

MARKETING ANALYTICS GUIDE

AI Customer Segmentation: Beyond Demographics to Predictive Behavior

Build behavioral micro-segments that drive measurable lift in conversion, retention, and revenue — not just better-looking charts

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AI Customer Segmentation: Beyond Demographics to Predictive Behavior

Most B2B companies today segment their market by firmographics — industry, company size, revenue range, and geography — and then layer in basic demographic contact data like job title and seniority. This approach was adequate when the primary marketing channel was a sales rep with a phone and a Rolodex. In 2026, when buyers conduct 70% of their research before contacting a vendor, and when digital touchpoints generate thousands of behavioral signals per active account, firmographic segmentation leaves enormous predictive value on the table. AI-powered behavioral segmentation does not replace firmographics — it layers behavioral patterns on top of them to create micro-segments that predict what a buyer is likely to do next, not just who they are. This guide covers the complete implementation path from behavioral data collection through model building, segment activation, and ongoing model maintenance.

IN THIS GUIDE

- ✓ Why demographic and firmographic segmentation is producing diminishing returns — and the behavioral evidence behind it
- ✓ A complete behavioral signal stack of 20 specific signals worth collecting across your digital touchpoints
- ✓ How to build a segmentation model from raw behavioral data to actionable, statistically validated clusters
- ✓ A micro-segment activation framework that maps message, offer, and channel to each behavioral segment
- ✓ A quarterly refresh protocol that keeps your segmentation model accurate as behavior evolves

Who this is for: B2B marketing strategists, data-driven CMOs, and marketing ops leaders who are ready to move beyond firmographic segmentation and build models that predict buying behavior.

SECTION 1

Why Demographic Segmentation Is Failing: The Evidence

Firmographic segmentation rests on an assumption that is increasingly false: that companies in the same industry, size band, and geography have similar buying behaviors and content needs. Research by McKinsey's B2B Pulse study (2025) found that within any given firmographic segment, buying behavior variance is now larger than the variance between segments. In other words, a 500-person SaaS company in Dallas behaves more differently from another 500-person SaaS company in Dallas than it does from a 1,000-person professional services firm — if you control for where they are in the buying journey, their historical engagement patterns, and their current active research topics. The practical consequence is that firmographic-segmented email campaigns produce open rates and conversion rates that are converging toward control group performance. When every company in the 'Mid-Market SaaS, 200-500 employees' segment receives the same content, the segment is not doing any targeting work — it is merely labeling. The companies that have moved to behavioral segmentation consistently report 2x to 4x improvements in email engagement, 30–50% increases in MQL-to-SQL conversion rates, and significantly better personalization scores in buyer surveys.

The failure mode is not just wasted marketing spend — it is wasted sales capacity. When SDRs receive leads segmented by firmographics alone, they default to a generic pitch sequence regardless of the lead's actual behavior and research context. A behavioral segment that tells an SDR 'this contact has visited your pricing page twice, downloaded your ROI calculator, and read three case studies in their vertical' enables a fundamentally different — and far more effective — conversation than 'this is a VP of Marketing at a 300-person SaaS company.'

- Firmographic variance finding: within-segment behavior differences now exceed between-segment differences
- Average email open rate for firmographic-only segments: 18-22%; for behavioral segments: 34-48%
- MQL-to-SQL conversion lift from behavioral segmentation: 30-50% in documented implementations
- SDR conversion to meeting: 2x higher when outreach references specific behavioral context vs. firmographic context
- Root cause: firmographics describe who a company is; behavior describes what they intend to do

3.4x

improvement in email engagement rates reported by B2B companies that transition from firmographic to behavioral primary segmentation (McKinsey B2B Pulse, 2025)

SECTION 2

The Behavioral Signal Stack: 20 Signals Worth Collecting

Building a behavioral segmentation model requires a systematic signal collection architecture before any model building begins. The 20 signals worth collecting span four categories: engagement behavior (how contacts interact with your content and communications), research behavior (what topics and formats they consume), purchase-intent behavior (actions that signal active evaluation), and relationship behavior (how they interact with your team and existing customers). Engagement signals: (1) email open frequency by content type, (2) email click-through rate by link category, (3) website session frequency over rolling 30-day window, (4) average pages per session and session depth, (5) scroll depth on long-form content, (6) video completion rate on product demo and educational videos. Research signals: (7) content topic cluster consumption (which of your defined topic areas does the contact read most?), (8) content format preference (video vs. written vs. webinar), (9) keyword search queries that drove site visits (from GA4 search console integration), (10) third-party topic surge signals from intent data provider.

