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Capacity Planning and Daily Output Optimization in Stainless-Steel Wire and Bright-Bar Manufacturing: Manpower Deployment, Material Traceability, Downtime Losses and Export Readiness

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Abstract : *Stainless-steel wire and bright-bar manufacturers operate multi-stage routes in which rated machine speed rarely equals the good, releasable output that can be promised to a customer. This paper examines how capacity planning and daily output optimization can be structured in such an environment, with attention to five planning variables: effective capacity, manpower deployment, downtime and bottlenecks, yield and material traceability, and export readiness. The study uses a qualitative, descriptive case approach grounded in an eight-week summer internship associated with Manish and Company, a stainless-steel wire and bright-bar manufacturing context, supplemented by operations-management literature and published standards and trade-policy sources. Because verified plant records were not available for disclosure, the quantitative analysis uses an explicitly illustrative benchmark schedule across four work centers. On the benchmark day, good output was 19.98 tones against a planned 21.4 tones (93.4% plan achievement) and 26.0 tones of theoretical capacity (76.8% rated utilization); tool or die changes and wire snapping accounted for 54% of 264 minutes of downtime. The paper proposes a capacity-planning and review framework and recommends a standard Daily Production Report, product-family capacity standards, a skill and deployment matrix, coded downtime reasons, a single material-identity record and progressive export documentation.*

Keywords: capacity planning; output optimization; stainless-steel wire; bright bars; overall equipment effectiveness; manpower deployment; traceability; export readiness

I. INTRODUCTION

1.1 Background

Stainless-steel wire and bright bars serve springs, fasteners, mesh, welding consumables, medical devices, food-processing equipment and general engineering. India is a major steel producer, with the Ministry of Steel (n.d.) reporting crude steel output of 149.4 million tones, which places the country among the world's largest producers (IBEF, n.d.). Within this base, stainless products are specialized:

chemistry, controlled processing and tight dimensional and surface requirements make the grade, size and route of each job material to what a line can deliver.

Capacity in such a plant is not the rated speed printed on a machine. Operations-management texts distinguish theoretical capacity from effective capacity, which is reduced by planned stoppages, changeovers, quality checks and unplanned losses (Heizer et al., 2023; Slack et al., 2022). In wire and bright-bar production this gap is wide, because output depends on material readiness, tooling, crew skills, process stability and the ability of downstream inspection

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and dispatch to release what is produced. Information flow is itself an operating resource: where material identity, status and responsibility are unclear, the next stage waits (Chopra, 2025).

1.2 Problem Statement

Many mid-sized processors plan against a single tones-per-day figure and report total tones without separating gross output, good output, quality hold and loss. This obscures the reasons for variance, overstates dispatchable capacity and weakens delivery promises, particularly to export customers who require traceable, documented and repeatable product. The problem addressed here is how capacity planning and daily output reporting can be made more transparent and decision-useful in a stainless-steel wire and bright-bar setting without heavy investment in systems.

1.3 Objectives

- To explain how effective, good-output capacity differs from rated capacity in a multi-stage wire and bright-bar route.
- To analyse, using an illustrative benchmark schedule, plan achievement, utilization, manpower productivity, downtime and yield loss.
- To examine the role of material traceability and export-readiness requirements in operational planning.
- To propose a practical framework and recommendations that a modest-sized manufacturer can adopt.

1.4 Research Questions

- RQ1. How should capacity be defined and calculated so that delivery promises reflect good, releasable output?
- RQ2. Which losses (downtime, yield and manpower-related) most constrain daily output, and how should they be recorded?
- RQ3. How do manpower deployment and skill authorisation affect effective capacity?
- RQ4. What practices strengthen traceability and export readiness within daily operations?

II. LITERATURE REVIEW AND CONCEPTUAL FRAMEWORK

2.1 Capacity: theoretical, effective and good output

Theoretical capacity is the output achievable under ideal conditions; effective capacity allows for planned losses such as maintenance, changeovers and breaks; and actual output falls further with unplanned stoppages, defects and instability (Heizer et al., 2023; Slack et al., 2022). A planning model therefore has to decompose the gap rather than quote a single rate.

2.2 Overall equipment effectiveness

Overall equipment effectiveness (OEE) multiplies availability, performance and quality, in effect operating time, rate of performance and first-pass yield (ASQ, n.d.). Its diagnostic value lies in the three questions it asks: how much planned time was actually available, whether the machine ran at the correct rate, and what share of output was good. Utilization is not productivity; a machine may run for much of a shift yet yield little useful output because of long changeovers, stoppages and rejections.

