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Total Interpretive Structural Modeling to Identify Enablers for Successful Implementation of Total Productive Management

Muhammad Zeeshan Javaid
Faculty of Management Studies, University of Central Punjab, Lahore
Email: zshnjavaid@gmail.com

Muhammad Zeeshan Shoukat
Institute of Business and Management, UET Lahore

Abdul Aziz Khan Niazi
Institute of Business and Management, UET Lahore

Abstract

Total productive management is a comprehensive program to improve machine availability focusing on human capability to get things done in most appropriate way, focusing on CLIT, OPL's, Kaizen, removal of HTA & SOC. Identified factors in this research will provide the road map for Pakistani industries to gain maximum from TPM. Unfortunately, in Pakistan due to the unavailability of enough understanding while implementing this powerful tool most of the organizations are not getting the desired outcome. Especially due to a lack of understanding about enablers while executing the TPM journey. The papers aim to identify the key enablers, rank them & identify relationships between them that strongly influence the TPM success journey in Pakistan. For this study based on literature review, 17 factors have been identified such as financial resources, leadership commitment, company's vision, training & development, team commitment, rewards & recognition & team meetings, etc. Population samples are subject matter experts in a well-known organization that holds strong TPM implementation knowledge & culture. Total interpretive self-structure molding (TISM) has been applied to impose a hierarchy on the finalized elements. A questionnaire-based Total interpretive self-structure molding (TISM) will be used to evaluate the results, in the end, MICMAC analyses have been carried out to segregate independent elements, dependent elements, linkage elements & autonomous elements. A structural relationship model will be developed at the end of this research. This study will be useful for managers & top management in the smooth transition of TPM culture over the organization to become lean.

Keywords: TPM (total productive management), MTBF (mean time between failure), MTTR (mean time to repair), SHE (safety health & environment)

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Introduction

Total Productivity Management (henceforth, TPM) is modernized management techniques to increase machine availability, maintenance reliability (MTTR, MTBF), product quality, performance & productivity (Spark and Han, 2001). According to the Pakistan Bureau of Statistics report (2016) Pakistan's industrial production index number in 2016 was 1 which is very low vs other countries like the USA having an industrial growth number is 3.4. There is an opportunity area for about 2.4 which can support Pakistani industries to overcome their industrialization sickness. As per Gupta et al., (2015) while implementing TPM journey in the organization only 18% of the industries are getting desired results on the below mention heads and rest of 82% of industries are not achieving desired results from the TPM technique (36% of industries only achieve 0 defects and few industries achieve 0 breakdowns which emphasize that this is the most important and difficult objective to achieve (Mugwindri Mbohwa, 2013)

The idea of TPM was given by Seiichi Nakajima who was very rich in hands-on experience related to maintenance activities. His approach was that a leadership mindset can engage frontline employees' teams to increase capabilities of their own to support machinability/productivity. This concept leads the base of TPM which was initially implemented in a company named Nippondenso which was the vendor of TOYOTA at that time. TPM culture in large works as a catalyst in organizations profitability.it supports maintenance reliability, quality, productivity & operators' capability (Ghirubaagiri, 2018). The TPM program is designed for the whole organization containing eight pillars (Prabowo et al., 2018). It is also seeking the enablers and factors that can play like a catalyst while implementing the TPM organizational-wide, and helpful to eliminating the barriers that restrict the organization to operate on its optimum potential (Ahuja and Khamba, 2008).

We have utilized Total Interpretive Structural Modelling (TISM) which is an innovative version of interpretive Structural Modeling (ISM). This novel extension has been introduced by Sushil (2012) to answer 'Why' in addition. This approach check the accuracy of TISM? A fully transitive reachability matrix is the backbone for both ISM and TISM. The transitive reachability matrix can be obtained by performing the paired comparison of the elements under consideration and subsequently checking transitivity. It becomes complex as the number of elements rises beyond 10 (Sushil, 2017).

These mentioned elements have been identified from literature review. Once the list of elements has been agreed by the panel, their opinion was sought to establish relationship between these elements. Experts were requested

to give their opinion through a questionnaire on whether a relationship exists between a pair of elements or not. The relationship amongst the elements has been inquired as direct or indirect (transitive). They were also required to explain the relationship where it existent. Their place in hierarchy has been decided using Total Interpretive Structural Modelling (TISM). MICMAC, another technique has been applied to classify the elements as Dependent elements, Independent elements, Autonomous elements & Linkage elements. This classification has been worked out by calculating their driving power & dependence power as extracted from the panel of experts. Key elements have been identified based on their driving power as well as place in total interpretive structural modeling. There are elements that can make the implementation of TPM more productive in terms of its outcome (Fakhraddin Maroofi, 2013). Furthermore, Identification of training elements required to be explored from the literature. Due attention has not been given to the relationship amongst elements and their impact on the outcome of training. This research aims to fill the gap in this area to enhance the outcomes of TPM implementation. There are only 10 enablers that researchers have studied throughout, but other factors that have not been studied have potential to influence the TPM culture while implementation. 24% of total GDP of Pakistan is contributed by the industrial sector

Our research problem is to identify the enablers, list them in sequence, and find the most important ones who could impact the TPM implementation in Pakistan. Behind this, our main agenda is to set the pattern for industries, so they can adopt this new methodology effectively, it will help industries to become lean, reduce their wastages and get maximum profit with minimum inputs. The objective of this study is ranked below:

RO1 To identify elements of enablers of TPM while implementation from literature review
RO2 Finalize the list of enablers through subject matter expert opinion
RO3 The relationship among them in a most appropriate way
RO4 Present & impose a hierarchy on them
RO5 Classify elements into autonomous elements, linkage elements, dependent elements & independent element clusters
RO6 To determine the key elements using TISM and MICMAC results
RO7 To discuss how the TISM model and classification diagram is helpful for researchers and practitioners

Literature Review

This contains an exploration of existing literature on TPM & enablers of TPM while implementation in organizations, the significance of enablers of TPM & their contribution by researchers. The available literature on enablers of TPM

has been discussed at the start. The significance of training is discussed in the 2nd part. Afterward, a literature review has been summarized and finally, the initial list of elements has been presented. The literature reviewed in detail related to enablers of TPM and found that research has already done some of the work based on enablers, but this work is not in the detail that cannot be effectively utilized in the Pakistan environment. It is observed that there is a gap between available research in the market & required data which can be very handy for TPM implementation in local organizations of Pakistan. So, they can reduce their per-unit costs to compete in the marketplace, or even they can compete globally Some of the enablers are essential before the launch of this journey. As we have already stated that "TPM IS A PARADIGM SHIFT" so is always a time tacking process to get things in the right way. Literature has been explored from renowned research publications to acquire the enablers of TPM while implementation in organizations. Numerous contributions are made by researchers in the field of TPM implementation. Scholars have been using several elements according to the nature of studies and contributed to the various elements from different industries. Following are the elements. The main factor of TPM implementation is to track benefits from TPM implementation. Sometimes companies didn't track the benefits from TPM. Benefits tracking is essential in terms of realizing the top management and consultants that we are heading in the right direction in the journey of TPM.

Based upon the extensive literature review, the initial list has been developed and placed hereunder. This list has been further discussed with a panel of experts for their opinion and to decide for the final elements to be studied for this research.

