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SYNERGISTIC SUITABILITY OF INTEGRATION OF TQM-BPR FOR INDIAN SMEs USING FUZZY-BASED MODEL SIMULATION

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Abstract-Total quality management (TQM) and Business Process Reengineering (BPR), are popular initiatives employed by organizations as performance improvement techniques for attaining customer satisfaction, reliability, productivity, market share, profitability and even survival. Now a day's all manufacturers are trying to implement new methods, i.e., Multi Criteria Decision Making (MCDM) like Analytical Hierarchy Process (AHP), Piecewise-Affine (PWA), A Fuzzy-Based (FB) model, etc., along with TQM-BPR drives to improve Business Performance. In this paper, an attempt has been made to show the synergistic suitability of Integration of TQM-BPR for Indian SMEs. For the study, the most relevant factors affecting these drives like Strategic Quality Planning, TQM issues, BPR issues and Integration of TQM-BPR issues has been considered and further these factors has been validated by the data given by experts in this fields using fuzzy logic toolbox of MATLAB which provides the steps for designing fuzzy inference systems using graphical tools.
Keywords: Total Quality Management; TQM; Business Process Reengineering; BPR; Fuzzy-Based Model; FB; Fuzzy Inference Systems; India.

1. INTRODUCTION

Due to the increasing competition and globalization pressures, organizations are looking for the best opportunity to improve their processes. Undoubtedly, in order to succeed in the market, organizations need to continue to reduce costs, improve product quality and increase customer satisfaction. That's why it's important to find ways to achieve as much as possible. In today's challenging economic climate, many organizations find that improved quality is an essential component of the global challenge. Gradually, many organizations recognize the strategic importance of good governance and quality. Many organizations have come to the conclusion that effective quality management can enhance their competitiveness and provide strategic marketing benefits [1]. This principle is pursued by many firms, both big and small, service and manufacturing, profit and nonprofit to figure out and develop their approaches towards quality management.

The importance of quality is mounted because of two main factors:

- Tough competition
- Educated customers

Quality means actual timing, precision and corrects value. Products/services are evaluated when it is met according to customer needs and hence customer satisfaction is the highest achievement of any organization that leads to high profitability. So, quality control must be focused rather than monitoring, which increases costs and takes time. [2] Quality Control Focused on:

- Begin before and together with production
- Make sure bad things will not happen
- Responsibility of each authority

Poor quality leads to losses in production (tangible) and services (intangible). It can be in the form of increased rejection, less production, large customer complaints, loss of time and in service sector it can be a conflicts between different departments, loss of morale. Quality can be in the form of design, process, product, system or services. As quality and productivity are complementary for each other so productivity increases when there is good quality.

This is a quality innovation but is considered creative, product, or conceptual product must be different from the past, and must be achieved with a decent, affordable price [2]. When all the game is about improving the quality, organizations are using different tools for quality improvement. Total Quality Management (TQM) and Business Process Reengineering (BPR) are such tools.

2. LITERATURE REVIEW

Total Quality Management (TQM) is based on the firm commitment of the unit to maximizing product and service advantages over long term. Re-engineering of a business process (BPR) allows for dramatic changes in the organization's processes that aim to maximize efficiency through the benefit of information and telecommunications. Although they seem to be two totally contradictory approaches, TQM and BPR can be integrated into the concept of "endless quality improvement".

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TQM is considered an important strategic approach to deliver higher quality products and services than customer expectations. Meanwhile, many organizations are implementing BPR, a "heat management tool", to achieve progress. Considering these two approaches in the context of a system, it can be assumed that the transition from TQM to BPR is the shift from variation into an active approach to evolving into a revolutionary process. The Learning Organization (LO) is regarded as a logical step after TQM. One of the main scenarios of LO is process re-engineering. Therefore, the BPR includes features outside of TQM. Many organizations implement BPR simultaneously as they are involved in the ongoing process of improving TQM [3].

In 1993 that Indian business markets realised the importance of implications to maintain quality throughout reengineer the process to side by side for improving business performance. Integrate TQM and BPR to address various issues of the organization and initiate different size changes. [4]

TQM and BPR are combined to make changes and benefits for achieving competitive advantage [5].

[3] In order to ensure sustainable competitive advantage, TQM and BPR integration seem to be the best management approach for many organizations. Although TQM and BPR represent two different approaches, the careful combination of these approaches can help achieve long-term results.

These two approaches are convincing, but only when combined. Both cares are similar to customer satisfaction, improvement process, and commitment to increasing productivity. TQM provides support for active BPR. [6].

The ultimate goal of TQM can be achieved with greater strength if the BPR concept is included with it. Strong approaches to these two concepts will provide better quality levels with high performance[7].

By combining TQM and BPR, it can help increase high productivity and high productivity, resulting in high productivity for the organization. [8].

TQM and BPR share a cross-functional relationship[9].

