Sixth Edition, 2008). Ikon, Nwankwo, and Catherine Nkechi (2006), research shows that production plan has a functional relationship between the factor of production planning and profitability. So, a proper production plan is needed to achieve maximum profit.

After making the production plan, a proper manufacturing company must have an MPS or Master Production Schedule. Which is a derivative of the production plan which leads to the MRP or Material Requirements Plan. MRP in short is only the list of material and their time series data which is only a more detailed version of MPS (Arnold et al., 2008). In preparing for a change in the production plan, production forecasting must be conducted to make sure the proposed changes will be feasible and appropriate for the production's future condition and situation. In such cases, conducting a forecast by basing it on previous production data will produce the best possible outcome. But in the case of today, with the global coronavirus pandemic happening, little to no company has such data for when it comes to pandemic conditions beforehand. Even so, with only a year's worth of production data, a forecast still can be conducted and so a production plan shift is plausible.

1.1 Problem Statement
The COVID-19 pandemic has reminded us about the importance of facing uncertainties. We all know that pandemics are unpredictable, just like the previous pandemics such as SARS (severe acute respiratory syndrome), MERS, chickenpox, Spanish Flu, and even bubonic plague. Other than a pandemic, some examples of uncertainties are financial crises. A good company is one that can adapt and survive to these conditions, even when it forces the company to change its business focus. The pandemic affects many industries, including the automotive industry. With

social restrictions and lockdowns in every part of the world, demand for automotive plummeted down, and many customers prefer to postpone their purchases. This decrease in demand affects both new and secondhand vehicles.

1.2 Objectives

The objective of this paper is to find historical data on COVID-19 response time around the world for manufacturing company to prepare shifting the production plan and generate an alternative production plan for 2021.

2. Literature Review

2.1 Production Planning

Production planning is the planning of the production process in a company or industry. Inside production planning, the resource allocation of activities of employees, materials, and production capacity is utilized to serve different customers (Fargher & Smith, 1992). The production plan is about balancing capacity and priority in manufacturing. By planning the production process, excess or waste materials, overproduction, and many inefficiencies can be prevented. Keeping the amount of production under control can also improve quality and prevent overwork, both for the workers and the machine. In a production planning system, there are five major levels from the general to the more specific ones which are strategic business plan, production plan, master production schedule, material requirements plan, and purchasing and production activity control. (Chapman et al., 2017) Here in figure 1 below is the production plan diagram from the general to the specific steps.

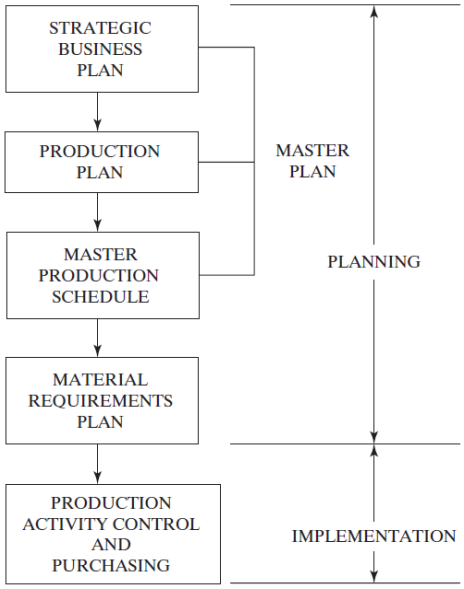

Figure 1: The Production Plan System

The production plan itself starts from a strategic business plan which is the main step, dealing with the planning of the major goals and the company objectives. It is divided into four plans, which are finance, marketing, engineering, and production. From the strategic business plan process, the production plan can be made. The production plan is concerned with how many products should be produced and stored based on demand and desired inventory level, regarding the availability of resources such as raw material. Both the strategic business plan and production plan process are not the most detailed ones since both deals with general and basic issues in production planning.

The next thing is the Master Production Schedule (MPS) which is the production plan for the individual end items. MPS is more specific since it deals with the number of goods being produced in a certain time, with inputs such as demand forecasting, inventory capacity, and sales orders. In the manufacturing process, we need materials, and that is when the Material Requirements Plan (MRP) comes into play. MRP deals with the demand and supply of resources, including raw materials in the manufacturing process. Using MRP can prevent excess materials in the inventory or

material shortage, which is not a good thing in the manufacturing process. Every step above from strategic business planning to MRP needs to be taken in the production planning, since whether it is general or specific things, all matters.

