A Study on Quality Control Practices in Small-Scale Industries (Ssis) In Delhi NCR Region

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***Abstract*—Small scale industries are also a crucial part of India's industrial economy. They contribute nearly 30% of India's GDP and over 40 million people work in this industry. The study on quality control practices adopted by SSIs in Delhi NCR which includes Noida, Ghaziabad, Faridabad and Gurugram. Through the use of descriptive research methodology, the primary data was collected through the use of structured questionnaires from 120 SSI proprietors, production managers and quality supervisors engaged in the manufacturing sector. The research studies the level of application of quality control, existing quality control method, barrier to application and correlation of quality practices with operational performance. For data analysis, descriptive statistical tools mean, median and mode were used. The findings show that 72% of SSIs have quality control, however, only a mere 28 % follow any quality management systems. The visual inspection still the most common method used (82%), while adoption of statistical process control is 14%. The major barriers identified were financial constraints (78%), lack of technical expertise (69%) and limited knowledge about modern quality tools (65%). The study concludes with suggestions for institutionalisation of government-sponsored quality consultancy, subsidised ISO certification and industry-academia partnership for quality enhancement for SSIs in the region.**

***Index Terms*—Quality Control, Small-Scale Industries, Delhi NCR, ISO Certification, Statistical Process Control, Total Quality Management, Manufacturing Excellence**

I. INTRODUCTION

SSIs or small-scale industries are now called Micro Small and Medium Enterprises (MSMEs). They are defined by the MSMED Act 2006. They are the backbone of India's industrial sector. The ministry of MSME, Government of India, has said that the sector has about 63 million units across the country. Further, these units produce over 6,000 varied products from traditional handicrafts to auto and electronic parts [1]. Delhi NCR, which includes Delhi, Noida, Ghaziabad, Faridabad, and Gurugram, has one of the highest concentrations of small-scale industries in North India. There are an estimated 45,000 registered small-scale units in the NCR region that operate in the engineering, textile, food processing, chemical, and electronic sub-sectors.

Quality control is the process of monitoring and verifying whether the products and services are conforming to the specifications that have been predetermined and required by the customer. In manufacturing competitiveness, it is very important. According to the International Organization for Standardization (ISO), quality control is the operational techniques and activities that are used to fulfil requirements for quality [2]. Better or effective quality management system leads to customer retention, rework cost reduction, better access to markets, and successful business expansion in the context of SSIs. Quality control in Delhi NCR SSIs seems to be being implemented in bits and parts and in too many cases superficially, as per anecdotal evidence and preliminary industry surveys.

The Indian government has initiated the Zero Defect Zero Effect (ZED) programme and has mandated Quality Control Orders (QCOs) for critical products aimed at the MSME sector. Moreover, it is undertaking cluster-based quality improvement projects [3]. Nevertheless, the unstained adoption of quality practices by the individual SSI units at the ground level is not well-documented, especially for a newly urbanizing region like the NCR where workforce migration and vigorous cost competition abound.

There is a gap in empirical research on quality control practices adopted by SSIs in Delhi NCR and this paper addresses the same. The study has the

following specific objectives: (i) to analyse the current level of awareness and implementation of quality control among the SSIs of the region, (ii) to identify the most commonly adopted quality management tools and techniques, (iii) to evaluate the relationship between various quality control practices and operational performance indicators, (iv) to assess the major obstacles inhibiting the adoption of quality management, and (v) to provide evidence-based recommendations for policymakers, industry associations of SSIs and ownes of SSIs to enhance quality standards.

This study also has implications beyond just the academia as much as 120 SSI units belonging to various manufacturing categories have been included in the study to generate primary data to facilitate the Noida Entrepreneurs Association, Faridabad Small Industries Association, etc., and the MSME development institutes of the region. "The findings are likely to help in launching quality awareness campaigns, subsidized training programs, and cluster-level quality certification."

The geographical scope of this study is limited to Delhi NCR, specifically the industrial clusters of Noida (i.e. Sector 63, Phase II); Ghaziabad (i.e. Sahibabad Industrial Area); Faridabad (i.e. DLF Industrial Area); and Gurugram (i.e. IMT Manesar). As per the sectors, the research includes the small-scale ones that are involved with engineering goods, electronics, … A descriptive cross-sectional design was employed for the study. The data was collected through the structured questionnaire. In-depth interview. And observation of shop-floor practices from January to March 2025.

