An empirical investigation on the deployment of Operational excellence in SMEs

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Abstract

Purpose: This study investigates the quantitative aspect of the various strains of Operational excellence (OE) and "Competitive-potential (CP)" in the SME sector. It has five steps, i.e., identifying the key performance constructs of OE and their hypothesized relationship pattern from literature, validating these constructs through factor analysis, formalizing their empirical relationships by structural-equation-modeling (SEM), path analysis of performance constructs with the empirical results, and lastly proposing a framework for OE deployment in SMEs.

Design/methodology/approach: Data for the deployment scores of Operational excellence procedures (OEPs) were collected through a structured questionnaire survey. Nine hundred participants from a stratified random sample were approached for the survey, and 473 responses were received. Sample stratification was based on Gender, Education, Experience, Position, Department, and Industry. Respondents had 5 to 30 years of experience managing manufacturing operations, holding the Manager position and above.

Findings: The path analysis of the structural model provides unique insights into OE's practical aspects in SMEs (Small and Medium Enterprises). Such as Contractual-conformance and Process-efficiency play pivotal roles as both have a significant positive impact on CP. Supplier efficacy, Consistency, and Product-excellence do not improve CP unless mediated by Contractual-conformance or Process-efficiency.

Research limitations/implications: The study provides important implications for academia, policymakers, and managers. The study identifies and validates the operational excellence key performance practices and proposes a framework for manufacturing organizations. SME managers can follow the framework to develop effective operational excellence strategies to help them achieve their organizational goals. Additionally, the study emphasizes the need for continuous culture in SMEs, which will help to support operational excellence deployment.

Overall, the implications presented in the study will help SMEs to enhance their competitiveness and operational performance.

Originality/value: The study explores the empirical investigation of the operational excellence deployment in SMEs. The study uses a mixed method approach for research design, including qualitative and quantitative approaches, and uses SEM to test the proposed framework.

Validation of OE's six key performance constructs and establishing their empirical relation is an attempt to advance the Operations excellence theory. Unlike large enterprises, SMEs demonstrate an incohesive response to the practices pertaining to Supplier efficacy, Consistency, and Product-excellence. This unique response pattern requires special treatment, which is incorporated into the proposed framework.

Keywords: Operational excellence; competitive potential; quality management; structural equation modeling; framework; SMEs.

1. Introduction

"Operational Excellence" (OE) is widely accepted in literature and applied in various industries to achieve business excellence and competitiveness. Generally, OE can be defined as the branch of management science which deals with the different strategies for consistent and reliable operations in industries(Sreedharan V. et al., 2018). In the literature, few studies have outlined performance outcomes, such as; shorter time to delivery and high responsiveness with OEPs such as; VSM and single-minute exchange of die (Taylor et al., 2020). Similarly, high product quality has been linked with the procedure of incorporating customer feedback in product design, raw material quality, and low rejection rate (Rahman et al., 2020; Tortorella et al., 2017). Owing to the basic principles of OE: waste elimination, adding value, defect reduction, efficacy of supplier(Bhattacharya et al., 2020), customer satisfaction, and effective quality management are generic practices(Zhou, 2016). OE procedures shall be equally helpful to SMEs in improving their Competitive-potential (CP) (Matt et al., 2020). However, in

comparison to large enterprises (LEs), SMEs have a poor tradition of implementing OE (Mahato et al., 2017); therefore, they have a relatively low CP (Bhattacharya et al., 2020). There needs to be more evidence of the implementation of OE in SMEs in comparison to LEs (Antony et al., 2017; Villa & Taurino, 2018; Zhou, 2016). SMEs' typical characteristics are simple organizational structure, accessibility to top management (Krishnan & Ganesh, 2014), more accessible communication, quick decision, and swift implementation(Buer et al., 2018). However, these positive traits are often countered by the lack of standardization and the absence of OEPs (Bhattacharya et al., 2020). Therefore, these small firms often suffer from poor quality, longer lead times, lower productivity, high inventory, and ultimately poor CP than LEs (Gunay & Kula, 2016). Still, it is increasingly challenging for SMEs to compete with LEs because they resist change and are averse to OE procedures due to the lack of resources and their inability to utilize them efficiently (Matt et al., 2020; Taylor et al., 2020). Therefore, they ask for a strategic approach for the deployment of OEPs (Kayvanfar et al., 2018), which can improve their efficiency, effectiveness, flexibility, and innovation (Brockhaus et al., 2016) to do better on cost, quality, and responsiveness (Bortolotti et al., 2013; Chukhrova & Johannssen, 2019). India is now recognized as one of the fastest-growing economies with many SMEs (Krishnan & Ganesh, 2014). But these small firms have alarmingly low CP (Mittal et al., 2017); therefore, Indian SMEs have been chosen to conduct this study. An OEP can enhance the CP of a firm but may be adverse for the other(Matt et al., 2020). Hence, a customizable OE strategy is crucial for SMEs to improve their CP and safeguard them from erroneous decisions (Marzi et al., 2021; Matt et al., 2020; Taylor et al., 2020). We found limited studies on operational excellence in SMEs from the literature analysis. There is a need to identify and validate the critical performance constructs of OE in SMEs. Based on the above-discussed issues, the following objectives have been formulated for the present study:

- To identify and then validate the critical performance constructs of OE in an SME environment.
- Develop an empirical model of CP as a function of the key OE constructs to decipher their relation in the context of small enterprises.
- To frame a set of guidelines for the strategic selection of OEPs for SME managers.

To accomplish these objectives, the subsequent procedure has been implemented. Initially, an exhaustive literature review is carried out to explore the underlying constructs of key OEPs in SMEs. Unique research hypotheses are developed from the framework of literature to depict the relation between OEPs and CP. Further, a large-scale survey-based empirical analysis considering India's SMEs is carried out to validate and confirm the constructs. The rest of the paper is arranged in this order; section 4 is the Data analysis, which includes validation of performance constructs by exploratory factor analysis using SPSS20.0, then the development of SEM. Section 5 is on the strategic framework for the OE deployment, followed by Discussion and findings in section 6, Managerial implications in section 7, and Conclusion in section 8.

2. Literature review

A systematic literature review was conducted to ensure that the reviewed data was as relevant as possible. It has three subsections: articles election, constructs of OE in SMEs, and research hypotheses.

2.1 Article selection

The approach for the systematic literature survey employed in this paper is based on (Guide & Ketokivi, 2015) and (Jamwal et al., 2021). Past articles of more than 25 years from three databases: Scopus, Web of Science, and Science Direct, were used in this review. Keywords are "operational excellence procedures," "process excellence," "process improvement," "quality management," "productivity improvement," "manufacturing procedures," "small and

medium scale enterprises," and combinations of these. A total of 734 articles were found in the initial search. A total of 162 articles were left after applying inclusion and exclusion criteria based on abstract, title, and keywords review. These articles were downloaded and then reviewed thoroughly. The exclusion criteria filtered irrelevant papers: anonymous articles were excluded first, then the duplicate items were removed. The inclusion criteria for the rest of the articles were high-quality journals based on the impact factor and the selected keywords. Following this approach, a total of 65 articles were shortlisted. The articles in the cross-references were also reviewed, and 4 more relevant papers were included. Based on novel contributions, 2 book sections and 3 conference papers were also selected. More than 80% of articles are from the last ten years to be abreast with the latest research. This targeted selection facilitated a focused literature review that uncovered OE's key performance constructs, presented in the next section.

2.2 Identifying key performance constructs of operational excellence in SMEs.

The implementation aspects of OE in SMEs have been discussed in detail in past research (Ali et al., 2020; Bortolotti et al., 2013; Marzi et al., 2021). Most authors have selected a specific OEP and sometimes a segment of operational excellence as part of their study (Sahoo, 2020). Therefore, implementation nuances are not covered in this paper. However, this research has attempted to identify OE's key constructs based on the underlying purpose of their deployment in SMEs, as discussed in the literature framework. Table 1 provides an inventory of the OEPs extracted from the literature. It has four columns and six blocks. A critical and close review of the OEPs in its first block indicates their specific purpose, documented in the third column. The literature also shows a common underlying sense for this set of procedures: to reduce the variation and defects that eventually improve output consistency. Similarly, the second set of OEPs intends to reduce waste and increase process efficiency. The definition of the constructs and their underlying reason for implementation is provided in the third column. Accordingly,

in this paper, six different key performance constructs of OE, viz., “Consistency(P)," “Process-efficiency," “Product-excellence," “Supplier-efficacy," “Contractual-conformance," and “Competitive-potential (CP)” are identified. Table 1 represents the key performance constructs of operational excellence.

<< Table 1. Key performance constructs of operational excellence (OE) >>

These six performance constructs, identified from the literature review, are later empirically validated in section 4. Before that, this paper attempts to uncover the relationship between these constructs in continuation of the literature review.