Table 1
Supporting Studies

Enablers/variables	Supporting Studies
Top management commitment	Hansson et al., (2003)
Company's vision towards lean	Hansson et al., (2003)
Training & development	Maroofi (2013)
5S culture	Sharadha et al., (2015)
Kaizen culture	Gupta et al., (2015)
Integration of TPM goal & objectives into business plans	Maroofi (2013)
Adaptability to change	Ghanem, 2021
Consultancy	Maroofi (2013)
Execution method	Hanson et al., (2003)
Cross functional circle teams	F Maroofi (2013)
Cross functional audits	Maroofi (2013
Before & After improvement	Maroofi (2013
Team meetings	Maroofi (2013)
Conflict management	Medina (2016)
Team autonomy	Liselott (2003)
CLIT program	Liselott (2013)

Reward & recognition	Brah et al., (2014)
Financial resources	Gupta et al., (2015)
Financial resources	Chan et al., (2005)
Cost to benefit ratio	Chan et al., (2005)

Figure 1. Initial literature-based Enablers for TPM while execution

Note: Doted lines present that based on subject matters experts' enablers can be added or removed from initial literature-based data.

Research Methodology

Research Design

This study focused on extensive literature review for probing elements of TPM implementation. Causal relationship studied through expert opinion via data collection (survey) and interview. Finally, the mixed method applied for data analyses via TISM and MICAMC to draw the conclusion.

Research Philosophy

The current study aimed to explore the inter relationships between the TPM elements with an in-depth investigation approach which has rarely been studied before, hence followed the 'Interpretivism' as research philosophy. Inductive approach has been opted by researchers for present study to develop theory based upon observations, measuring, and interpreting the responses. A research strategy explains the major components of a research project i.e. the research topic area and focus, perspective of research, research design and the research methods. Qualitative interviews have been elucidated as strategy for current study, as researchers have primarily conducted interviews from experts and then interpreted relationships amongst training elements. It states how to answer the research question and implementation of the methodology. The four main types of research strategies are case study, qualitative interviews, quantitative survey, and action-oriented research (Saunders, Lewis & Thornhill, 2016).

Generally, in case study research, information is pursued from several sources such as interviews, surveys, analysis of documents and observations. Data can be qualitative, quantitative or a mix of both. Qualitative interviews are of different types i.e. structured, semi-structured, unstructured, and most widely used method for collection of data. Rich information can be accessed through Interviews, but this requires extensive planning concerning the development of the structure. Structures are mainly deciding about who to interview and how, whether to conduct individual or group interviews, and how to record and then analyze them. Quantitative survey is a widely used method in business research. This allows access to significantly high numbers of participants. The availability of online sites enables the wide and cheap distribution of surveys and the organization of the responses. Although the development of questions may appear easy, to develop a meaningful questionnaire that allows the answering of research questions is difficult. Questionnaires need to appeal to respondents cannot be too long, too intrusive, or too difficult to understand. They also need to accurately measure the issue under investigation. For these reasons it is also advisable.

Time Horizon

Cross sectional is reported as suitable when a problem at time is to be dealt with for answering a research question. Cross sectional is generally helpful for surveys; case study or grounded theory is used. Cross-sectional time horizon has been finalized to collect data for present study to manage data collection at single stage.

The population for current study is senior management who have extensive experience of TPM implementation in different organizations of Pakistan including some of the multinationals in Pakistan. Certain criterion is opted by the researcher to determine the sample which is the subgroup or subset of the total population. Sample selection has been executed by considering the people as respondents who fulfilled criteria for being an expert as proclaimed by various researchers from the targeted population.

Criteria for Expert

After a minimum 10 years of experience in training a person is to be considered an expert (Silva, 2017). When due to complexity of an issue about a situation the set of solutions seems obscure, experts will be able to provide alternative solutions because of the experience they have. Experts are good at recognizing the problems about a specific domain (Kloker et al., 2018). The individuals for this study are considered as experts having more than 15 years of experience in the industrial sector of Pakistan related to TPM implementation. Starting from Production manager, performance & productivity manager, process & packaging specialists & also including the department heads who have in-depth knowledge of process & their related matters.

Sampling Techniques

Purposive sampling technique has been finalized as respondents (experts) are finalized through certain criteria to understand the problem and respond accordingly. Sample Size: 5 to 10 experts are required (Kloker et al., 2018). However, in different studies, investigating the size of panels of experts, no consistent relationship was found between size of panel and effective criteria. For precise opinions, in this study a panel of corporate practitioners was selected from telecom companies of Pakistan who are experts in the field of training and development. The selected sample for this study is a heterogeneous group of 9 experts. The sample comprises 9 experts from the corporate sector having experience of TPM executions in well-known multinationals.

Instrument for Data Collection

For data collection in this study, a knowledge-based questionnaire has been adapted. Which is the advanced form of n x n matrix type questionnaire listing all the elements. Every pair defining the relationship was mentioned to acquire the response as a close ended question. Pair comparison which interpretive structural modeling (ISM) methodology describe as i influence j and j influence i was mentioned as F1 influence F2 and F2 influence F1 for 1st and 2nd elements. All the relevant pairs were mentioned in the questionnaire to find the response against each pair of elements. Experts were briefed and asked to respond as 'Yes' if the relation exists and 'No' incase where the relationship is absent. In case the response is yes, experts were requested to explain the reason. The reason would be helpful in better interpretation of the relationships. Knowledge based questionnaire sample form has been attached in Annexure C. Initially, sample questionnaires were shared with few experts to validate the understanding about the questions. Pilot testing results were quite satisfactory, so according to expert advice, data collection was initiated for the decided panel of experts.

Techniques of Data Analyses

To find the transitive relationships identification is the key difference between TISM and modified TISM, as it is helpful in reducing the expert intervention with prompt response for a large number of factors (Sushil, 2017; Singh et al., 2019). Fuzzy MICMAC analysis is the advanced form of MICMAC analysis technique to find in depth strength of the element's relationships (Attri, Grover & Kumar, 2013). Micmac analysis helps in Yes or No based logics.

Total Interpretive Structural Modeling (TISM)

Interpretive Structural Modeling (ISM) has been proposed by (Warfield, 1974) to deal with complex issues that help to answer 'What' and 'How' research questions to develop structural models. This technique has been proposed to deal with complex issues through a combination of modeling language of words, digraphs, and discrete mathematics. In this technique the variables are structured. Interpretive structural modeling comprises many interrelated links and nodes (Warfield, 1973). When it comes to explaining the links by answering the question of "How", ISM remains quiet (Alawamleh & Popplewell, 2011).

ISM methodology consists of the following steps

1. Identification of Elements/Factors/Challenges
2. Establishing the Contextual Relationship
3. Construction of structural Self Interaction Matrix through pairwise comparison

4. Initial Reachability matrix development
5. Final Reachability matrix development through Testing Transitivity
6. Level Partitioning from Reachability matrix (Final Matrix)
7. Digraph construction without transitivity
8. Interpretive Model Development

Total Interpretive Structural modeling (TISM)

Total Interpretive Structural modeling is an innovative version of interpretive Structural Modeling (ISM). This novel extension has been introduced by (Sushil, 2012) to answer 'Why' in addition. This approach checks the accuracy of TISM as provided. Fully transitive reachability matrix is the backbone for both ISM and TISM. The transitive reachability matrix can be obtained by performing the pair comparison of the elements under consideration and subsequently checking transitivity. It becomes complex as the number of elements rises beyond 10 (Sushil, 2017).

1. Identification of Elements/Factors/Challenges
2. Establishing the Contextual Relationship
3. Interpretation of Relationship
4. Initial Reachability matrix development – Logic (Knowledge based)
5. Final Reachability matrix development through Testing Transitivity
6. Level Partitioning from Reachability matrix (Final Matrix)
7. Digraph construction without transitivity
8. Interactive & Interpretive Matrix for final digraph
9. Total Interpretive Model Development

MICMAC Analysis

MICMAC is known as Matrice d'Impact croises-multiplication applique' and classmen (cross- impact matrix multiplication applied to classification). This analysis technique is helpful for the calculation of driving power and the dependence power of the elements (Trigunarsyah & Parami Dewi 2015).