TQM uses Element as well as BPR for improvement. In many cases, the organization uses soft "TQM" soft "soft elements", but uses reactive elements, if necessary. Similarly, the answer to this last question shows that organizations are afraid to take risks and they are more likely to do the TQM. Previous findings suggest that organizations can use both process improvement methods. [10]

As the success of an organization depend upon its product quality, cost. But in the present scenario all manufacturing organizations concentrate on producing high quality products, involving low cost In order to achieve optimum levels of above said factors, the policy adopted in the organization should be rational, perfect and easy to implement. So, these days' manufacturers are trying to implement some new methods like multi criteria decision making (MCDM) models like analytical hierarchy process (AHP), piecewise-affine (PWA), a fuzzy-based (FB) model, neural networks, etc., along with TQM-BPR drives to improve business performance.

3. METHODOLOGY

Present study has been done by fuzzy logic toolbox of MATLAB using fuzzy inference system (FIS) for justifying the suitability of TQM alone and TQM-BPR combined approach. The toolbox helps building models of complex system behaviours using simple logic rules, and then implementing those rules in a Fuzzy Inference System (FIS). As the work focuses on identifying the suitability of above said approaches by fuzzy-based simulation (FBS) model. Therefore, the most important factors like Strategic Quality Planning, TQM issues, BPR issues, and Integration of TQM-BPR issues are taken into account. These factors had been taken after considering the view points of TQM-BPR coordinators from different manufacturing organizations.

A suitable TQM alone and TQM-BPR method is expressed by the following equation:

Suitable TQM method = f [SQP and TQM issues] (1)

Suitable Integration of TQM-BPR method = f [SQP, BPR issues and Integration of TQM-BPR issues] (2)

Therefore, the above equation is further optimized with use of Fuzzy Logic (FL). In recent years, a number and variety of applications of FL have increased significantly. The result proves that the synergistic suitability of Integration of TQM-BPR is much better than suitability of TQM alone for Indian manufacturing organizations.

4. FUZZY LOGIC (FL) - A BRIEF INTRODUCTION

FL starts with the concept of a fuzzy set. A fuzzy set is a set without a crisp, clearly defined boundary. It can contain elements with only a partial degree of membership. On the other hand, a membership function (MF) is a curve that defines how each point in the input space is mapped to a membership value (or degree of membership) between 0 and 1. The only condition a MF must really satisfy is that it must vary between 0 and 1. The function itself can be arbitrary curves whose shape can be define as a function that suits from the point of view of simplicity, convenience, speed, and efficiency. A function is a mathematical representation of the relationship between the input and output of a system or a process. It facilitates the optimisation of process output by defining the true relationship between input and the output variables. Optimisation in this context means minimising the requirement variability and shifting its mean to some desired target value specified by the customer. The function presented in equations (1) and (2) is formulised and refined with the use of FL. However, in present study the refined function is presented as sets (sequences) of FL rules evaluated using the fuzzy logictoolbox in MATLAB. The fuzzy logic toolbox graphical user interface (GUI) tool to build a FIS is shown in Fig 1.

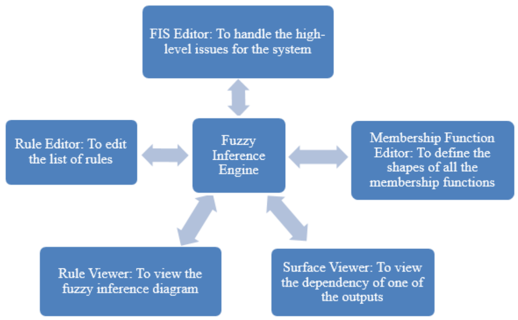

Fig-1 Tools used in fuzzy logic toolbox

4.1 Fuzzy Inference System

Fuzzy inference is the process of formulating the mapping from a given input to an output using FL. The mapping then provides a basis from which decisions can be made, or patterns discerned. FISs have been successfully applied in fields such as automatic control, data classification, decision analysis, expert systems, and computer vision. Because of its multidisciplinary nature, FISs are associated with a number of names, such as fuzzy-rule-based systems, fuzzy expert systems, fuzzy modelling, fuzzy associative memory, FL controllers, and simply (and ambiguously) fuzzy systems. The flowchart depicting the procedure of FIS used in present study is shown in Fig 2. There are two types of FISs that can be implemented in the fuzzy logic toolbox: Mamdani-type and Sugeno-type. Mamdani-type inference, as defined for the toolbox, expects the output MFs to be fuzzy sets. After the aggregation process, there is a fuzzy set for each output variable that needs defuzzification. It is possible, and in many cases much more efficient, to use a single spike as the output MF rather than a distributed fuzzy set. This type of output is sometimes known as a singleton output MF, and it can be thought of as a pre-defuzzified fuzzy set. Sugeno-type systems can be used to model any inference system in which the output MFs are either linear or constant. Fuzzy inference process comprises of five parts: fuzzification of the input variables, application of the fuzzy operator (AND or OR) in the antecedent, implication from the antecedent to the consequent, aggregation of the consequents across the rules, and defuzzification.