3. Development of Research hypotheses

The literature indicates the existence of OEs' performance constructs (Table 1). It infers that they exhibit a specific relationship pattern with each other, which formed the basis for the hypothesis of the empirical model. This section underscores the systemic patterns noticeable in the framework of literature. For example, the “Consistency” procedures aim to reduce variation but, in due course, eliminate process waste, therefore positively impacting “Process-efficiency” (Zhou, 2016). Their impact on “CP” is higher when “Process-efficiency” procedures are implemented simultaneously (Narasimhan et al., 2005). “Consistency” also enhances responsiveness, productivity, and customer satisfaction, therefore, enabling organizations to improve “CP” (Noshad & Awasthi, 2015). The contemporary literature also suggests that procedures under “Consistency,” such as; Six-Sigma, emphasize too many statistical tools, so there is lesser focus on “CP” and “Contractual-conformance” (Mahato et al., 2016; Shahriar et al., 2022). The “Contractual-conformance” procedures intend to comply with the defined requirements of the product, process, environment, and safety (Gunay & Kula,

2016). Since "Consistency" is about reducing variation, which results in defects or errors, it positively impacts "Contractual-conformance" (Buer et al., 2018). The "Contractual-conformance" procedures are broadly covered under TQM and TPM. Meeting the "Contractual-conformance" standards improves the predictability of the process output. Hence, it positively influences "CP" (Sreedharan V. et al., 2018; Talapatra et al., 2019). The broadly agreed perspective from the literature has been formulated as the research hypotheses:

H1: A "Consistent" process positively impacts the "Process-efficiency" (H1a), "Competitive-potential" (H1b), and "Contractual-conformance" (H1c).

H2: A high degree of "Contractual-conformance" positively impacts the "Competitive-potential".

The procedures under "Supplier-efficacy" make the manufacturing process more responsive to meet customers' expectations; therefore, it implies a positive effect on "CP ."It simultaneously impacts "Contractual-conformance" by ensuring high-quality raw materials (Noshad & Awasthi, 2015; Talapatra et al., 2022). In contradiction with the popular view, few researchers have pointed out that due to regulatory restrictions, such procedures do not always show favorable results on "Contractual-conformance" and "CP," especially in SMEs, because the regulatory obligations also increase cost and other liabilities (Mohanty & Prakash, 2014). When "outsourcing" reduces the price, there is a direct impact on "CP," whereas "meeting service levels" at the supplier's end impacts "Contractual-conformance," which mediates influence to "CP" as well (Chakraborty et al., 2019). The widely accepted view on "Supplier-efficacy" has been formulated as the third research hypothesis:

H3: "Supplier-efficacy" procedures enhance "Competitive-potential" (H3a) and "Contractual-conformance" (H3b).

"Product-excellence" procedures are applied to the component and the product. They also aim to improve product performance through knowledge creation, thereby positively impacting

"Contractual-conformance" (Asif et al., 2013; Saha et al., 2022). They also increase productivity to enhance "CP" (Sreedharan V. et al., 2018). "Product-excellence" requires significant research and development expenditure, which does not always yield positive results. Therefore, in the case of SMEs, it is not necessary to have a positive impact. However, empirical evidence from the available literature has broadly indicated that "Product-excellence" has an amplified effect on "CP" when mediated by "Contractual-conformance" (Chakraborty et al., 2019). These insights are formulated as the fourth research hypothesis:

H4: "Product-excellence" procedures enhance "Competitive-potential" (H4a) and have a positive impact on "Contractual-conformance" (H4b).

The "Efficiency" procedures are applied to make the process lean and responsive to gain CP. A few exceptions, such as (Radnor & Johnston, 2013; Talapatra & Uddin, 2019), state that to increase "Process-efficiency," firms have reduced their capacity and inventory to such an extent that they cannot respond to any contingency. Such situations adversely impact responsiveness and "CP". However, the available literature has also established that significant positive differences in "CP" could be achieved by improving "Efficiency" (Brockhaus et al., 2016). The fifth hypothesis has been formulated as follows:

H5: Increase in "Process-efficiency" improves the "Competitive-potential."

These five research hypotheses collectively present a theoretical framework of Operational excellence. It is based on the broadly acceptable qualitative relationship between OEs' different constructs in the existing literature. Still, there are exceptions as well in the context of SMEs. Therefore, there lies subjectivity and confusion in describing the impact of OEPs on CP (Sahoo, 2020). The theoretical framework and the research hypotheses between the exogenous and endogenous constructs are neatly explained in Figure 1. Empirical data were collected to scrutinize the theoretical framework by developing an SEM in section 4, followed by the path analysis. The insights derived from the path analysis are used to build a strategic framework

for OE deployment in SMEs.

<< Figure 1: Theoretical framework based on research hypotheses. >>

3.1 Research methodology

Primarily, two research gaps were identified in the review of the existing literature,

- Firstly, the quantitative assessment of OEs' various strands and their effect on CP remains mostly unexplored.
- Secondly, the absence of empirical assessment of the critical performance constructs of OE has led to an ad-hoc approach towards deploying OEPs in SMEs without any meaningful gain in CP (Silva et al., 2021).

The motivation of the present research is to identify and validate OE's key performance constructs and derive an empirical model of CP. Then propose an OE deployment framework that selects OEPs with a definite positive impact on SMEs' CP and safeguards from erroneous decisions.

Underlining the contradictions in deploying OE in an SME environment vis-à-vis LE is a novelty of this study. The proposed framework providing a set of deployment guidelines is a unique contribution to OE literature.

Figure 2 depicts the research methodology adopted for the purpose. It has a three-

pronged approach: (i) Fixed questionnaire survey. (ii) Focused group consultations, and (iii) Semi-structured interviews. All three research methods were used in parallel over four months. The survey through questionnaires enabled the collection of quantitative data. Workshops and consultations, held with focused groups, helped in (i) identifying the procedures, (ii) developing the questionnaire, and (iii) deciding on the profile of respondents. The semi-structured interviews helped to understand respondents' behavior and profile to improvise the questionnaire and encourage participation.

Variables in the collected dataset were tested for normality using the Anderson-darling test and Box-plot analysis to detect the presence of outliers. The p-values greater than 0.05 implied a normal distribution of the variables, and three outliers were detected. The corresponding rows of observations were removed before the computation of descriptive statistics.

3.2 Survey Questionnaire

A list of OEPs was developed from past research but included contemporary and latest procedures, such as; cross-functional design-development teams, involving suppliers and customers in the design process, and customer feedback to determine product features. These procedures are relatively new but have gained high acceptance (Thomas et al., 2016). The guidelines were drawn from the OE studies and then enlisted in Table 1 with supporting literature references. From the inventory of procedures, 37 OEPs with five measures of CPs were enlisted that are widely applied by SMEs. Then a comprehensive questionnaire was developed to gauge the deployment of the shortlisted OEPs. A focused group of 14, comprised of academics and industry consultants, reviewed the questionnaire so that any relevant procedure was not missed out to ensure its content validity (Flink, 2010). This review recommended replacing – "Better product" with two separate questions- "Better product

features" and "High product quality." Generally, customers' feedback is taken on product features, but they are not involved in the designing process, but suppliers are involved (Fynes & De Búrca, 2005). (Matt et al., 2020), illustrated a semi-structured interview with 27 senior industry managers from 13 firms, all Managers and above, to assess its appropriateness and interpretability. Their feedback suggested providing a short operation definition for each procedure and a bi-lingual set of questionnaires.

<< Figure 2: Research methodology >>

This feedback was incorporated into the final set of the questionnaire. The questionnaire was divided into two parts to eliminate the chances of Common Method bias in the survey design. The first part comprised questions on the diffusion of OEPs (independent variables), and the second part highlighted the realization of CPs (dependent variables). It was ensured that two different interviewees responded to the two parts of the questionnaire. Post-survey, Harman's single factor test was done on the collected data where the contribution of the single factor was 23.44% which is less than 50%. Hence the survey instrument is not impacted by common method bias (Ketokivi, 2019). The questionnaire is presented in Appendix 2. The result of Harman's test is provided in Appendix-1.

The selection of participants in survey research is critical for reliable results. This research adopted the approach described for the respondents' appropriate selection (Abbey & Meloy, 2017). A database of registered SMEs was taken from the Planning Commission portal (https://niti.gov.in/), and their employee data was taken from Indiamart.com and 99Datacd.com. SMEs engaged in the manufacturing of a range of products, viz., Automobile parts and components, Electrical and electronics, Machine tools and equipment, FMCG, and home appliances, were considered in this study. Flyer emails were sent on the proposed survey,

which received 6081 responses. Suitable participants were identified by their functional specialization and hierarchical level in the organization, as recommended by (Flink, 2010). In the context of this study, only those respondents were considered who had 5 to 30 years of experience in managing manufacturing operations, holding the position of Manager and above (Bhattacharya et al., 2020). This yielded a list of 4213 eligible participants. Stratified random sampling is an effective method to obtain unbiased results because it ensures adequate participants of various characteristics (Matt et al., 2020). In this study, we considered Gender, Education, Experience, Position, Department, and Industry to divide the eligible participants into strata (Flink, 2010). Through this approach, 900 potential respondents were selected from the list of eligible participants to pursue the data collection further. The final set of questions was sent to these participants. Responses were sought for each question regarding usage of procedures on the Likert scale of 1 to 5, where 1 indicated complete non-deployment of OEP. In contrast, 5 indicated a full deployment (Ramezankhani et al., 2018). After repeated mailings and follow-ups, 473 responses were received, of which 317 were complete. Table 2 provides the participant's profile in the survey. Non-response bias was found in-significant (Table 3), as the p-values of paired-t tests on the early and late respondents were more than 0.05 (Matt et al., 2020).