2.2 Production Plan and Forecasting

For this paper, we focused on the production plan, one of the most general aspects in production planning. Production plan focuses on the quantities of each product group that must be produced in each period, the desired inventory levels, the resources of equipment, labor, and material needed in each period, and the availability of the resources needed. This step is not the most detailed one since it only focuses on the product, and Production planners must devise a plan to satisfy market demand within the resources available to the company. This will involve determining the resources needed to meet market demand, comparing the results to the resources available, and devising a plan to balance requirements and availability. This process of determining the resources required for production and comparing them to the available resources from the company takes place at each of the planning levels and is the problem of capacity management. For effective planning, there must be a balance between priority and capacity. Along with the market and financial plans, the production plan is concerned with implementing the strategic business plan. The planning horizon is usually 6 to 18 months (about 1 and a half years) and is reviewed each month or quarter. (Chapman et al., 2017).

Forecasting is the act of "predicting" and it applies to many aspects in life, such as weather, customer demand, and much more. It is an important problem that spans many fields including business and industry, government, economics, environmental sciences, medicine, social science, politics, and finance. Forecasting problems are often classified as short-term, medium-term, and long-term. Short-term forecasting problems involve predicting events only a few time periods (days, weeks, months) into the future. Medium-term forecasts extend from one to two years into the future, and long-term forecasting problems can extend beyond that by many years. Short- and medium-term forecasts are required for activities that range from operations management to budgeting and selecting new research and development projects. Long-term forecasts impact issues such as strategic planning. (Montgomery, 2008, p. 1)
As we all know, forecasting is an important matter in business and industry, and that includes the manufacturing sector. That is why a forecasting process should be applied before manufacturing. A process is a series of connected activities that transform one or more inputs into one or more outputs. All work activities are performed in processes, and forecasting is no exception. The activities in the forecasting process are problem definition, data collection, data analysis, model selection and fitting, model validation, forecasting model deployment, and finally, monitoring forecasting model performance. (Montgomery, 2008, p. 12)

One of the methods for forecasting is linear forecasting. Known as FORECAST.LINEAR, this formula is one of the functions of Microsoft Excel. Based on the official description from Microsoft, it is a method for to predict future sales, inventory requirements, or consumer trends. The syntax is as below:

FORECAST.LINEAR(x, known_y's, known_x's)
- or -
FORECAST (x, known_y's, known_x's)

The FORECAST/FORECAST.LINEAR function syntax has the following arguments:

Argument	Required	Refers to
x	yes	The data point for which you want to predict a value.
known_y's	yes	The dependent array or range of data.
known_x's	yes	The independent array or range of data.

Remarks:

- If **x** is nonnumeric, FORECAST and FORECAST.LINEAR return the #VALUE! error value.
- If **known_y's** or **known_x's** is empty or one has more data points than the other, FORECAST and FORECAST.LINEAR return the #N/A error value.

- If the variance of **known_x's** equals zero, then FORECAST and FORECAST.LINEAR return the #DIV/0! error value.
- The equation for FORECAST and FORECAST.LINEAR is a+bx, where:

$$a = \bar{y} - b\bar{x}$$

and:

$$b = \frac{\sum (x - \bar{x})(y - \bar{y})}{\sum (x - \bar{x})^2}$$

and where x and y are the sample means AVERAGE(known_x's) and AVERAGE (known y's).

2.3 Impact of COVID-19 on Automotive Industry

Based on the report by Boston Consulting Group in 2020, the automotive industry has shown tremendous resilience, even in the pandemic era. From the economic downturn experienced in spring 2020 when the pandemic began to spread, it has rebounded and results in an increase in new-vehicle sales over the last few months across China, Europe, and the United States. However, despite encouraging reports on progress toward a vaccine, numerous risks remain, and the forecast shows that sales in Europe and the United States will not rebound to pre-COVID levels until the expected earliest rebound in 2023. Meanwhile, the rebounding of China's economy continues to accelerate, with the potential to approach 30 million new vehicles sold by 2025. In other countries, the growth of the automotive industry differs.

