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BBA	SEMESTER V	UNIVERSITY OF KERALA	COURSE CODE: UK5DSCMGT301

OPERATIONS MANAGEMENT

EXAM REVISION NOTES

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MODULE I

INTRODUCTION TO OPERATIONS MANAGEMENT, CONCEPTS, AND PRODUCTIVITY

Operations Management (OM) Foundations: Operations management is the systemic business discipline responsible for planning, designing, directing, executing, and controlling the conversion processes that transform heterogeneous resource inputs—including human labour, physical machinery, raw materials, energy, and digital information—into finished goods and high-value services. While traditional production management was confined strictly to factory shop floors and mechanical fabrication, modern operations management universally spans manufacturing enterprises, tertiary service delivery organizations, public institutions, and global logistics networks.

Chronological Evolution of Operations Thought: The historical development of operations reflects key conceptual revolutions: **Craft Production** (pre-industrial artisan customization with zero interchangeability); **Principle of Interchangeable Parts** (Eli Whitney, 1798, establishing dimensional tolerances); **Scientific Management** (Frederick Winslow Taylor, introducing time studies, scientific task breakdown, and incentive wages); **Motion Study** (Frank and Lillian Gilbreth, formulating micro-motion analysis across 17 Therbligs); **Moving Assembly Line** (Henry Ford, 1913, integrating paced conveyors with interchangeable parts to slash assembly time); **Operations Research** (WWII, introducing mathematical programming, queueing models, and simulation); **Total Quality Management and Lean Production** (W. Edwards Deming, Taiichi Ohno, and Shigeo Shingo, creating the Toyota Production System, JIT, and waste elimination); and **Industry 4.0** (cyber-physical systems, digital twins, and artificial intelligence).

The Universal Transformation Model: Operating systems function via the input-transformation-output framework. **Transformed Resources** are actively altered during processing: physical materials (fabricated into products), digital information (processed into reports or analytics), and customers (experiencing physiological, educational, or locational change). **Transforming Resources** act upon inputs without being consumed: skilled operating personnel, plant facilities, automated machine tools, and computer networks. Transformation mechanisms comprise physical conversion, locational transit, commercial exchange, temporal storage preservation, physiological healthcare, and informational synthesis.

Service Operations Dynamics (IHIP Framework): Service delivery organizations manage four foundational service realities: **Intangibility** (services cannot be held or stored, requiring visible proxies like pristine facility hygiene and professional staff attire); **Inseparability** (simultaneous production and consumption, preventing isolation of defects and mandating real-time quality control); **Perishability** (unutilized service capacity is lost forever, demanding yield management and differential off-peak pricing); and **Heterogeneity** (human interpersonal variance, requiring standardized operating procedures and customer relationship scripts).

The Service Process Matrix: Formulated by Roger Schmenner, this matrix classifies service operations along two structural axes—labour intensity and customer customization: **Service Factory** (low labour, low customization, e.g., commercial airlines, freight trucking); **Service Shop** (low labour, high customization, e.g., specialized hospitals, auto repair); **Mass Service** (high labour, low customization, e.g., commercial retail banking, public schools); and **Professional Service** (high labour, high customization, e.g., corporate legal counsel, management consulting).

Productivity Metrics and Mathematical Analysis: Productivity measures economic conversion efficiency, expressed mathematically as Total Output / Total Input. **Single-Factor Productivity** isolates individual asset performance (e.g., Labour Productivity = Units Produced / Direct Labour Hours Worked; Machine Productivity = Units Produced / Machine Operating Hours). **Multi-Factor Productivity (MFP)** aggregates multiple resources into a common currency denominator: Value of Finished Output / (Labour Cost + Material Cost + Energy Cost + Capital Overhead). Increasing production volume by adding inputs does not improve productivity; genuine productivity expansion occurs only when the ratio of output to input expands.

Operations Strategy and Strategic Alignment: Operations strategy translates corporate vision and business unit priorities into concrete operational capabilities. Operations executives balance five core competitive priorities: **Cost Leadership** (asset utilization and waste minimization); **Quality** (design tolerances and zero-defect conformance); **Speed / Delivery Time** (short order lead times); **Dependability** (punctual order fulfillment); and **Flexibility** (rapid volume and mix adjustments). Terry Hill differentiates **Order Qualifiers** (baseline mandatory standards required for market consideration, such as ISO certification) from **Order Winners** (differentiating capabilities that win customer contracts, such as 24-hour custom delivery).

