

PRODUCT DESIGN AND DEVELOPMENT

DIPLOMA WALLAH

MECHANICAL

JHARKHAND UNIVERSITY OF TECHNOLOGY (JUT)

◆ 1.1 Characteristics of Successful Product Development & Customer Need Identification

■ Definition

Product development refers to the sequence of activities by which a new product is conceived, designed, developed, produced and launched into the market. Successful product development not only delivers a product but ensures it meets real customer needs, is technically feasible, manufacturable, cost-effective, and profitable over its lifecycle. It involves cross-functional collaboration of marketing, engineering, manufacturing, quality, and service teams. A product that succeeds in the market often begins with clear identification of which customer needs it will fulfil. Hence, customer-need identification is the process of discovering, understanding and prioritising the needs, expectations and desires of potential customers. Without accurate need identification, development risks creating features that don't match market demand.

✿ Explanation

1. Identifying **voice of the customer** (VOC) is fundamental. Organisations must capture what customers explicitly say and also their latent needs (unspoken problems) to be successful. (northhighland.com)
2. One characteristic of successful product development is **market relevance** – products must address actual problems or desires of users; otherwise they may fail. (LinkedIn)
3. Effective products are developed with a **clear vision and objectives**, aligning business strategy with market opportunity. (Acorn Product Development)
4. The process should be **cross-functional**, involving multiple teams (design, engineering, marketing) so that technical, user, and market factors are integrated. (Acorn Product Development)
5. Time to market and cost control are key: successful development balances speed, cost and quality. (wolfmatrix.com)

6. Customer need identification uses methods like **surveys, interviews, observation, prototyping**, to collect data and insights. ([gocious.com](#))
7. Organising the collected needs into structured formats, clustering similar needs and prioritising them is important for design focus. ([gocious.com](#))
8. Establishing relative importance of customer needs (which needs are critical vs nice-to-have) helps guide design trade-offs. ([Qualtrics](#))
9. Continuous feedback and iteration: as product develops, customer needs may change, so managing and adapting to change is a mark of successful development. ([cognidox.com](#))
10. Validation: before full development, testing early concepts with customers to ensure the need is met increases success likelihood. ([Harvard DCE](#))

Applications (5 points):

1. Development of a new smartphone by studying battery life, camera quality and user preferences.
2. Designing a household appliance (e.g., smart refrigerator) based on user-pain points about storage, energy efficiency and convenience.
3. Launching a medical device that addresses specific patient or clinician needs identified via interviews and observations.
4. Automotive product development (e.g., a new electric vehicle) where customer needs around range, charging, comfort, cost are identified.
5. Industrial equipment design where manufacturer's operational needs, maintenance issues and safety requirements are prioritised.

Advantages

1. Increases the probability that the developed product will be accepted in the market.
2. Helps allocate resources efficiently by focusing on high-priority customer needs rather than unnecessary features.
3. Reduces the risk of developing a product that fails due to mismatch with customer expectations.
4. Enhances customer satisfaction, loyalty and competitive advantage.
5. Facilitates better design decisions, improved product-market fit and business success.

✖ Disadvantages

1. Gathering and analysing customer needs can be time-consuming and costly.
2. Customers may not always articulate their true needs or may state solutions instead of underlying problems. ([Strategyn](#))
3. Over-reliance on current customer needs may stifle radical innovation or fail to capture latent unmet needs.
4. Mis-prioritisation of needs can lead to wasted resources or missed market opportunities.
5. Organising large amounts of qualitative data and translating into design requirements can be complex and error-prone.

💡 Summary

Product development ka successful hona iska matlab hai ki us product ne customer ki asli zaroorat ko samjha aur uske mutabiq banaaya gaya ho. Agar hum customer needs theek se pehchaan lein aur unko priority dein, to product market me chalne ki sambhavna bahut badh jati hai.

◆ 1.2 Definition of Product Design, Principles of Good Product Design, Design by Evolution & Innovation

☰ Definition (7-8 lines):

Product design is the complete process of conceiving, planning and creating a new product or improving an existing one so that it is functional, manufacturable, appealing and satisfying for users. It involves translating customer needs into product specifications, selecting materials, determining form and function, and preparing the product for production and market launch. Good product design strikes a balance between usability, aesthetics, cost, reliability and sustainability. It is both an art and a science – combining creative ideas with engineering practicality. Ultimately, it serves as a bridge between what customers want and what manufacturers can deliver.

✳ Explanation

1. **Functionality first:** A product must perform its intended function efficiently and reliably.

2. **User-centricity:** Design must consider user needs, behaviour, environment and ergonomics.
3. **Simplicity and clarity:** The design should avoid unnecessary complexity and features that confuse users.
4. **Aesthetics:** Visual appeal, material finish, colour, form all contribute to user satisfaction.
5. **Manufacturability and economy:** Design must allow cost-effective production, assembly and maintenance.
6. **Reliability and durability:** Products should last over time and under usage conditions without failure.
7. **Sustainability:** Use of eco-friendly materials, energy efficiency and minimal waste are key.
8. **Maintainability and serviceability:** Design should make repair, spare-parts and upgrades easier.
9. **Standardisation and modularity:** Using standard parts or modular design reduces cost and increases flexibility.
10. **Iteration and refinement:** Good design often evolves – from initial concepts through testing and improvements.

Also, design can happen in two broad ways:

- **Design by Evolution:** Improving existing products incrementally (e.g., making a current fridge quieter, more efficient).
- **Design by Innovation:** Introducing a radically new product or concept (e.g., a foldable smartphone or a self-driving car).

Applications

- Designing a new mobile phone with improved battery, camera and user interface.
- Developing a next-generation electric vehicle with new body style, lighter materials and smart features.
- Creating home appliances (smart washing machine) with connected features and efficient design.
- Designing industrial equipment (modular CNC machine) for easier maintenance and upgrades.

- Developing medical devices (portable diagnostic machine) that are user-friendly and easy to transport.

Advantages

1. High-quality design increases user satisfaction and brand loyalty.
2. Efficient design reduces manufacturing cost and time.
3. Good design differentiates products in competitive markets.
4. Sustainability in design can reduce environmental impact and regulatory risk.
5. Design that balances usability and aesthetics can command higher price margins.

Disadvantages

1. Investing in high-quality design increases upfront cost and time.
2. Over-designing (too many features/complexity) may confuse users or raise cost unnecessarily.
3. Radical innovation carries high risk — users may reject unfamiliar designs.
4. Maintaining design flexibility for future upgrades can complicate initial design.
5. Balancing aesthetics with functionality and cost constraints may lead to compromises.