<< Table 2: Participant's profile >>

<< Table 3: Non-response biasness Test >>

4. Data and analysis

The data collected from the survey is critically analyzed. The critical performance constructs followed by their procedures and descriptions are provided in Table 4, respectively. The mean deployment score for the OEPs and Cronbach's alpha is also offered. A commonly accepted cut-off value of Cronbach's alpha is 0.7 during the early stage of research (Krishnan & Ganesh, 2014). Still, a cut-off of 0.80 or higher is required in the advanced stage for adequate reliability (Nunnally, J. C., & Bernstein, 1994). In this study, each construct has a Cronbach's alpha of more than 0.82 (Table 4). Hence, these OEPs, rephrased as survey items in Table 4, have adequate internal Consistency to measure their corresponding performance construct.

<< Table 4: Measurement items for the key performance constructs of OEs >>

In this research, the measures used are the constructs identified in section 2.3, i.e., "Consistency," "Supplier-efficacy," "Product-excellence," "Process-efficiency," "Contractual-conformance," and "CP." The measurement items for each construct are a unique set of procedures represented by OEP_{ij}, such as; seven methods, OEP_{11} through OEP_{17}, to measure the "Consistency" construct.

4.1 Validation of the key performance constructs by Exploratory factor analysis

The OE performance constructs obtained in section 2.2 have the necessary theoretical validation because they are extracted from the literature (Abbey & Meloy, 2017). However, these constructs need to be validated empirically by Exploratory factor analysis of the survey data (Fynes & De Búrca, 2005). However, before that, the suitability of factor analysis needs to be checked by the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy and Bartlett's test of sphericity. Small values of the significance level (less than 0.05) suggest that factor analysis is suitable. In this study, KMO is 0.887, more than the recommended minimum, and Bartlett's

test has a significance of 0.045 (Shan et al., 2013). Given the results of the two tests, factor analysis is suitable for validating performance constructs (Table 5).

<< Table 5: Exploratory Factor analysis output >>

A principal component factor analysis with a varimax rotation was used in this study, with an eigenvalue more than or equal to 1.0. This implies that every factor has more variance than a single observed item (Fynes & De Búrca, 2005). The output of the exploratory factor analysis is provided in Table 5. The average factor loading is more than 0.7, which indicates a good convergence of the procedure items to the corresponding performance constructed (Shan et al., 2013). The cross-loading of the procedure items to other constructs is less than 0.3; hence there is adequate discriminant validity; in other words, the performance constructs are unique (Byrne, 2010). Thus, the proper convergent and discriminant validity in the factor analysis validates the six key performance constructs identified from the literature review (Ketokivi, 2019).

4.2 Structural Equation Modeling (SEM) and Path Analysis

This study has a defined objective of building a strategic framework for OE deployment, and SEM has proven its utility in strategy building by its unique way of defining observable and unobservable variables in a cause-and-effect model based on specific theoretical hypotheses (Aktepe et al., 2015). The visible variables are the survey items, and the unobservable variables are called the constructs. It is not limited to the exploration of correlation; instead, it confirms the correlations between theoretically developed constructs with data (Kiraz et al., 2020).

As a variable reduction technique, the factor analysis reduced 37 procedure items into six key performance constructs and retained 74.8% variation (Section 4.1). So the underlying constructs of Operational excellence that impact CP are consistent, and the results reveal that these constructs barely miss 25.2% of information explained by all procedures (Shan et al., 2013). Therefore, SEM can be applied to empirically confirm the correlations between theoretically developed constructs and CP(Kiraz et al., 2020). Before building the structural model, critical assumptions on linearity and multicollinearity must be tested(Byrne, 2010). The linear regression of constructs and CP has a p-value less than 0.002; therefore, the null hypothesis of no relation was rejected in favor of their linear relation at a significance level of 0.05 (Bollen & Noble, 2011). Variance inflation factor (VIF) is a statistic indicating the severity of multicollinearity, and a smaller value, less than 10, is desired. The obtained VIF was less than 3; therefore, the multicollinearity condition is also ensured (Fynes & De Búrca, 2005). The SEM, developed by AMOS16.0, depicts the empirical relationship between the critical constructs of Operational excellence and CP, presented in Figure 3. The standardized regression coefficient is inscribed beside the arrow, indicating an independent variable's effect on the dependent variable.

< Figure3: Structural equation model of the key constructs of Operational Excellence >

The stars written as superscripts describe the statistical significance of the regression coefficient. For example, improving "Product-excellence" by 1-standard deviation (1-SD) has an impact of 0.51-SD in the "Contractual-conformance." The corresponding significance level

is 0.001, as implied by the three stars written alongside (Byrne, 2010). Similarly, 1-SD higher "Consistency" brings 0.44-SD higher "Process-efficiency" (p-value < 0.001) and 0.14-SD higher "Contractual-conformance" (p-value < 0.05) (Bollen & Noble, 2011). "Supplier efficacy" impacts -0.25-SD on "Contractual-conformance," which contradicts the theoretical hypothesis. "Process efficiency" also has an effect of 0.28-SD on CP for a 1-SD rise (p-value <0.001) (Byrne, 2010). OEPs of each construct are mentioned in the SEM. For example, "Product-excellence" has its defining procedures from OEP_{41} through OEP_{47}. A detailed elucidation of these items is given in Table 4. The exogenous constructs indirectly impact the CP(Kumar et al., 2014). The outcomes of the hypothesis tests are provided in Table 6.

<< Table 6: Summary of the hypothesis tests >>

Based on this path analysis findings, a framework is developed in section 5 to select OEPs that ensure a definite positive impact on CP and prevent setting the others considering the risk involved. Before that, the compliance check of the SEM is presented in the next section.

4.2.1 Goodness of fit (GOF) for structural equation model

Several parameters have been used in literature to describe the Goodness of fit of the structural model. A statistically significant Chi-square/degrees of freedom (Χ2/df) indicates that the observed and predicted covariance matrices do not match (Guide & Ketokivi, 2015). The obtained value for χ^2/df was 1.258, less than the maximum acceptable limit of 5 (Kiraz et al., 2020). Goodness-of-fit index (GFI) is the proportion of variance accounted for by the estimated population covariance, which is higher, the better. The reported GFI is 0.938, within the acceptable range of 0.90~0.95 (Lance et al., 2006). Comparative-fit-index (CFI) tells how the model fits the data better than the model where all observed variables are uncorrelated (Ketokivi, 2019). The reported CFI is 0.964, within the prescribed range of 0.95~0.97

(Krishnan & Ganesh, 2014). Similarly, the reported Normed-fit-index (NFI) of 0.946 is within the scope of 0.90~0.95, and the Root Mean Square Error of Approximation (RMSEA) was at 0.05, within the acceptable limit (Kiraz et al., 2020). All the vital indices for model fitness were in the excellent range. Hence, the overall structural model fitted the data well.

5. Strategic Framework for OE Deployment in SME Firms

The SEM in Figure 3 depicts the relation between CP and OE's key performance constructs, which is generalizable for SMEs. Still, every SME firm's OE implementation strategy is bound to differ from other firms because each organization is at a different stage of its OE journey (Kiraz et al., 2020). Therefore, managers need to assess the applicability of OEPs in their firms to achieve the desired success (Kaur & Sharma, 2016). However, there needs to be a structured approach to evaluating the suitability of an OEP in an SME firm plays a significant roadblock in the OE deployment (Silva et al., 2021). The framework takes cues from the empirical relation between the key OE constructs, built-in section 4.2, and then defines a customized assessment flow for each OE procedure.

<< Figure 4: Framework for deployment of Operational Excellence >>

As an example, from the framework, if a "Consistency" procedure is selected, its potential impact on "Process efficiency" and "Contractual conformance" shall be evaluated by the managers. Arrows represent the decision flows. The firm lines indicate a positive impact, and the dotted line implies a lack of positive impact on the subsequent performance construct of OE. Dots represent the procedure's outcome regarding its impact on the CP of the firm. Every assessment flow concludes with two options; (i) implement the OEP or (ii) re-evaluate the risk. A black dot implies that the selected OEP has significant potential to increase CP, whereas the

white dot seeks a closer evaluation of the risk in implementing the procedure. This framework's customized assessment flow for each OEP has significant managerial implications for the SME managers as it helps to accurately decide if a selected system will positively impact the CP or evaluate the risk with the management before implementation. Thus, it safeguards the risk of implementing an OEP that may be futile CP.