In addition, it is also seen that in the pandemic, cars are considered as the safest mode of transport (especially since social distancing is easier in a car compared to public transportation, and it is also possible to prevent the spread of the virus by traveling alone with a car). A report from Boston Consulting Group also shows that the increase in demand for cars happened in China, while Europe and the United States have a mixed likelihood of buying cars or not.

3. Methodology

Our methodology is derived from the company data, and we make future predictions from time series data from public domain (Media, Organization, etc.). Then, we used linear forecasting (FORECAST.LINEAR command) in Microsoft Excel to predict the trend of production plan during the pandemic so in the end, an accurate forecast for the next three months after June 2021 can be made.

4. Data Collection

4.1 Production Plan 2021

Below is table 1 which shows the actual production plan of the company for January until June 2021.

Table 1: Production Plan of 2021

				QTY					
No.	Part No.	Part Name	PRICE	Jan-21	Feb-21	Mar-21	Apr-21	May-21	Jun-21
1	24610-KWW -7400	SPINDLE COMP GEAR SHIFT	Rp 13,629	10,655	9,055	12,800	12,350	5,400	8,250
2	24630-KWW -6400	ARM COMP, GEAR SHIFT	Rp 11,971	10,655	9,055	12,800	12,350	5,400	8,250
3	24610-KPH -9000	SPUNDLE COMP,GEAR SHIFT	Rp 21,415	7,701	8,101	10,200	8,000	4,050	9,100
4	24630-K41-N000	ARM COMP, GEAR SHIFT	Rp 11,170	7,701	8,101	10,200	8,000	4,050	9,100
5	2461A-K45-N000-IN	SPINDLE ASSY, GEAR SHIFT	Rp 22,662	28,723	24,072	28,850	28,800	15,840	30,240
6	22131-KVB -9000	PLATE,RAMP	Rp 8,654	12,011	11,411	13,200	6,600	6,000	9,000
7	22131-KWN -9000	PLATE,RAMP	Rp 10,393	40,379	36,375	35,220	43,395	36,597	23,216
8	50B50-K50-T000	LINK ASSY,ENG HANGER	Rp 60,799	-	-	-	-	-	-
9	50B50-K59-A106	LINK ASSY, ENG HANGER	Rp 62,962	48,301	43,101	43,060	49,220	25,781	40,826
10	50B50-K81-A106	LINK ASSY, ENG HANGER	Rp 66,132	12,015	11,415	13,200	6,600	6,000	9,000
11	50B50-KQJA-N000	LINK ASSY, ENG HANGER	Rp 76,500	32,900	33,346	48,205	41,250	21,615	41,265
12	22131-KQJA -9000	PLATE,RAMP	Rp 9,040	73,289	72,051	106,010	90,240	41,250	78,750
				284,330	266,123	333,745	306,805	171,983	266,997

4.2 COVID-19 Response Time by Country

Below is table 2 which shows the response time from COVID-19 to the actual lockdown/curfew for the first 3 month of 2020 from several countries around the world:

Table 2: Countries response time (in days) from COVID-19 to implement lockdown/curfew for the first 3 month of 2020