Summary

Product design ka matlab hai ek aisa product banana jo users ko chahiye ho, use karne me aasan ho, dikhe achha ho aur cost aur manufacturing ke hisaab se feasible bhi ho. Evolution ya innovation — dono tarah ke design se market me alag position banaya ja sakta hai.

 (Image: "Principles of Good Product Design – infographic showing key principles like simplicity, usability, sustainability, aesthetics")

◆ 1.3 Product Development Process

Definition (7-8 lines):

The product development process is a structured series of phases which a company follows to transform a new idea into a market-ready product. It begins with identifying customer needs or market opportunities, proceeds through concept creation, design, prototyping, testing, production and launch, and often continues with feedback and improvement. This process ensures technical feasibility, consumer desirability, and manufacturability, while balancing cost, time and risk. It involves coordination among multiple teams – marketing, engineering, manufacturing, quality assurance and supply chain. By using a clearly defined process, organisations can manage resource allocation, control risk, shorten time-to-market, and improve chances of commercial success. In many industries this is set up as a “stage-gate” or “phase-gate” model that uses decision points (“gates”) before moving from one phase to the next. [Simplexity Product Development+2](#)[Planview+2](#)

❖ Explanation (10 points / ~7-8 lines):

1. **Ideation / Opportunity Identification:** At this initial phase teams brainstorm ideas based on customer needs, technology trends, competitor analysis or regulatory changes. [Figma+1](#)
2. **Screening / Concept Development:** Ideas are filtered to select those with feasibility, market potential and strategic fit. Concepts are developed and defined in more detail. [cognidox.com+1](#)
3. **Business Case & Planning:** For the selected concept, a business case is made: cost estimates, market size, resource needs, risk assessment, timeline etc. [Planview+1](#)
4. **System Level & Detail Design:** The product architecture is defined, subsystems, interfaces, manufacturing processes are planned and detailed engineering begins. [tcgen.com](#)
5. **Prototype / Development:** Physical or digital prototypes are built, tested for functionality, manufacturability, user experience. Early testing helps identify issues. [GeeksforGeeks+1](#)
6. **Validation & Testing:** Extensive verification of product against requirements, market testing or pilot production runs to validate quality, performance and market acceptance. [tcgen.com+1](#)
7. **Production / Launch Preparation:** Manufacturing set-up, supply chain, logistics, marketing launch plan are executed and final product prepared for full-scale production. [Indeed+1](#)
8. **Commercialisation / Market Launch:** Product enters the market, distribution begins, marketing campaigns start; product performance and feedback are tracked. [Applify](#)

9. **Post-Launch Review & Iteration:** After launch, product performance is monitored, customer feedback collected, improvements or modifications planned – product development is continuous. [GeeksforGeeks+1](#)
10. **Gate Reviews:** At key points between phases (“gates”), decision makers review progress, decide whether to go ahead, revise or stop. This helps control risk, cost and time. [Wikipedia+1](#)

 **Applications (5 points):**

1. Launching a new smartphone model in consumer electronics.
2. Introducing a new variant of a car/vehicle in the automotive industry.
3. Developing a new medical device or healthcare equipment.
4. Creating smart home appliance (for example a connected refrigerator) for domestic market.
5. Designing heavy-machinery or industrial equipment with updated features and improved manufacturability.

 **Advantages (5 points):**

1. Provides clear structure and sequence to the development effort, reducing chaos.
2. Helps manage risk by evaluating and controlling at each stage, using prototypes and gate reviews.
3. Reduces time-to-market by aligning teams, resources and milestones.
4. Ensures alignment among multiple functions (marketing, design, manufacturing), improving product-market fit.
5. Improves resource allocation and cost control via early screening and planning.