Structural versus Infrastructural Decision Areas: Operations decisions bifurcate into two structural categories: **Structural Decisions** (high-capital, long-term commitments including facility capacity sizing, geographic location, process technology, and vertical integration/outsourcing boundaries); and **Infrastructural Decisions** (tactical systems and human routines including job design, quality assurance systems, production planning and control, inventory policies, and operational KPI scorecards).

MODULE II

DESIGNING OPERATIONS, WORK SYSTEMS, AND FACILITY LAYOUTS

Product Design and Lifecycle Economics: Product design defines physical form, utility, and specifications, fixing up to eighty percent of total lifecycle manufacturing, warranty, and environmental disposal costs. The structured design process spans idea generation, concept screening, preliminary engineering design, prototype testing, and final production tooling. Contemporary firms deploy **Concurrent Engineering**, where cross-functional teams (design, manufacturing, procurement, quality) collaborate simultaneously from inception, eliminating sequential "over-the-wall" delays and engineering change orders.

Design for Manufacturing and Assembly (DFMA): DFMA streamlines product geometry to simplify fabrication and assembly. Core techniques include: **Part Count Reduction** (consolidating multiple separate parts into integrated molded components); **Standardization** (using standard off-the-shelf fasteners across models); **Modular Design** (creating interchangeable sub-assemblies); and **Mistake-Proofing (Poka-Yoke)** (asymmetrical mating geometries preventing incorrect assembly).

Quality Function Deployment (QFD) and the House of Quality: QFD is a structured graphic planning methodology translating customer desires (the Voice of the Customer or WHATs) into measurable engineering parameters (the Voice of the Engineer or HOWs). The **House of Quality** matrix correlates customer requirements with engineering parameters, analyzes competitive benchmarks, and identifies engineering trade-offs in its triangular correlation roof.

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Process Typologies (The Product-Process Matrix): Hayes and Wheelwright classify manufacturing processes into five distinct operational archetypes along the volume-variety spectrum: **Project** (unique, one-off, large-scale fixed-position layout, e.g., dam construction); **Job Shop** (low volume, high variety, functional department layout, general-purpose machinery); **Batch Production** (moderate volume, medium variety, recurring product families, periodic machine setups); **Mass Production** (high volume, standardized products, dedicated assembly line, low unit cost); and **Continuous Flow** (extreme volume, non-discrete commodities, highly automated 24/7 fluid flow, e.g., oil refining).

Facility Layout Architectures: Facility layout arranges machines, workstations, and material pathways to minimize handling costs: **Process Layouts (Functional)** cluster identical machines into departments, maximizing flexibility for job shops; **Product Layouts (Line Layout)** arrange stations sequentially along a paced conveyor, minimizing unit cycle time for mass production; **Cellular Layouts (Group Technology)** group dissimilar machines into U-shaped cells dedicated to specific part families; and **Fixed-Position Layouts** keep massive stationary products in place while workers and tools move to the site.

Assembly Line Balancing Methodology: Line balancing assigns elemental assembly tasks to sequential workstations such that idle time across all stations is minimized. Cycle Time (C) equals Available Operating Time / Desired Daily Output Quota. Theoretical Minimum Workstations (N_min) equals Sum of Task Times / Cycle Time. Line efficiency evaluates the proportion of workstation time actively utilized: [Sum of Task Times / (Actual Stations × Cycle Time)] × 100. Balance Delay represents lost capacity due to workstation imbalance: 100% - Line Efficiency. The **Ranked Positional Weight (RPW)** heuristic allocates tasks based on cumulative downstream duration.

Work Study, Method Study, and Work Measurement: Work study systematically investigates human work to enhance productivity. **Method Study** records and critically examines tasks via the **SREDIM** sequence (Select, Record, Examine, Develop, Install, Maintain) to eliminate non-value-adding motions. **Work Measurement (Time Study)** establishes the standard time for a qualified worker. Observed Time is adjusted by the Performance Rating factor to compute Normal Time: Observed Time × (Rating / 100). Standard Time incorporates allowances for personal physiological needs (5%), basic fatigue (4%), and shop delays: Normal Time × (1 + Allowance Fraction).