Purchase-intent signals: (11) pricing page visits and return visits, (12) demo or trial request — including abandonment before form submission, (13) ROI or pricing calculator interactions, (14) competitor comparison page visits, (15) integration or technical documentation page visits. Relationship signals: (16) sales call or meeting attendance, (17) response rate to SDR outreach by message type, (18) event registration and attendance, (19) referral activity (has the contact referred others or been referred?), (20) product usage depth if applicable (trial feature adoption rate). Each signal should be collected as a discrete HubSpot custom event or CRM property update — not inferred from aggregate page view data. The difference between a contact who visited the pricing page (event) and a contact who 'has 5 website visits' (aggregate) is the difference between actionable intent signal and background noise.

- Collect signals at the contact level, not the account level — behavior varies significantly within buying committees
- Minimum tracking setup: pricing page visit, content topic consumption, email engagement by type, form interactions
- Advanced tracking: scroll depth, video completion, calculator interactions, search query data
- In-product signals (for SaaS): feature adoption, session frequency, and depth are the strongest predictors
- Use HubSpot custom events or a dedicated CDP (Segment, RudderStack) as the collection layer
- Data retention: behavioral signals older than 90 days lose predictive value; apply recency weighting

Most teams collect 3-4 of these 20 signals reliably and 2-3 more inconsistently. The model you can build with 12+ consistently collected signals is fundamentally more predictive than anything achievable with 4.

SECTION 3

Building Your Segmentation Model: From Data to Actionable Clusters

Behavioral segmentation models for B2B marketing do not require a data science team to implement. The approach most accessible to marketing ops teams is k-means clustering applied to normalized behavioral features using a low-code data tool or Python. The process has six steps. Step 1 — Feature preparation: Export your behavioral signal data for all contacts with at least 30 days of tracked history. Normalize each signal to a 0–1 scale to prevent high-frequency signals (like email opens) from dominating low-frequency but high-value signals (like pricing page visits). Apply recency weighting — signals from the last 30 days should receive 2x weight versus signals from 60–90 days ago. Step 2 — Cluster number selection: Run k-means clustering for $k=3$ through $k=8$ and use the elbow method (plotting within-cluster sum of squares against k) to identify the optimal number of clusters. For most mid-market B2B companies, 4–6 behavioral clusters emerges as the optimal range — enough specificity for meaningful personalization, few enough to operationalize across a marketing and sales team. Step 3 — Cluster profiling: For each cluster, calculate the mean signal values and identify the top 3–4 behavioral signals that most distinguish it from other clusters. Name each cluster based on its dominant behavior pattern — names like 'Active Evaluators,' 'Passive Researchers,' 'Technical Validators,' and 'Executive Scanners' are more operationally useful than 'Cluster 1.'

Step 4 — Firmographic overlay: Append firmographic data to each cluster to understand the demographic composition. Do not use firmographics to define clusters — use them to understand who ends up in each behavioral cluster. This reveals unexpected patterns: mid-market companies may split between 'Active Evaluators' and 'Passive Researchers' at similar rates, while enterprise companies disproportionately populate 'Technical Validators.' Step 5 — Outcome correlation: Calculate the opportunity creation rate, average deal size, and win rate for contacts who were in each cluster at the time their opportunity was created. This tells you which behavioral segments are your highest-value buyers — not just your most engaged contacts. Step 6 — CRM integration: Write each contact's cluster assignment to a HubSpot custom property and automate the reassignment logic to run weekly as new behavioral data accumulates.

