

**“ANALYSIS AND IMPACT ON TOTAL PRODUCTIVE MAINTENANCE A PRIME  
MOVER TO REGAIN VERTICAL GROWTH DURING POST COVID- 19”**

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**ABSTRACT**

**Purpose:** Covid has given a shock and opportunity to sit back and retrospect. To recover losses and bring profitability, convention methods will not suffice. We need extraordinary qualities. We cannot develop now; we should already have within us or sharpen the same. The growth trajectory we need is like a hockey stick.

**Theoretical framework:** Learning from Japan, this nation comes back to growth after every calamity. This nation has two fundamental qualities 1. Culture of Excellence ie. Upkeep of resources to use to an optimal level and 2. Culture of Resilience behavior.

**Design/methodology/approach:** TPM (Total Productive Maintenance) gives the culture of Excellence and Resilience, these two qualities when exploited we can have “V” growth. The questionnaire was developed after checking the reliability the same was administrated with 100 TPM experts from different companies in India and Sri Lanka who shared their views.

**Findings:** - There is a clear correlation between Vertical growth to companies practicing TPM and having Resilience behaviour as their strength is established

**Research, Practical & Social implications:** - *This research study shows the importance of resilience in the business, there are uncertainty and risk, and few companies bounce back due to the ability they possess by practicing excellence tools and building a work culture. TPM (Total Productive Maintenance) is one of the tools. The outcome is self-satisfaction and motivates the workforce to face uncertainties and problems.*

**Originality / Value:** - The contents are original and due citation is given for the comments taken for the Literature reviews.

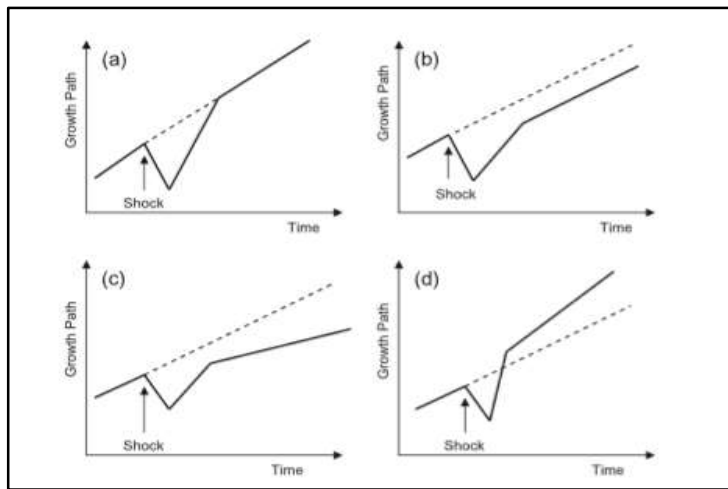
**Keywords:** - Resilience, TPM (Total Productive Maintenance) & CoVID-19

**INTRODUCTION**

The world came to full halt in 2020, the attack of CoVID-19 Virus has pull-down shutters on all sectors and business came to standstill. This is unprecedented and the recovery of the loss of business will take each country by 5-20 Years, once the lockdown is released, will it be a smooth start, it may not as the disturbance in the ecosystem is too high. Resilience and Motivated team (TPM) are required to bounce back.

There are established companies with reputed brands and infrastructure, for them too it will take many months to come back to the efficiency or to the potential which they left mid-March 2020. Then comes the question how many companies will follow the (a) or (d) curve, if they do, they stay ahead of competitors and quickly regain the cash flow. Many of them companies who fall in (b) and (c) will take many more months to come back.

**Table 1**



Source: James and Ron, “the economic resilience of regions: towards an evolutionary approach, pp 29

TPM has the adaptive cycle model, which can take care of the economic resilience. The reason why TPM can do better are (1) TPM focus on the common Goal (2) it breaks department barriers and hence problems are addressed faster (3) It believes on structured approach and focuses more on preventive approach than reactive approach with a good problem-solving skills. (4) The Key Management Indices (KMI) Key Performance Indices (KPIs) both short terms can be reset its tide over any crisis. The will of people working need to be high with pride, passion and persevere abilities, all this helps in building resilience.