2.3 Bottlenecks and flow

A bottleneck is the stage that limits conforming output. In multi-stage routes the bottleneck can move with product mix, tooling and downstream requirements, and raising output at a non-constraint merely builds work in progress ahead of the constraint (Heizer et al., 2023; Slack et al., 2022). Improvement effort should therefore target the constraint and the flow of the whole route.

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2.4 Manpower planning and skill mix

Headcount does not equal capability. Two shifts of equal size can differ in output where skill authorisation differs, and a skill matrix makes visible who may run a machine, who is in training and who may only support (Slack et al., 2022). Crew capability is part of process capacity.

2.5 Quality, yield and traceability

Quality is built in through incoming material, machine settings, tooling, process control and measurement, not only final inspection. Yield, the ratio of good output to input, becomes informative only when losses are categorised (process allowance, avoidable loss, rework, hold, weighing or data difference). In industrial products, traceability serves both inventory control and quality control, since parent material and derived lots must remain linked to heat, job and status.

2.6 Standards, policy and export context

Product standards define dimensions, mechanical properties, chemistry, testing and acceptance criteria. Those referenced in the study material include ASTM A580/A580M for stainless-steel wire (ASTM International, n.d.) and EN 10270-3 for stainless spring wire (CEN, n.d.), alongside Indian standards administered through the Bureau of Indian Standards (BIS, n.d.). Indian exporters operate within the framework of the Foreign Trade Policy (DGFT, 2023). Export success depends on documentation produced as the product moves, and on awareness of trade-remedy risk in destination markets.

2.7 Research gap

General operations literature explains capacity, OEE and bottleneck principles, and standards and policy documents explain compliance requirements, but little practitioner-oriented work shows how these combine in the daily reporting of a stainless-steel wire and bright-bar plant, where product-family routes, manpower authorisation and export traceability interact. This paper addresses that gap using an internship-based case.

2.8 Conceptual framework

Table 1 summarises the framework used in the analysis.

Planning variable	What it determines	Typical data source	Principal operational response
Effective capacity	Good tonnes deliverable per shift or day	Rated rate, net hours, availability, performance, yield	Product-family capacity standards
Manpower deployment	Skills available at the right line	Shift roster, attendance, authorisation records	Skill and deployment matrix
Downtime and bottlenecks	Where conforming output is restricted	Downtime log, WIP, release queues	Pre-staging; coded reason codes; constraint focus
Yield and traceability	Conformity and reconciliation of material	Inward log, DPR, movement balance	Single material-identity record
Export readiness	Ability to release documented, traceable product	Heat, inspection, certificates, packing records	Progressive export file

Source: Author's synthesis based on Heizer et al. (2023), Slack et al. (2022), Chopra (2025) and ASQ (n.d.).

Table 1: Conceptual framework: planning variables and operational response

III. RESEARCH METHODOLOGY

The study adopts a qualitative, descriptive and exploratory case design grounded in a summer internship project concerned with production capacity planning and daily output optimization at Manish and Company. Primary evidence

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comprises internship observation of raw-material inward and movement, manpower allocation, daily production recording, loss and downtime categories, and export-documentation requirements, together with an eight-week activity log. Methods included observation, process flow charting, logbook entries, benchmarking and basic manpower calculations.

Three evidence classes are distinguished: company-published information, internship information (activities and observations), and standard industry operating benchmarks, being realistic planning ranges. Verified plant production records, machine logs and quality records were not available for disclosure. All figures in Section V are therefore illustrative benchmark values, not audited plant results, and they are used to show how a manager would structure a decision once verified data are available. Interpretation follows analytic generalisation: observations are compared with the framework in Table 1 rather than used to test statistical relationships. No survey was conducted and no sample or statistical test is reported.

IV. CONTEXT: THE CASE SETTING

The internship setting is a stainless-steel wire and bright-bar manufacturing context. Wire routes typically run from receipt of rod or coil through annealing, pickling, drawing, fine drawing or sizing, inspection, coiling, packaging and dispatch. Bright-bar routes run from receipt through peeling or turning, straightening, grinding or polishing, sizing, end preparation, inspection, bundling and dispatch.

The organisation is a functional structure in which production is supported by stores, quality, maintenance, safety, dispatch and administration. In the internship material, Manish and Company is framed as the workforce-contracting partner (contract personnel engagement, attendance coordination and deployment support), while production authority rests with the plant's operating hierarchy. This interface makes the alignment of manpower records and production records central to the analysis.