- Minimum data requirements: 300+ contacts with 60+ days of behavioral history and at least 8 signals tracked
- Use k-means clustering; test $k=3$ through $k=8$; use elbow method to select optimal k
- Name clusters by behavior, not numbers: 'Active Evaluators,' 'Technical Validators,' etc.
- Firmographic overlay comes after clustering — never use firmographics as clustering features
- Outcome correlation is mandatory: identify which clusters generate highest pipeline and revenue

- Automate weekly cluster reassignment in HubSpot as behavioral data updates
- Flag cluster transition events: a contact moving from 'Passive Researcher' to 'Active Evaluator' is a high-value trigger

47%

of contacts shift behavioral cluster at least once in a 90-day window, making weekly model refresh essential for accuracy

SECTION 4

The Micro-Segment Activation Framework: Message, Offer, Channel per Segment

Segmentation without activation is data visualization. The value is created when each behavioral cluster receives a specifically designed message strategy, content offer, and channel mix that reflects what that segment's behavior tells you about their needs and buying stage. The activation framework for each segment has three dimensions. Message strategy defines what you talk about — the pain point you emphasize, the business outcome you connect to, and the proof type you lead with. Offer defines what you give them — the content asset, interactive tool, or experience that matches their consumption preference and their stage. Channel defines how you reach them — the mix of email, paid social, SDR outreach, and retargeting that fits their engagement pattern. For an 'Active Evaluator' segment (high pricing page frequency, demo request abandonment, competitor comparison page visits), the activation framework is: Message — commercial, ROI-focused, comparison-friendly; Offer — an ROI calculator, a competitive comparison guide, or a pricing consultation; Channel — SDR sequence within 24 hours, retargeting ads on high-intent keywords, email with direct CTA. For a 'Technical Validator' segment (high documentation visits, integration page engagement, low email engagement), the framework is: Message — technical specificity, integration capabilities, security and compliance detail; Offer — technical documentation, sandbox trial, integration playbook; Channel — email with technical content, developer community presence, LinkedIn targeted at technical roles.

For a 'Passive Researcher' segment (low frequency, top-of-funnel content consumption, no pricing or demo activity), the framework is: Message — educational, thought leadership, category awareness; Offer — research reports, industry benchmarks, educational webinars; Channel — nurture email sequence, awareness retargeting, content syndication. For an 'Executive Scanner' segment (very short sessions, high-level content consumption, occasional email engagement): Message — executive summary format, business outcome focus, brevity above all; Offer — one-page executive briefs, analyst reports, peer case studies; Channel — LinkedIn InMail from senior team members, personalized executive email, invitation to executive roundtable. The activation matrix should be documented and version-controlled so that all content creators, SDRs, and campaign managers are working from the same segment-to-activation map.

- Active Evaluator: commercial message + ROI calculator or comparison guide + SDR + retargeting
- Technical Validator: technical message + sandbox trial or integration guide + email + dev community
- Passive Researcher: educational message + research reports + nurture sequence + awareness retargeting

- Executive Scanner: summary-format message + executive brief or analyst report + LinkedIn InMail
- Document activation matrix: message + offer + channel for each segment in a shared reference doc
- Cluster transition triggers: when a contact moves from Passive Researcher to Active Evaluator, auto-enroll in commercial sequence within 48 hours
- Measure activation: track email engagement, CTA conversion, and SDR meeting rate separately for each segment

The highest-ROI segment transition to watch is Passive Researcher → Active Evaluator. This is a buying journey inflection point. Catching it within 48 hours and activating the commercial play is worth more than all the nurture work that preceded it.

SECTION 5

Tech Stack Requirements: What Your ESP and CRM Need to Support

Behavioral segmentation at scale requires five technical capabilities: event tracking, data storage and transformation, model execution, CRM property management, and campaign activation. Event tracking must be implemented on your website (HubSpot tracking code + custom events, or GA4 with BigQuery export), your email system (engagement event tracking at the individual link and email type level, not just aggregate open rates), and your product if applicable (via Amplitude, Mixpanel, or Segment). Without individual-level event data, you are working with aggregate metrics that cannot produce contact-level behavioral scores. Data storage and transformation: for companies under 10,000 contacts, HubSpot's native custom properties and activity feeds are sufficient as a data layer. Above 10,000 contacts, or for companies wanting to run machine learning clustering algorithms, a data warehouse (BigQuery, Snowflake) with a reverse ETL tool (Census, Hightouch) is required to sync segment assignments back to the CRM. Model execution: k-means clustering can be run in Python (scikit-learn library), in BigQuery ML using SQL, or via purpose-built customer data platforms like Segment Engage or Klaviyo's Predictive Audiences (the latter is email-platform-specific). For companies without data engineering resources, Segment Engage provides the most accessible path to automated behavioral segmentation with CRM sync.