Companies (As of July 2020) do not have confidence that the Covid will melt away and the business will come back to normal. Companies are worried to face Covid and build strategies around that. The sentiment for quicker normally needs confidence and resilience, In the list of 500 best companies only 14.3% are confident to bounce back in next six to eight months. In one more study Asia Supply chain specific

39% of the companies will recover in 2-3 Months, about 54% in 6-12months and 7% will have long lasting effects. Didier, Matteo and Sahil (2020)

Study is required on the qualities which will separate from quick business achievers (hockey stick or V growth) to slow growth recoveries. What are the qualities required to embrace and excel this change? Can it happen overnight - No? Only companies who have practiced excellence or countries having the right cultures can make a quick turnaround.

V economy is a quick recovery after a deep crisis. Japan has seen many natural disasters and every time came out stronger and better. These qualities need to be understood and if available the same will help to come out of the Covid business lockdown. Learning lessons for the past when businesses were deeply hit by pandemic and seismic culture shifts, it's important to recognize that many of the Japanese companies in the Tohoku region continue to show resilience, despite facing serious financial setbacks from the disaster. We need to learn how these businesses manage not only to be able to survive, but thrive?

Harvard Business School professor Hirotaka Takeuchi, “Japanese dedication to responding to the needs of employees and the community first, is serving good a moral learning”. Less important is the pursuing layoffs and other cost-cutting measures in the face of a crippled economy. These Japanese companies are consistent in creating lasting changes in society.”

Japanese story of successes is because of Resilience and establish Indian Auto sector successes is because of TPM. Author is trying to whether this attitude can sail us through Covid period and bounce back like a Hockey stick growth.

## LITERATURE REVIEW

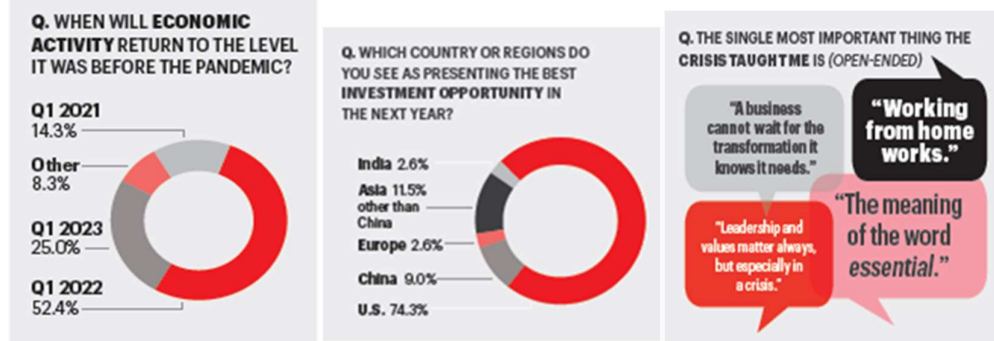


Fig 1-3 Fortune Survey with CEO of Fortune 500 companies

Covid has ruined the economy sitting and crying will not help, as an individual, as a company as a nation we need to come back quickly to terms. We need to “Rethink ways of working – 1. Speed up and delegate decision making 2. Step up execution excellence. The front-line persons should be able to take extra responsibility and lesser micromanagement by superiors. 3. Cultivate extraordinary collaboration and partnerships 4. Build and keep an agile team, by TPM processes, and establishing the right culture 5. Unleash nimble, empowered teams and individual potential 6. Make hybrid work, 7. Field tomorrow’s leaders today 8. Learn how to learn 9. Rethink the role of CEOs and leaders now is the time, the Coronavirus pandemic is the challenge of our times. The time for organizations to build for speed is now. This will be a long process and must leap into the arena and recognize that many of their familiar organization constructs will need to be reimaged”. Aaron, Daniel, Charlotte, and Bob (2020).

“Organizational excellence can be described as the ongoing efforts to develop an internal structure of procedures and guidelines that are intended to motivate and inspire employees to

deliver services and products that meet the requirements of customers while remaining within the expectations of the business.” (Daharat, A. N. M., Ismail, A. F. M. F., Sued, M. K. 2022) “This is needed because we think that the firms, organisations and institutions that comprise regional economies are continually changing and adapting to their economic environments. These changes are increasingly driven by the creation, acquisition and commercial exploitation of new knowledge. These processes are never in equilibrium. We reject equilibrium versions of resilience and argue instead that we should seek an understanding of the concept from an evolutionary perspective”. James and Ron. (2010), this is the reason we work on continuous improvement and excellence can never stop.