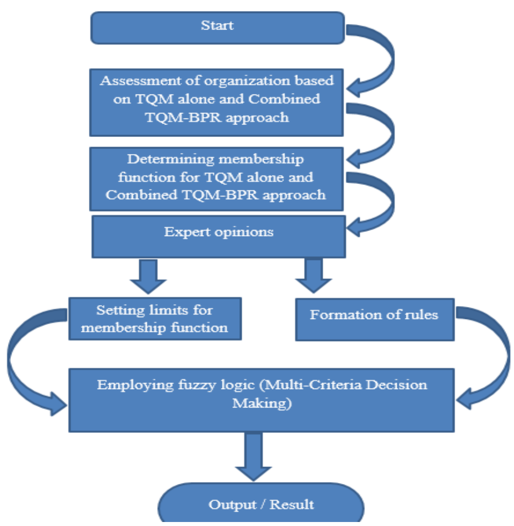

Fig-2 FIS procedure used in present study

4.2 Fuzzification

The first step is to take the inputs and to determine the degree to which they belong to each of the appropriate fuzzy sets via MFs. In fuzzy logic toolbox software, the input is always a numerical value limited to the input variable and the output is a fuzzy degree of membership in the qualifying linguistic set (always the interval between 0 and 1).

4.3 Rule evaluation

The FIS develops appropriate rules and on the basis of the rules the decision is made. This is principally established on the concepts of the fuzzy set theory, fuzzy IF-THEN rules, and fuzzy reasoning. FIS uses 'IF... THEN ...' statements, and the connectors existent in the rule statement are 'OR' or 'AND' to create the essential decision rules. The basic FIS can accept either fuzzy inputs or crisp inputs, but the outputs it provides are virtually all the time fuzzy sets. When the FIS is employed as a controller, it is needed to have a crisp output. Hence, in the present study the rules are formed with the expert knowledge, feedback and guidance given by experts in the manufacturing industries and are further refined with experienced persons in the field of operation, production management and are further refined, following real life application and appraisal which will either confirm them or require them to be modified.

4.4 Defuzzification

The input for the defuzzification process is a fuzzy set (the aggregate output fuzzy set) and the output is a single number. As much as fuzziness helps the rule evaluation during the intermediate steps, the final desired output for each variable is generally a single number. However, the aggregate of a fuzzy set encompasses a range of output values, and so must be defuzzified in order to resolve a single output value from the set.

5. FUZZIFICATION OF TQM ALONE ORGANIZATIONS

Fig 3 depicts the empirical transfer function of TQM from equation (1) as a FL system with inputs and output being fuzzified using appropriate MFs. Here, the inputs are the factors like Strategic Quality Planning and TQM issues. The output is the result whose value shows whether to accept, under consider or reject the selection of TQM. The following sections narrate each component of the system.

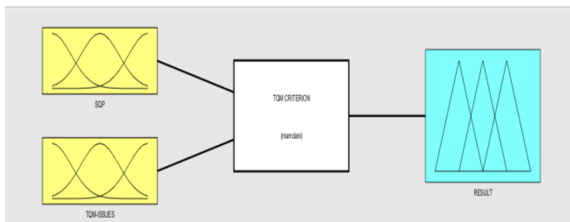

Fig-3 Empirical transfer function of TQM alone

5.1 Setup Membership Function of Strategic Quality Planning (SQP)

The manufacturing organization always faced a trouble while making Strategic planning for Quality. Each Department of organization has to maintain the specific goals to improve quality within the organization. The fuzzy set rules defines if SQP more than -5% of required value than system is considered rejected, if SQP lies between -5% to -3% it is considered very low. If the value lies between -3 to -1% it is considerable low. If SQP varies between -1 to +1% than it is optimum. If the value lies between +1% to +3% it is considerable high. If SQP varies between +3% to +5% it is considered very high. If SQP more than 5% then it is accept. The range of SQP in fuzzy format is shown in Table- 1 and the Membership transfer function in fuzzy format of SQP in Fig-4. The trimf triangular membership function curve is used to represents membership functions of SQP, as it is a simplest membership function formed by straight lines. These straight line membership functions have the advantage of simplicity and symmetrical in nature.

Table 1 Range for SQP

S.NO.	Linguistic Term	Range
1	Reject	More than -5%
2	Very low	-5% to -3%
3	Considerable Low	-3% to -1%
4	Optimum	-1% to +1%
5	Considerable High	+1% to +3%
6	Very High	+3% to +5%
7	Accept	More than +5%