CRM property management: create dedicated properties in HubSpot for segment assignment, segment entry date, and segment transition history. The transition history property is important for tracking how contacts move between segments over time — this is the data that will eventually tell you which transition patterns predict deal creation. Campaign activation: ensure your email service provider, paid social advertising accounts (LinkedIn Campaign Manager, Google Ads), and SDR sequencing tool (Outreach, Salesloft, or HubSpot Sequences) can accept contact segment assignments as targeting criteria. LinkedIn Campaign Manager supports custom audience upload and HubSpot integration, making behavioral segment retargeting directly achievable without third-party tooling.

- Required: individual-level event tracking on website, email, and product (not just aggregate metrics)
- Under 10K contacts: HubSpot native properties sufficient as data layer
- Over 10K contacts: data warehouse + reverse ETL recommended (BigQuery/Snowflake + Census/Hightouch)
- Model execution options: Python/scikit-learn, BigQuery ML, Segment Engage, Klaviyo Predictive
- HubSpot properties to create: segment_name, segment_entry_date, segment_transition_history

- Activation integration: verify LinkedIn Campaign Manager, Google Ads, and SDR tool accept segment properties as targeting
- CDP shortcut: Segment Engage or Amplitude Audiences provides end-to-end behavioral segmentation without custom engineering

68%

of marketing ops teams attempting behavioral segmentation stall at the data layer — missing individual-level event tracking on their own website

SECTION 6

Compliance and Consent: Building Legally Sound Behavioral Segmentation

Behavioral segmentation in a B2B context involves collecting and processing data about individuals' digital behavior — which triggers compliance obligations under applicable privacy laws even when the individuals are acting in a professional capacity. In the US B2B context, the primary frameworks to address are: the California Consumer Privacy Act (CCPA) as amended by CPRA, which applies if you collect data from California residents regardless of their employment context; CAN-SPAM for email engagement tracking; and emerging state-level privacy laws in Virginia (CDPA), Colorado (CPA), Connecticut, and others that are broadly similar to CCPA in their behavioral data treatment. Under CCPA/CPRA, behavioral data collection for the purpose of targeted advertising or selling/sharing data to third parties requires opt-out rights and disclosure in your privacy policy. For first-party behavioral segmentation used exclusively for your own marketing to the individuals whose data you collect — the most common B2B use case — the compliance requirements are primarily transparency and opt-out mechanisms rather than prior consent. Your privacy policy must disclose what behavioral data you collect, for what purpose, and how long you retain it. Your website must offer an accessible opt-out for data collection used in profiling or targeted advertising.

For email engagement tracking specifically, CAN-SPAM does not require consent for behavioral tracking (opens, clicks) in commercial emails sent to business contacts — but GDPR applies to contacts in the EU regardless of their professional status, and requires a legitimate interest legal basis or explicit consent for behavioral profiling. If your contact database includes EU individuals, segment your data handling by geography and apply GDPR-compliant processing to the EU subset. Practically: maintain a clean suppression list, honor opt-outs within 10 business days, ensure your DPA with your ESP and CRM vendors covers behavioral data processing, and review your privacy policy annually against your actual data collection practices.

- CCPA/CPRA: disclose behavioral data collection in privacy policy; provide opt-out mechanism for CA residents
- First-party segmentation for own marketing: generally permissible under legitimate interest in US context
- CAN-SPAM: no prior consent required for email engagement tracking to US business contacts
- GDPR applies to EU contacts regardless of professional status — requires LI basis or consent for profiling
- Segment data handling by geography for EU vs. US contacts if your list includes both
- Data retention policy: define and enforce a maximum retention period for individual behavioral events (90-180 days recommended)

- Vendor DPA: confirm your ESP, CRM, and CDP have signed DPAs covering behavioral data processing

The most common compliance oversight in behavioral segmentation: retaining individual-level event data indefinitely because 'it might be useful later.' Define a retention window (90 days is defensible for most use cases) and automate deletion of events beyond that window.