When the whole world is in crisis, where can we find answer? Its Japan were they meet crisis every decade and has resilience to bounce back and create a V economy. “Many Japanese companies are not that popular with Wall Street types because they are not as focused on gaining superior profitability and maximizing shareholder value,” he says. “They talk consistently instead about creating lasting changes in society.” “Wise leaders bring different people together and spur them to action.” (Interviews from Professor Hirotaka Takeuchi, Harvard Business School). Culture and giving back to the society build huge resilience. TPM helps the same.

Studies and research have been done on the impact of TPM towards business performance. ‘All three companies implemented and benefited TPM because they were exhibiting considerable business difficulties (e.g. reduction of business in traditional markets and facing plant closure)’. (F. Ireland and Dale 2001).

TPM helps business Performance studies also show that business performance between TPM and non-TPM firms. The preceding tests show significant positive correlations between TPM and business performance. Therefore, we expect TPM firms to fare better, in terms of business performance, than non-TPM firms. The p-values for all performance indicators are all below the 0.01 significance level. Thus, significant differences in the business performance measures indicate a significant positive impact of TPM.

**Table 2**

Performance of TPM and non-TPM Firms.					
Mean	S.D	Mean	S.D	p-Value	
Financial	2.2090	0.4600	2.5267	0.5722	0.000
Managerial	2.1020	0.4409	2.6831	0.7640	0.000
Operational	2.2049	0.4939	2.5738	0.4058	0.000
Overall	2.1053	0.4079	2.5969	0.5151	0.000
Business					

Source: Shaukat Ali Brah (2004). Relationship between total productive maintenance and performance. International Journal of Production Research

The above studies show significance of TPM in financial, managerial competency, operational efficiencies and overall business.

From Japanese successes we understand the importance of TPM as a process and Resilience as a behavioural trait which will help during and after every crisis. Cultivation of Resilience and to ensure it sustain Hardiness is required, a study on US Air force pilots suggests “When it comes to hardiness, our findings suggest a more multifaceted concept than resilience. The

resulting factor structure of hardiness from this study (engagement, self-determination, flexibility, and meaning) is supported in the literature. Within the military population, active engagement and pursuit of goals or objectives are important characteristics of service members” (Duckworth et al., 2007), which relate to both resilience and hardiness.

“Further support in the military literature as a critical construct, but constructs such as optimism, proactive personalities, and self-efficacy have previously been identified as essential contributors to psychological hardiness to military personnel” (Sinclair, Waitsman, Oliver, & Deese, 2013). “Flexibility and internal locus of control share similarities with the original hardiness theory and serve as potential protective factors for PTSD” (Mark & Cristina, 2018) “This re-entry and recovery phase of the pandemic crisis provides leaders with a compelling reason to engage and strengthen overall connections with employees. Recognizing and addressing the core human emotions of grief, loss, and anxiety in the workplace is a chance to rebuild organizational health, productivity, and talent retention. All the practical steps we recommend above stem from the need for clear, empathetic communication that keeps people optimistic and hopeful, but also resilient and prepared for further disruption. This stage of recovery will challenge organizations’ communications functions to become even more agile, as they shift between crisis response mode and normal, more future-oriented strategies” *David, Ana, and Joe (2020)*. TPM helps to create empathy, belongings and ownership in shop floor, this has been studied and concluded.

“We found that Digital innovation and business transformation with emotional resilience are positively linked with organizational growth.” (Marirajan Murugan, & Natarajan, P. M., 2022) This journal tries to study that TPM and resilience are the foundation for vertical growth post Covid and neither of them can be done overnight, the companies who possess these qualities have higher chance to succeed.

## MATERIAL AND METHODOLOGY

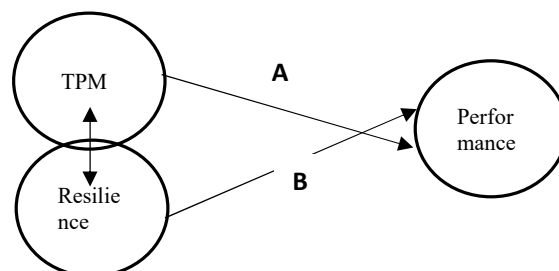
Objectives were set, and based on objectives hypothesis was generated. Construct was identified for Resilience and TPM, The same was put to the questionnaire with reliability >0.7, these results were put into eigenvalue and prioritized. These values were then subject to SEM before Conclusion was derived.

### Objectives: -

1. “V” economy model to regain lost ground – relation of TPM and Resilience towards business recovery.
2. Does companies with inbuilt resilience have a better chance to overcome the lost business and have trajectory growth?
3. Capture all learnings for future use.