Ergonomics and Job Design: Modern job design integrates ergonomics to adapt workplaces to human physiological capabilities. Anthropometric workspace design dimensions benches to human body envelopes. Environmental controls regulate lighting (500-1000 lux for assembly) and noise (under 85 dB). **Job Enlargement** expands task variety horizontally, while **Job Enrichment** provides vertical autonomy and decision-making responsibility to combat monotony and boost motivation.

MODULE III

FACILITY LOCATION, CAPACITY PLANNING, AND PRODUCTION SCHEDULING

Facility Location Planning Determinants: Long-term location commitments dictate freight logistics costs, tax rates, and talent availability. Primary determinants include proximity to consumer markets (vital for perishable goods and high-contact services); proximity to raw materials (dominant for weight-losing processes where Weber's Material Index exceeds 1.0); labour market dynamics (wage levels and skilled machinist availability); logistics infrastructure (deepwater ports, freight rail, highways); and regulatory incentives (Special Economic Zone tax concessions).

Quantitative Location Selection Methodologies: Operations executives deploy objective mathematical models: **Factor Rating Method** computes weighted composite scores: Sum of (Factor Weight × Site Score), selecting the location with highest total score; **Locational Break-Even Analysis** models total cost as Fixed Cost + (Variable Cost per Unit × Volume), identifying cost-minimizing sites across volume ranges; and the **Centre of Gravity Method** calculates Cartesian coordinates (X*, Y*) for central distribution hubs by weighting regional destination coordinates with monthly shipment container tonnages: X* = Sum(d_ix × W_i) / Sum(W_i).

Capacity Planning Concepts and Measurement: Capacity is the maximum sustainable output rate of an operating facility. **Design Capacity (Theoretical)** is the maximum engineered output under ideal conditions with zero downtime. **Effective Capacity** reflects realistic output accounting for scheduled preventive maintenance, product mix setups, and rest allowances. Utilization Rate equals (Actual Output / Design Capacity) × 100. Efficiency Rate equals (Actual Output / Effective Capacity) × 100. Capacity cushions provide buffer headroom for unexpected demand surges.

Aggregate Production Planning (APP) Strategies: Intermediate planning (3 to 18 months) balancing aggregate supply with market demand across product families. **Chase Strategy** adjusts production rates to match monthly demand exactly by hiring, laying off workers, or adjusting work hours, eliminating finished goods inventory at the cost of severe workforce churn and training expenses. **Level Strategy** maintains a constant workforce headcount and uniform output rate, absorbing demand fluctuations through inventory accumulation during low seasons and backorders during peaks. **Mixed Strategy** combines a stable core workforce with overtime, temporary labour, and subcontracting.

Production Planning and Control (PPC) Architecture: PPC is the operational engine coordinating shop-floor execution through five sequential functions: **Routing** (establishing the exact machine path and sequence of operations); **Loading** (assigning jobs to specific work centres based on finite or infinite capacity); **Scheduling** (allocating precise calendar start times and completion deadlines); **Dispatching** (issuing authorized work orders and blueprints to operators); and **Expediting** (monitoring job progress, tracking work-in-process, and resolving bottleneck delays).

Priority Dispatching Rules and Johnson's Algorithm: When competing jobs queue at a machine centre, priority sequencing rules dictate order: **FCFS (First-Come, First-Served)** processes in arrival order; **SPT (Shortest Processing Time)** processes the shortest job first, mathematically proven to minimize average flow time and work-in-process inventory; **EDD (Earliest Due Date)** prioritizes nearest delivery deadlines, minimizing maximum lateness; and **Critical Ratio (CR)** calculates (Due Date - Today) / Work Remaining. For n jobs on two sequential machines, **Johnson's Rule** sequences jobs with shortest duration on Machine 1 at the front, and shortest on Machine 2 at the back, minimizing total makespan.

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MODULE IV

QUALITY MANAGEMENT, SIX SIGMA, LEAN, AND SUPPLY CHAIN INTEGRATION

Dimensions of Quality and Cost of Quality (COQ): Garvin's eight quality dimensions encompass Performance, Features, Reliability (MTBF), Conformance (tolerance adherence), Durability, Serviceability, Aesthetics, and Perceived Quality. In service operations, Parasuraman, Zeithaml, and Berry's **SERVQUAL** model evaluates Tangibles, Reliability, Responsiveness, Assurance, and Empathy. The Cost of Quality framework categorizes costs into **Conformance Costs** (Prevention: training, vendor audits, design reviews; Appraisal: testing, inspection) and **Non-Conformance Costs** (Internal Failure: scrap, rework, downtime; External Failure: warranty claims, recalls, litigation). World-class manufacturing proves that prevention investments drastically shrink failure costs, driving total quality costs to minimal levels.