6. Discussion of findings

An extensive literature review identified the key performance constructs of OE and their hypothesized relationships. A theoretical OE framework was developed based on the six detected constructs and five hypotheses. A comprehensive list of OEPs was prepared from relevant literature to validate the framework empirically. A focused group of 14 experts reviewed it. The group comprised academicians and industry managers, as recommended by (Flink, 2010). This review recommended replacing and rephrasing a few questions to make them understandable. Later, semi-structured interviews were conducted with 27 senior industry managers. They have over 12 years of experience managing industrial operations, as suggested by (Matt et al., 2020). Their feedback was to include a short definition for each procedure. The Exploratory factor analysis validated the existence of six key performance constructs of OE in SMEs. The SEM depicting the relationship between different critical constructs for achieving 'CP' is shown in Figure 3. The results emerging from the path analysis of SEM reveal an insightful pattern vis-à-vis the research hypothesis. This research's findings are crucial for several reasons, as they show the nature of the practical relations between the constructs of OEs'. Hypothesis **H1** states that a "Consistent" process has a positive impact on "Process-efficiency" (H1a), "Competitive-potential" (H1b), and "Contractual-conformance" (H1c). For this hypothesis to be supported, at least one significant path from "Consistency" to the other three performance constructs shall exist (Amoako-Gyampah & Acquaah, 2008). The results depicted in Figure 3 show that the path coefficient from "Consistency" to "CP"

(coefficient=0.12) is positive and becomes significant when moderated by "Process-efficiency" (coefficient=0.14, p-value=0.01) or "Contractual-conformance" (coefficient=0.14, p-value=0.01) as both paths are positive and significant at 0.01 level. Hence, the findings support **H1** (Buer et al., 2018). Hypothesis **H2** states that "Contractual-conformance" positively impacts "Competitive-potential." The path analysis (coefficient= 0.54, p-valye= 0.01) exhibits that **H2** cannot be rejected (Kiraz et al., 2020). Similarly, the path from "Process-efficiency" to CP (Coefficient=0.28, p-value=0.001) implies that **H5** cannot be rejected. Therefore, it can be concluded that although there is light diffusion of procedures under "Consistency," "Process-efficiency," and "Contractual-conformance" in SMEs (Yadav et al., 2017), the pattern of relationship is found to be similar to that exhibited by large enterprises. However, hypothesis **H3** states that "Supplier-efficacy" positively impacts "CP" (H3a) and "Contractual-conformance" (H3b). But its path to "CP" (coefficient=0.10, p-value> 0.05) is insignificant and, to "Contractual-conformance" (coefficient= -0.25, p-value < 0.001) is contrary to the hypothesis. On the whole, one can conclude that it does not have a significant impact on CP. Therefore, the SEM negated the hypothesis **H3**. Generally, "Supplier-efficacy" procedures are introduced based on sound decision models (Westphal & Sohal, 2016). Still, many such systems in SMEs are deployed to meet regulatory restrictions (Mohanty & Prakash, 2014). It seems to be a plausible reason behind the different relationship between "Supplier-efficacy" procedures in SMEs. Similarly, hypothesis **H4** states that "Product-excellence" positively impacts "CP" (H4a) and "Contractual-conformance" (H4b). While its path to "CP" was not significant but to "Contractual-conformance" (coefficient= 0.51, p-value= 0.001) is significant; therefore, **H4** cannot be rejected (Byrne, 2010). The low success rate of the R&D projects seems to be the reason for this (Mishra & Shah, 2009). The path analysis findings are applied to build the framework for OE deployment in SME firms.

7. Managerial implications

The research hypotheses and theoretical framework of OE are derived from literature. Therefore, the deviations highlighted in SEM's path analysis underscore the nuances of OE in an SME environment compared to the theoretical narrative. These insights of this study are noted below as the findings:

1. Six key constructs of OE– "Supplier-efficacy," "Consistency," "Process-efficiency," "Product-excellence," "Contractual-conformance," and "Competitive-potential (CP)" identified from literature are empirically validated to exist in an SME environment.
2. In contrast with the literature-based theoretical perspective, a "Consistency" procedure alone is insufficient to enhance "CP"; however, it can do so if mediated by "Contractual-conformance", and "Process-efficiency".
3. "Supplier-efficacy" deteriorates "Contractual-conformance", contrary to the theoretical narrative. Hence, it does not have enough potential to enhance the "CP" of SMEs. This divergence is attributed to the fact that meeting the regulatory requirements takes precedence over "CP" when SMEs implement "Supplier-efficacy" procedures.
4. Opposite to the literature perspective, in the case of SMEs, "Product-excellence" does not improve "CP." Process excellence is more attractive for SMEs as it brings in "Process-efficiency" and "Consistency" to guarantee product quality and CP (Zhou, 2016) at an affordable cost, unlike "Product-excellence" (Belekoukias et al., 2014). The "Product-excellence" procedures, such as incorporating customer-recommended product features, and designing based on material availability, are highly research-oriented and expensive (Blackhurst et al., 2005). Traditionally SMEs significantly lag in R&D compared to LEs, and their success rate in redefining the product is meager (Catenazzo & Paulssen, 2020). This is a plausible reason for "Product-excellence" not impacting "CP" in SMEs. However, its

relationship with "Contractual-conformance" is as per the theory. Hence, it could improve it.

5. "Contractual-conformance" and "Process-efficiency" demonstrated their relationship pattern precisely according to the theory; therefore, potentially, they enhance the "CP."

These deviations have substantial practical and managerial implications in the OE deployment in an SME environment. The lack of a guiding framework to assess a procedure's suitability is a significant roadblock in OE deployment for SME firms (Silva et al., 2021). The proposed framework (Figure 4) provides a systematic approach to assess the suitability of an OEP. It utilizes the empirical relation between key performance constructs of OE and CP, depicted by the SEM (Figure 3), and its path analysis to design the flow of assessment, which is unique and customized for each OEP. This framework makes the deployment strategy more robust. It prioritizes the procedures that have a definite positive impact on CP and simultaneously seeks a close review of the risk associated with other systems that do not positively impact CP. Thus, the framework enables SME managers to strategically select the procedures to enhance CP and hedge the risk of choosing non-benefiting OEPs.

8. Conclusion, limitations, and future work

To summarize, this research has attempted to achieve three objectives. The first objective has attempted to advance the theory of operational excellence by identifying six key performance constructs of OE from an extensive literature survey based on their deployment purpose. These constructs are denoted as "Consistency," "Product-excellence," "Process-efficiency," "Supplier-efficacy," "Contractual-conformance," and "Competitive-potential (CP)." The factor analysis validated the existence of these six critical constructs of OE. For the second objective, a set of research hypotheses were developed, depicting the relationship between different strands of procedures based on the literature framework. Most of the literature evidence on OE comes from large, established firms. Therefore, the hypotheses had a natural

allegiance to large-scale industries. The path analysis of SEM offered significant insights into OEs' practical aspects when carried out in SMEs. For instance, improving the process "Consistency" positively impacts CP when mediated by "Contractual-conformance" and "Process-efficiency." Similarly, in contradiction to the theory, "Supplier-efficacy" does not impact "Contractual-conformance" or CP, and "Product-excellence" moves "CP" when mediated by "Contractual-conformance." These insights indicated that OEs' deployment in SMEs may produce different results than witnessed in large-scale industries.

Regarding the third objective, a customizable framework was developed for the OE deployment in SMEs. The proposed framework uses the insights of the path analysis of the structural model to design the flow of assessment for an OE procedure. The framework selects procedures with a definite positive impact on CP and hedges from the OEPs, which can have an adverse effect.

This study has a few limitations which can be addressed in future research. First, the scope of the study is limited to manufacturing SMEs located in India. The generalization of findings to other countries shall be made with caution because cultural factors are often not salient (Ketokivi, 2019). A similar methodology can be extended to another sector, such as services. Future studies' selection of impactful variables and performance measures shall be extracted from the relevant literature (Taylor et al., 2020). Micro enterprises (less than ten employees) are characterized by their presence limited to local markets, minimal growth ambitions, and less focus on operational excellence (Matt et al., 2020). A similar strategic framework for OE shall be attempted in future research. Recent studies have identified that human resource management (Gunay & Kula, 2016), leadership, reward and recognition, training, and employee development play a critical role in high operational performance and CP (Catenazzo & Paulssen, 2020). Therefore, future research shall consider human factors in determining key performance constructs.

This study's findings indicate that more focus is required to make 'Product-excellence' procedures centric towards "Contractual-conformance" to enhance "CP" eventually. To start with, a closed-loop and integrated quality management system with "Product-excellence" is required (Brockhaus et al., 2016). Similarly, "Supplier efficacy" procedures of SMEs need to impact "Contractual-conformance" to impact CP positively. Future research shall focus on developing common objectives for "Supplier efficacy," quality management, and the rapidly changing environmental and regulatory requirements (Noshad & Awasthi, 2015). Studies and experiments have to continue with a broader perspective to make the process "Consistency" more compatible for the SMEs by incubating "Process-efficiency" and "Contractual-conformance". Future research shall explore enhancing the existing "Consistency" procedures by setting industry 4.0 enablers, quantitative methods, and quality management. Further, in future studies, a large survey with more practices can be explored in the context of developing economies, which will help explore more opportunities in various industry sectors.