Here is the summary of the methodology used in this study.

Item	Description
Philosophy	Interpretivism
Approach	Inductive
Paradigm	Qualitative
Time Frame	Cross-Sectional
Unit of Analysis	Individuals
Sample	Heterogeneous panel of experts
Sample Size	9 Experts (Kloker et al., 2018)
Sampling Technique	Purposive
Expert (Respondents)	15 years & above experience
Data Collection	Questionnaire & Interview
Analysis Technique(s)-TISM	To Impose Hierarchy
Analysis Technique(s)-Micmac	For Direction (classification)

Analysis and Results

The current study attempted for identification of enablers of TPM while implementation in the Pakistani industrial sector in perspective of their contextual relationship with each other and its impact on TPM implementation. Below are the activities that have been performed step by step to achieve the objective of current study. According to total interpretive structural modeling (TISM), the first step is to identify the elements from available literature online, for this reason research work has been done after careful review of previous work done in this area. These identified elements have been presented to subject matter experts for further validation because there is possibility of adding and subtracting elements which we have identified through literature review. After discussion, the final list has been prepared. Once finalized, the next step is to check their relationships and develop a reachability matrix (Aspinwall & Elgharib, 2013). The finalized enablers and their definition whose relationship is supposed to be studied have been identified from literature. Literature can be helpful for selection of elements and definition. The Idea generation established theories or understanding in the field found beneficial for this purpose. To collect the previous research work for review, a rigorous search has been conducted by the help of renowned research publications i.e. Elsevier, Emerald, Taylor & Francis. Elements related to TPM while implementation which have been identified through rigorous literature review, While the identification of enablers of TPM, the literature which was explored based on most recent years. Various enablers have been found in the field of research contributed by the scholars.

Table 2
Initial literature-based list of enablers for TPM while implementation

Sr #	Elements	Code
1	Top management commitment	F1
2	Company's vision towards lean	F2
3	Training & development	F3
4	5S culture	F4
5	Kaizen culture	F5
6	Integration of TPM goal & objectives into business plans	F6
7	Adaptability to change	F7
8	Consultancy	F8
9	Execution method	F9
10	Cross functional circle teams	F10
11	Cross functional audits	F11
12	Before & After improvement	F12
13	Team meetings	F13
14	Financial resources	F14
15	Conflict management	F15
16	Team autonomy	F16
17	CLIT program	F17
18	Reward & recognition	F18
19	Technical capabilities	F19
20	Cost to benefits ratio	F20

Finalization of Elements

Once identified from the literature, all the enablers of TPM have been discussed with subject matter experts. Role of the experts is crucial to decide about the phenomenon in theory development. Panel has been formulated as a combination of practitioners as well as research professionals. Through rich experience and practical knowledge of the subject, experts have been helpful to finalize the most appropriate elements for this study. Experts have been elucidated having 10 years and above experience in the field of TPM implementation, having training from JIPM institution from successful implementation of TPM. All are working as middle or higher managers in their respective areas. (Chidambaranathan, Muralitharan & Deshmukh, 2009).

Table 3
Experts Profiles

Sr #	Designation	Organization	Experience	Qualification
1	Process manager	Unilever Pakistan	15 Years	Masters
2	Logistics specialist	Nestle Pakistan	15 Years	Masters
3	Performance & Prod lead	Toyota motors	15 Years	M. Phil
4	Packaging Manager	PepsiCo international	18 Years	Masters
5	Reliability manager	Descon Pvt ltd	10 Years	Masters
6	Process Specialist	PepsiCo international	15 Years	Masters
7	Senior Manager	PepsiCo international	26 Years	Masters
8	Packaging Specialist	PepsiCo international	20years	Masters
9	Site expert & trainer	PepsiCo international	10 Years	Masters

The above provided list of experts has enriched knowledge & experience of TPM execution throughout their professional career. All in the provided list are the corporate professionals from the industrial sector of Pakistan having experience of TPM execution in all big multinationals in Pakistan. Initial list explored from literature having 20 enablers has been shared with the panel of experts for their recommendation. After in-depth argument and reasoning, sixteen elements have been finalized for this study through approval voting (agreed by majority of experts), a detailed table has been appended in Annexure A. Once finalized the list of elements is again shared with a panel of experts to develop consensus amongst the experts before the data collection stage. This consensus helped in minimizing the conflicts during the analysis stage and augmented the accuracy of results. The panel of experts played a vital role in the finalization of elements. The finalized list after the approval has been provided below along with the element codes. After assessment by experts we have finalized the elements for further study. Finalized items list is mentioned below. 16 out of 20 elements have been finalized by an expert panel for the rest of study. Element codes assigned against each element will be used for this study and analysis purpose from here onward.

Relationship amongst Elements

Total interpretive structural modeling (TISM) provides an edge over traditional Interpretive Structural Modeling(ISM) in this step (Sushil, 2017). In ISM, the nature of the relationship is provided whether the relationship exists or not but TISM explains the cause of the relationship particularly. The contextual relationship has been studied between the elements of interest. One to one interview was scheduled with every expert to inquire about the relationship among the elements. Here interpretation of every response recorded through an "Interpretive Logic-Knowledge Base".

This logic has been prepared for comparison of selected elements pairwise. 'Yes' has been marked as (1) and (0) has been marked for 'No' in case of each pair comparison. In the case of 'Yes' answered by the respondent, an explanation has been asked to understand the reason for that relationship. Reason helps to understand the cause or impact of relationships amongst the training elements. Then the reachability matrix is prepared by placing 1 in that cell where response has been given as 'Yes' and 0 for response 'No'. Transitivity check, i.e. if X=Y & Y=Z, then X=Z, on reachability matrix has been performed through expert opinion. Once we found a transitive relationship, then 'YES' has been replaced with 'NO'.

Knowledge base and "transitive" has been replaced in the interpretation column. Any relationship identified as an indirect relationship by the experts has been marked as a transitive relationship as well. To differentiate the transitive relationship from the direct relationship, 1* has been marked in the analysis table. For every transitive relationship, explanations requested from experts to be specified in the results.

Table 4
Finalized elements list

Sr #	Elements	Code
1	Top management commitment	F1
2	Company's vision towards lean	F2
3	Training & development	F3
4	5S culture	F4
5	Kaizen culture	F5
6	Adaptability to change	F6
7	Consultancy	F7
8	Execution method	F8
9	Cross functional circle teams	F9
10	Cross functional audits	F10
11	Before & After improvement	F11
12	Team meetings	F12
13	Conflict management	F13
14	Team autonomy	F14
15	CLIT program	F15
16	Reward & recognition	F16

Experts from elucidated panel having the research background helped a lot in this phase to address the challenges of logic interpretations. The final interpretation prepared for each pair in this study after the relevant working has been established in model development.

Level Partitioning

Partitioning of levels has been done the same as in interpretive structural modeling (ISM) methodology. That element has been considered at the top level where intersection of the reachability set and the antecedent set is the same as the reachability set (Sushil, 2018). Once the top element(s) is identified, they are removed from the table. Then the next intersection values have been matched with antecedent value and having the same values are identified as 2nd level. Once their place was decided as 2nd, they were removed from the table as well. This process continues until the levels of remaining elements have been determined.