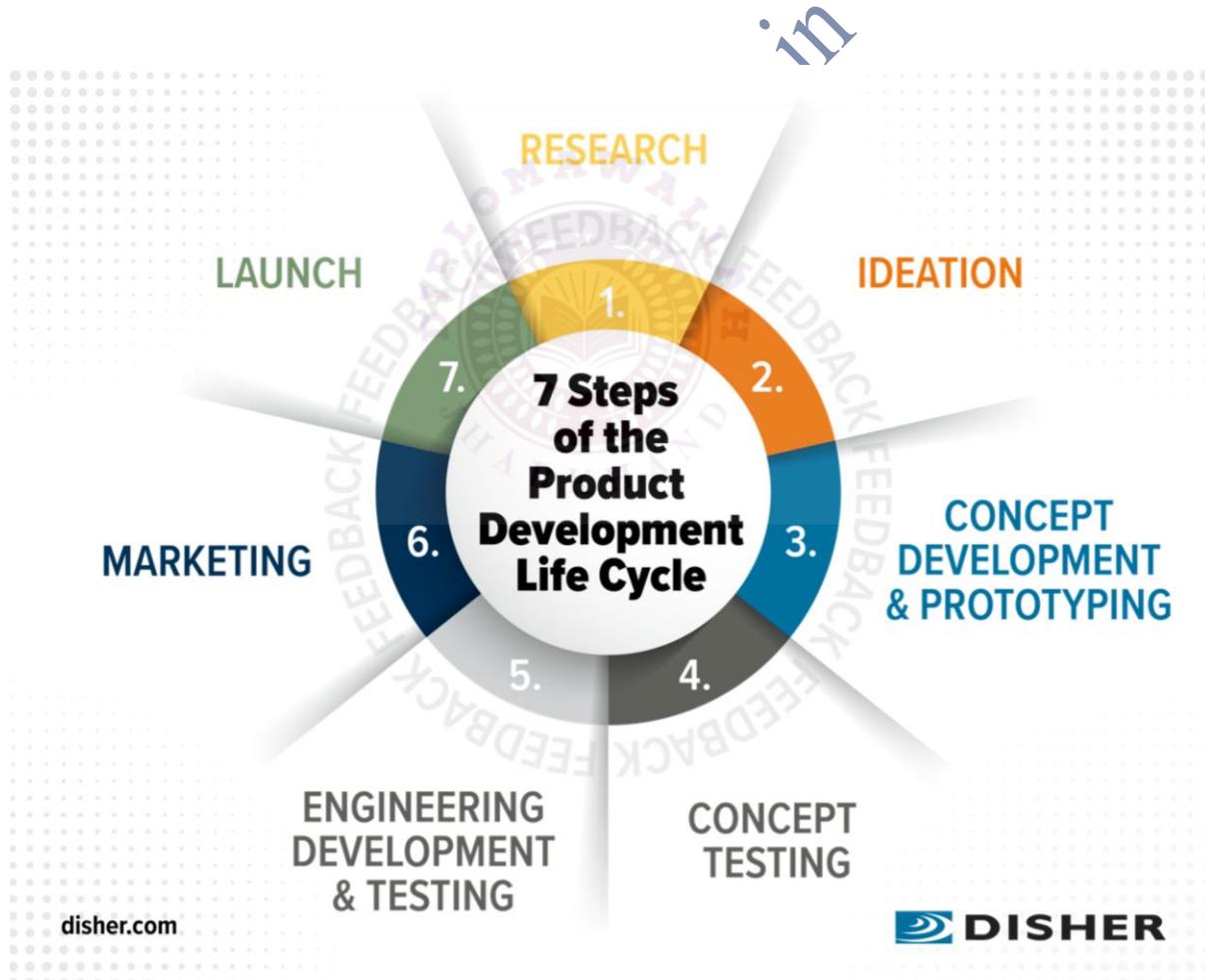
 **Disadvantages (5 points):**

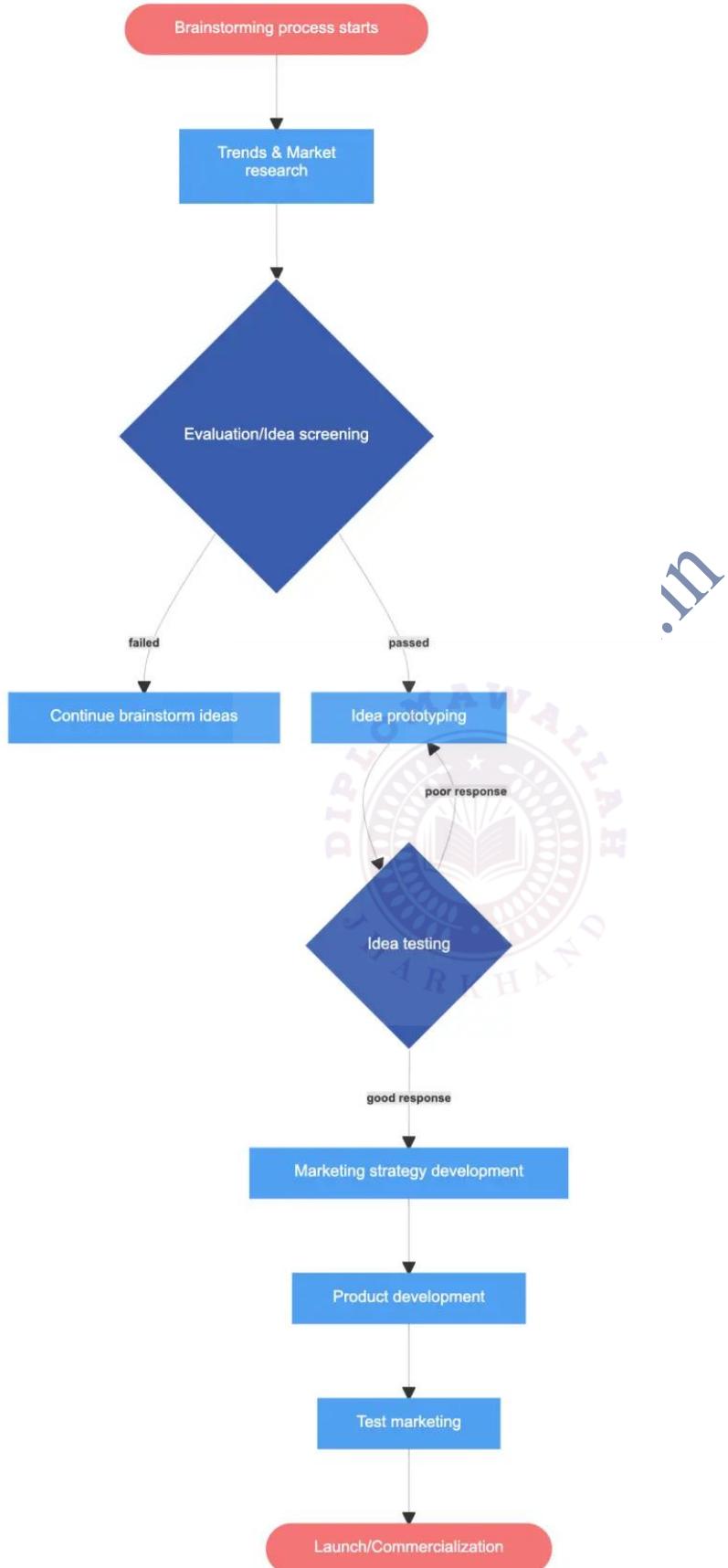
1. If rigidly followed, the process can become bureaucratic and slow innovation.
2. Managing coordination across many functions is complex and may cause delays.
3. Multiple iterations, prototypes, testing phases can increase cost and time.