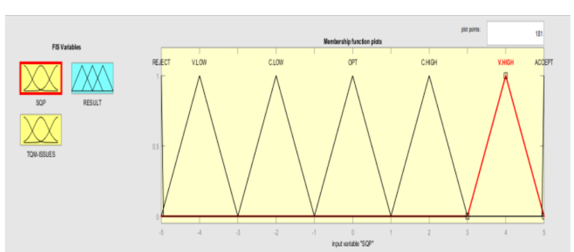

Fig-4 Membership Transfer Function in Fuzzy Format of SQP

5.2 Setup Membership Function of TQM issues

The senior executive's responsibility to provide highly visible leadership in maintaining an environment that supports quality improvement as well as organization need to encourage team work. The fuzzy set rules defines if TQM issues more than -6% of required value than system is considered rejected, if TQM issues lies between -6% to -4% it is considered very low. If the value lies between -4 to -2% it is considerable low. If TQM issues varies between -2 to +2% than it is optimum. If the value lies between +2% to +4% it is considerable high. If TQM issues varies between +4% to +6% it is considered very high. If TQM issues more than 6% then it is accept. The range of TQM issues in fuzzy format is shown in Table-2 and the Membership transfer function in fuzzy format of TQM issues in Fig-5. The trimf triangular membership function curve is used to represents membership functions of TQM issues.

Table 2 Range for TQM issues

S.NO.	**Linguistic Term**	**Range**
1	Reject	More than -6%
2	Very low	-6% to -4%
3	Considerable Low	-4% to -2%
4	Optimum	-2% to +2%
5	Considerable High	+2% to +4%
6	Very High	+4% to +6%
7	Accept	More than +6%

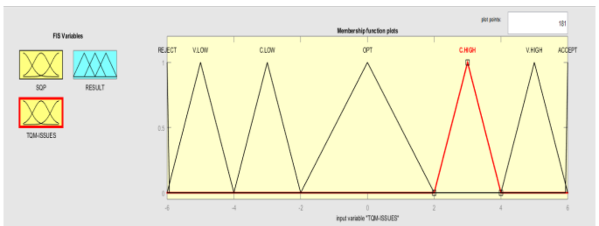

Fig-5 Membership Transfer Function in Fuzzy Format of SQP

5.3 Results checking the suitability of TQM approach

As discussed earlier, again the result is to decide whether to select the TQM approach is effective to enhance the quality and manufacturing performance. If the result value lies between 0 to 3, it is considered as rejected approach, between 3 to 6 is considered as poor (Under Consideration) and between 6 to 8 is considered as acceptable approach and between 8–10 as Optimum approach is shown in Table-3. The transfer function of results in fuzzy format is shown in Fig-6. The gaussmf curve is used to represents the membership functions of results. The result has advantage to represent smooth and non-zero outputs at all points.

Table 3 Range for TQM Result Measurement

Fuzzy	Linguistic term	Range
1	Reject	0-3
2	Under Consideration	3-6
3	Acceptable	6-8
4	Optimum	8-10

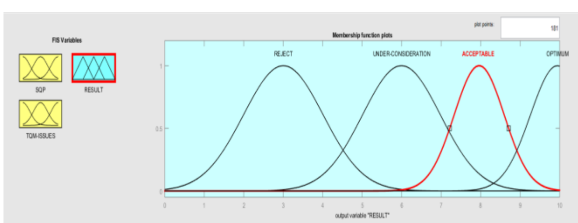

Fig-6 Transfer Membership Function of Results in Fuzzy Format

5.4 Fuzzy evaluation rules and solution for TQM alone approach

The following Tables 4 shows the formation of Fuzzy Rules. There are 25 rules following the format ‘if (condition a) and (condition b) than (result c)’ corresponding to the combination of input conditions. These if-than rule statements are used to formulate the conditional statements that comprise FL in case of TQM approach. For example, ‘if SQP is very high’ and ‘TQM issues is very high’ than the result is ‘the system is acceptable’. As discussed earlier, these rules are formed with the expert knowledge, feedback and guidance given by experts in the manufacturing industries and are further refined with experienced persons in the field of operation and production management from different manufacturing industries across India. Fig-7 shows the Fuzzy Set Rule for TQM approach.

Table-4. Demonstrating Fuzzy Rules for TQM Result

TQM / SQP	V.LOW	C.LOW	OPT	C.HIGH	V.HIGH
V.LOW	REJECT	REJECT	REJECT	REJECT	REJECT
C.LOW	REJECT	REJECT	REJECT	REJECT	REJECT
OPT	REJECT	REJECT	ACCEPT	ACCEPT	ACCEPT
C.HIGH	REJECT	REJECT	ACCEPT	ACCEPT	ACCEPT
V.HIGH	REJECT	ACCEPT	ACCEPT	ACCEPT	ACCEPT