Country	first cas	first restriction	response time
Gambia	17-Mar	1-Jul	106
Canada	25-Jan	17-Apr	82
Jordan	27-Jan	18-Apr	81
Cambodia	27-Jan	15-Apr	78
Kuwait	24-Feb	10-May	75
Singapore	23-Jan	7-Apr	74
Chille	4-Mar	14-May	71
Finland	29-Jan	8-Apr	69
Bahama	15-Mar	21-May	67
Nepal	24-Jan	24-Mar	59
USA	21-Jan	19-Mar	57
Russia	31-Jan	28-Mar	56
Germany	27-Jan	22-Mar	54
India	30-Jan	25-Mar	54
Malaysia	24-Jan	16-Mar	51
UK	31-Jan	23-Mar	51
France	24-Jan	12-Mar	47
Australia	25-Jan	13-Mar	47
Argentia	4-Mar	19-Apr	46
Oman	24-Feb	10-Apr	45
Ukraine	3-Mar	17-Apr	45
Philipines	30-Jan	15-Mar	44
Turkey	11-Mar	23-Apr	43
Belgium	4-Feb	18-Mar	42
Maldives	7-Mar	17-Apr	41
Italy	31-Jan	9-Mar	37
UAE	29-Jan	6-Mar	36
Austria	25-Feb	1-Apr	35
North Korea	22-Jan	24-Feb	33
Georgia	26-Feb	31-Mar	33
Azerbaijan	28-Feb	31-Mar	31
Bahrain	24-Feb	26-Mar	30
Nigeria	27-Feb	29-Mar	30
Mexico	28-Feb	30-Mar	30
Afganistan	24-Feb	25-Mar	29
Indonesia	2-Mar	30-Mar	28
Cuba	24-Feb	23-Mar	27
Algeria	25-Feb	23-Mar	26
North Macedonia	26-Feb	24-Mar	26
Pakistan	26-Feb	24-Mar	26
Iceland	28-Feb	26-Mar	26
Romania	26-Feb	23-Mar	25
Angola	21-Mar	15-Apr	25
Greece	26-Feb	22-Mar	24
New Zealand	28-Feb	24-Mar	24
Egypt	14-Feb	9-Mar	23
Armenia	1-Mar	24-Mar	23
Lebanon	21-Feb	15-Mar	22
Croatia	25-Feb	18-Mar	21
Vietnam	24-Jan	13-Feb	20
Tunisia	2-Mar	22-Mar	20
Israel	21-Feb	12-Mar	19
Brazil	26-Feb	17-Mar	19
Colombia	6-Mar	25-Mar	19
Monaco	28-Feb	17-Mar	17
Morocco	2-Mar	19-Mar	17
Costa Rica	6-Mar	23-Mar	17
Netherland	27-Feb	15-Mar	16
Lithuania	28-Feb	16-Mar	16
Jordan	2-Mar	18-Mar	16
Poland	4-Mar	20-Mar	16
San marino	27-Feb	14-Mar	15
Equador	1-Mar	16-Mar	15
Luxemberg	1-Mar	16-Mar	15
Cyprus	9-Mar	24-Mar	15
Norway	26-Feb	12-Mar	14
Haiti	5-Mar	19-Mar	14
Macau	22-Jan	4-Feb	13
Denmark	27-Feb	12-Mar	13
Senegal	2-Mar	15-Mar	13
Paraguay	7-Mar	20-Mar	13
Estonia	27-Feb	11-Mar	12
Eritrea	21-Mar	2-Apr	12
Ireland	1-Mar	12-Mar	11
Andorra	2-Mar	13-Mar	11
Qatar	1-Mar	11-Mar	10
Portugal	2-Mar	12-Mar	10
Zimbabwe	20-Mar	30-Mar	10
Cezch Republic	1-Mar	10-Mar	9
Usbekistan	15-Mar	24-Mar	9
Uganda	21-Mar	30-Mar	9
Spain	1-Mar	9-Mar	9
Saudi Arabia	2-Mar	9-Mar	7
China	18-Jan	24-Jan	6
Iran	19-Feb	23-Feb	4
Venezuela	13-Mar	17-Mar	4
Kazakhstan	15-Mar	19-Mar	4
Iraq	24-Feb	27-Feb	3
Switzerland	25-Feb	28-Feb	3
Taiwan	21-Jan		0
Belarus	28-Feb	none	0
Guatemala	13-Mar	13-Mar	0
Somalia	16-Mar		0
South Africa	27-Mar	27-Mar	0
Hongkong	21-Jan	18-Jan	-3
Montenegro	17-Mar	10-Mar	-7
Syria	22-Mar	14-Mar	-8

5. Results

5.1 Time Interval from First Confirmed Case to Lockdown/Curfew in 2020

According to our data, these are interval times of responses to the COVID-19 pandemic from countries around the world. We used public data to see how countries respond to COVID-19 pandemic and all data available in the source section below in the Figure 2.