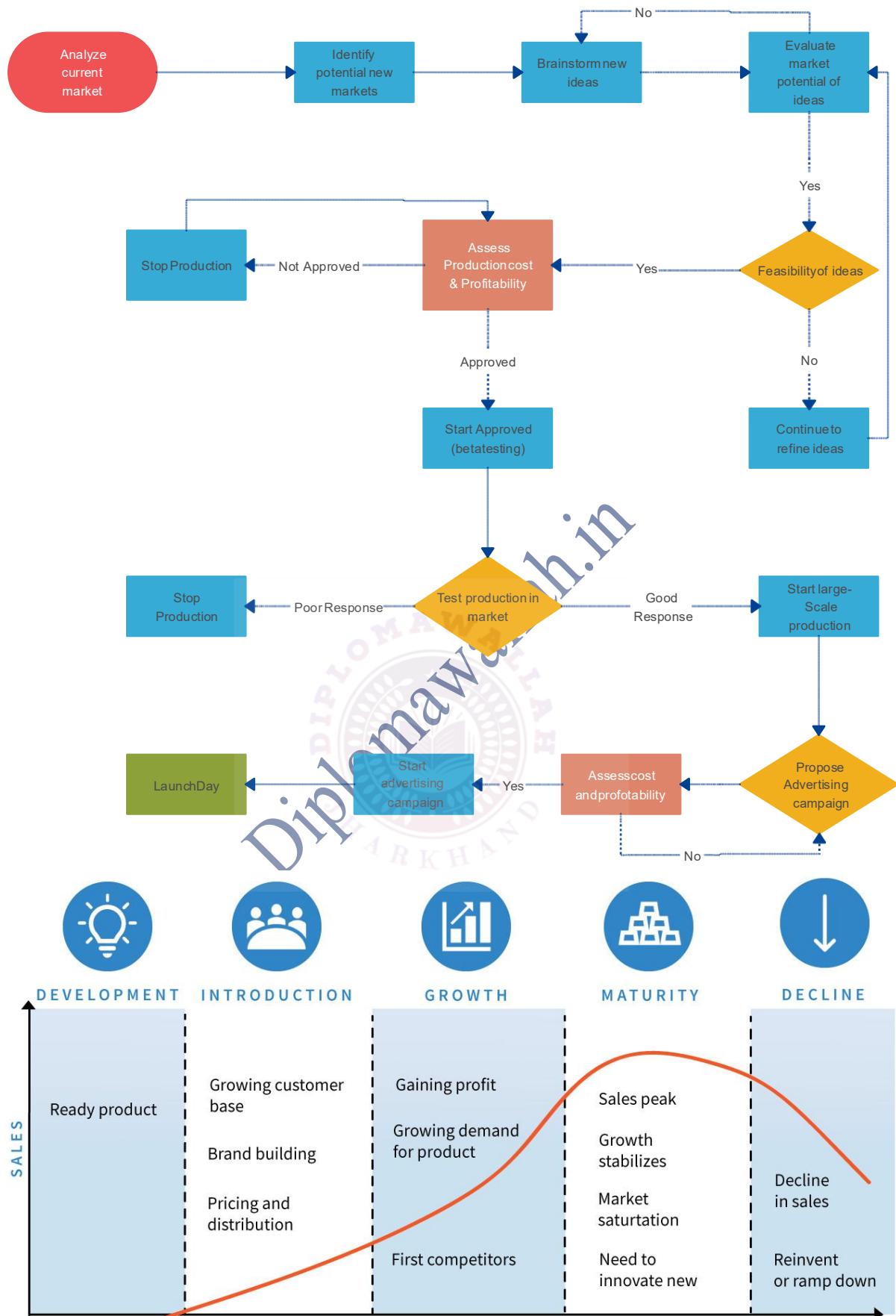
4. Changes in market or customer needs may outpace the process and lead to mis-fit.
5. Over-emphasis on process can stifle creative or radical innovation (companies may focus on incremental improvements only).

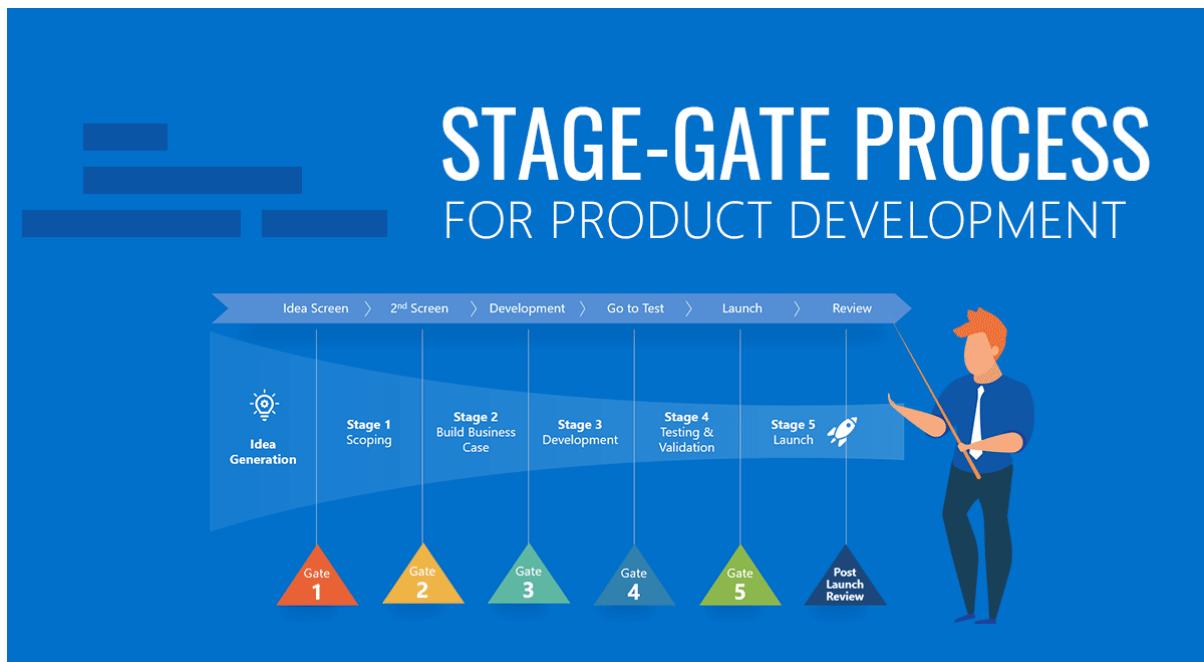
 **Summary (Hinglish, 2-3 lines):**

Product development ka process ek roadmap hai idea se market tak ka safar. Agar har stage sahi-sahi aur timely execute ho, to product market me hit ho sakta hai – warna cost badh sakti hai, delay ho sakta hai ya product fail ho sakta hai.









◆ 1.4 Concept Development

■ Definition

Concept development is the phase in product development where a selected idea is transformed into a detailed product concept that can be further developed and tested. It involves defining the target market, customer needs, key features, benefits, cost constraints and how the product will compete in the marketplace. At this stage, the abstract idea takes shape into a viable offering, described in terms that customers understand and value. It bridges the gap between raw ideas and full product design, assessing technical feasibility, market viability and business fit. It often involves generating multiple concepts, classifying them, combining features, and then selecting the best for further development. [Ice Cream](#)

[Tutor+3komninos.eu+3coursecontent+3](#)

✿ Explanation

1. **Generate Multiple Concepts:** After screening ideas, different concept alternatives are created to explore variations in features, functions or user experience. [entrepreneurship-isemi.com+2ProductLogic LLC+2](#)
2. **Concept Classification Tree:** Concepts are organised in a logical tree to map out variations and pathways – helps in visualising and comparing alternatives.
3. **Concept Combination Table:** Features or sub-concept elements are combined in tables to create hybrid concepts, enabling creative mixing of options.