Table 5
Initial reachability matrix

	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12	F13	F14	F15	F16
F1	1	1	0	1	1	1	0	0	0	0	0	0	1	0	1	1
F2	0	1	1	1	1	1	0	0	0	0	0	0	1	0	0	1
F3	0	0	1	1	1	1	0	1	0	0	1	1	0	0	1	0
F4	0	1	0	1	1	1	0	0	0	0	1	0	0	0	1	0
F5	1	0	0	1	1	0	0	0	0	0	1	0	0	0	1	0
F6	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
F7	0	1	1	0	0	1	1	1	1	1	0	1	0	1	1	0
F8	0	0	0	0	0	0	0	1	1	0	0	0	0	1	0	0
F9	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0
F10	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0
F11	0	0	0	1	1	0	0	0	0	0	1	0	0	0	0	0
F12	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1
F13	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
F14	0	0	0	0	0	0	0	1	0	0	0	0	0	1	1	0
F15	0	0	0	1	1	0	0	0	0	0	0	1	0	0	1	0
F16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1

Table 6
Reachability matrix

	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12	F13	F14	F15	F16
F1	1	1	1*	1	1	1	0	0	0	0	1*	1*	1	0	1	1
F2	1*	1	1	1	1	1	0	1*	0	0	1*	1*	1	0	1*	1
F3	1*	1*	1	1	1	1	0	1	1*	0	1	1	1*	1*	1	1*
F4	1*	1	1*	1	1	1	0	0	0	0	1	0	1*	0	1	1*
F5	1	1*	0	1	1	1*	0	0	0	0	1	1*	1*	0	1	1*
F6	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
F7	0	1	1	1*	1*	1	1	1	1	1	1*	1	1*	1	1	1*
F8	0	0	0	0	0	0	0	1	1	0	0	0	0	1	1*	0
F9	0	0	0	0	0	0	0	1	1	0	0	0	0	1*	0	0
F10	0	0	0	1*	1*	0	0	0	0	1	0	1*	0	0	1	0
F11	1*	1*	0	1	1	1*	0	0	0	0	1	0	0	0	1*	0
F12	0	0	0	1*	1*	0	0	1*	0	0	0	1	1	1	1	1
F13	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
F14	0	0	0	1*	1*	0	0	1	1*	0	0	1*	0	1	1	0
F15	1*	1*	0	1	1	1*	0	0	0	0	1*	1	1*	1*	1	1*
F16	0	0	0	1*	1*	0	0	0	0	0	0	1*	0	0	1	1

1* transitive relationship

In this study, Adaptability to change (F6) & Reward & recognition (F16) has been found on 1st level hence placed on top position at the TISM hierarchy and hereafter eliminated from the iteration table to proceed further for the level partitioning of the remaining elements.

Table 7
Iteration Level 1

	Reachability sets	Antecedent set	Intersection	Level
F1	1,2,3,4,5,6,11,12,13,15,16	1,2,3,4,5,11,15	1,2,3,4,5,15	
F2	1,2,3,4,5,6,8,11,12,13,15,16	1,2,3,4,5,7,11,15	1,2,3,4,5,11,15	
F3	1,2,3,4,5,6,8,9,11,12,13,14,15,16	1,2,3,4,7,	1,2,3,4	
F4	1,2,3,4,5,6,11,13,15,16	1,2,3,4,5,7,10,11,12,14,15,16	1,2,3,4,5,11,15,16	
F5	1,2,4,5,6,11,12,13,15,16	1,2,3,4,5,7,10,11,12,14,15,16	1,2,4,5,11,12,15,16	
F6	6	1,2,3,4,5,6,7,11,15	6	1
F7	2,3,4,5,6,7,8,9,10,11,12,13,14,15,16	7	7	
F8	8,9,14,15	2,3,7,8,9,12,14	8,9,14	
F9	8,9,14	3,7,8,9,14	8,9,14	
F10	4,5,10,12,15	7,10	10	
F11	1,2,4,5,6,11,15	1,2,3,4,5,7,11,15	1,2,4,5,11,15	
F12	4,5,8,12,13,14,15,16	1,2,3,5,7,10,12,14,15,16	5,12,14,15,16	
F13	13	1,2,3,4,5,7,12,13,15	13	
F14	4,5,9,12,14,15	3,7,8,9,12,14,15	9,12,14,15	
F15	1,2,4,5,6,11,12,13,14,15,16	1,2,3,4,5,7,8,10,11,12,14,15,16	1,2,4,5,11,12,14,15,16	
F16	4,5,12,15,16	1,2,3,4,5,7,12,15,16	4,5,12,15,16	1

Table 8
Iteration Level 2

	Reachability sets	Antecedent set	Intersection	Level
F1	1,2,3,4,5,11,12,13,15	1,2,3,4,5,11,15	1,2,3,4,5,11,15	
F2	1,2,3,4,5,8,11,12,13,15	1,2,3,4,5,7,11,15	1,2,3,4,5,11,15	
F3	1,2,3,4,5,8,9,11,12,13,14,15	1,2,3,4,7	1,2,3,4	
F4	1,2,3,4,5,11,13,15	1,2,3,4,5,7,10,11,12,14,15	1,2,3,4,5,11,15	
F5	1,2,4,5,11,12,13,15	1,2,3,4,5,7,10,11,12,14,15	1,2,4,5,11,12,15	
F7	2,3,4,5,7,8,9,10,11,12,13,14,15	7	7	
F8	8,9,14,15	2,3,7,8,9,12,14	8,9,14	
F9	8,9,14	3,10,11,12,14	14	
F10	4,5,10,12,14	3,7,8,9,14	14	
F11	1,2,4,5,11,15	1,2,3,4,5,7,11,15	1,2,4,5,11,15	2
F12	4,5,8,12,13,14,15	1,2,3,5,7,10,14,15	5,14,15	
F13	13	1,2,3,4,5,7,12,13,15	13	2
F14	4,5,8,9,12,14,15	3,7,8,9,12,14,15	8,9,12,14,15	
F15	1,2,4,5,11,12,13,14,15	1,2,3,4,5,7,8,10,11,12,14,15	1,2,4,5,11,12,14,15	

Conflict management (F11) & Before & after improvement (F12) have been marked at 2nd level and removed from the iteration table after recognition of their position in TISM

Table 9
Iteration Level 3

	Reachability sets	Antecedent set	Intersection	Level
F1	1,2,3,4,5,12,15	1,2,3,4,5,15	1,2,3,4,5,15	
F2	1,2,3,4,5,8,12,15	1,2,3,4,5,7,15	1,2,3,4,5,15	
F3	1,2,3,4,5,8,9,12,14,15	1,2,3,4,7	1,2,3,4	
F4	1,2,3,4,5,15	1,2,3,4,5,7,10,12,14,15	1,2,3,4,5,15	3
F5	1,2,4,5,12,15	1,2,3,4,5,7,10,12,14,15	1,2,4,5,12,15	3
F7	2,3,4,5,7,8,9,10,12,14,15	7	7	
F8	8,9,14,15	2,3,7,8,9,12,14	8,9,14	
F9	8,9,14	3,7,8,9,14	8,9,14	3
F10	4,5,10,12,15	7,10	10	
F12	4,5,8,12,14,15	1,2,3,5,7,10,12,14,15	5,12,14,15	
F14	4,5,8,9,12,14,15	3,7,8,9,12,14,15	8,9,12,14,15	
F15	1,2,4,5,12,14,15	1,2,3,4,5,7,8,10,12,14,15	1,2,4,5,12,14,15	3

5S culture (F4), Kaizen culture (F5), CLIT program (F15) & cross functional circle teams (F9) are recognized on third place of the Total interpretive structural model (TISM).