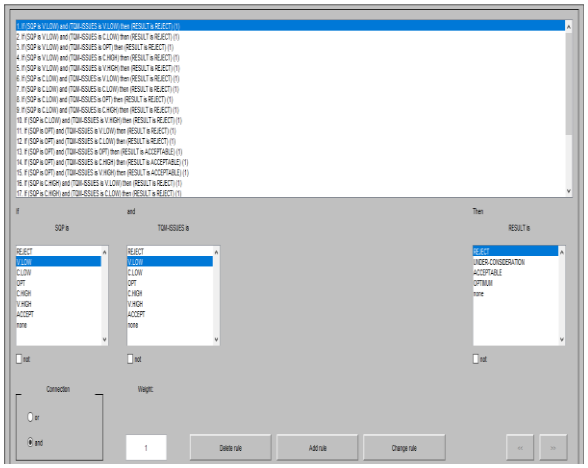

Fig-7 Fuzzy Set Rule for TQM approach

A continuum of fuzzy solutions for equation (1) is presented in Fig 8 using the rule viewer of fuzzy toolbox of MATLAB. The rule viewer displays a roadmap of the whole fuzzy inference process and it is based on the fuzzy inference diagram. The rule viewer allows interpreting the entire fuzzy inference process at once. It also shows how the shape of certain MFs influences the overall result as it plots every part of every rule. Each rule is a row of plots, and each column is a variable. The rule numbers are displayed on the left of each row. By clicking on a rule number, the rule in the status line can be viewed. The two inputs can be set within the upper and lower specification limits and the output response is calculated as a score that can be translated into linguistic terms. In this instance the order output of 7.03 indicates 'acceptable system' linguistically from Table 3.

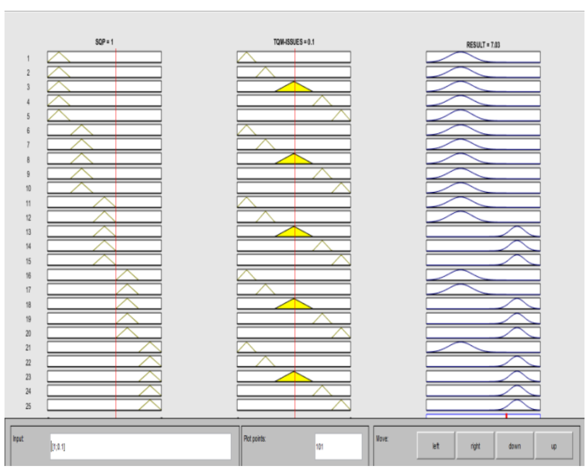

Fig-8 Continuum Fuzzy solution for TQM Results

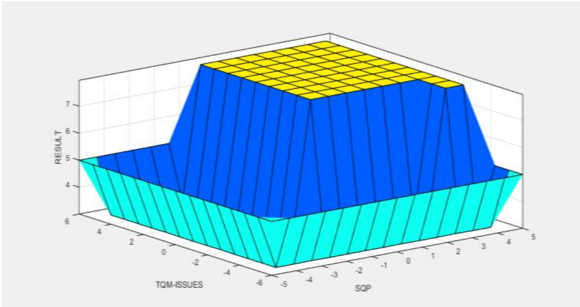

Fig-9 Output Surface View of SQP vs TQM issues and TQM results

6. FUZZIFICATION OF INTEGRATION OF TQM-BPR ORGANIZATIONS

Fuzzy logic system with inputs and output being fuzzified using appropriate MFs. The inputs to FL are success factors Strategic Quality Planning (SQP), BPR issues and Integration of TQM-BPR issues. The output is the result whose value shows whether to accept, under consider or reject the selection of TQM approach to achieve manufacturing performance. The data has been collected by consulting various representatives of specific industries. The representative of industries provides information regards to current issues they were facing and their solution in quantitative way. The data has been taken out at the each level of organization. The following sections narrate each component of the system as shown in Fig-10 which depicts the empirical transfer function of Integration of TQM-BPR organizations from equation (2).

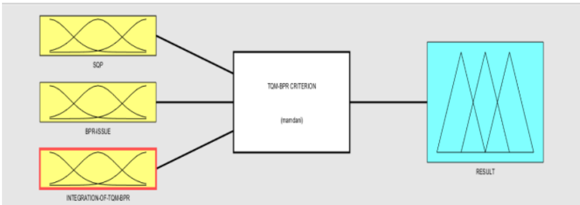

Fig-10 Empirical Transfer Function of Integration of TQM-BPR approach

As far as the fuzzy set rules for other components of the system, i.e.,SQP is concerned has been taken same as discussed earlier in Table 1.

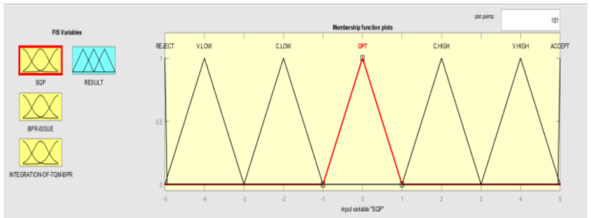

Fig-11 Membership Transfer Function in Fuzzy Format of SQP for TQM-BPR approach

6.1 Setup Membership Function of BPR issues

The senior executive's responsibility to provide highly visible leadership in maintaining an environment and to share information with the employees about BPR project to implement it well in an organization to enhance the business performance. The fuzzy set rules defines if BPR issues more than -9% of required value than system is considered rejected, if BPR issues lies between -9% to -6% it is considered very low. If the value lies between -6 to -3% it is considerable low. If BPR issues varies between -3 to +3% than it is optimum. If the value lies between +3% to +6% it is considerable high. If BPR issues varies between +6% to +9% it is considered very high. If BPR issues more than 9% then it is accept. The range of BPR issues in fuzzy format is shown in Table-5 and the Membership transfer function in fuzzy format of BPR issues in Fig-12. The trimf triangular membership function curve is used to represents membership functions of BPR issues.