4. **Define Target Market & Benefits:** For each concept, define which customer segment it serves, what benefits it delivers, and how it stands against competition. komninos.eu+1
5. **Feasibility & Resource Assessment:** At this stage, technical feasibility, manufacturing implications, cost estimates and business viability are considered. Unishivaji+1
6. **Selecting Promising Concepts:** Through screening or scoring, the most feasible and attractive concept(s) are selected for detailed development. coursecontent+1
7. **Iteration & Refinement:** Concept development is iterative – feedback from research leads to refining or combining concepts before final selection. [Ice Cream Tutor](http://IceCreamTutor)
8. **Documentation & Visualization:** Concepts are often documented with sketches, renderings or brief prototypes, making them easy to evaluate. ProductLogic LLC
9. **Communication to Stakeholders:** Clear representation of the concept helps marketing, engineering, manufacturing and service teams align on what will be built.
10. **Preparing for Next Phase:** The selected concept becomes the input to detailed design, prototyping and testing phases.

 **Applications (5 points):**

- Creating multiple design proposals for a new smartphone (screen size, battery, camera combinations) and selecting the best.
- Developing various concept layouts for a smart refrigerator (modular storage, cooling zones, smart features) via combination tables.
- Defining concept alternatives for an electric scooter targeting urban commuters vs leisure users.
- Generating and comparing concepts for a wearable health device (design, sensors, communication).
- Using classification trees to map user interface options for a new app or hardware product.

 **Advantages (5 points):**

1. Encourages creative exploration – more ideas and variations before committing.
2. Helps avoid costly mistakes – prior to detailed design, feasibility and market fit are evaluated.
3. Enables better alignment across teams – clear concept reduces misunderstandings.
4. Improves chance of market success – customers' needs and competitive context are integrated early.
5. Provides structured way to compare alternatives and select the optimal path.

Disadvantages

1. Time-consuming if too many concepts are generated and evaluated.
2. Risk of analysis paralysis – too many choices may delay decision.
3. If concept development is weak, may lead to selecting suboptimal concept and downstream problems.
4. Cost of prototyping or visuals in concept stage may increase budget.
5. Without proper market/customer input, concept may still not meet real needs.

Summary

Concept development stage me hum idea ko ek "shape" dete hain – alag-alagh options banate hain, unko compare karte hain, aur best concept choose karte hain jo market aur business dono ke hisaab se sahi ho. Ye agle design phase ki foundation hoti hai.



Start-to-Finish Product Development Process

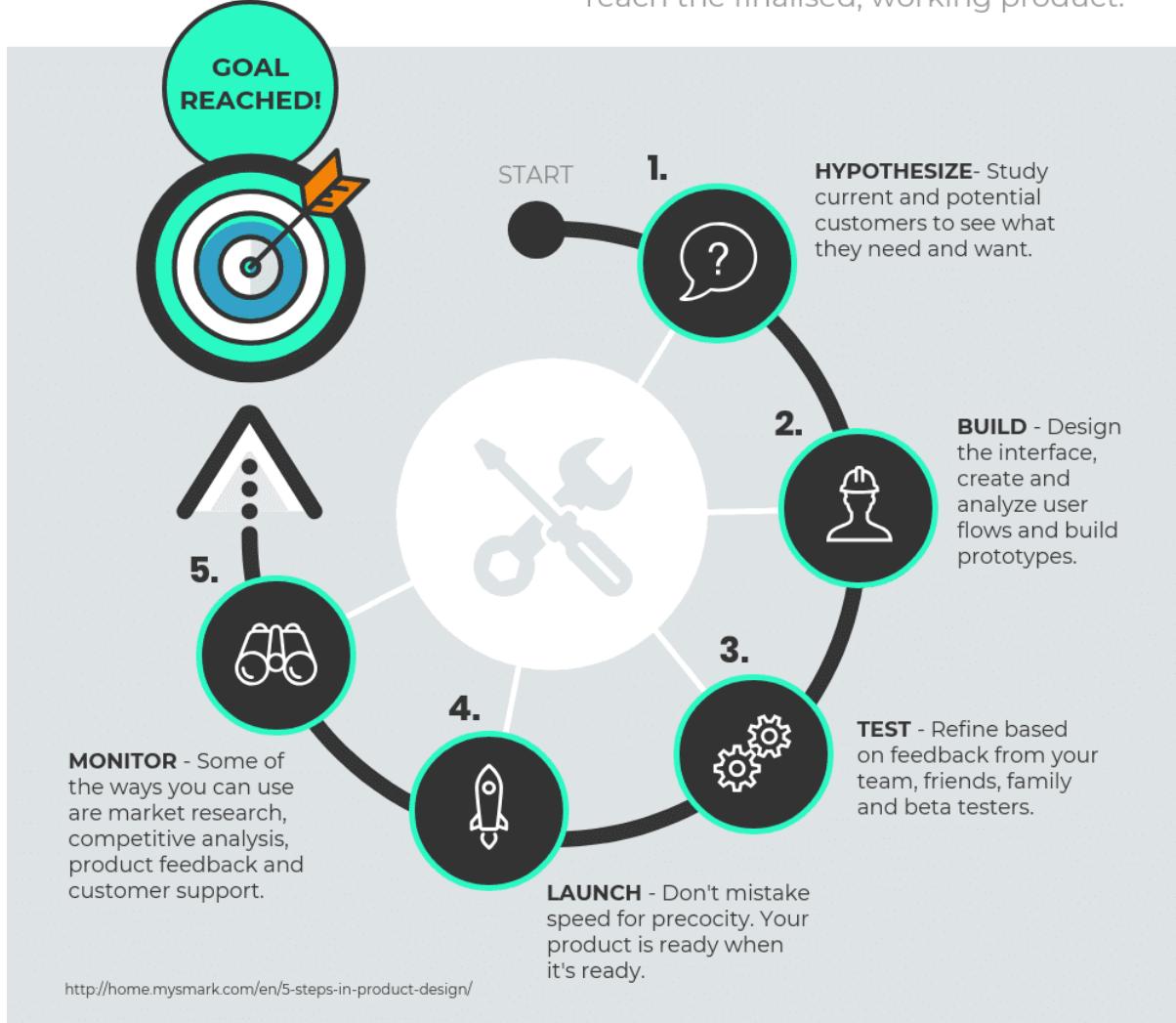
EcoBags manufactures eco-friendly bags for environmentally conscious people. Here is our detailed product development process from ideation to product launch. To learn more, visit us at www.ecobags.com