SECTION 7

Testing and Validation: How to Know Your Segments Are Real

Clustering algorithms will always produce clusters — the question is whether those clusters reflect genuine behavioral differences or are statistical artifacts of the algorithm's parameters. Validation happens at two levels: statistical validation and business outcome validation. Statistical validation uses two standard tests. Silhouette score: measures how well each contact fits its assigned cluster relative to neighboring clusters. Silhouette scores range from -1 to 1; a score above 0.3 indicates meaningful cluster separation; above 0.5 is excellent. Run silhouette analysis on your k-means output before acting on the clusters. Davies-Bouldin index: measures average similarity between clusters; lower scores indicate better-separated clusters. A DBI below 1.0 for a behavioral segmentation model is a reasonable target. If your silhouette score is below 0.2 or your DBI is above 2.0, your clusters are not meaningfully distinct — this typically indicates insufficient signal diversity (too few behavioral features) or insufficient contact volume. Business outcome validation is the more important test for marketing purposes. Compare opportunity creation rates, deal velocity, and average deal size for contacts from each cluster. If two clusters have identical downstream outcomes despite different behavioral profiles, they should be merged — they are distinct behaviors but represent the same buying journey stage and therefore warrant the same activation strategy. If a cluster has no correlation to any measurable business outcome (not higher or lower pipeline generation), it is a behavioral artifact, not a business-relevant segment.

Run a holdout validation: withhold 20% of your contact records from the initial clustering, then predict their cluster assignments using the trained model and compare predicted to actual outcomes for that holdout group. If the model predicts well on the holdout (contacts predicted to be 'Active Evaluators' convert at the same rate as the training-set 'Active Evaluators'), the model generalizes. If predictive accuracy drops sharply on the holdout, the model is overfitting to the training data and needs more features or more training contacts before activation.

- Statistical test 1: Silhouette score — target above 0.3; above 0.5 is excellent
- Statistical test 2: Davies-Bouldin index — target below 1.0
- If silhouette below 0.2: add more behavioral features or increase contact sample size before acting on clusters
- Business validation: confirm each cluster has a distinct opportunity creation rate and deal velocity
- Merge clusters with identical business outcomes — different behavior but same buyer stage = same activation
- Holdout validation: withhold 20% of contacts; test whether the model predicts their outcomes correctly

- Revalidate statistically every quarter as new behavioral data accumulates and cluster composition shifts

34%

of behavioral segmentation models deployed without statistical validation produce cluster assignments that do not correlate with downstream pipeline outcomes

SECTION 8

From Segments to Personalization: The Content Matrix Approach

Once behavioral segments are defined and validated, the immediate operational challenge is ensuring that every piece of content produced serves a specific segment at a specific stage — not a general audience. The content matrix approach creates a structured map of your content library organized by segment on one axis and buying stage on the other. For a four-segment model with three stages (awareness, consideration, decision), the matrix has 12 cells. Each cell should contain 2–3 specific content assets appropriate for that combination of segment and stage, along with the distribution channel and CTAs appropriate for that cell. Start by auditing your existing content library and assigning every piece to the matrix cell it best serves. You will likely find that most content clusters in 3–4 cells (typically mid-funnel, broad audience content) while other cells — particularly decision-stage content for specific segments — are nearly empty. These gaps become your content production roadmap. The matrix also exposes over-production: if you have 15 awareness-stage blog posts for passive researchers but zero decision-stage content for technical validators, you are producing content that does not serve your highest-value segment at the moment they are most likely to convert.

For email marketing, the content matrix directly informs your nurture sequence architecture. Each behavioral segment should have its own sequence track, with content assets pulled from the matrix cells that correspond to that segment's stage at each touch. As contacts move between behavioral clusters (monitored via the weekly reassignment), they should be automatically unenrolled from their current sequence track and enrolled in the track appropriate for their new segment. This is the operational mechanism that makes behavioral segmentation feel like genuine personalization to the recipient rather than demographic mail-merge.

- Build a 4×3 content matrix minimum: 4 segments × 3 buying stages = 12 cells with 2-3 assets each
- Audit existing content library against matrix; identify empty or underpopulated cells
- Prioritize content production for decision-stage cells of your highest-pipeline-generating segments
- Assign every new content piece to a specific matrix cell before production begins
- Each email nurture sequence should correspond to one segment row of the matrix
- Automate sequence re-enrollment on segment transition: when cluster changes, sequence changes
- Review content matrix quarterly: remove stale assets, identify new gaps, align with segment composition

The content matrix converts a segmentation model from a data project into an editorial strategy. Without it, you produce content for the segment you know best rather than the segment you need most.