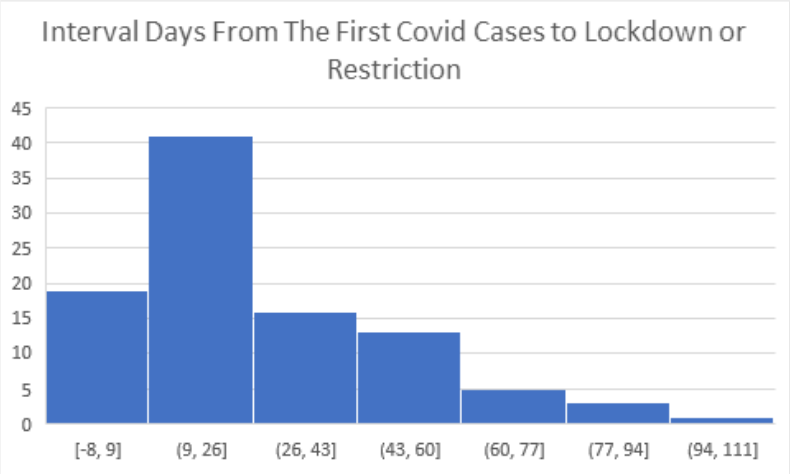

Figure 2: Interval Days from the First COVID-19 Cases to Lockdown/Restriction

Here is the distribution of days from many countries' responses around the world, some countries responded even before the first case was reported, and a few of them are not even using lockdown as a precaution to COVID-19, and some we found no historical data for curfew nor lockdown. From this data, we found out that the average number of days countries respond to COVID-19 is around 27 days (about 4 weeks). And can be concluded that companies on average have 27 days (about 4 weeks) to respond to a lockdown based on official data. Just like now, if the rate of COVID-19 infection goes up, companies including manufacturing companies can predict when lockdowns or social restrictions could happen. The data suggested that the company has an extremely limited time to shift their production plan, based on the data we suggested for future epidemic/pandemic manufacturing company prioritized product with a lower number of production and move the product with many productions later to spread it evenly.

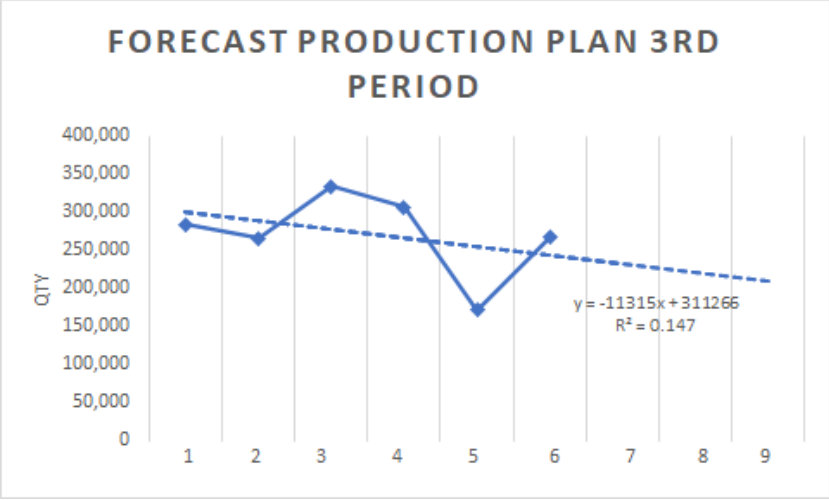

Figure 3: Forecast of the Production Plan for 3rd Period

5.2 The Effect to Production Plan One Year Later

According to our data until mid 2021, we linear forecasted the production plan as the graph shown in Figure 3. The graph illustrated that the production of the company will be decreasing with no indication of growth. This indicated that pandemic decreasing the demand for vehicle spare-part thus decreasing the volume of production plan and forecasted January through September.

6. Conclusion

From this paper, we concluded that there was a limited time span of countries reacting to a global pandemic. Most are in the range of 9 to 26 days (about 3 and a half weeks) from the first case to lockdown or curfew, with an average time are 27 days (about 4 weeks). The Effect of the pandemic can be seen with linear forecasting. Even though the pandemic has been a year, the effect to the automotive manufacturing sector still can be seen, affecting the demand of spare part which lower the volume need of the production.

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