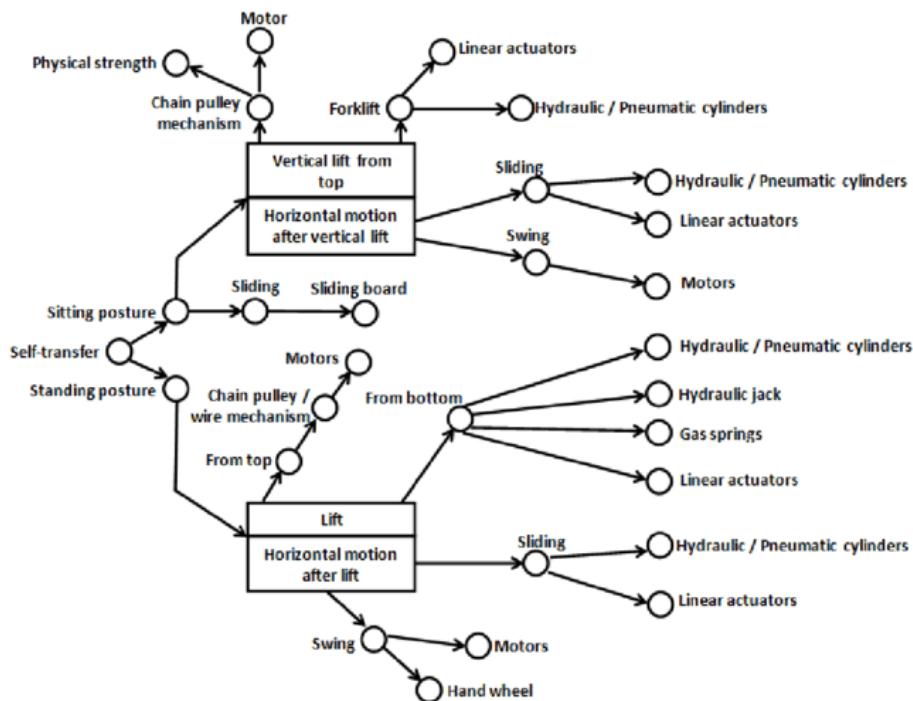


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STEPS IN PRODUCT DESIGN

Product design involves many steps in order to reach the finalised, working product.





◆ 1.5 Concept Selection

■ Definition (7-8 lines):

Concept selection is the phase in product development where from among several generated product concepts, one (or a few) is chosen for further development. It involves systematic evaluation of alternatives against defined criteria – technical feasibility, customer desirability, cost, risk, manufacturability and strategic fit. The aim is to reduce uncertainty and choose the concept with the highest chance of success before moving to detailed design and development. This stage typically uses structured tools like screening matrices and scoring models to compare concepts. The outcome is a clear decision on which concept(s) proceed, and which are dropped or combined. In essence, concept selection bridges concept generation and detailed design by choosing the best path forward.

✿ Explanation (10 Points / ~7-8 lines):

1. **Concept Screening:** A preliminary quick filter to eliminate concepts that clearly don't meet minimum thresholds (feasibility, cost, market fit) using simple criteria. [Portland State University Library+1](#)
2. **Concept Scoring:** On the remaining concepts, a more detailed quantitative evaluation is done: criteria are weighted, each concept is scored, summed up and ranked. [AHMCT+1](#)

3. **Selection Criteria Setup:** The team defines selection criteria based on customer needs, business objectives, technical constraints and manufacturing considerations. [Computer Action Team](#)
4. **Matrix Methods:** Commonly used tools include the Stuart Pugh Pugh Matrix (screening: +/0/-) and weighted decision-matrix for scoring. [Wikipedia+1](#)
5. **Benchmarking/Reference Concept:** A reference concept (datum) may be used to compare alternatives, improving consistency of scoring. [Computer Action Team+1](#)
6. **Iteration & Combination:** The process may loop – concepts may be improved, combined, new ones generated if none meet targets. [Sathyabama University+1](#)
7. **Selection Decision:** After screening and scoring, top concept(s) are selected to move forward into detailed design and development. [Teknik Industri Unpatti](#)
8. **Reflection:** Teams reflect on the selection process to learn and refine for future projects. [Scribd](#)
9. **Risk Management:** Early elimination of weak concepts saves resources and reduces risk of pursuing poor ideas. [Question AI](#)
10. **Communicating Decision:** Clear documentation of why a concept was chosen ensures alignment across teams (engineering, marketing, manufacturing). [Liberal Studies at Berkeley](#)

Applications

- Selecting the best smartphone concept out of three feature sets (camera-centric vs battery-centric vs budget-centric).
- Choosing the concept for an electric scooter: “urban commuter” variant vs “recreational” variant.
- Picking among wearable health device concepts: continuous monitoring model vs simplified alert model.
- Choosing between home-appliance concepts: integrated smart refrigerator with IoT vs modular cheaper version.
- In industrial equipment: selecting concept for a machine tool: high-precision luxury vs cost-efficient mass-market version.

Advantages (5 points):

1. Narrowing focus means resources are dedicated only to the most promising concept.
2. Structured decision-making reduces bias and increases transparency.
3. Early elimination of poor concepts reduces cost and development time.
4. Enhances cross-functional alignment since decision criteria are explicit.
5. Improves chances of market success because selection is aligned with customer needs and business objectives.

Disadvantages

1. If criteria or weights are wrong, you may eliminate concepts that could succeed later.
2. Over-reliance on quantitative scoring may overlook qualitative insights or innovation potential.
3. Iterations/combinations can become time-consuming and slow decision-making.
4. Choosing too early may lock you into sub-optimal path if market shifts happen.
5. If team lacks experience, decision matrices may give false sense of rigor while underlying assumptions are weak.

Summary

Concept selection stage me alag-alag design ideas me se best path choose ki jaati hai – jisme hum decision criteria set karte hain, ideas ko score karte hain, aur sabse promising idea aage badhate hain. Agar ye process sahi se ho, to development smooth aur beneficial hota hai.