Table-5. Range for BPR issues

S.NO.	Linguistic Term	Range
1	Reject	More than -9%
2	Very low	-9% to -6%
3	Considerable Low	-6% to -3%
4	Optimum	-3% to +3%
5	Considerable High	+3% to +6%
6	Very High	+6% to +9%

7	Accept	More than +9%

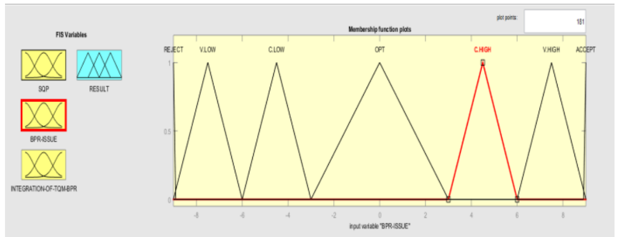

Fig-12 Membership Transfer Function in Fuzzy Format of BPR issues

6.2 Setup Membership Function of Integration of TQM-BPR issues

The organization need to maintain the quality throughout re-engineer process and need to use benchmarking technique to implement new process with better quality to enhance the business performance . The fuzzy set rules defines if Integration of TQM-BPR issues more than -10% of required value than system is considered rejected, if value lies between -10% to -8% it is considered very low. If the value lies between -8 to -6% it is considerable low. If value varies between -6 to +6% than it is optimum. If the value lies between +6% to +8% it is considerable high. If Integration of TQM-BPR issues varies between +8% to +10% it is considered very high. If Integration of TQM-BPR issues more than 10% then it is accept. The range of Integration of TQM-BPR issues in fuzzy format is shown in Table-6 and the Membership transfer function in fuzzy format of Integration of TQM-BPR issues in Fig-13. The trimf triangular membership function curve is used to represents membership functions of Integration of TQM-BPR issues.

Table-6. Range for Integration of TQM-BPR issues

S.NO.	Linguistic Term	Range
1	Reject	More than -10%
2	Very low	-10% to -8%
3	Considerable Low	-8% to -6%
4	Optimum	-6% to +6%
5	Considerable High	+6% to +8%
6	Very High	+8% to +10%
7	Accept	More than +10%

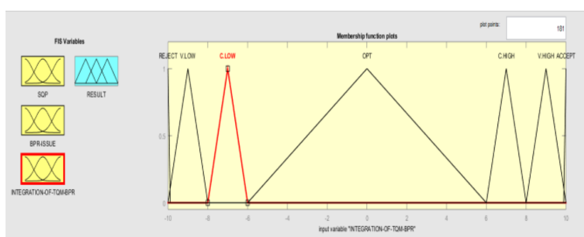

Fig-13 Membership Transfer Function in Fuzzy Format of Integration of TQM-BPR issues

6.3 Results checking the suitability of Integration of TQM-BPR approach

As discussed earlier, again the result is to decide whether to select the Integration of TQM-BPR approach is effective to enhance the quality and manufacturing performance. If the result value lies between 0 to 3, it is considered as rejected approach, between 3 to 6 is considered as poor (Under Consideration) and between 6 to 8 is considered as acceptable approach and between 8–10 as Optimum approach is shown in Table-7. The transfer function of results in fuzzy format is shown in Fig-14. The gaussmf curve is used to represents the membership functions of results. The result has advantage to represent smooth and non-zero outputs at all points.

Table-7 Range for Integration of TQM-BPR approach result measurement

Fuzzy	Linguistic term	Range
1	Reject	0-3
2	Under Consideration	3-6
3	Acceptable	6-8
4	Optimum	8-10

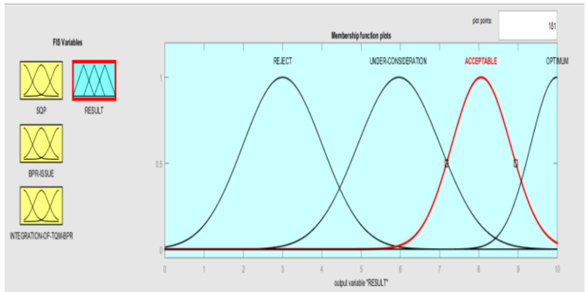

Fig-14 Transfer Membership Function of Results for Integration of TQM-BPR approach in Fuzzy Format

6.4 Fuzzy evaluation and rules and solution for Integration of TQM-BPR approach

The following Tables 8, 9 and 10 shows the formation of fuzzy rules. There are 75 rules following the format ‘if (condition a) and (condition b) and (condition c) than (result c)’ corresponding to the combination of input conditions These if-than rule statements are used to formulate the conditional statements that comprise FL in case of Integration of TQM-BPR approach. For example, ‘if SQP is very high’ and ‘BPR issues is optimum’ and ‘Integration of TQM-BPR issues is very high’ than the result is ‘the system is acceptable’. As discussed earlier, these rules are formed with the expert knowledge, feedback and guidance given by experts in the manufacturing industries and are further refined with experienced persons in the field of operation and production management from different manufacturing industries across India. The fuzzy set rules has been formed considering three different cases when Integration of TQM-BPR issues is very high, optimum and very low as shown in Fig-15.