Table 10
Iteration Level 4

	Reachability sets	Antecedent set	Intersection	level
F1	1,2,3,12	1,2,3	1,2,3	
F2	1,2,3,8,12	1,2,3,7	1,2,3	
F3	1,2,3,8,12,14	1,2,3,7	1,2,3	
F7	2,3,7,8,10,12,14	7	7	
F8	8,14	2,3,7,8,12,14	8,14	4
F10	10,12	7,10	10	
F12	8,12,14	1,2,3,7,10,12,14	12,14	
F14	8,12,14	3,7,8,12,14	8,12,14	4

Team autonomy (F14), Execution method (F8) have been placed at fourth level of TISM

Table 11
Iteration Level 5

	Reachability sets	Antecedent set	Intersection	Level
F1	1,2,3,12	1,2,3	1,2,3	
F2	1,2,3,12	1,2,3,7	1,2,3	
F3	1,2,3,12	1,2,3,7	1,2,3	
F7	2,3,7,10,12	7	7	
F10	10,12	7,10	10	
F12	12	1,2,3,7,10,12	12	level 5

Team meetings (F12) are placed on fifth level of TISM.

Table 12
Iteration Level 6

	Reachability sets	Antecedent set	Intersection	level
F1	1,2,3	1,2,3	1,2,3	6
F2	1,2,3	1,2,3,7	1,2,3	6
F3	1,2,3	1,2,3,7	1,2,3	6
F7	2,3,7,10	7	7	
F10	10	7,10	10	6

Top management commitment (F1), company's vision towards lean (F2), Training & development (F3) & cross functional audits (F10) are recognized on sixth place of the Total interpretive structural model (TISM)

Table 13
Iteration Level 7

	Reachability sets	Antecedent set	Intersection	level
F7	7	7	7	7

At the final level, Consultancy (F7) have been identified for bottom position of TISM. These level have been achieved through step by step working for level calculations according to this methodology.

Table 14
Iterations

Factor	Reachability set	Antecedent set	Intersection	Level
F6	6	1,2,3,4,5,6,7,11,15	6	level-1
F16	4,5,12,15,16	1,2,3,4,5,7,12,15,16	4,5,12,15,16	level-1
F11	1,2,4,5,11,15	1,2,3,4,5,7,11,15	1,2,4,5,11,15	level -2
F13	13	1,2,3,4,5,7,12,13,15	13	level -2
F4	1,2,3,4,5,15	1,2,3,4,5,7,10,12,14,15	1,2,3,4,5,15	level -3
F5	1,2,4,5,12,15	1,2,3,4,5,7,10,12,14,15	1,2,4,5,12,15	level -3
F15	1,2,4,5,12,14,15	1,2,3,4,5,7,8,10,12,14,15	1,2,4,5,12,14,15	level -3
F9	8,9,14	3,7,8,9,14	8,9,14	level -3
F14	8,14	2,3,7,8,12,14	8,14	level -4
F8	8,12,14	3,7,8,12,14	8,12,14	level -4
F12	12	1,2,3,7,10,12	12	level -5
F1	1,2,3	1,2,3	1,2,3	level -6
F2	1,2,3	1,2,3,7	1,2,3	level -6
F3	1,2,3	1,2,3,7	1,2,3	level -6
F10	10	7,10	10	level -6
F7	7	7	7	level -7

The digraph (figure-2) is representation of direct as well significant transitive links and further helpful in developing the final model. TISM model has been formed through results of interpretive logic pair-wise comparisons, transitivity of reachability matrix and binary interaction matrix together. The interpretation has been provided for each relationship in TISM. This model has been developed with help of digraph and logic provided by the expert panel against each link have been discussed accordingly, helpful to understand causal relationships.

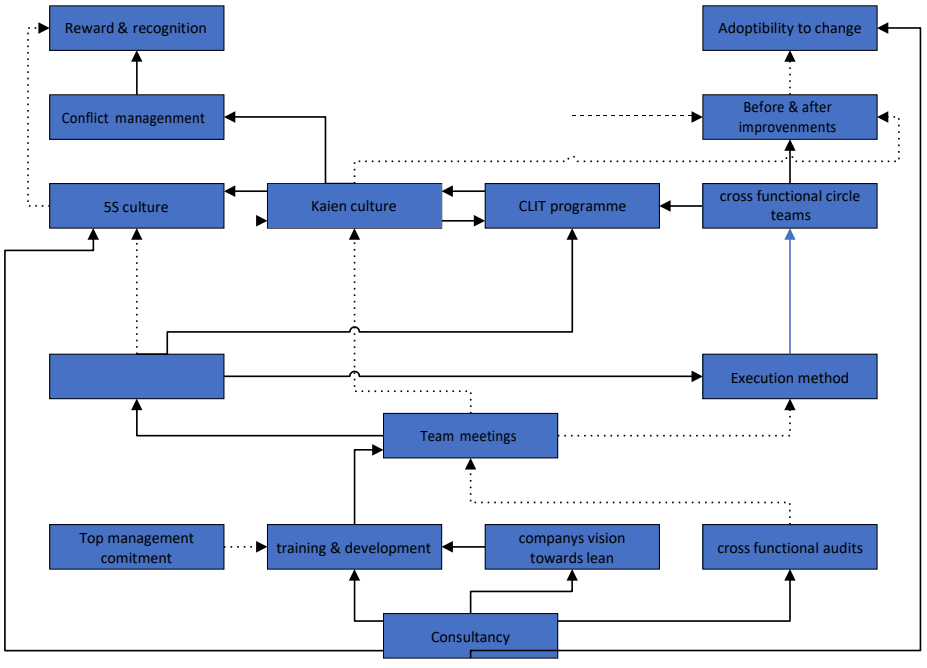

Figure 2.

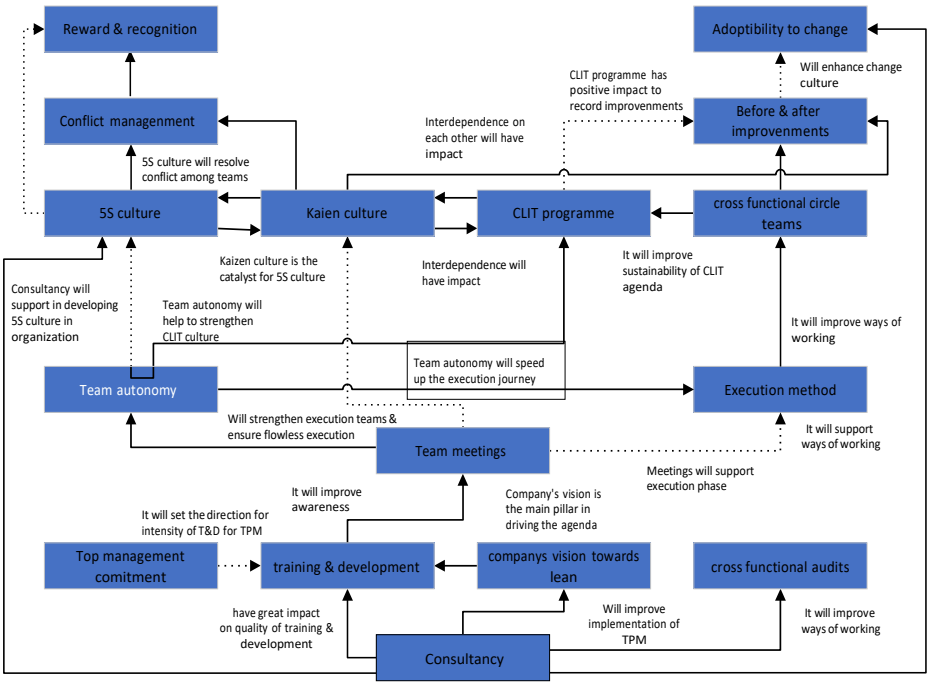

Figure 3

After preparation of final model (figure-3), model has been shared with subject matters experts for validation of relationship among enablers of TPM while implementation. Responses have been recorded on scale of 1 to 5 for model assessment. (Jayalakshmi and Pramod, 2015) proclaimed that model can be validated from experts. Current model has been rated as overall average of 4.15, hence, this model considered as approved (Annexure B).