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Appendix-1: Harman's Single Factor Test for common method bias

Factor	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of variance	Cumulative %	Total	% of variance	Cumulative %
1	9.573	25.873	25.873	8.674	23.444	**23.444**
2	4.717	12.748	38.621			
3	4.032	10.896	49.517			
4	2.912	7.871	57.388			
5	2.555	6.907	64.295			
6	1.611	4.354	68.649			
7	1.168	3.157	71.806			
8	1.024	2.767	74.573			
9	.878	2.373	76.945			
10	.876	2.368	79.314			
11	.642	1.734	81.048			
12	.604	1.633	82.681			
13	.561	1.517	84.198			
14	.523	1.414	85.612			
15	.502	1.356	86.968			
16	.490	1.324	88.292			
17	.441	1.193	89.485			
18	.404	1.091	90.576			
19	.365	.988	91.563			
20	.328	.886	92.449			
21	.306	.827	93.275			
22	.271	.733	94.009			
23	.255	.689	94.698			
24	.230	.620	95.318			
25	.225	.607	95.925			
26	.205	.555	96.480			
27	.189	.512	96.992			
28	.172	.465	97.456			
29	.160	.433	97.889			
30	.152	.412	98.301			
31	.138	.374	98.675			
32	.103	.279	98.953			
33	.098	.264	99.217			
34	.094	.254	99.471			
35	.068	.183	99.654			
36	.066	.178	99.832			
37	.062	.168	100.000			

Appendix-2: Survey questionnaire

Questionnaire for the survey on **"Deployment of operational excellence in the SMEs."**

Dear Sir,

We are surveying to study the deployment of operational excellence practices in Indian SMEs. As you are engaged in a manufacturing SME, you have unique insight into operational excellence. The information we seek from you will help us understand the deployment strategies for operational excellence and the needs of SMEs. We would be grateful if you could participate in this survey. Please answer the questions in the attached questionnaire. You can discuss the questionnaire with your colleagues while answering the same. The information you provide will be aggregated with other survey respondents; no third party will have access to it. This information will be used for academic research only and kept strictly confidential.

Section 1: Company profile

1. Name of the company: _____
2. Number of employees: _____
3. Turnover of the last financial year: _____
4. In which province is your company located: _____
5. Product of the company: □ Automobile parts □ Electrical & electronics, Machine Tools □ FMCG □ Home appliances

Section 2: Participant's profile

1. Your gender: □ Male □ Female
2. Your education: □ Graduate □ Postgraduate □ Other
3. Education stream: □ Science Humanities □Technical □ Business & Finance
4. Your work experience (in years): □ 1~5 □ 6~10 □ 11~15 □ 15~20 □ Above 20
5. Your position in the management hierarchy of the company: □ Junior □ Mid □ Senior
6. Your department: □ Production □ Logistics □ Quality □ R&D □ Sourcing □ Finance/HR

Section 3.1: Questionnaire on the deployment of operational excellence.

On a scale of 1 (not implemented at all) to 5 (fully implemented), to what extent do you practice the following operational excellence practices in your organization?

(Tick your choice).

Practices	1	2	3	4	5
Six Sigma DMAIC projects	□	□	□	□	□
Quality Circle	□	□	□	□	□
Statistical process control	□	□	□	□	□
Design of experiments (DOE)	□	□	□	□	□
Quality function deployment (QFD)	□	□	□	□	□
Benchmarking competitor's process	□	□	□	□	□
Failure mode effect analysis (FMEA)	□	□	□	□	□
Sharing customer feedback with	□	□	□	□	□
Outsourcing non-core functions	□	□	□	□	□
Reducing supply base	□	□	□	□	□
Supplier performance monitoring	□	□	□	□	□
Long-term relationships with key	□	□	□	□	□
Value Stream Mapping (VSM)	□	□	□	□	□
Enterprise resource planning (ERP)	□	□	□	□	□
Visual control	□	□	□	□	□
Single-minute exchange of die	□	□	□	□	□
Poka-yoke	□	□	□	□	□
Just in time (JIT)	□	□	□	□	□
Cross-functional design/development	□	□	□	□	□
Involving suppliers in design process	□	□	□	□	□
Customer feedback in determining	□	□	□	□	□
Designing based on the commonality	□	□	□	□	□
Factoring manufacturability in design	□	□	□	□	□
Consideration of component	□	□	□	□	□
Profit considerations during product	□	□	□	□	□
Quality policy, manual, and objectives	□	□	□	□	□
QMS Portal	□	□	□	□	□
Performance monitoring and reporting	□	□	□	□	□
Standard operating procedure	□	□	□	□	□
TQM/ISO audits by internal auditors	□	□	□	□	□
Training and education on contractual	□	□	□	□	□

Section 3.2: Questionnaire on performance measures.

On a scale of 1 (Strongly disagree / Very poor) to 5 (Strongly agree / Very effective), to what extent do you rate the following performance measures of your organization compared to the significant industry competitors?

(Tick your choice).

Performance parameters	1	2	3	4	5
Responsiveness to customer needs/query	□	□	□	□	□
On-time delivery	□	□	□	□	□
Product features designed as per customer demands	□	□	□	□	□
The cost of the product is competitive.	□	□	□	□	□
High product quality	□	□	□	□	□

For any future correspondence regarding this survey, please contact us. Thank you for participating in this survey.