Selection Criteria	Seat(A)	Handle(B)	Measuring m/c(C)	Adjustable screw(D)	Height(E)	Centroid Rod(F)	Digital Screen(G)
Ease to use	0	+	+	+	0	-	+
Ease to handling	-	0	0	0	+	+	0
Readability of setting	0	-	0	0	0	0	0
Controlling height	-	0	0	0	0	0	-
Sum '+'s	0	1	1	1	1	1	1
Sum '0's	2	2	3	3	2	2	2
Sum '-'s	2	1	0	0	0	1	1
Net score	-2	0	1	1	1	0	0
Rank	3	2	1	1	1	2	2
Continue?	No	Combine	Yes	Yes	Yes	Combine	Combine

Parameter	Rocker Bogie	Zoë	SpaceCat
Suspension	+	0	-
Obstacle Climbing	+	0	0
Control	0	0	0
Size	0	0	0
Power	-	0	-
Topple	+	0	+
Complexity	-	0	-
Payload	+	0	+
Speed	0	0	+
Cost	-	0	-
Total	1	0	-1



select the best solutions
Pugh matrix

Criteria	Solutions / Ideas				Weighting
	Solution A	Solution B	Solution C	Solution D	
Can it be implemented quickly	+	+	S	S	1
Will solve the problem fully	-	S	S	-	5
Costs less than the budget	+	+	S	S	1
Wont impact the customer	+	+	S	+	2
No regulatory risks	-	-	S	-	1
Weighted Sum of Positives	4	4		0	
Number of Sames	0	1		2	
Weighted Sum of Negatives	-6	-1		-6	

How to complete a Pugh Matrix

- 1) **Finalise** the selection of solutions, assessment criteria and weightings that you will include in your matrix
- 2) **Choose** a solution that be your standard
- 3) **Compare** each solution against the standard and note whether you think it is better, the same or worse
- 4) **Calculate** the Weighted Sums
- 5) **Focusing** on strongest solutions, look for opportunities to combine the best aspects of different solutions

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◆ 1.6 Identification of Customer Need

☰ Definition (7-8 lines):

Identification of customer need is the process of discovering what customers actually require, expect or desire from a product or service – including both explicit (stated) and latent (unstated) needs. It involves collecting raw data directly from customers

or observing their behaviours and then interpreting, organising and prioritising these needs to inform design and development. The aim is to translate the "voice of the customer" into actionable product requirements that align with business strategy and technical feasibility. This step is foundational in product development, as it ensures that the subsequent design, concept generation and specification phases are grounded in real user needs rather than assumptions.

❖ Explanation (10 Points / ~7-8 lines):

1. First you must **identify who the customers or stakeholders** are – not just the end user, but all who influence or use the product (users, service staff, retailers, etc.). [Google Sites+3](#) [Pressbooks B.C. Campus+3](#) [SNU OpenCourseWare+3](#)
2. **Data collection:** Use methods like interviews, focus groups, observations of real use, surveys and social-listening to gather raw customer data. [Cornell CIT Courses+2](#) [Tufts University+2](#)
3. **Interpretation of raw data:** Translate this data into customer needs statements (what the product must do) rather than features or solutions. [Coroflot+1](#)
4. **Organising needs:** Group similar needs into clusters/hierarchies (primary, secondary) and remove duplicates or ambiguous statements. [coursecontent+1](#)
5. **Establishing relative importance:** Prioritise needs in terms of how critical they are to customers and the business (e.g., rating or ranking methods). [Cornell CIT Courses+1](#)
6. **Latent vs explicit needs:** Recognise that many needs are hidden (latent) and cannot be discovered just by asking; observation is key. [Google Sites+1](#)
7. **Avoid specifying solutions too early:** Needs should be phrased in non-solution-biased form so design teams have flexibility. [Theseus+1](#)
8. **Stakeholder alignment:** Ensure that all stakeholder groups understand and agree on identified needs so that everyone is aligned. [Google Sites](#)
9. **Feedback and iteration:** After launching or during development, needs may evolve – so revisit and refine needs as required. [ExtruDesign](#)
10. **Foundation for product specification:** The output of this process becomes the input to concept generation, selection and final specification stages of development. [coursecontent+1](#)

❖ Applications (5 points):

- While designing a new smartphone, interviewing users to identify their highest priority features – battery life, durability, camera ease-use.
- In home appliance design, observing how families use existing refrigerators to uncover latent needs like faster access, noiseless operation or child-safe compartments.
- For industrial machinery, mapping needs of operators, maintenance staff, and production line to define design requirements like ease of cleaning, downtime minimisation or automation.
- In apparel or wearable device development, using social listening to find what users complain about (comfort, heat, fit, battery) and translating into design needs.
- In software or app development, analysing support tickets and usage data to identify pain points, - then converting them into product improvement needs.

 **Advantages (5 points):**

1. Ensures product is built to match **real customer requirements**, increasing chance of success.
2. Helps avoid wasted resources on features that customers don't value.
3. Enables prioritisation of development efforts by focusing on high-importance needs.
4. Encourages innovation by uncovering latent needs that users themselves may not articulate.
5. Aligns cross-functional teams (marketing, design, engineering) around a common understanding of what customers really want.

 **Disadvantages (5 points):**

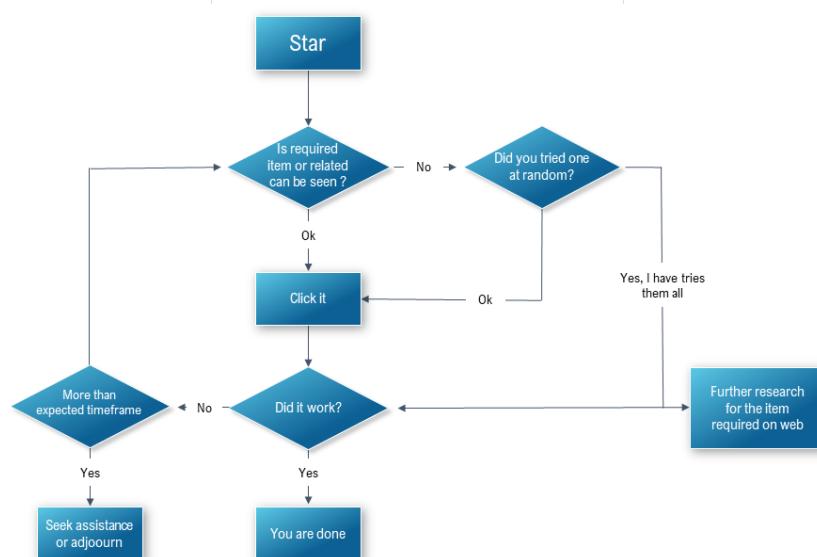
1. Gathering and interpreting customer needs can be **time-consuming** and resource intensive.
2. Customers may **not clearly articulate** their true underlying needs – risk of mis-interpretation.
3. Prioritising needs may lead to simplification or ignoring less obvious but critical latent needs.
4. If needs identification is done poorly or biased, it may set the product on the wrong path.