### Study Model

A tentative study model was researched.



Endogenous Variable: Business Performance

Exogenous Variable: TPM & Resilience

Parent Journal:

A – 1. Kathleen, Roger & Kristy (1999). “The impact of total productive maintenance practices on manufacturing” performance. *Journal of operations Management*, 39-58

2. Shaukat Ali Brah (2004). “Relationship between total productive maintenance and performance”. *International Journal of Production Research*.

B - 1. James & Ron. (2009). the economic resilience of regions: towards an evolutionary approach. *Cambridge Journal of Regions, Economy and Society*, 3, 27–43

2. Olutayo, Oluseyi, and Tolulope (2016) The 10-Item Connor–Davidson Resilience Scale: Factorial Structure, Reliability, Validity, and Correlates Among Student Nurses in South-western Nigeria. *Journal of the American Psychiatric Nurses Association* 2016, Vol. 22(1) 43–51

**A: TPM** the above journals have established the significance that, with TPM we can achieve business performance when the plant / company is in financially bad shape. This extraordinary situation with Covid has dried up company reserves, and company needs a system which can take care of culture and adaptive environment – TPM can give the same.

17 Constructs were taken from the parent Journal for designing the questionnaire

**B: Resilience** James and Ron have studied 45 years of economy with many recessions, the speedy recovery will happen with adaptive resilience.

13 Constructs were taken from the parent Journal for designing the questionnaire

H<sub>0</sub>: TPM and resilience don't have a significant impact on organization regain through V economy.

H<sub>1</sub>: TPM and resilience have a significant impact on organization regain through V economy.

The Model, questionnaire and further analysis is studied to verify the laid hypothe

**Analysis & Findings**

A questionnaire was made with inputs on TPM linking with performance and 17 Construct were identified (Kathleen, Roger & Kristy 2001) and need of Resilience to comeback after a deep crisis, 13 Construct were identified based on CD scale (Olutayo , Oluseyi and Tolulope .2016).These questionnaires were sent to TPM Experts, TPM practitioners and Managers from reputed organisations both India and abroad.100 respondents had responded.

**TPM** 17 Construct were tested and following are the findings and interpretations

**Table 3**

**KMO and Bartlett's Test**

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.	.857
Bartlett's Test of Sphericity	Approx. Chi-Square
	669.506
	df
	136
	Sig.
	.000

Source: from internal statistical calculations

KMO value is between 0.80 -0.89 and considered as “meritorious”. KMO> 0.60 is eligible for factor analysis. In the case of the Bartelrts data, the test statistic is very high (669.506), and accordingly the null hypothesis is rejected (Sig. = .000).

**Table 4**

Dimension reduction technique was used to reduce the constructs. (From 17 to 5)

	Construct	Initial Eigen value		M	SD	Z- Skewness	Z- Kurtosis
		Total	%				
1	Daily Maint. By Prod Optr.	6.32	37.2	4.28	0.821	-3.86	0.43
2	Success from past 3years of problem solving	1.52	9.0	4.41	0.59	3.21	2.75
3	Good Maint. Strategy	1.22	7.2	4.57	0.558	3.42	-0.75
4	Covid Discipline	1.10	6.5	4.57	0.808	10.27	15.22
5	Pride in Clean plant	0.87	5.7	4.80	0.452	11.58	17.72
Total %		<b>65.6</b>					

Source: from internal statistical calculations

### Resilience

13 Construct were tested and following are the findings and interpretations

**Table 5**

#### KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.933
Bartlett's Test of Sphericity	Approx. Chi-Square	863.702
	df	78
	Sig.	.000

Source: from internal statistical calculations

KMO value is between 0.90 to 1.00 and considered as “marvellous”. KMO> 0.60 is eligible for factor analysis. In the case of the Bartelrts data, the test statistic is very high (863.702), and accordingly the null hypothesis is rejected (Sig. = .000).

**Table 6**

Dimension reduction technique was used to reduce the Construct's.