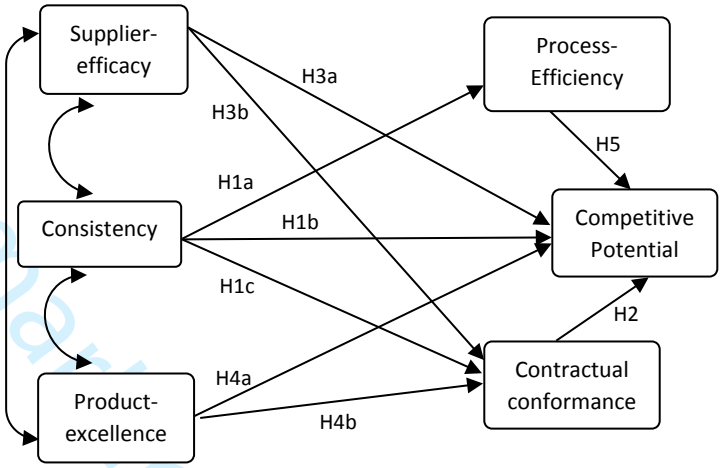


Figure1: Theoretical framework based on research hypotheses

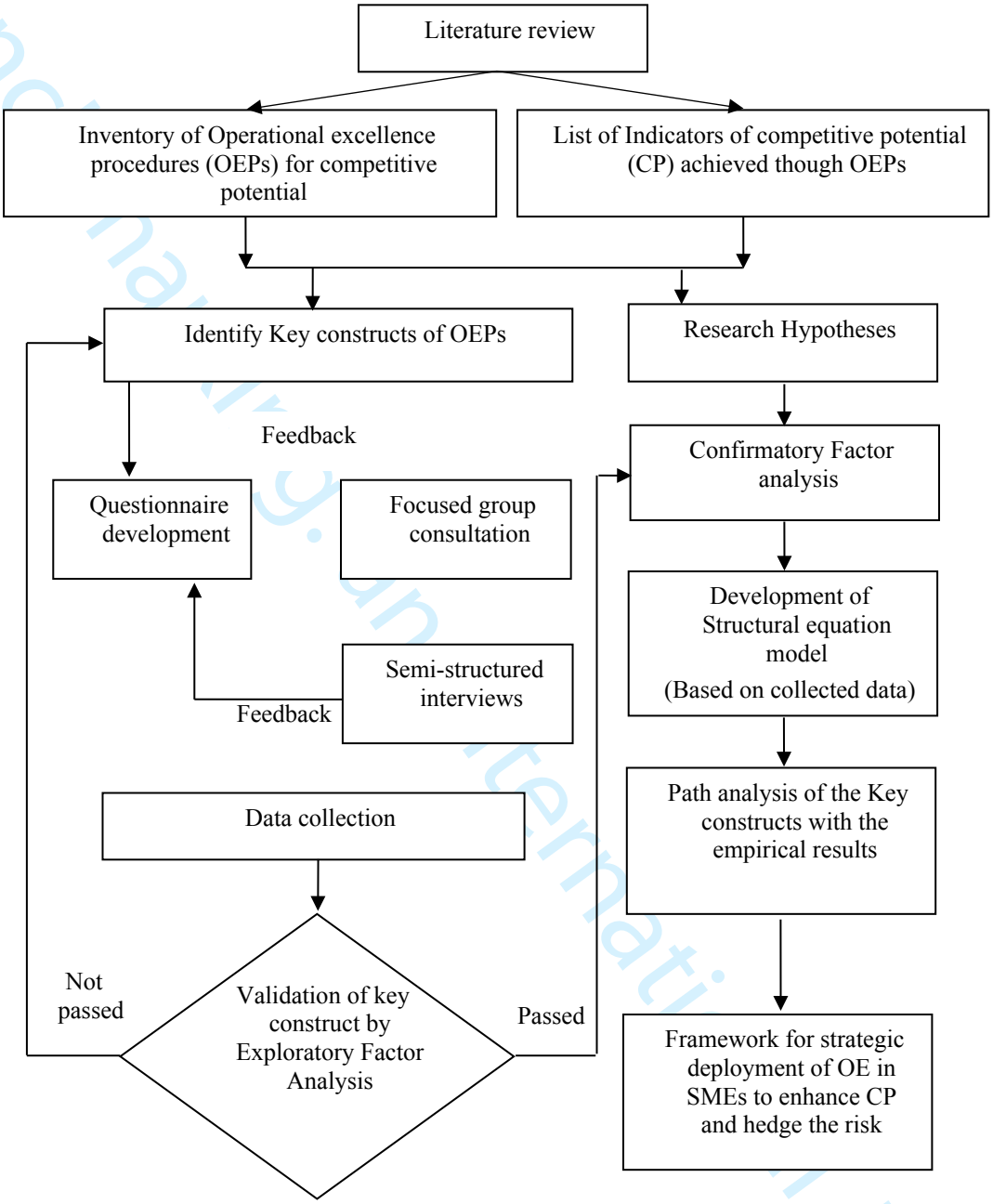
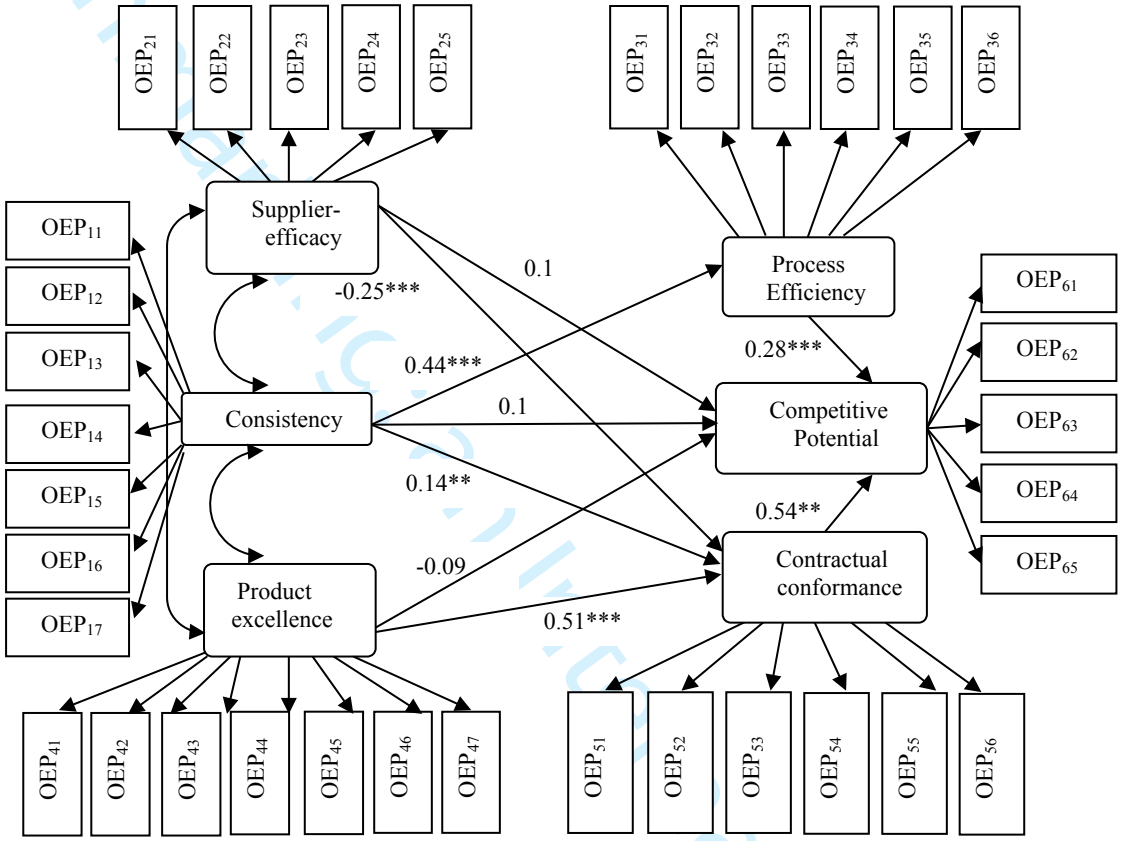


Figure 2: Research methodology



*** 0.001 level of significance, **0.05 level of significance

Figure3: Structural equation model of the key constructs of Operational Excellence

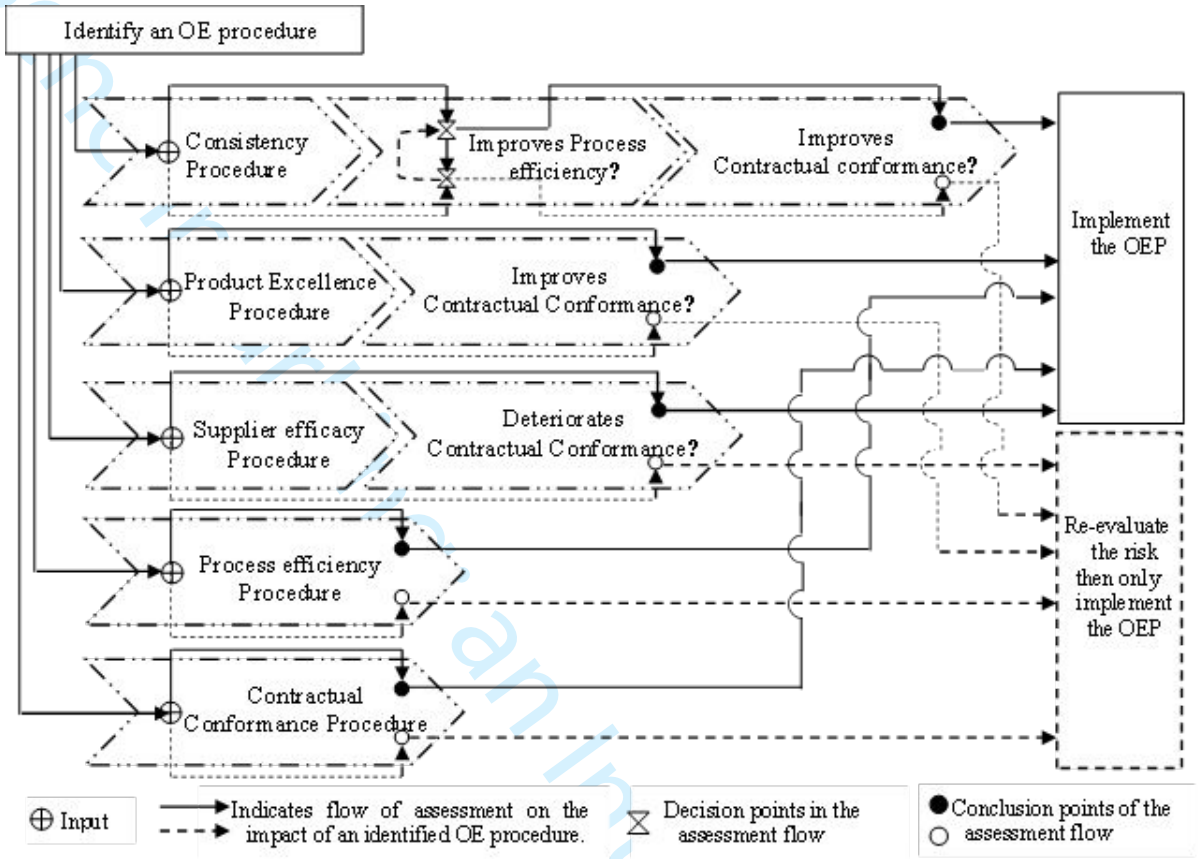


Figure4: Framework for deployment of Operational Excellence

Table1. Key performance constructs of operational excellence (OE)