Table-8 Demonstrating Fuzzy Rules for TQM-BPR Result when ‘Integration of TQM-BPR issues’ is Very High

BPR / SQP	V.LOW	C.LOW	OPT	C.HIGH	V.HIGH
V.LOW	REJECT	REJECT	REJECT	REJECT	REJECT
C.LOW	REJECT	REJECT	REJECT	REJECT	REJECT
OPT	REJECT	ACCEPT	ACCEPT	ACCEPT	ACCEPT
C.HIGH	REJECT	ACCEPT	ACCEPT	ACCEPT	ACCEPT
V.HIGH	REJECT	ACCEPT	ACCEPT	ACCEPT	ACCEPT

Table-9 Demonstrating Fuzzy Rules for TQM-BPR Result when ‘Integration of TQM-BPR issues’ is Optimum

BPR / SQP	V.LOW	C.LOW	OPT	C.HIGH	V.HIGH
V.LOW	REJECT	REJECT	REJECT	REJECT	REJECT
C.LOW	REJECT	REJECT	REJECT	REJECT	REJECT
OPT	REJECT	ACCEPT	ACCEPT	ACCEPT	ACCEPT
C.HIGH	REJECT	ACCEPT	ACCEPT	ACCEPT	ACCEPT
V.HIGH	REJECT	ACCEPT	ACCEPT	ACCEPT	ACCEPT

Table-10 Demonstrating Fuzzy Rules for TQM-BPR Result when ‘Integration of TQM-BPR issues’ is Very Low

BPR / SQP	V.LOW	C.LOW	OPT	C.HIGH	V.HIGH
V.LOW	REJECT	REJECT	REJECT	REJECT	REJECT
C.LOW	REJECT	REJECT	REJECT	REJECT	REJECT
OPT	REJECT	REJECT	REJECT	REJECT	REJECT
C.HIGH	REJECT	REJECT	REJECT	ACCEPT	ACCEPT
V.HIGH	REJECT	REJECT	ACCEPT	ACCEPT	ACCEPT