	Construct	Initial Eigen value		M	SD	Z- Skewness	Z- Kurtosis
		Total	%				
1	TPM helps in adapt change	7.70	59.5	4.42	0.684	-4.780	3.58
2	Think of Self strong person	0.88	7.0	4.46	0.642	-4.211	2.19
3	Build confidence towards goal	0.72	5.5	4.56	0.592	-4.083	0
Total %		<b>72</b>					

Source: from internal statistical calculations

### SEM -R analysis

Lavaan 0.6-6 ended normally after 80 iterations

Estimator	ML
Optimization method	NLMINB
Number of free parameters	12
Number of observations	100

Model Test User Model:

Test statistic	4.601
Degrees of freedom	3
P-value (Chi-square)	0.203

Model Test Baseline Model:

Test statistic	144.633
Degrees of freedom	10
P-value	0.000

User Model versus Baseline Model:

Comparative Fit Index (CFI)	0.988
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*A CFI value of .95 or higher is presently accepted as an indicator of good fit (Hu & Bentler, 1999).*

Tucker-Lewis Index (TLI)	0.960
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*Values for both the NFI and NNFI should range between 0 and 1, with a cut-off of .95 or greater indicating a good model fit*

Log likelihood and Information Criteria:

Log likelihood user model (H0)	-417.021
Log likelihood unrestricted model (H1)	-414.720

*Log Likelihood value is a measure of goodness of fit for any model. Higher the value, better is the model*

Akaike (AIC)	858.042
Bayesian (BIC)	889.304
Sample-size adjusted Bayesian (BIC)	851.405

*AIC and BIC score are high that means the number of terms used is very high, to improve*



*the model and to tend towards parsimonious model we need to reduce the number of terms AIC score of 5 is considered good for that two terms must be reduced.*

Root Mean Square Error of Approximation:

RMSEA	0.073
90 Percent confidence interval - lower	0.000
90 Percent confidence interval - upper	0.197
P-value RMSEA <= 0.05	0.300

**RMSEA** of between 0.08 to 0.10 provides a mediocre fit and below 0.08 shows a **good fit** (MacCallum et al, 1996, therefore the RMSEA Score can be considered as good fit.

Standardized Root Mean Square Residual:

SRMR	0.033
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*The **SRMR** is an absolute measure of fit and is defined as the standardized difference between the observed correlation and the predicted correlation. It is a positively biased measure and that bias is greater for small N and for low do studies. Because the SRMR is an absolute measure of fit, a value of zero indicates perfect fit. The SRMR has no penalty for model complexity. A value less than .08 is generally considered a good fit (Hu & Bentler, 1999, The SRMR is considered as a good fit.*

Parameter Estimates:

Standard errors	Standard
Information	Expected
Information saturated (h1) model	Structured

Latent Variables:

	Estimate	Std.Err	z-value	P (> z )
Resl =~				
Retpmchange	1.000			
Restrong	1.249	0.178	7.007	0.000
Tpm =~				
TPMPride	1.000			
TCLTIAM	6.211	5.964	1.041	0.298

*TPM helps change and builds individual strong has significance with resilience and TPM Pride ad CLTI is not*

Regressions:

	Estimate	Std.Err	z-value	P (> z )
Pastperf ~				
Resl	0.484	3.049	0.159	0.874

Tpm            3.526   23.879   0.148   0.883

Covariances:

	Estimate	Std.Err	z-value	P(> z )
Resl ~				
Tpm	0.028	0.027	1.048	0.295

Variances:

	Estimate	Std.Err	z-value	P(> z )
.Retpmchange	0.242	0.041	5.968	0.000
.Restrong	0.063	0.035	1.791	0.073
.TPMPride	0.274	0.039	6.985	0.000
.TCLTIAM	0.542	0.248	2.183	0.029
.Pastperf	0.163	0.087	1.877	0.060
Resl	0.222	0.060	3.694	0.000
Tpm	0.003	0.008	0.328	0.743