Product variety shapes planning. Fine-wire work yields fewer tonnes per shift than heavy drawing but demands tighter control of tension, die sequence, spooling and inspection; bright-bar work depends on peeling allowance, straightening, grinding and final surface acceptance. Tonnes per day must therefore be read alongside product family and route.

V. ANALYSIS: CAPACITY, LOSSES AND CONTROLS

5.1 Effective capacity and the benchmark profile

The planning relationship used is:

Effective capacity = Rated hourly rate × Net available hours × Availability × Performance × Quality yield.

Net available hours exclude planned breaks, cleaning, set-up and tool changes; availability reflects breakdowns and unplanned stoppages; performance reflects speed loss and minor stoppages; and quality yield converts processed to good output. As an illustration, a benchmark drawing line rated at

0.42 tonnes per hour with 16 net production hours, 0.88 availability, 0.92 performance and 0.96 quality yield gives an effective good-output capacity of approximately 5.2 tonnes per day. A low availability factor points to maintenance and downtime control, low performance to speed and process losses, and low yield to quality and conversion losses.

Table 2 presents the four-work-centre benchmark day.

Table 2: Illustrative benchmark capacity and output by work centre (tonnes per day)

Work centre	Theoretical capacity	Planned good output	Good output achieved	Plan achievement	Constraint noted
Heavy draw	7.0	5.8	5.42	93.4%	Die changes; handling
Fine wire draw	4.2	3.4	3.02	88.8%	Snapping; tension
Bright bar (peel/turn)	8.0	6.5	6.15	94.6%	Not specified
Grinding / polishing	6.8	5.7	5.39	94.6%	Not specified
Total	26.0	21.4	19.98	93.4%	

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Source: Illustrative benchmark schedule from the internship material; line-wise plan achievement computed by the author from the tabulated values.

Theoretical totals exceed planned good output because the plan allows for availability, performance, quality and mix losses. Dispatch promises should therefore be based on effective good output rather than theoretical capacity.

5.2 Plan achievement and daily KPI review

Total planned good output was 21.4 tonnes against 19.98 tonnes achieved, a plan achievement of 93.4%. Against theoretical capacity of 26.0 tonnes, rated-capacity utilisation was 76.8%. Both figures are correct; they differ in denominator and answer different questions. The shortfall is attributable to changeover, snapping, input variation and inspection queues, and should be classified in review as structural, temporary or assigned to corrective action. Table 3 gives the KPI set.

Table 3: Benchmark KPI dashboard

KPI	Benchmark	Review frequency	Management question
Plan achievement	93.4%	Daily	Which line missed scheduled good output?
Good-output yield	96.9%	Daily	Is the gap loss, hold or data timing?
Rated-capacity utilisation	76.8%	Weekly	Is the gap due to mix, set-up or availability?
Downtime concentration	54% (top two reasons)	Weekly	Can set-up and snapping be reduced first?
Good tonnes per worker	2.00 t/person-day	Weekly	Is crew size aligned with work content?
Traceable dispatch	Target 100%	Monthly	Can every bundle be linked to heat and certificate?

Source: Benchmark dashboard from the internship material. Values are illustrative.

The table is best read as a management dashboard rather than a scorecard: each measure is linked to a question and a review cadence.

5.3 Manpower efficiency

The benchmark crew comprised 4 operators and 6 helpers across the four work centres, equating to 4.995 good tonnes per operator and 1.998 (approximately 2.00) good tonnes per production person. Benchmark crewing assumes one operator with one or two assistants for heavy drawing and bright-bar work, and one operator with one assistant for fine and finishing processes. These ratios need careful interpretation: helpers may support several processes, operators spend time on set-up, inspection and paperwork, and fine-wire output per person is lower but may carry higher value per tonne. The objective is the right skill, content and workload at each line, not a lower headcount; leaving a line short to improve the ratio risks longer changeovers, unsafe handling and quality failure. Where the bottleneck is material handling, added handling support is more useful than an added operator; where it is technical, additional people may not raise output.

5.4 Downtime and bottlenecks

Total benchmark downtime was 264 minutes (Table 4).

Table 4: Benchmark downtime by reason

Reason	Minutes	Share	Control response
Tool/die change	85	32%	Pre-stage dies and tools
Wire snapping	58	22%	Review tension, lubrication and die wear
Material waiting	42	16%	Improve stores issue and heat identification
Maintenance	35	13%	Track repeat failures
Quality hold/queue	28	11%	Balance inspection with production

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Other	16	6%	Use defined reason codes

Source: Illustrative benchmark schedule from the internship material.