Total Quality Management (TQM) and Continuous Kaizen: TQM unites the entire organization in continuous improvement. Core philosophies include Deming's 14 Points, Juran's Quality Trilogy (Planning, Control, Improvement), and Crosby's Zero Defects. The **Plan-Do-Check-Act (PDCA) Cycle** provides the operational mechanism for Kaizen. Shop-floor visual management relies on the **5S Framework**: Sort (Seiri), Set in Order (Seiton), Shine (Seiso), Standardize (Seiketsu), and Sustain (Shitsuke). Frontline workers analyze defects using the **Seven Basic QC Tools**: Ishikawa Fishbone diagrams, Pareto charts (80/20 rule), Check sheets, Histograms, Scatter diagrams, Stratification, and Control charts.

Quality Standards and Certifications: ISO 9001:2015 certifies Quality Management Systems based on customer focus, leadership, process approach, and risk-based thinking, validating process capability rather than individual products. **ISO 14001:2015** governs Environmental Management Systems, verifying ecological compliance and resource conservation. The **Bureau of Indian Standards (BIS)** oversees the ISI certification mark for mandatory consumer safety and industrial standard compliance in India.

Six Sigma Methodology and Statistical Process Control (SPC): Pioneered by Motorola, Six Sigma targets near-perfection with no more than **3.4 Defects Per Million Opportunities (DPMO)**. Improvement projects follow the **DMAIC Framework**: Define (project charter and CTQ requirements), Measure (baseline data and Gage R&R), Analyze (root-cause discovery), Improve (Design of Experiments optimization), and Control (standardization and SPC charts). **Statistical Process Control (SPC)** distinguishes common cause random variation from special cause assignable disturbances using control limits at ± 3 standard deviations: **X-bar and R Charts** monitor continuous variables, while **p-Charts and c-Charts** monitor discrete attribute defect counts. **Process Capability (Cp and Cpk)** benchmarks process spread against engineering specification tolerances.

Lean Production, Just-in-Time (JIT), and Supply Chain Drivers: Lean eliminates the Seven Classical Wastes (Muda): Overproduction, Waiting, Transportation, Inappropriate Processing, Unnecessary Inventory, Motion, and Defects. JIT deploys pull production regulated by physical or electronic Kanban cards: $k = [D \times L \times (1 + \alpha)] / C$. **Supply Chain Management (SCM)** balances cost efficiency and responsiveness across six strategic drivers: Facilities (centralized vs decentralized), Inventory (cycle vs safety stock), Transportation (slow ocean vs rapid air), Information (real-time data mitigating the Bullwhip Effect), Sourcing (offshore vs nearshore), and Pricing (everyday low vs peak pricing). The **SCOR Model** coordinates Plan, Source, Make, Deliver, Return, and Enable processes.

MODULE V

MATERIALS MANAGEMENT, INVENTORY MODELS, AND MAINTENANCE ENGINEERING

Integrated Materials Management and Purchasing: Materials represent 50% to 70% of total manufactured product costs; a small percentage reduction in materials spend yields massive expansions in net profit. Materials management coordinates procurement, warehousing, stores accounting, and inventory replenishment. Sourcing procedures follow standardized steps: purchase requisition, vendor identification, quotation appraisal via the **Weighted Point Method** (evaluating Quality, Delivery, and Price), purchase order release, and goods receipt inspection.

Selective Inventory Control Techniques: Organizations manage thousands of SKUs using Pareto-based selective control: **ABC Analysis** categorizes inventory by annual monetary consumption value (Class A: 10-20% items, 70-80% value, requiring tight daily executive control; Class B: 20-30% items, 15-20% value; Class C: 50-70% items, 5-10% value, managed via simple two-bin systems); **VED Analysis** classifies items by operational criticality (Vital, Essential, Desirable); **FSN Analysis** tracks movement velocity (Fast, Slow, Non-moving); **HML Analysis** classifies unit purchase price; and **SDE Analysis** categorizes procurement scarcity (Scarce, Difficult, Easy).