II. LITERATURE REVIEW

A. Small-Scale Industries in the Indian Context

The theoretical underpinnings of SSI development in India stem from the pioneering work of scholars looking at the role of cottage and small industries in economic development of the nation. Khanka [4] examined the role of SSIs in generating employment, industrializing rural areas, and developing regions in a balanced manner. According to the study, SSIs contribute about 45% of manufactured output and 40% of total exports of India. The figures have not changed much over the years. In a more recent study by Prasad and Sridevi [5], the performance characteristics of SSIs has been examined in post liberalization era. It shows that units having formal quality management system have 34% more productivity and 28% less rejection than those units having only informal rejection system.

Delhi NCR region is a unique case study in the national scenario of SSIs. According to an assessment done by Kumar and Singh [6], different types of SSIs in NCR were assessed in their spatial distribution and sectoral composition. The study found three most dominant clusters, Noida-Greater Noida electronics corridor, Faridabad-Ballabgarh engineering belt and Ghaziabad-Sahibabad diversified manufacturing zone. Their study showed that the trend is changing for SSIs to be the Tier-2 and Tier-3 suppliers to large original equipment manufacturers in the various automotive and consumer electronics that are driving up quality expectations from small suppliers.

B. Quality Management Theory and Practices

This study’s theoretical frameworks have been laid upon the transition from inspection-based quality management to total quality management (TQM) and Six Sigma. Deming's [7] unique ideas provided the statistics of quality control. The idea is to reduce the variation in the processes. Continuous checking must be done to achieve this end. The Plan-Do-Check-Act (PDCA) Cycle was introduced by Deming. Juran [8] stated the quality trilogy (quality planning, quality control and quality improvement) approach which offered a management-oriented counterpoint to Deming’s statistical focus. Crosby [9] stated zero defects shifted organization’s culture from detection to prevention.

Several researchers have examined the importance of these theories to small-scale manufacturing. Authors Ghobadian and Gallear undertook a very comprehensive study involving TQM implementations in SMEs having found out certain differences between large-enterprise and small-firm quality management. A group of researchers found that SMEs face unique barriers such as limited finances, lack dedicated quality department, lower level of education of managers, and weaker supplier bargaining power. They claimed that a simple focused quality approach, rather than a full-fledged TQM implementation, yielded better results for small firms having limited resources.

ISO 9001 certification has become the international benchmark for quality management systems. According to Corbett et al. [11], a study of the financial performance of 916 ISO 9001-certified firms in the US showed a statistically significant improvement in return on assets and sales growth after ISO 9001 certification. In an Indian context, ISO certified SSIs in the Punjab engineering cluster reported 18% reductions in customer complaints and 22% improvement in on-time delivery performance after receiving certification, as per Sharma [12].

C. Quality Control in Indian SSIs: Empirical Studies

Numerous studies have looked into quality management practices of Indian small-scale industries. Patel and Patel [13] examined a total of 85 small scale industries (SSIs) of Gujarat chemical cluster and result showed that only 31% have documented quality procedures. Furthermore, the interviews show that 24% carries out regular internal quality audit while only 12% employ statistical process control techniques. Across the surveyed units, the most common quality method in use was final visual inspection, with hardly any emphasis on in-process quality.

Agarwal [14] conducted survey of quality practices among Ludhiana hosiery SSIs and found 68% of owners claimed to know quality concepts, but only 19% could express which quality parameters applied to their products. According to the study, the absence of formal technical education among the predominantly family-managed workforce along with limited exposure to modern manufacturing practices through industry events or suppliers is the reason for this disparity.

Verma and Gupta [15] are the most directly relevant precedent to this study. The authors studied the quality management practices of 60 SSIs located in Delhi-Faridabad industrial belt. Five respective CSFs for quality implementation. They are top management commitment, employee training, customer feedback mechanism, supplier quality assurance and using quality data for decisions. But, engineering SSI is only a part of the whole manufacturing sector studied in the broader NCR Region. Quality practices in all manufacturing sectors have not been studied.