Description of the practice	OEP_{ij}	Key performance construct	Reference
▪ Six Sigma DMAIC projects	OEP_{11}	**Consistency** To reduce variation and defects to achieve consistency in process output	(Bhattacharya et al., 2020) (Antony et al., 2017) (Noshad & Awasthi, 2015)(Radnor & Johnston, 2013)(Thomas et al., 2016)(Sahoo, 2020)
▪ Quality Circle	OEP_{12}		
▪ Statistical process control	OEP_{13}		
▪ Design of experiments (DOE)	OEP_{14}		
▪ Quality function deployment (QFD)	OEP_{15}		
▪ Benchmarking competitor's process	OEP_{16}		
▪ Failure mode effect analysis (FMEA)	OEP_{17}		
▪ Sharing customer feedback with suppliers	OEP_{21}	**Supplier efficacy** To improve the efficiency of the supply chain	(Al-Shboul et al., 2017) (Catenazzo & Paulssen, 2020) (Meds & Alvesalo, 2010) (Narasimhan et al., 2005) (Zhou, 2016)(Ramezankhani et al., 2018) (Chakraborty et al., 2019)(Westphal & Sohal, 2016)
▪ Outsourcing non-core functions	OEP_{22}		
▪ Reducing supply base	OEP_{23}		
▪ Supplier performance monitoring	OEP_{24}		
▪ Long term relationships with key suppliers	OEP_{25}		
▪ Value Stream Mapping (VSM)	OEP_{31}	**Process efficiency** To increase efficiency by eliminating waste and making the processes Lean	(Abbey & Meloy, 2017) (Asif et al., 2013) (Thomas et al., 2016) (Yadav et al., 2017)
▪ Enterprise resource planning (ERP)	OEP_{32}		
▪ Visual control	OEP_{33}		
▪ Single minute exchange of die (SMED)	OEP_{34}		
▪ Poka-yoke	OEP_{35}		
▪ Just in time (JIT)	OEP_{36}		
▪ Cross functional design/development teams	OEP_{41}	**Product excellence** To channelize creativity for achieving product excellence	(Asif et al., 2013) (Blackhurst et al., 2005) (Chukhrova & Johannssen, 2019)(Kumar et al., 2014) (Matt et al., 2020) (Mishra & Shah, 2009)
▪ Involving suppliers in design process	OEP_{42}		
▪ Customer feedback in determining product features	OEP_{43}		
▪ Designing based on commonality of parts	OEP_{44}		
▪ Factoring manufacturability in design	OEP_{45}		
▪ Consideration of component availability	OEP_{46}		
▪ Profit considerations during product design	OEP_{47}		
▪ Quality policy, manual and objectives	OEP_{51}	**Contractual conformance** To confirm the contractual requirements	(Al-Shboul et al., 2017) (Antony et al., 2017) (Ben Romdhane et al. 2017) (Chukhrova & Johannssen, 2019)(Kumar et al., 2014) (Noshad & Awasthi, 2015) (Yadav et al., 2017)
▪ QMS Portal	OEP_{52}		
▪ Performance monitoring and reporting	OEP_{53}		
▪ Standard operating procedure	OEP_{54}		
▪ TQM/ISO audits by internal auditors	OEP_{55}		
▪ Training and education on contractual obligations	OEP_{56}		
▪ Responsiveness	OEP_{61}	**Competitive potential** To gauge the organization's performance on its competitive potential	(Bortolotti et al., 2013)(Buer et al., 2018)(Matt et al., 2020)(Magniez et al., 2009) (Brockhaus et al., 2016)
▪ On time delivery	OEP_{62}		
▪ Product features	OEP_{63}		
▪ Cost	OEP_{64}		
▪ Product Quality	OEP_{65}		

Table 2: Participant's profile

Characteristics		Number of Participants	Percentage%
Gender	Male	233	73.5%
	Female	84	26.5%
Education	Graduate	185	58.4%
	Postgraduate	87	27.4%
	Others	45	14.2%
Education Stream	Science	125	39.4%
	Humanities	37	11.7%
	Technical	106	33.4%
	Business and Finance	49	15.5%
Work Experience (In Years)	1-5	31	9.8%
	6-10	93	29.3%
	11-15	107	33.8%
	15-20	37	11.7%
	Above 20	49	15.5%
Position	Junior management	61	19.2%
	Mid management	221	69.7%
	Senior management	35	11%
Department/Function	Shop floor/Production	101	31.9%
	Warehouse and logistics	42	13.2%
	Quality control	49	15.5%
	R&D	36	11.4%
	Sourcing and Procurement	53	16.7%
	Finance and HR	36	11.4%
Type of SME	Automobile parts and components	100	31.5%
	Electrical and Electronics	53	16.7%
	Machine tool and equipment	58	18.3%
	FMCG	49	15.5%
	Home appliances	57	18%

Table3: Nonresponse biasness test

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	LP1_E - LP1_L	.16000	1.09470	.15481	-.15111	.47111	1.033	49	.306
Pair 2	LP2_E - LP2_L	.14000	1.19540	.16905	-.19973	.47973	.828	49	.412
Pair 3	LP3_E - LP3_L	.06000	1.26829	.17936	-.30045	.42045	.335	49	.739
Pair 4	LP4_E - LP4_L	-.12000	1.17178	.16571	-.45302	.21302	-.724	49	.472
Pair 5	LP5_E - LP5_L	-.12000	1.25584	.17760	-.47691	.23691	-.676	49	.502
Pair 6	LP6_E - LP6_L	.08000	1.36785	.19344	-.30874	.46874	.414	49	.681
Pair 7	LP7_E - LP7_L	.06000	1.26829	.17936	-.30045	.42045	.335	49	.739
Pair 8	SCEI1_E - SCEI1_L	.32000	1.67137	.23637	-.15500	.79500	1.354	49	.182
Pair 9	SCEI2_E - SCEI2_L	.12000	1.62431	.22971	-.34162	.58162	.522	49	.604
Pair 10	SCEI3_E - SCEI3_L	.24000	1.47855	.20910	-.18020	.66020	1.148	49	.257
Pair 11	SCEI4_E - SCEI4_L	.28000	1.41479	.20008	-.12208	.68208	1.399	49	.168
Pair 12	SCEI5_E - SCEI5_L	.18000	1.52114	.21512	-.25230	.61230	.837	49	.407
Pair 13	DDP1_E - DDP1_L	.00000	.75593	.10690	-.21483	.21483	.000	49	1.000
Pair 14	DDP2_E - DDP2_L	.14000	.80837	.11432	-.08974	.36974	1.225	49	.227
Pair 15	DDP3_E - DDP3_L	.06000	.89008	.12588	-.19296	.31296	.477	49	.636
Pair 16	DDP4_E - DDP4_L	.08000	.80407	.11371	-.14851	.30851	.704	49	.485
Pair 17	DDP5_E - DDP5_L	.02000	.89191	.12614	-.23348	.27348	.159	49	.875
Pair 18	DDP6_E - DDP6_L	.12000	1.00285	.14182	-.16501	.40501	.846	49	.402
Pair 19	DDP7_E - DDP7_L	.18000	.94091	.13306	-.08740	.44740	1.353	49	.182
Pair 20	SSP1_E - SSP1_L	.22000	1.23371	.17447	-.13062	.57062	1.261	49	.213
Pair 21	SSP2_E - SSP2_L	.04000	1.19455	.16893	-.29949	.37949	.237	49	.814
Pair 22	SSP3_E - SSP3_L	.12000	1.20611	.17057	-.22277	.46277	.704	49	.485
Pair 23	SSP4_E - SSP4_L	.08000	1.17526	.16621	-.25400	.41400	.481	49	.632
Pair 24	SSP5_E - SSP5_L	.24000	1.45069	.20516	-.17228	.65228	1.170	49	.248
Pair 25	SSP6_E - SSP6_L	.30000	1.19949	.16963	-.04089	.64089	1.769	49	.083
Pair 26	SSP7_E - SSP7_L	.20000	1.12486	.15908	-.11968	.51968	1.257	49	.215
Pair 27	CP1_E - CP1_L	-.18000	.71969	.10178	-.38453	.02453	-1.769	49	.083
Pair 28	CP2_E - CP2_L	-.04000	1.04900	.14835	-.33812	.25812	-.270	49	.789
Pair 29	CP3_E - CP3_L	-.04000	.63760	.09017	-.22120	.14120	-.444	49	.659
Pair 30	CP4_E - CP4_L	-.16000	.81716	.11556	-.39224	.07224	-1.385	49	.172
Pair 31	CP5_E - CP5_L	.06000	1.09563	.15495	-.25137	.37137	.387	49	.700
Pair 32	CQ1_E - CQ1_L	.18000	1.00387	.14197	-.10530	.46530	1.268	49	.211
Pair 33	CQ2_E - CQ2_L	-.08000	1.04667	.14802	-.37746	.21746	-.540	49	.591
Pair 34	CQ3_E - CQ3_L	.10000	.88641	.12536	-.15191	.35191	.798	49	.429
Pair 35	CQ4_E - CQ4_L	-.10000	1.07381	.15186	-.40517	.20517	-.659	49	.513
Pair 36	CQ5_E - CQ5_L	.00000	.83299	.11780	-.23673	.23673	.000	49	1.000
Pair 37	CQ6_E - CQ6_L	.08000	1.06599	.15075	-.22295	.38295	.531	49	.598