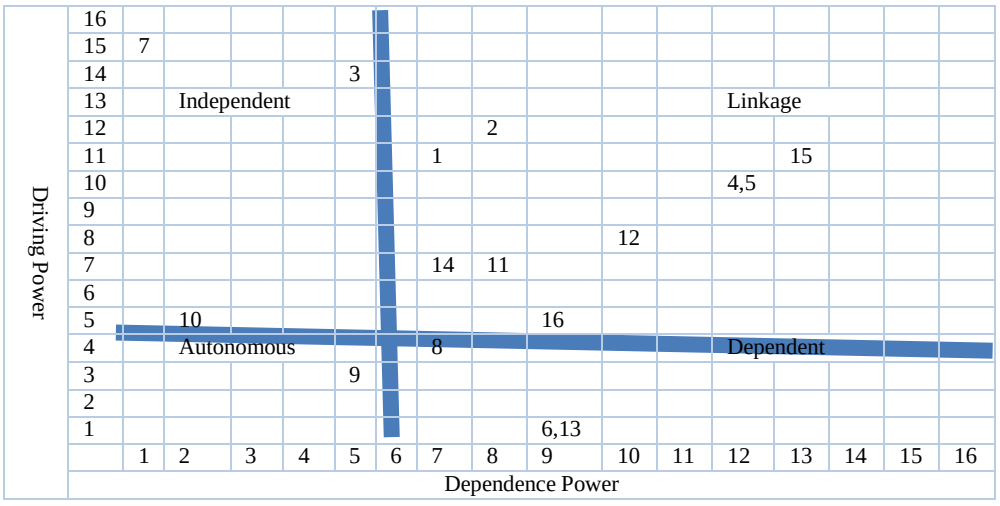

Figure 4 MICMAC Analysis

Data acentric MICMAC mode

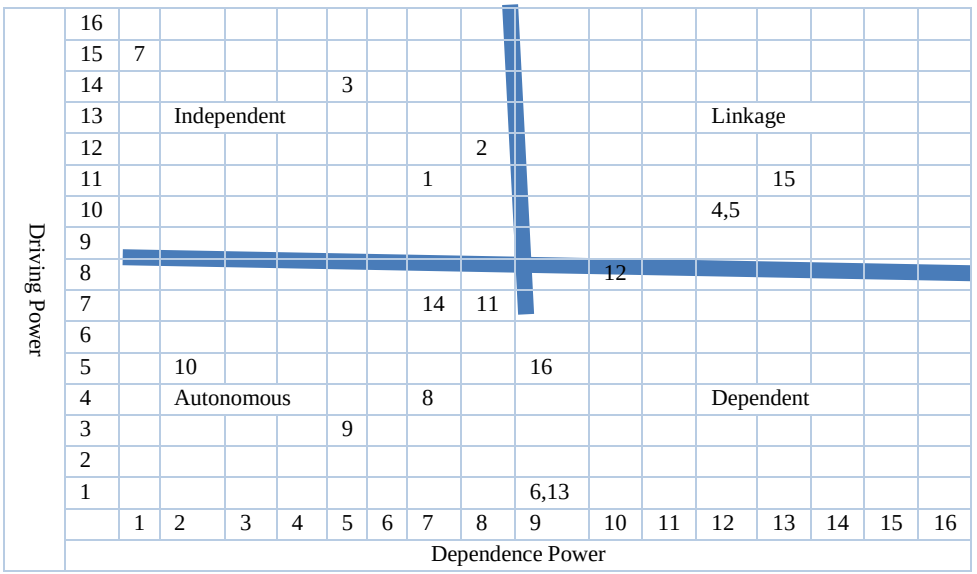

Figure 5. Scale acentric MICMAC model

Autonomous Elements (Quadrant I)

First quadrant of MICMAC has been labeled as autonomous. All those elements having weak driving and weak dependence powers are required to be placed here because they do not have much significance on the relationship of training elements (Malek & Desai, 2019). According to the current analysis of MICMAC (table14) cross functional circle teams (F9), cross functional audits(F10), have been found lying in the autonomous quadrant, total 2 enablers are found in this category. This is the second quadrant showing the elements with high dependence powers and low driving powers in MICMAC analysis (Malek & Desai, 2019). Following are the nine elements found dependent in this study. Adaptability to change (F6), Execution method (F8), conflict management (F13) & reward & recognition (F16) found in this quadrant. Overall, 4 enablers of TPM while execution lie in this area of study. Third quadrant in FMICMAC is known as the linkage quadrant. Elements having high driving and high dependence powers are placed here (Malek & Desai, 2019). According to current study, Top management commitment (F1), Companies vision towards lean(F2),5S culture(F4), Kaizen culture(F5), Before & after improvement (F11),Team meeting (F12),Team autonomy (F14) & CLIT program (F15) are lying in this quadrant. Total eight enablers of TPM while execution has been found in this area of study. Elements with strong driving powers and weak dependence powers are placed in this quadrant (Malek & Desai, 2019).Consultancy (F7) & Training & development (F3) are those elements which have highest driving powers. Total 2 elements lie in this area of study. F7 and F1 are the enablers with strongest driving power and weak dependence power emerging as critical & significant independent elements respectively.

Position & Coordination of Elements

The overall classification of all the elements has been presented in table 15, from highest to lowest order of driving powers. Based on impact level (table 16) which is calculated by driving power minus dependence, the most critical enabler is consultancy which has impact level of 14, other enabler is training & development which has impact level of 9 having significant impact.

Table 15
Based on driving powers

Sr #	Element	Code	Driving power	Dependence power	Cluster
1	Consultancy	F7	15	1	Independent
2	Training & development	F3	14	5	Independent
3	Company's vision towards lean	F2	12	8	Linkage
4	Top management commitment	F1	11	7	Linkage
5	CLIT program	F15	11	13	Linkage
6	5S culture	F4	10	12	Linkage
7	Kaizen culture	F5	10	12	Linkage
8	Team meetings	F12	8	10	Linkage
9	Before & After improvement	F11	7	8	Linkage
10	Team autonomy	F14	7	7	Linkage
11	Cross functional audits	F10	5	2	Autonomous
12	Reward & recognition	F16	5	9	Dependent
13	Execution method	F8	4	7	Dependent
14	Cross functional circle teams	F9	3	5	Autonomous
15	Conflict management	F13	1	9	Dependent
16	Adaptability to change	F6	1	9	Dependent

Results

Consultancy (F7), Training & development (F3) are highly important elements to enhance TPM outcomes while execution in the industrial sector of Pakistan. All these 2 enablers of total productive Management are ranked as driving enablers and placed at bottom (level 7 & level 6) in TISM. They are labeled as the noteworthy independent elements for driving the relationship with other elements and have the Company's vision towards lean (F2) & Top management commitment(F1) having significant impact on TPM execution & driving outcomes from this wonderful initiative which is already adopted worldwide. MICMAC analysis classified F7 & F3 as independent, F6,F8,F13 & F16 as dependent F1,F2,F4,F5,F11,12,F14 & F15 as linkage & F9,F10 as Autonomous.