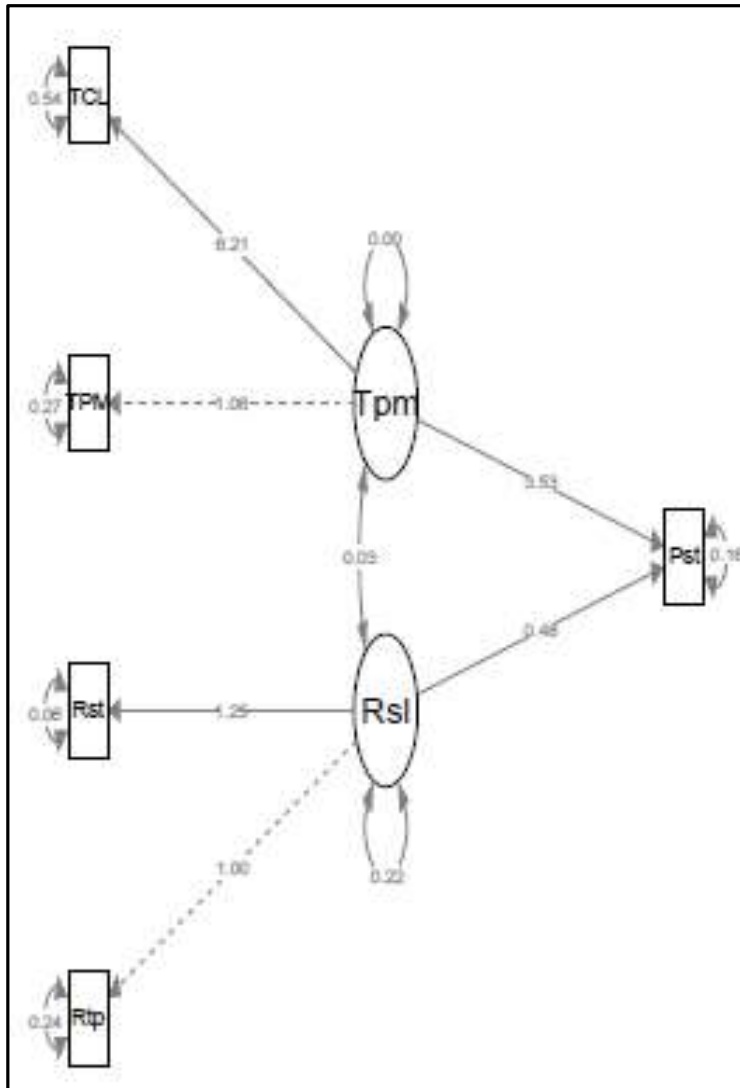


Fig 5

*TPM as a variable has very variance (3.53) towards Past performance and Resilience (0.48) too has linkage towards performance.*

*Impact of CLTI and Abnormality in keeping the equipment's in basic condition (fundamental goal of TPM ) has very high Variance (6.21)*

*TPM pride (1.08) also has covariance towards the variable TPM.*

*Resilience and TPM has exogenous relationship of 0.03 though the value is less their existing relationship and each other compliments in bringing the performance.*

*TPM helps building the individuals to be strong which is a important variance (1.25)*

*TPM is all about change for better and resilience helps in that (1.00).*

*TPM and Resilience compliments each other in building the change*

**Hypothesis:-**

H<sub>0</sub>: TPM and resilience don't have a significant impact on organization regain through V economy.

H<sub>a</sub>: TPM and resilience have a significant impact on organization regain through V economy.

**Interpretation of results:**

The Regression analysis and the SEM path diagram shows that there is regression and the constructs consisting of CLTI, Pride from TPM and making individual strong and help adapt change are from resilience. The values are significant and has direct correlation towards the past performance and hence it can be concluded that TPM and resilience if exists now can bring vertical growth post Covid.

**CONCLUSION**

Based on the data, this paper has identified the effect of TPM and resilience to achieve performance post Covid crisis i.e. V economy. The study proves that, it is easier to avert most crisis with the help of TPM and resilience. Hence it is highly important to embed these features in the organizational culture.

Covid will go abruptly the way it has come without notice. Business is important for companies and individuals to survive, after the (-) Growth there should be a (+) growth will be incremental or vertical. The study shows that companies practising TPM and having Resilience in their DNA, can expect to have double digit (V) growth in the short period. As we speak companies having TPM base has put the covid norms fast and effective compared to Non TPM practising companies, and resilience cannot be built overnight these qualities should be part of excellence and should have witnessed many crisis in the past.

### RESEARCH GAP

This phenomenon of Covid is only few months old, many researchers are yet to conclude. We also need to study the impact of TPM, and resilience may be after one year to validate the study done in this journal. This journal gives an opportunity to improvise the results and revalidate the model after one or two years. New normal and the behaviour patterns may change which will create new sets of problems and opportunities for further research.

### Abbreviations

TPM: Total Productive Maintenance

### SEM Abbreviations:

Resl: Resilience

Retpmchange: Resilience, TPM helps adapt change

Restrong: Resilience Think of self as strong person

TPMPride: TPM -Pride at Shop floor for cleanliness

TPMCLTIAM: TPM CLTI &Abnormality mitigation

Pastperf: past Performance in 3 years show continuous improvement in parameters

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