III. METHODOLOGY

A. Research Design

The research design of this study is descriptive and cross-sectional in nature. Due to the study's aim of providing accounts of existing quality control practices, measuring how common they are, in addition to identifying them and the patterns and barriers associated with them. Not providing causal estimates or testing theoretical models. Thus, a descriptive approach is appropriate. The primary data has been collected by a structured questionnaire complementing semi-structured interviews with direct site observations.

B. Study Area and Population

The geographical region includes the four major industrial centers of Delhi NCR: (1) Noida and Greater Noida (Gautam Buddh Nagar district, Uttar Pradesh) which has electrical, electronics and precision engineering SSIs; (2) Ghaziabad and Sahibabad (Ghaziabad district, Uttar Pradesh) which has a diversified manufacturing base like metal fabrication, rubber products, food processing, etc.; (3) Faridabad (Haryana) which is known for auto-components, machinery parts, textiles; and (4) Gurugram IMT Manesar (Haryana) which has electronics assembly, engineering goods and other industries. The sampling frame was prepared from District Industries Centres (DICs) directories, Noida Entrepreneurs Association, and Faridabad Industries Association, which yielded a population of about 2,800 active SSIs with investment and turnover as per MSMED Act.

C. Sampling Procedure

A systematic random sampling method was applied in this study to ensure proportional representation of the whole industrial zones of each bulk manufacturing sector. The study adopted a sample size of 120 units that was calculated using the formula for finite populations at 95% confidence level with a margin of error equal to 5 . This is adjusted for likely non response. The classification system consisted of type location (four zones) and type of economic activity (five types). The distribution of the samples that was achieved was as follows: Noida: 34 units; Ghaziabad: 28 units; Faridabad: 32 units; Gurugram: 26 units; by sector:

Engineering: 38; Electronics: 24; Textiles: 22; Food Processing: 20; Chemicals: 16.

D. Data Collection Instruments

The major tool for collecting primary data was a structured questionnaire consisting of thirty-two items organized in five sections: (A) Demographic and organizational profile-8; (B) Quality control awareness and organizational commitment-6; (C) Quality management practices and tools-8; (D) Performance outcomes and operational metrics-5; and (E) Barriers and challenges-5. The responses used a combination of Likert-type scales (5-point), dichotomous yes/no formats, and categorical responses. The pilot test of the questionnaire involved 15 SSI proprietors who were not part of the sample. It helped to refine the wording, response categories, and sequencing of the questions. Based on the analysis of the pilot data, still reliable (Cronbachα would 0.82)

E. Data Analysis Methods

Using frequency counts, percentages, mean, median, and mode through descriptive statistics the analysis of data was performed. An analysis of cross-tabulations was conducted to analyse the relationship between the categorically subdivided variables like the industry sector and the quality management adoption level. Through the scoring of the Likert-scale responses, the barriers and the impact on the performance were ranked. All the calculations were checked by the manual techniques and also statistical software.

TABLE I Sample Distribution by Industrial Zone and Sector

Zone	Engineering	Electronics	Textiles	Food	Chemical	Total
Noida	10	12	4	5	3	34
Ghaziabad	8	4	6	7	3	28
Faridabad	12	5	8	4	3	32
Gurugram	8	3	4	4	7	26
Total	38	24	22	20	16	120

IV. RESULTS AND DISCUSSION

A. Profile of Respondent SSIs

Based on a survey of 120 SSI units, the average operational year was 15.3, with the mode being 10. The highest proportion of companies in the sample, 62%, were sole proprietorships. The employee numbers of the workforces ranged from 8 to 95 with a median at 28. First-generation entrepreneur owned firms constituted 58% of dominant ownership pattern, while family-managed second-generation business accounted for 32%. The distribution of annual turnover indicated that as much as 42% of the units are in the category of Rs. 25-50 lakh. 31% are in Rs. 50-100 lakh category while 27% are above Rs. 1 crore.

B. Quality Control Awareness and Implementation

A total of 84% of the respondents stated that they are aware of the concept of quality control. Also, 72% of the respondents said that quality checking is done in their units. Nevertheless, further investigation indicated a considerable abyss between high awareness and organised implementation.

Just 28 percent of the health-related services had documented Quality Control (QC) procedures while only 16 percent maintained quality records for over one year. 22% of the surveyed units held ISO 9001 certification. 35% were aware of ISO standards but did not opt for certification. In fact, high cost and complexity were the deterrents.