Tool changes and snapping together account for 54% of downtime, indicating that preparation and process stability are the first targets. The constraint should be identified through where work in progress accumulates and where material waits. As an illustration, if polishing can produce 5.7 good tonnes but inspection can release only 4.9, inspection is the effective bottleneck regardless of machine rating.

5.5 Yield and conversion loss

Conversion yield is good output divided by input issued; for example, 6.00 tonnes issued and 5.76 tonnes of good output give a yield of 96.0% and a loss of 4.0%. On the benchmark day, good-output yield was 96.9% and total conversion loss was 0.63 tonnes (3.2% when expressed against good output, as in Table 5).

Table 5: Benchmark conversion loss by category

Category	Tonnes	Share	Control response
Scale/pickling	0.22	1.1%	Review route allowance and bath condition
Trim/end loss	0.12	0.6%	Review cut length
Snapping/rework	0.16	0.8%	Root-cause review
Nonconforming/hold	0.09	0.5%	First-piece approval
Unaccounted difference	0.04	0.2%	Reconcile weighing and registers
Total	0.63	3.2%	Benchmark planning range

Source: Illustrative benchmark schedule from the internship material.

Predictable losses such as scaling may form part of the process allowance, whereas frequent breaks signal issues with tension, lubrication, die condition, alignment or input quality. Comparisons should be made like for like (same grade, size and route), and the basic control is that input equals good output plus expected loss, hold, rework and any residual difference; unexpected differences prompt a check of weighing and recording.

5.6 Material traceability, output optimisation and export readiness

Traceability risks arise where material is split, part-processed, returned to stores or moved to another area so that the original heat is no longer linked to the work-in-progress bundle. Unit confusion (kilograms inward, tonnes in production, bundles outward) and end-of-shift weights taken after material has moved compound the problem. A single record per material lot, carrying supplier, grade, heat, size, inbound and outbound weight and job number, with linked child identifications for splits and an end-of-day movement balance, addresses both.

Output optimisation is largely a matter of recovering lost time: sequencing compatible jobs, pre-staging dies, gauges and tags, confirming material early and approving the first piece, supported by a 24 to 48 hour planning board showing machine, product family, grade, size, heat, planned tonnes, tooling, crew, quality requirement and dispatch priority. A line with short changeovers may produce more good tonnes than a faster line with long ones, and output should not be raised by pushing operators to unsafe or unsustainable levels.

Export readiness depends on the same records. Stainless wire falls under HS heading 7223, bar and rod classification depends on steel type, finish and alloying, and trade-remedy investigations by the US International Trade Commission into stainless wire rod and bar from India illustrate market-access risk. Typical export documents include the commercial invoice, packing list, transport document, certificate of origin where required, inspection or test certificate and customer-specific declarations. If heat numbers are lost at inward, the final certificate cannot be built.

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5.7 SWOT summary

Table 6: SWOT analysis of the operating setting

Strengths	Weaknesses
Downstream product specialisation; technical entry barriers; export capability; structured shop-floor data; flexibility from contract labour	Only tonnes reported, hiding gauge and route differences; manpower substitutions not visible at machine level; inconsistent downtime reasons; manual data duplication and delay

Opportunities	Threats
Export buyers seeking traceability; low-cost digital Daily Production Reports; reduced changeover and snapping waste; product-family capacity standards; closer stores, production, quality and outbound alignment	Raw-material price fluctuation; imported competition; trade remedies; grade and surface inconsistency; manual-handling risk; penalties for late quality release

Source: Author's analysis from the internship material.

VI. CONTROLS THAT OPERATIONALISE THE PLAN

A capacity plan has value only if it is executed through simple, sustainable controls.

• Daily Production Report (DPR). Records job, material heat, planned quantity, opening WIP, start and finish time, good quantity, loss, downtime, manpower, quality status and comments, and ends with a handover action. It separates output produced from output released.

• Product-family capacity library. Holds tonnes per shift, yield range, set-up time, crew requirement and key quality checks for each family, grade group, size range and route, with assumptions stated.

• Skill and deployment matrix. Shows who is authorised, in training or supporting at each line, with baseline crew and replacements planned before the shift.

• Coded downtime reasons. Allow concentration analysis and assignment of each loss type to production, maintenance, stores or quality.

• Material-identity record and movement balance. Preserves the link from inward to dispatch.

• Progressive export file. Builds documentation as the product moves rather than at dispatch.

VII. FINDINGS AND DISCUSSION

Finding 1: Capacity must be defined as good, releasable output. Rated and planned figures answer different questions (76.8% against 93.4% on the benchmark day), and promises should rest on effective good output (Heizer et al., 2023).