SECTION 9

Quarterly Segment Refresh: Keeping the Model Accurate

Behavioral patterns change as your market evolves, your product changes, and your buyer's research habits shift. A segmentation model built in Q1 that is never updated will produce increasingly inaccurate assignments by Q3, as behavioral signals that were predictive in January become less relevant after a product launch, a market shift, or a change in your content library.

The quarterly refresh protocol has five steps. Step 1 — Outcome correlation review: Pull the opportunity creation rate, deal velocity, and win rate for each behavioral cluster over the prior quarter. If any cluster's outcomes have changed significantly (more than 20% shift in any metric), the cluster's business meaning has changed and its activation strategy needs to be reviewed. Step 2 — Signal relevance audit: Review which behavioral signals contributed most to cluster separation (using feature importance metrics from your clustering analysis). Remove signals that have become noise (low variance, poor cluster differentiation) and add new signals that have been instrumented in the prior quarter. Step 3 — Re-run clustering: With the updated signal set, re-run the k-means algorithm and validate against silhouette scores. If the optimal k has changed, update the number of segments and re-map the activation matrix accordingly.

Step 4 — Activation update: For any segment whose behavioral profile has shifted, update the content matrix assignments and sequence enrollment logic to reflect the new profile. New signals that emerged during the quarter — new content types, new pricing tier pages, new product features — may need new content assets to serve the segments that consume them. Step 5 — Documentation and communication: Update the segment definitions document shared with SDRs, content creators, and paid media teams. A segment that was 'Technical Validators' in Q1 may have expanded to include non-technical users of a new feature in Q3 — SDRs using Q1 messaging with Q3 contacts will create friction. The quarterly refresh is a cross-functional update, not just a data operation.

- Step 1: Outcome correlation review — flag any cluster with 20%+ shift in opportunity rate or win rate
- Step 2: Signal relevance audit — remove low-variance signals; add new signals instrumented this quarter
- Step 3: Re-run clustering with updated signal set; validate silhouette score; adjust k if needed
- Step 4: Update content matrix and sequence enrollment logic for any shifted segment profiles
- Step 5: Publish updated segment definition document to all teams using segmentation for activation
- Quarterly review meeting: ops, content, sales, and paid media should all attend segment refresh review

- If a cluster disappears entirely on re-run, investigate: either the behavior no longer exists or a data pipeline broke

61%

accuracy degradation in behavioral segmentation models that are not refreshed quarterly, measured by silhouette score drop over 12 months

Implementation Checklist

Phase 1 — Foundation

- ☐ Audit current signal collection: identify which of the 20 behavioral signals are tracked individually
 - ☐ Implement missing event tracking for top 8 priority signals (pricing page, content type, email by link, calculator)
 - ☐ Verify HubSpot custom events are firing at individual contact level, not aggregate
 - ☐ Export 60+ days of behavioral history for all contacts with sufficient activity
 - ☐ Normalize and weight signals; apply recency weighting (30-day signals = 2x weight)
 - ☐ Confirm tech stack supports behavioral segmentation: CRM custom properties, ESP targeting by property
-

Phase 2 — Build and Launch

- ☐ Run k-means clustering for k=3 through k=8; use elbow method to select optimal number of clusters
 - ☐ Validate clusters: silhouette score >0.3, Davies-Bouldin index <1.0
 - ☐ Name clusters by dominant behavior pattern; document defining characteristics of each
 - ☐ Run holdout validation on 20% of contacts; confirm model generalizes to unseen data
 - ☐ Correlate each cluster with pipeline outcomes: opportunity rate, deal size, win rate
 - ☐ Write cluster assignments to HubSpot custom property; automate weekly reassignment
 - ☐ Build content matrix: 12+ cells mapping segment × stage to specific assets and CTAs
 - ☐ Build behavioral segment email sequence tracks in HubSpot; configure re-enrollment on segment transition
-

Phase 3 — Optimize

- ☐ Measure activation lift: compare email engagement, SQO rate, deal velocity by segment vs. pre-segmentation baseline
 - ☐ Quarterly: outcome correlation review; signal relevance audit; re-run clustering
 - ☐ Quarterly: update content matrix with new assets; remove stale content from matrix
 - ☐ Quarterly: publish updated segment definitions to sales, content, and paid media teams
 - ☐ Annual: full methodology review — evaluate whether k-means remains appropriate or advanced models (gradient boosting) are warranted
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