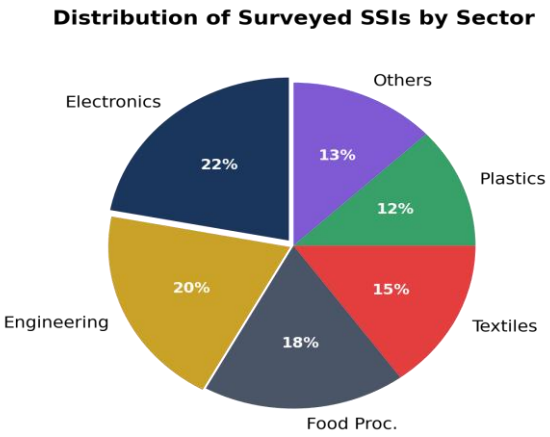

Fig. 1. Distribution of respondent SSIs by industry sector (N=120).

The respondents belong mainly to engineering sector SSIs as seen in Fig. 1 (31.7%). This is because the industrial belt of NCR has a concentration of metal working and component manufacturing. Electronics units (20%) were largely located in Noida and Gurugram, while textiles (18.3%) had a stronger presence in Faridabad and Ghaziabad.

C. Quality Management Techniques Adopted

In table II offers the details about the quality management measures adopted by SSI taken in survey. "At the last stage of production, visual inspection appeared to be the technique used most frequently, 82% of the units." According to the report, 46% performed in-process inspection. More sophisticated techniques had even lower adoption: sampling inspection (34%), use of calibrated measuring instrument (38%); and documented tests (26%). Only 14% of the units, which are mainly the electronics SSIs supplying large OEMs, used statistical process control (SPC) techniques. A mere 8 % of the respondents confirmed the formal implementation of TQM principles.

TABLE II Quality Control Methods Adopted by Respondent SSIs

Quality Control Method	N	%	Rank
Visual inspection (final stage)	98	81.7	1
In-process inspection	55	45.8	2
Use of calibrated instruments	46	38.3	3
Sampling inspection (AQL)	41	34.2	4
Documented testing protocols	31	25.8	5
Statistical process control	17	14.2	6
TQM implementation	10	8.3	7

Based on their quality ranking (Table II), the use of basic inspection measures is most frequent, systematic quality management methods are infrequent. This phenomenon occurs in all four industrial zones and all five sectors thus suggesting systemic factors rather than sector-specific constraints.

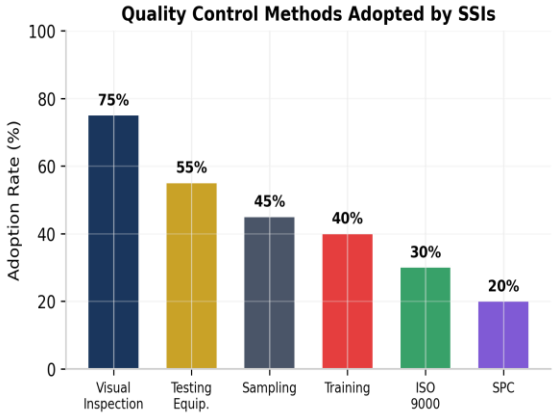

Fig. 2. Adoption percentage of quality control methods across respondent SSIs.

D. Barriers to Quality Control Implementation

The ten possible barriers were rated by the respondents on a 5-Likert scale (1=Not a barrier, 5=Major barrier). Table III shows the ranked mean scores. The most significant barrier is financial constraints (mean=4.42) followed by lack of technical know-how (mean=4.18) and low awareness of modern quality tools (mean=3.95). Ranking very close on costs and training of quality professionals was the high cost of quality certification (mean=3.88), lack of trained quality personnel (mean=3.72). The rating for customer pressure was interestingly the lowest (mean=2.34) which indicates that a large number of SSI customers in the NCR supply chain do not impose strict quality standards.