Economic Order Quantity (EOQ) and Replenishment Models: The classical EOQ model mathematically balances annual ordering costs ($D/Q \times S$) with annual inventory holding costs ($Q/2 \times H$). Total Annual Variable Cost equals $(D/Q) \times S + (Q/2) \times H$. Optimal EOQ equals Square Root of $[(2 \times D \times S)/H]$. At optimal EOQ, annual ordering cost exactly equals annual carrying cost. The **Reorder Point (ROP)** equals (Daily Demand × Lead Time) + Safety Stock. When vendors quote volume price discounts, total cost appraisals incorporate purchase costs to determine if price breaks offset higher holding costs. Under demand variability, Safety Stock equals $Z \times \sigma_d \times$ Square Root of Lead Time, safeguarding against stockouts.

Material Requirements Planning (MRP I, MRP II, and ERP): While finished goods experience independent market demand, components and raw materials experience dependent demand. **MRP I** synthesizes three primary inputs: Master Production Schedule (MPS), Bill of Materials (BOM) explosion tree, and Inventory Records to compute net material requirements and schedule planned order releases. **Manufacturing Resource Planning (MRP II)** expands this into a closed-loop system integrating shop-floor machine loading, labour hours, and financial cash flows. **Enterprise Resource Planning (ERP)** unifies all enterprise business processes on a shared relational database.

Maintenance Engineering Strategies and Reliability Metrics: Modern plant management coordinates three maintenance strategies: **Breakdown Maintenance (Run-to-Failure)** for non-critical, redundant assets; **Preventive Maintenance (Time/Usage-Based)** scheduled periodic overhauls and lubrication; and **Predictive Maintenance (Condition-Based)** leveraging vibration analysis, thermography, and oil diagnostics to repair machinery only when physical failure signatures emerge. Quantitative metrics include **Mean Time Between Failures (MTBF)** measuring reliability, **Mean Time to Repair (MTTR)** measuring maintainability, and System Availability: $A = MTBF / (MTBF + MTTR)$. Plant component replacement evaluates individual vs group replacement policies to minimize total maintenance costs.

Total Productive Maintenance (TPM) and Overall Equipment Effectiveness (OEE): TPM pursues zero breakdowns, zero defects, and zero accidents through total workforce involvement and **Autonomous Maintenance (Jishu Hozen)**. The **Eight Pillars of TPM** encompass autonomous maintenance, focused improvement (Kobetsu Kaizen), planned maintenance, quality maintenance, early equipment management, training, safety/environment, and office TPM. Machine utilization is quantified by **Overall Equipment Effectiveness (OEE)**: Availability Rate × Performance Rate × Quality Rate. World-class manufacturing targets an OEE of 85% or higher, eliminating the six big equipment losses.

Material Codification and Stores Documentation: Systematic stores administration relies on standardized material codification systems: **Numerical Codification** (assigning discrete hierarchical numbers), **Mnemonic Codification** (utilizing alphabetic abbreviations aiding human memory), and **Block Systems** (reserving specific number blocks for distinct material classes). Accurate internal inventory accounting utilizes two complementary records: **Bin Cards** (maintained by the storekeeper inside the physical warehouse, recording quantitative movements in real time); and the **Stores Ledger** (maintained in the finance/cost accounting office, tracking both physical quantities and monetary valuations). Sourcing workflows require strict document verification: **Material Requisition Notes (MRN)** authorizing stock withdrawals from the warehouse, and **Goods Received Notes (GRN)** certifying quality and quantity verification before vendor invoices are approved for financial settlement.

Vendor Development and Sustainable SCM Practices: Modern materials management transcends transactional buyer-supplier relationships toward long-term **Supplier Partnering and Co-Maker-ship**. Strategic buyers conduct formal vendor development programs, providing technical assistance, quality calibration tools, and early supplier involvement (ESI) in product design. Concurrently, organizations implement **Green Supply Chain Management (GSCM)** and **Sustainable Procurement**: auditing supplier carbon footprints, requiring RoHS (Restriction of Hazardous Substances) and REACH compliance, mandating recyclable packaging materials, and instituting closed-loop reverse logistics networks to recapture end-of-life products and minimize environmental degradation.

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