Table 16
Based on impact level

Sr #	Element	Code	Driving	Dependence	Impact	TISM LEVEL	Cluster
1	Consultancy	F7	15	1	14	7	Independent
2	Training & development	F3	14	5	9	6	Independent
3	Company's vision towards lean	F2	12	8	4	6	Linkage
4	Top management commitment	F1	11	7	4	6	Linkage
5	CLIT program	F15	11	13	-2	3	Linkage
6	5S culture	F4	10	12	-2	3	Linkage
7	Kaizen culture	F5	10	12	-2	3	Linkage
8	Team meetings	F12	8	10	-2	5	Linkage
9	Before & After improvement	F11	7	8	-1	2	Linkage
10	Team autonomy	F14	7	7	0	4	Linkage
11	Cross functional audits	F10	5	2	3	6	Autonomous
12	Reward & recognition	F16	5	9	-4	1	Dependent
13	Execution method	F8	4	7	-3	4	Dependent
14	Cross functional circle teams	F9	3	5	-2	3	Autonomous
15	Conflict management	F13	1	9	-8	2	Dependent
16	Adaptability to change	F6	1	9	-8	1	Dependent

Final Table for TISM results supported by MICMAC

Table 17

Final Table for TISM results supported by MICMAC

Results of Litereture review ratified by experts				Result of MICMAC Anyleses		TISM results	comments
No.	**Enablers**	**Driving power**	**Dependance power**	**Effectivness**	**Cluster**	**Level**	
F1	**Top management commitment**	11	7	4	Linkage	6	Significane
F2	**Company's vision towards lean**	12	8	4	Linkage	6	Significane
F3	**Training & development**	14	5	9	Independent	6	Significane
F4	**5S culture**	10	12	-2	Linkage	3	
F5	**Kaizen culture**	10	12	-2	Linkage	3	
F6	**Adaptability to change**	1	9	-8	Dependant	1	
F7	**Consultancy**	15	1	14	Independent	7	Key factor
F8	**Execution method**	4	7	-3	Dependant	4	
F9	**Cross functional circle teams**	3	5	-2	Autonomus	3	
F10	**Cross functional audits**	5	2	3	Autonomus	6	Significane
F11	**Before & After improvement**	7	8	-1	Linkage	2	
F12	**Team meetings**	8	10	-2	Linkage	5	
F13	**Conflict management**	1	9	-8	Dependant	2	
F14	**Team autonomy**	7	7	0	Linkage	4	
F15	**CLIT program**	11	13	-2	Linkage	3	
F16	**Reward & recognition**	5	9	-4	Dependant	1	

	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12	F13	F14	F15	F16
F1	–	It will set the tone for implementation	–	Will improve KPIs	top management commitment is must in driving any agenda	top management commitment is must in driving any agenda	–	–	–	–	–	–	will reduce conflicts among teams	–	top management commitment is must in driving any agenda	top management commitment is must in driving any agenda
F2	–	–	Company's vision is the main pillar in driving the agenda	Company's vision is the main pillar in driving the agenda	Company's vision is the main pillar in driving the agenda	Company's vision is the main pillar in driving the agenda	–	–	–	–	–	–	Company's vision is the main pillar in driving the agenda	–	–	Company's vision is the main pillar in driving the agenda
F3	–	–	–	Interdependence will have impact	Interdependence will have impact	organize adaptability to change	–	It will improve execution	–	–	It will improve awareness	It will improve awareness	–	–	It will improve awareness	–
F4	–	Will improve KPIs	–	–	It will act as base for Kaizen	Interdependence will have impact	–	–	–	–	Interdependence will have impact	–	–	–	Interdependence will have impact	–
F5	–	–	–	kaizen culture is catalist for 5s culture	–	–	–	–	–	–	Interdependence will have impact	–	–	–	It will improve the culture	–
F6	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
F7	–	Will improve implementation of TPM	have great impact on quality of training & development	–	–	will enhance change culture	–	It will improve ways of working	It will improve ways of working	It will improve ways of working	–	It will improve ways of working	–	It will improve ways of working	It will improve ways of working	–
F8	–	–	–	–	–	–	–	–	It will improve ways of working	–	–	–	–	It will provide liberty of decision to people	–	–
F9	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
F10	–	–	–	–	–	–	–	–	–	–	–	–	–	–	It will improve coordination and speed of work	–
F11	–	–	–	Interdependence will have impact	Interdependence will have impact	–	–	–	–	–	–	–	–	–	–	–
F12	–	–	–	–	–	–	–	–	–	–	–	–	coordination and speed of work	–	It will help strengthen the culture	It will help strengthen the culture
F13	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
F14	–	–	–	–	–	–	–	will speed up the execution journey	–	–	–	–	–	–	It will help strengthen the culture	–
F15	–	–	–	Interdependence will have impact	Interdependence will have impact	–	–	–	–	–	–	–	–	–	–	–
F16	–	–	–	–	–	–	–	–	–	–	–		–	–	is the performance booster for CI culture	–

Figure 6 Interpretive matrix

Conclusion and Recommendations

The panel existed of 9 experts were solicited using the criteria: i) knowledge related to TPM execution ii) must be related to industrial sector of Pakistan iii) must having 10 years or above experience of TPM execution in their respective industries iv)having career experience more than 15 years. Sixteen enablers of Total productive Management have been finalized from the Top management commitment (F1), Company's vision towards lean(F2), Training & development (F3), 5S culture(F4), Kaizen culture (F5) Adaptability to change (F6), Consultancy(F7), Execution method(F8), Cross functional circle teams (F9), Cross functional audits(F10),Before & After improvement (F11), Team meetings (F12),Conflict management(F13), Team autonomy(F14), CLIT program (F15), Reward & recognition(F16) list of sixteen enablers which were finalized by subject matters experts. According to total interpretive structural modeling (TISM) analysis of this study consultancy (F7) have been placed at VII level (i.e. bottom), therefore, are the key elements who play vital roles in The TPM execution. Their effectiveness has been confirmed as leading elements through MICMAC results (Driving power minus dependence power). Top Management commitment (F1), Company's vision towards lean Training (F2), Training & development (F3) & Cross functional audits (F10) are placed on Sixth level indicating their significance is the most significant in the all enablers list. Team meetings (F12) have been placed in fifth level emerging as important enablers for TPM execution. Execution method (F8) & Team autonomy (F14) has been identified in the fourth level of enablers of TPM execution. The 5s culture (F4), Kaizen culture (F5), Cross functional circle teams (F9) & CLIT program has been placed in the third level of this TISM model. Before & after improvement (F11) & conflict Management (F12) Placed in second level in TISM study. Adaptability to change (F6) & Reward & recognition (F16) has been placed in the first level of TISM. According to MICMAC analyzes MICMAC analysis classified, F3 & F7 as independent F6, F8, F13 & F16 as dependent F1, F2F4, F5, F11, F12, F14 & F15 as linkage F9, F10 as Autonomous.

Contribution of the Study

This study has contributed a list of enablers for implementation of Total productive management in the industrial sector of Pakistan for productivity improvement based on subject matter experts review & conclusion. The relationship amongst these enablers coupled with interpretations has been studied. The interpretation helped to develop knowledge-based & practical understanding that how one enabler can influence the other and what is the driving power of individual enablers when they start influencing others. Model

has been developed by imposing hierarchies using total interpretive structural modeling (TISM). MICMAC, another technique has been utilized in this study to finalize driving and dependence diagrams, helpful to strengthen the findings of TISM. Finally based upon the results of both techniques, effectiveness and key elements identification has been decided which is already discussed in detail above.