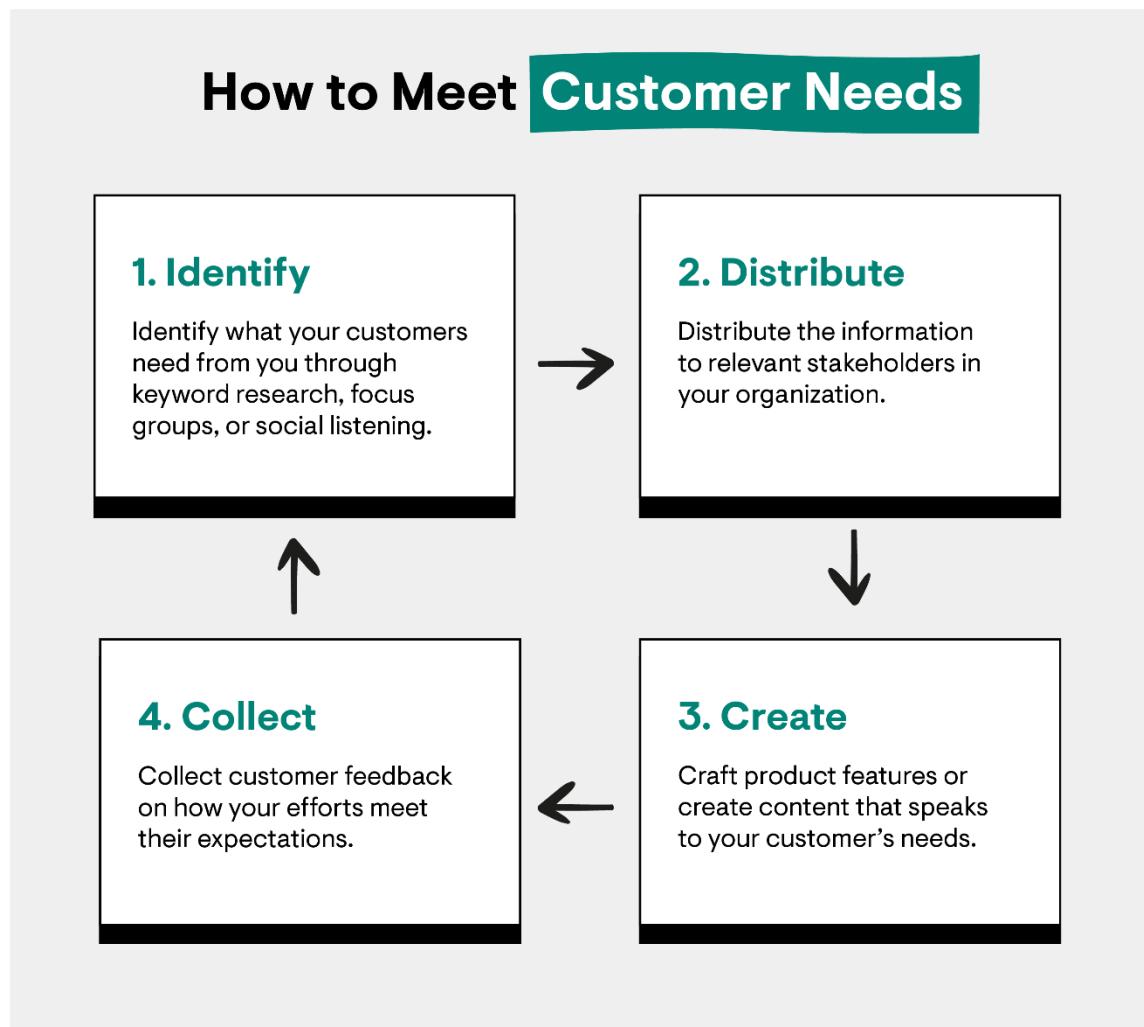
5. Needs may change rapidly due to market dynamics, technology or competitor actions — so what was identified may become obsolete.

Summary

Customer need identification me hum customer ke jahaan-zaha-problem aur chaahe-gaah ko samajhte hain — phir unko group karke priority dete hain. Agar ye step strong ho jaye, to product market me zyada chance se pasand hogा.

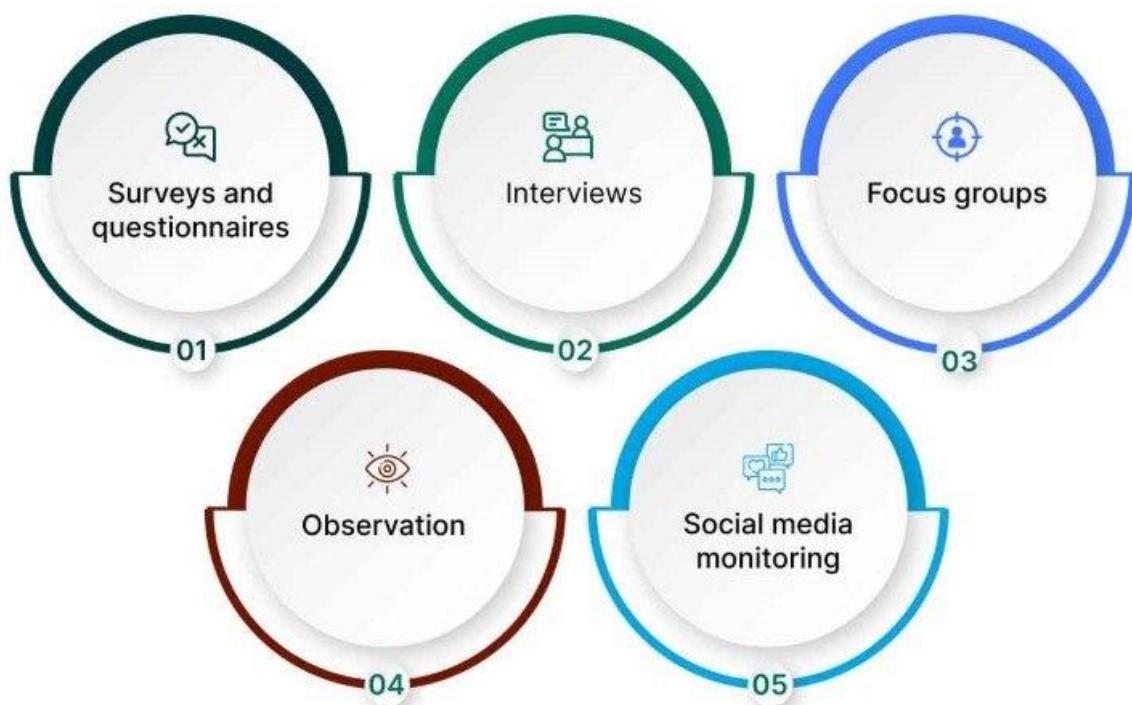
Customer Service Improvement Interface Process Flow Chart





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Methods of Identifying Customer Needs



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