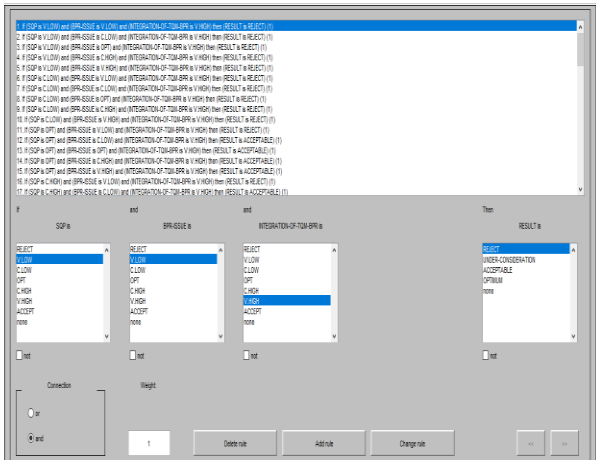

Fig-15 Fuzzy Set Rule for Integration of TQM-BPR approach

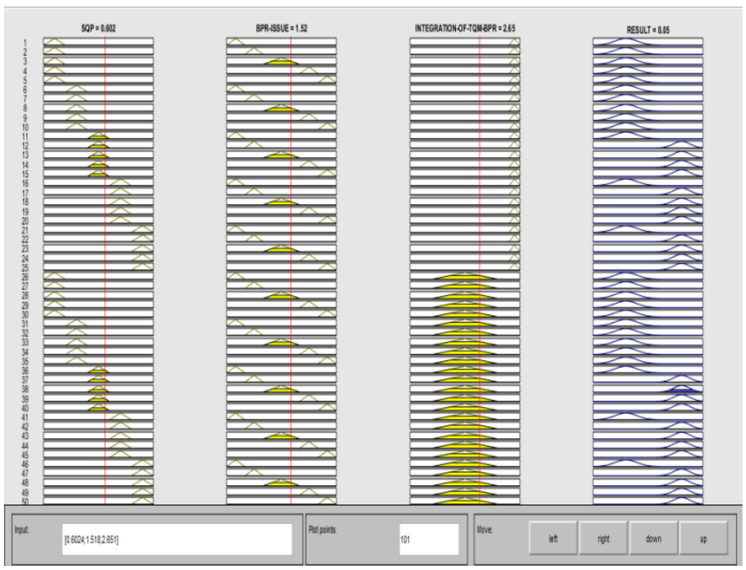

Fig-16 Continuum Fuzzy solution for Integration of TQM-BPR Results

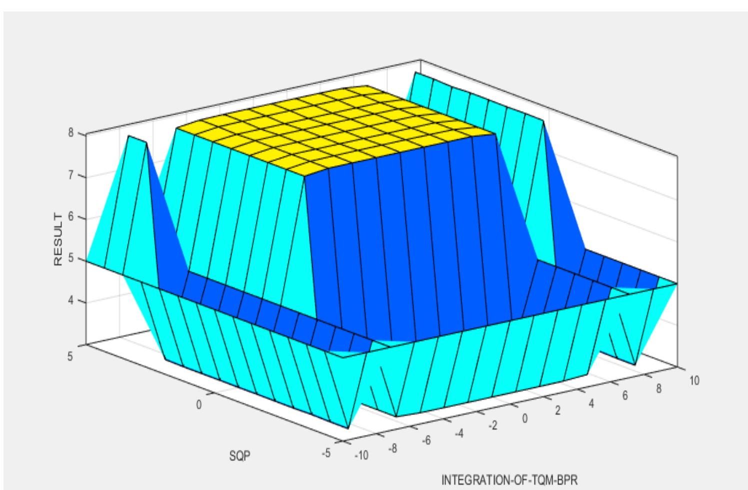

Fig-17 Output surface view of SQP vs Integration of TQM-BPR and TQM-BPR Results

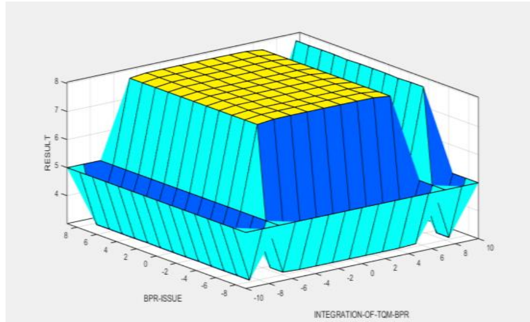

Fig-18 Output surface view of BPR issue vs Integration of TQM-BPR and TQM-BPR Results

A continuum of fuzzy solutions for equation (2) is presented in Figure 16 using the rule viewer of fuzzy toolbox of MATLAB. The three inputs, i.e., quality, maintenance and cost can be set within the upper and lower specification limits and the output response is calculated as a score that can be translated into linguistic terms. In this instance if the value of SQP is entered 0.602 (optimal value), BPR issues is 1.52 (optimal value) and Integration of TQM-BPR is 2.65 (optimal value) the order output is coming as of 8.05 which specifies the system is highly 'optimum' linguistically. The entire output surface of the TQM-BPR combined approach along with output set based on the entire span of the input set is shown in Fig 17 and 18. To analyse the performance of fuzzy system, three-dimensional plots output can be used and finally, the output can determine the most appropriate strategy to follow from any combination of inputs. Hence, this paper attempts to prove that if TQM-BPR drives are used together there synergistic effect can improve business performance in better way than applying these quality drives alone in Indian manufacturing organizations.

7. CONCLUSION

TQM and BPR approaches are considered to be techniques and tools needed for the planning, implementation and control of the quality and reengineer process. The objective of both systems is to achieve the synergy and acts as two drivers to improve the business performance excellence in the context of manufacturing organization. TQM focuses on principles towards achieving the customer satisfaction and continuous improvements, whereas BPR can get a strong change in productivity (measured by cost, timeliness, service, and quality).These approaches are generated in developed countries and have different orientations. Similarities, differences and interrelationship among these two techniques in terms of objectives concept, methodologies and scope have remained confusing to the industry. Similarly, selection of one of these or combination of these techniques has remained a problematic issue in organizations. Therefore, in this study an assessment of the SMEs has been done based on TQM alone and TQM-BPR combined approach using fuzzy logic toolbox of MATLAB. Most important factors under TQM alone, i.e., Strategic Quality Planning and TQM issues and under TQM-BPR, i.e., Strategic Quality Planning, BPR issues and Integration of TQM-BPR issues has been considered as MFs for fuzzy input as discussed by experts in this field and TQM-BPR coordinators from various manufacturing organizations. Also, there expert opinion has been taken to formulate the fuzzy 'if then' rules. Lastly, FIS has been formed for both the approaches and the fuzzification process of TQM alone and TQM-BPR combined approach has been performed during run time by assigning appropriate MFs to the required approaches. The result shows that if TQM-BPR drives are used together there synergistic effect can improve business performance in better way than applying these drives alone and this has been shown with the help of fuzzy rule viewer and also to analyses the performance of fuzzy system, three-dimensional plots output has been used with the help of surface view tool of fuzzy toolbox of MATLAB.

8. REFERENCES

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