Finding 2: A small number of loss causes dominate. Tool changes and snapping account for 54% of downtime, so preparation and process stability offer the quickest gains.

Finding 3: The bottleneck is the point where conforming output is restricted, not the slowest machine.

Inspection or release capacity can limit dispatch even when machine capacity is adequate.

Finding 4: Skill authorisation, not headcount, is the manpower constraint. Output per person must be read with product mix and work content, and crew reduction to improve a ratio is counter-productive.

Finding 5: Traceability is both a quality and a capacity control. Heat identity and unit consistency determine whether reconciliation and export certification are possible.

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Finding 6: Visibility is the principal improvement opportunity. Reporting only total tonnes, inconsistent reason coding and manual records conceal the causes of variance; many small, low-cost fixes together are likelier to raise output than any single large change.

VIII. RECOMMENDATIONS

• Standardise the Daily Production Report across drawing, bright-bar, finishing and packing work centres, with mandatory fields limited to those needed for action, completed close to the activity and reviewed before handover. A trigger such as a result more than 10% below plan, or a repeated downtime reason, can create an action entry, with the threshold calibrated once actual data exist.
• Build product-family capacity standards in a controlled spreadsheet at first, replaced over time by verified historical data.
• Improve manpower allocation through a shift-aligned operator and helper matrix, reviewed weekly against good tonnes, downtime, overtime, quality and safety observations.
• Reduce changeover and snapping losses through pre-staging checklists (dies, tools, gauges, tags, material, first piece and quality sheet) and root-cause review by grade, diameter, machine, die, shift, operator and input heat.
• Strengthen traceability with one identification per material lot, linked child identities for splits and an end-of-day movement balance classifying weighing differences, process loss, rework, hold and data errors.
• Build export readiness into operations using a customer-document matrix so that production, quality, stores and dispatch complete the required fields as work progresses.
• Phase implementation through a simple staged rollout (for example 30, 60 and 90 days) so that controls are adopted without creating administrative burden.

IX. LIMITATIONS AND DIRECTIONS FOR FUTURE RESEARCH

The study rests on a short internship and a single organisational context. Verified plant production records were not used, so all quantitative values are illustrative benchmarks, and the findings are analytical rather than statistically generalisable. No survey or hypothesis testing was undertaken. Future research could apply the same formulae to verified DPRs, machine logs and quality records, compare several processors, measure the effect of pre-staging and reason-coding on changeover and snapping losses, and test the link between traceability practice and export-claim outcomes.

X. CONCLUSION

In stainless-steel wire and bright-bar manufacturing, capacity planning is the discipline of converting rated machine capability into good, releasable and traceable output. The benchmark analysis shows that plan achievement, rated utilisation, yield, downtime concentration and output per person each answer a different management question, and that a few causes, notably tool changes and wire snapping, account for most lost time. Manpower authorisation, material identity and export documentation are part of capacity rather than administrative additions to it. Simple controls (a standard DPR, product-family standards, a skill matrix, reason codes, a single material record and a progressive export file) can make losses visible and actionable at low cost. Once verified plant data are available, the framework can be applied to produce plant-specific standards and targets.

REFERENCES

[1] American Society for Quality. (n.d.). Quality glossary. https://asq.org/quality-resources/quality-glossary
[2] ASTM International. (n.d.). ASTM A580/A580M: Standard specification for stainless steel wire. ASTM International.
[3] Bureau of Indian Standards. (n.d.). Standards and quality information. https://www.bis.gov.in/

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ISSN: 2581-9429
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[4] European Committee for Standardization (CEN). (n.d.). EN 10270-3: Steel wire for mechanical springs, Part 3: Stainless spring steel wire. CEN.
[5] Chopra, S. (2025). Supply chain management: Strategy, planning, and operation (8th ed.). Pearson.
[6] Directorate General of Foreign Trade. (2023). Foreign Trade Policy 2023. Government of India. https://content.dgft.gov.in
[7] Heizer, J., Render, B., & Munson, C. (2023). Operations management: Sustainability and supply chain management (14th ed.). Pearson.
[8] India Brand Equity Foundation. (n.d.). Steel industry in India. https://www.ibef.org/industry/steel-india/infographic
[9] Ministry of Steel, Government of India. (n.d.). Steel sector information. https://steel.gov.in/
[10] Slack, N., Brandon-Jones, A., & Burgess, N. (2022). Operations management (10th ed.). Pearson.