TABLE III Barriers to Quality Control Implementation (Ranked by Mean Score)

Barrier	Mean	Median	Mode
Financial constraints	4.42	5.0	5
Inadequate technical expertise	4.18	4.0	4
Limited	3.95	4.0	4

awareness of QC tools			
High certification cost	3.88	4.0	4
Lack of trained personnel	3.72	4.0	4
Absence of government support	3.55	4.0	3
Low customer quality pressure	2.34	2.0	2

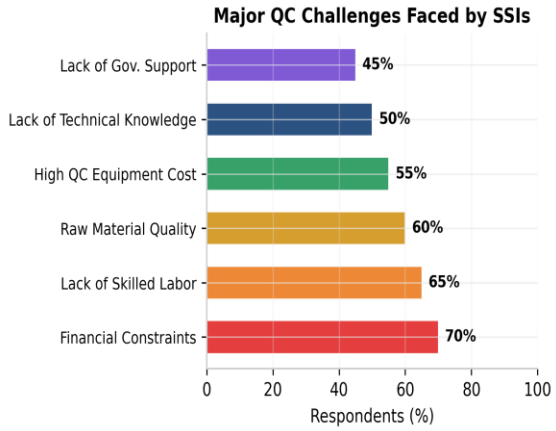

Fig. 3. Key barriers to quality control implementation (mean scores).

E. Quality Control Investment Patterns

Examination of the investment in quality-related activities reveals that 45% of the SSIs were spending less than 1% of the annual turnover on quality control. 32% of the SSIs were spending 1-2% while only 23% of the SSIs were spending more than 2%. The median annual quality expenditure was reported as Rs. 72,000. "The variation is quite high though, reportedly varying from Rs. 8,000 up to Rs. 15,00,000 depending on the size and sector of the unit." The most common quality-related investments were in measuring instruments (68% of investing units) and inspector wages (55%). Slight allocations were most often made to quality training (18%), external consultancy (8%) or certification costs (12%).

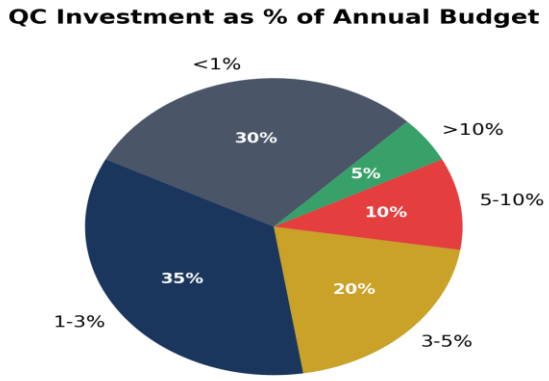

Fig. 4. Distribution of quality control investment as percentage of annual turnover.

F. Impact of Quality Practices on Performance

SSIs were classified as Low (no documented QC, N=42), Medium (documented basic QC practices, N=52) or High (documented structured QC, N=26) based on their quality control maturity. Cross-tabulation analysis showed people's performance differs across groups. SSIs of high maturity exhibit a mean rejection rate of 2.8% compared to 8.4% for low-maturity SSIs. Customer complaint frequency exhibited a similar pattern: high maturity units averaged 1.2 complaints per quarter versus 5.8 for low maturity units. Productivity, defined as output per worker per day, was 18% higher in the high-maturity group.

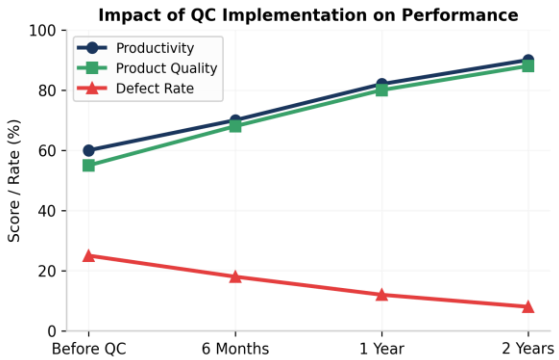

Fig. 5. Performance metrics by quality control maturity level.

G. Awareness versus Adoption Gap

A key finding of the study is that there exists a major gap between quality awareness and adoption. Figure Six examples show this gap in respect of the seven quality management concepts Despite 84%

knowledge of quality control basic process; adoption rates of various practices were much lower – ranging from 28% to 82%. While 57% of respondents were aware of ISO 9001, only 22% were certified. Statistical Process Control showed the largest awareness-adoption gap with 48% stating they were aware of SPC but only 14% adopting it. This indicates that nearly half (48%) of the respondents were aware of SPC, however, 75% of the aware respondents did not adopt it.