Implications

This research has strengthened the understanding of causal relationships amongst the enablers of Total productive management in the industrial sector of Pakistan, which will be very helpful for industries to initiate the culture of total productive management in their routine working which ultimately helped them to improve their efficiencies via machine availability. The findings concluded in this study have implications for the industrial sector. Significance of this research implication has been argued as mentioned ahead.

Practical Implications

Total productive management is a powerful technique for organizations to become lean in this way they can stay in the market to compete there competitions. In Pakistan industries can utilize findings of this study for implementation of TPM culture in their organizations. In this way they can get maximum benefits from Total productive management. European countries have their productivity rate twice even thrice vs comparison of Pakistani industries. is envisioned that the results of current study would be supportive to enhance the productivity by considering derived enablers.by using outcome of this study organization can easily identify there course of action while implementation or execution of total productive management. Instead of focusing on all the areas they can focus on specific areas highlighted by this study and can get maximum outcomes in terms of productivity enhancement.

Theoretical Implications

The current research also augments the prevailing literature on the training and organizational development. This study contributed to the relationship amongst the training elements for theoretical understanding of the phenomenon. Consolidated list of the elements would be beneficial for scholars. Model has been developed using modified total interpretive structural modeling (TISM) and clustering of the elements has been identified through driving-dependence power using Fuzzy MICMAC which contributed towards literature. Validation of links in TISM model from experts is another contribution in literature to present appropriate interpretation of relationships. Effectiveness of the elements has been identified by the help of TISM and MIACMAC, and can be utilized by the research scholars.

Limitation

This study has several limitations that are required to be mentioned for developing the understanding at reader's end. First limitation, the list of training elements has been identified, however, all the elements may not be applicable to every organization. Second limitation, the current study is personal judgment of a panel of experts related from different industries of Pakistan (heterogeneous), (experts from different industries). Third limitation, current sample size has been opted as 9 experts, a smaller sample size. Fourth limitation, the model developed in this research is not tested or validated statistically. Fifth limitation, data collection approach has been adopted as cross-sectional time frame, further data can be collected through longitudinal time approach.

References

Ahuja, I. P. S., & Khamba, J. S. (2008). Assessment of contributions of successful TPM initiatives towards competitive manufacturing. *Journal of Quality in Maintenance Engineering, 14*(4), 356-374.

Alawamleh, M. & Popplewell, K. (2011). Interpretive structural modelling of risk sources in a virtual organization. *International Journal of Production Research, 49*(20), 6041-6063

Aspinwall, E., & Elgharib, M. (2013). TPM implementation in large and medium size organisations. *Journal of Manufacturing Technology Management, 24*(5), 688- 710.

Attri, R., Grover, S., Dev, N., & Kumar, D. (2013). An ISM approach for modelling the enablers in the implementation of Total Productive Maintenance (TPM). *International Journal of System Assurance Engineering and Management*, *4*(4), 313-326.

Chidambaranathan, S., Muralitharan, C., & Deshmukh, S. G. (2009). Analyzing the interaction of critical factors of supplier development using Interpretive Structural Modeling—an empirical study. *The International Journal of Advanced Manufacturing Technology, 43*(11-12), 1081-1093.

Chan, F. T. S., Lau, H. C. W., Ip, R. W. L., Chan, H. K., & Kong, S. (2005). Implementation of total productive maintenance: A case study. *International journal of production economics*, *95*(1), 71-94.

Maroofi, F. (2013). Total Productive Maintenance for modeling the enablers in the performing of ISM access. *International Research Journal of Applied and Basic Sciences*, *6*(8), 1161-1174.

Ghirubaagiri, A. (2018). *Critical success factors and barrier in implementation of Total Productive Maintenance* (Doctoral dissertation, University Teknologi Malaysia).

Jayalakshmi, B. & Pramod, V. (2015) Total Interpretive Structural Modeling (TISM) of the Enablers of a Flexible Control System for Industry. *Global journal of flexible system management 16(1), 63-85.*

Hansson, J., Backlund, F., & Lycke, L. (2003). Managing commitment: increasing the odds for successful implementation of TQM, TPM or RCM. *International Journal of Quality & Reliability Management*, *20*(9), 993-1008.

Kloker, S., Straub, T., Morana, S., & Weinhardt, C. (2018). The effect of social reputation on retention. Designing a social real time Delphi platform. *In Proceedings of the 26th European Conference on Information Systems (ECIS2018), Portsmouth, UK, 2018.*

Liselott, L. (2003). Team development when implementing TPM. *Total Quality Management*, *14*(2), 205-213.

Medina, M. N. (2016). Conflict, individual satisfaction with team, and training motivation. *Team Performance Management*, *22*(3/4), 223-239

Ghanem, M. S. (2021). Total Productivity Maintenance (TPM): A Hospitality Industry's New Maintenance Approach. *Journal of Association of Arab Universities for Tourism and Hospitality*, *20*(1), 236-264.

Mugwindiri, K., & Mbohwa, C. (2013). Availability performance improvement by using autonomous maintenance: The case of a developing country, Zimbabwe. *In Proceedings of the World Congress on Engineering* 1(1), 5-6

Gupta, P., Vardhan, S., & Al Haque, M. S. (2015, March). Study of success factors of TPM implementation in Indian industry towards operational excellence: An overview. In *2015 International Conference on Industrial Engineering and Operations Management (IEOM)* (pp. 1-6). IEEE.

Prabowo, H. A., Suprapto, Y. B., & Farida, F. (2018). The evaluation of eight pillars total productive maintenance (TPM) implementation and their impact on overall equipment effectiveness (OEE) and waste. *Sinergi*, *22*(1), 13-18.

Saunders, M., Lewis, P., & Thornhill, A. (2016). Research methods for business students (Seventh). *Nueva York: Pearson Education*.

Sharadha, P. Deshpand, V,. Damle, Margle L, Patel, Akshy, B, Kholamkar (2015). Implementation of 5s technique in manufacturing organization: A case study. *International journal of research in engineering & technology,* 4, 138-150.

Brah, S. A., & Chong, W. K. (2004). Relationship between total productive maintenance and performance. *International Journal of Production Research*, *42*(12), 2383-2401.

Sushil, A. (2012). Interpreting the Interpretive Structural Model. *Global Journal of Flexible Systems Management 13(2), 87–106*

Sushil, A. (2017). Modified ISM/TISM Process with Simultaneous Transitivity Checks for Reduced Direct Pair Comparisons. *Global Journal of Flexible Systems Management, 18*(4), 331-351.

Sushil, A. (2018). How to check correctness of total interpretive structural models? *Annuals of operations research 270(1), 473–487*

Trigunarsyah, B., & Parami Dewi, A. A. D. (2015, May). Using a design–build system: an interpretive structural model. *In Proceedings of the Institution of Civil Engineers-Municipal Engineer 169*(1), 3-12.

Warfield, J. N. (1973). Binary matrices in system modeling. *IEEE Transactions on Systems, Man, and Cybernetics*, *5*, 441-449.

Warfield, J. N. (1974). Toward interpretation of complex structural models. *IEEE Transactions on Systems, Man, and Cybernetics*, *5*, 405-417.

Singh, S., Sinha, S., Das, V. M., & Sharma, A. (2019). A framework for linking entrepreneurial ecosystem with institutional factors: a modified total interpretive structural modelling approach. *Journal for Global Business Advancement*, *12*(3), 382-404.