Table4: Measurement items for the key performance constructs of OEs

Key performance construct	OEP_{ij}	Description of the practice	Mean	Cronbach's alpha
Consistency	OEP_{11}	Six Sigma DMAIC projects	3.43	0.931
	OEP_{12}	Quality Circle	3.38	
	OEP_{13}	Statistical process control	3.43	
	OEP_{14}	Design of experiments (DOE)	3.65	
	OEP_{15}	Quality function deployment (QFD)	3.25	
	OEP_{16}	Benchmarking competitor's process	3.53	
	OEP_{17}	Failure mode effect analysis (FMEA)	3.65	
Supplier-efficacy	OEP_{21}	Sharing customer feedback with suppliers	2.51	0.944
	OEP_{22}	Outsourcing non-core functions	2.47	
	OEP_{23}	Reducing supply base	2.25	
	OEP_{24}	Supplier performance monitoring	2.34	
	OEP_{25}	Long term relationships with key suppliers	2.36	
Process-efficiency	OEP_{31}	Value Stream Mapping (VSM)	2.87	0.891
	OEP_{32}	Enterprise resource planning (ERP)	2.76	
	OEP_{33}	Visual control	3.14	
	OEP_{34}	Single minute exchange of die (SMED)	2.92	
	OEP_{35}	Poka-yoke	2.98	
	OEP_{36}	Just in time (JIT)	2.99	
Product-excellence	OEP_{41}	Cross functional design/development teams	3.99	0.920
	OEP_{42}	Involving suppliers in design process	3.92	
	OEP_{43}	Customer feedback in determining product features	3.93	
	OEP_{44}	Designing based on commonality of parts	3.91	
	OEP_{45}	Factoring manufacturability in design	4.01	
	OEP_{46}	Consideration of material and component availability during conceptualization	3.95	
	OEP_{47}	Profit considerations during product design	3.97	
Contractual conformance	OEP_{51}	Quality policy, manual and objectives	3.82	0.828
	OEP_{52}	QMS Portal	4.04	
	OEP_{53}	Performance monitoring and reporting	3.92	
	OEP_{54}	Standard operating procedure	4.08	
	OEP_{55}	TQM/ISO audits by internal auditors	3.91	
	OEP_{56}	Training and education on contractual obligations	3.68	
Competitive potential	OEP_{61}	Responsiveness	3.58	0.856
	OEP_{62}	On time delivery	3.75	
	OEP_{63}	Product features	3.78	
	OEP_{64}	Cost	3.61	
	OEP_{65}	Product Quality	3.78	

Table 5: Exploratory Factor analysis output

Key performance construct	OEP	Factor Loading					
		Consistency	Product excellence	Supplier-efficacy	Efficiency	Contractual conformance	Competitive Potential
Consistency	OEP_{17}	0.88	--	--	--	--	--
	OEP_{15}	0.87	--	--	--	--	--
	OEP_{14}	0.84	--	--	--	--	--
	OEP_{16}	0.82	--	--	--	--	--
	OEP_{13}	0.77	--	--	--	--	--
	OEP_{11}	0.75	--	--	--	--	--
	OEP_{12}	0.72	--	--	--	--	--
Product-excellence	OEP_{44}	--	0.89	--	--	--	--
	OEP_{43}	--	0.88	--	--	--	--
	OEP_{42}	--	0.82	--	--	--	--
	OEP_{45}	--	0.81	--	--	--	--
	OEP_{41}	--	0.76	--	--	--	--
	OEP_{47}	--	0.70	--	--	--	--
	OEP_{46}	--	0.62	--	--	--	--
Supplier-efficacy	OEP_{21}	--	--	0.89	--	--	--
	OEP_{24}	--	--	0.89	--	--	--
	OEP_{22}	--	--	0.89	--	--	--
	OEP_{25}	--	--	0.88	--	--	--
	OEP_{23}	--	--	0.87	--	--	--
Process-efficiency	OEP_{34}	--	--	--	0.95	--	--
	OEP_{35}	--	--	--	0.89	--	--
	OEP_{31}	--	--	--	0.75	--	--
	OEP_{32}	--	--	--	0.71	--	--
	OEP_{33}	--	--	--	0.70	--	--
	OEP_{36}	--	--	--	0.52	--	--
Contractual conformance	OEP_{51}	--	--	--	--	0.88	--
	OEP_{52}	--	--	--	--	0.82	--
	OEP_{55}	--	--	--	--	0.73	--
	OEP_{54}	--	--	--	--	0.64	--
	OEP_{51}	--	--	--	--	0.50	--
	OEP_{56}	--	--	--	--	0.45	--
Competitive potential	OEP_{62}	--	--	--	--	--	0.77
	OEP_{63}	--	--	--	--	--	0.72
	OEP_{65}	--	--	--	--	--	0.69
	OEP_{61}	--	--	--	--	--	0.63
	OEP_{64}	--	--	--	--	--	0.59

Table 6: Summary of hypothesis tests

Hypothesis		Result of the Hypothesis test
H1	"Consistency" of the process output has a positive impact on "Process-efficiency" *(H1a),* "Competitive-potential" *(H1b)* and, "Contractual-conformance" *(H1c)* of the process.	H1a: Confirmed
		H1b: Not confirmed
		H1c: Confirmed
H2	"Contractual-conformance" has a positive impact on "Competitive-potential".	H2: Confirmed
H3	"Supplier-efficacy" procedures positively impact "Competitive-potential" *(H3a)* and "Contractual-conformance" *(H3b).*	H3a: Not confirmed
		H3b: Not confirmed
H4	"Product-excellence" procedures have a positive impact on "Competitive-potential" *(H4a)* and also on "Contractual-conformance" *(H4b).*	H4a: Not confirmed
		H4b: Confirmed
H5	Increase in "Process-efficiency" of the process improves the "Competitive-potential".	H5: Confirmed

Reviewer: 1
Recommendation: Minor Revision

Reviewer Comments:

This study contains an innovative idea. However, it has the following shortfall:

1. The use of language needs proofreading and editing.

Additional Questions:
1. Originality: Does the paper contain new and significant information adequate to justify publication?: The manuscript of this version is now suitable for publication, subject to one correction mentioned by the reviewer.
2. Relationship to Literature: Does the paper demonstrate an adequate understanding of the relevant literature in the field and cite an appropriate range of literature sources? Is any significant work ignored?: Now literature review section looks good.
3. Methodology: Is the paper's argument built on an appropriate base of theory, concepts, or other ideas? Has the research or equivalent intellectual work on which the paper is based been well designed? Are the methods employed appropriate?: The methodology section has been improved.
4. Results: Are results presented clearly and analysed appropriately? Do the conclusions adequately tie together the other elements of the paper?: Now it looks good.
5. Implications for research, practice and/or society: Does the paper identify clearly any implications for research, practice and/or society? Does the paper bridge the gap between theory and practice? How can the research be used in practice (economic and commercial impact), in teaching, to influence public policy, in research (contributing to the body of knowledge)? What is the impact upon society (influencing public attitudes, affecting quality of life)? Are these implications consistent with the findings and conclusions of the paper?: Both theoretical and practical implications for research are included.
6. Quality of Communication: Does the paper clearly express its case, measured against the technical language of the field and the expected knowledge of the journal's readership? Has attention been paid to the clarity of expression and readability, such as sentence structure, jargon use, acronyms, etc.: The use of language needs proofreading and editing.

Response to reviewers

Dear Reviewer, Thank you for your feedback and additional questions. We appreciate your positive assessment of the innovative idea presented in our study and acknowledge the shortfall regarding the use of language, which requires proofreading and editing.
We have ensured that the language in our manuscript is thoroughly reviewed and improved to enhance clarity, readability, and adherence to the technical language expected by the journal's readership.

Additional Questions responses:

1. **Originality:** We are pleased to hear that the manuscript of this version is considered suitable for publication, subject to one correction mentioned by the reviewer. We appreciate the recognition of the new and significant information presented in our

paper, justifying its publication. We have addressed the specific correction highlighted by the reviewer to ensure the overall suitability of the manuscript.

2. **Relationship to Literature:** We are glad to know that the literature review section is now deemed satisfactory, demonstrating an adequate understanding of the relevant literature in the field and citing an appropriate range of literature sources. We have made efforts to consider significant works and ensure they are appropriately referenced in the revised manuscript.
3. **Methodology:** We appreciate the acknowledgment that the methodology section has been improved. We have diligently worked on building our paper's argument on an appropriate base of theory, concepts, and ideas. The research and intellectual work on which the paper is based have been well designed, and we have utilized appropriate methods. These enhancements aim to strengthen the robustness of our research and ensure its scholarly integrity.
4. **Results:** We are pleased to hear that the results are now presented clearly and analyzed appropriately, contributing to the overall coherence of the paper. We have made efforts to ensure that the conclusions effectively tie together the other elements of the paper, providing a comprehensive and cohesive overview of our findings.
5. **Implications for research, practice, and/or society:** We thank the reviewer for recognizing that our paper identifies both theoretical and practical implications for research. We have made explicit connections between our findings and their implications for research, practice, and society. By bridging the gap between theory and practice, we aim to contribute to the body of knowledge, influence public policy, and have a positive impact on society. The implications are consistent with the findings and conclusions presented in the paper.
6. **Quality of Communication:** We appreciate the reviewer's feedback regarding the need for proofreading and editing to ensure the quality of communication in our paper. We have checked for any shortcomings in the language used, including sentence structure, jargon use, acronyms, and overall clarity of expression. In the revised version, we have given meticulous attention to these aspects, improving the language to align with the technical standards of the field and enhance the readability of the manuscript.

Thank you for your valuable comments and guidance. We have carefully addressed each point raised, making the necessary revisions to enhance the quality and suitability of our manuscript for publication in the journal.