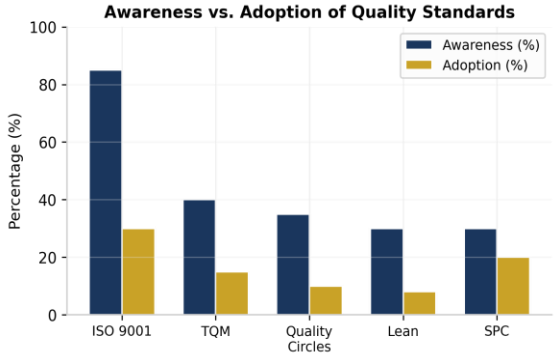

Fig. 6. Quality management awareness versus adoption rates among respondent SSIs.

H. Discussion

This study finds results consistent with earlier work on quality administration in Indian SSIs. The fact that visual inspection is the most preferred quality method (82%) in Punjab is in line with Patel and Patel [13] findings at Gujarat and Verma and Gupta [15] findings at Delhi-Faridabad belt. The low adoption rate of SPC, which is 14 per cent, corresponds with national-level MSME quality surveys conducted by the Quality Council of India. Such surveys report SPC usage at 11-16 per cent across major clusters of industry. The finding that financial constraints represented the major obstacle (mean=4.42) supports Ghobadian and Gallear [10] arguments that resource constraints characterize SME quality management. The findings from this study indicate that just conducting an awareness campaign will not be enough as there is a large awareness-adoption gap. Hence, financial incentives along with technical assistance are indispensable. The difference in performance indicated by various levels of quality maturity is an excellent business case for investing in quality in SSIs. The 18% productivity gain and 67% fall in rejection rates (8.4% to 2.8%) from structured quality practices indicate that quality pays back in concrete terms and within measurable time frames. This message could be delivered to SSI owners through the industry association programme.

V. CONCLUSION AND RECOMMENDATIONS

This study provides an empirical assessment of quality control practices by 120 small scale industries of 4 industrial zones of the Delhi NCR region. The results indicate that while there is considerable awareness of quality concepts within the sector, the implementation of structured quality management practices is uneven, often deficient and neglecting important aspects. From this analysis, we come to the following main conclusions.

To start with, 72% of SSIs have quality control systems in place but practically all of them use visual inspection at final stage of production. More statistical process control and total quality management are in use in only a small minority of units, mostly those which are suppliers to quality conscious original equipment manufacturers (OEMs) in the auto and electronics sector.

Furthermore, it is documented in the study that there exists an awareness-adoption gap across all quality management concepts that is significant. The biggest gaps are regarding documented quality procedures and ISO 9001 certification where while awareness is quite high (62% and 57% respectively) adoption is very low (28% and 22% respectively). This shows that the informational barriers combine with resource constraints and technical barriers.

Thirdly, the analysis shows a clear positive correlation between quality management maturity and operational performance. SSIs that have introduced structured quality practices report significantly lower rejections; less customer complaints and higher productivity as compared to units that depend on informal inspection.

The most important reasons for hindrances in quality improvement are financial constraints, lack of technical expertise, and non-awareness of modern quality tools. The low rating of customer pressure (mean=2.34) suggests that demand-side incentives for quality investment are weak in important segments of the NCR supply chain.

According to the findings, the following recommendations can be made. The establishment of mobile quality clinics, which will provide on-site technical help to the SSIs, by Government Organizations and Institutes working for the development of MSME may be a low-cost way to breach the shortage of expertise. Enhancement of the ZED certification scheme, with improved financial incentives exclusively for Delhi NCR clusters, will enhance adoption rates. Industry associations can organize benchmarking visits connecting SSI proprietors with some good quality-managed units to help plug the awareness-adoption gap through peer learning. "Curriculum modules on simple quality management approaches for small firms could be developed for academic institutions and delivered through extension programs." The evidence presented in this study points towards constructing SSI's as investment in quality not as a regulatory burden but as a vehicle for competitiveness and sustainable growth.

The study's limitation is that quality practice change cannot be analysed from the findings as they are based on a single point in time. Also, the research was carried out in the NCR of India. So, the result cannot be generalised for analysis in other parts of India which have a different industrial and institutional context. Longitudinal designs in the future could help to find out the quality improvement path. Greater geographical reach could help compare different industrial clusters.

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