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Design Guidelines and Strategies for Interim Innovation

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ABSTRACT

This study introduces 'interim innovation' as a new innovation category, blending advanced features from emerging technologies into accessories for mainstream products, thereby overcoming traditional barriers to innovation adoption. Utilizing a descriptive methodology, it combines literature review and case studies to analyze interim products across seven key attributes, leveraging innovation diffusion theory. It underscores the advantages of interim innovations in terms of cost-effectiveness, compatibility, sustainability, and inclusivity, while acknowledging their limitations in utility and aesthetic appeal. The research concludes with actionable design guidelines and strategic insights aimed at reducing innovation resistance and accelerating market acceptance.

Keywords: Design innovation, Innovation product development, Concept generation and inspiration, Design strategy, Design guideline, Diffusion of innovations

INTRODUCTION

Innovation is the act of generating a new product, service, or process (Veryzer Jr, 1998). According to an organizational standpoint, the definition of innovation ought to be more refined and focused on commercial activities (Ram, 1987). In this study, innovation is primarily focused on commercial activities and the application of new ideas to physical products.

Innovation can be classified into two primary categories, continuous and discontinuous. Continuous or incremental innovation represents ongoing processes that enhance existing products or services through regular improvements over time, yielding positive outcomes for companies in terms of cost efficiency or feature enhancement (Lianto, Dachyar et al., 2018, Rubin and Abramson, 2018). On the other hand, discontinuous innovation has many different terms such as "radical," "disruptive," "discontinuities" and more. However, "radical innovation" and "disruptive innovation" are more commonly used (Tellis, 2006). Radical innovation significantly transforms or creates markets by introducing breakthrough features, enhancing performance, or cutting costs (Dosi, 1988). Disruptive innovation is when a new product or service starts in a small market and gradually overtakes the existing one, transforming the industry (Dan and Chieh, 2008). There are notable distinctions between radical and disruptive innovation. Radical innovations, driven by technological breakthroughs, typically target the high-end market

prioritizing performance over cost, unlike disruptive innovations (Norman and Verganti, 2014). In contract, disruptive innovations emerge in low-end or new markets with products and services that evolve to meet the needs of initially overlooked yet eventually profitable customers (Christensen, Raynor et al., 2013). According to Reinhardt and Gurtner (2015), disruptive innovations introduce an additional performance dimension to existing solutions but may not have a lower price and increase adoption risk for customers due to their newness and difference. To summarize, three primary types of innovation are identified: radical, targeting high-end markets with technological breakthroughs; continuous or incremental, enhancing features and reducing costs for mainstream markets; and disruptive, creating new markets or catering to the low-end with improved products and services for discerning customers.

However, this study points out products that mix innovation categories, acting as attachable accessories aimed at mainstream and budget-friendly markets but offering high-end features. For example, electric bike conversion kits, standing desk converters, and AirBar transform ordinary bikes, desks, and laptops into electric bikes, adjustable standing desks, and touchscreen devices, respectively. These innovations allow for cost-effective upgrades of everyday items, facilitating easy enhancements without substantial financial outlay. The aim is to thoroughly investigate these products to discern their patterns and characteristics, proposing a new category of innovations.

LITERATURE REVIEW

Innovations offer significant benefits to society, yet they often necessitate individuals to learn new skills, acquire knowledge, or adapt their lifestyles. Consequently, innovation resistance emerges when individuals resist or refuse new innovations, often due to perceived risks, established habits, or a preference for current practices (Ram and Sheth, 1989). Kuisma, Laukkanen et al. (2007) differentiate rejection as passive non-adoption and resistance as active yet not always leading to non-adoption. Ram (1987) stated that initial resistance is a common occurrence when adopting new innovations. Resistance and adoption may coexist, with rejection possible; identifying resistance reasons is vital for successful innovation diffusion.

Ram and Sheth (1989) identified barriers to innovation adoption include functional (usage, value, risks) and psychological (traditions, norms, perceived image) factors. These barriers can hinder innovation diffusion, the spread of new ideas based on perceived benefits and usability. To understand and overcome innovation barriers, Rogers, Singhal et al. (2014) introduced the diffusion of innovation theory (DIT), highlighting five key characteristics—relative advantage, compatibility, complexity, trialability, and observability—that determine the varying adoption rates of innovations and help overcome barriers to innovation.

Relative advantage, encompassing economic, social, or utilitarian benefits, significantly impacts an innovation's adoption rate by its perceived superiority over predecessors (Rogers, 2003). However, its effectiveness varies with users' needs and perceptions (Oldenburg and Glanz, 2008), suggesting broader adoption relies on the technology's applicability across diverse domains.

Compatibility, the alignment between an innovation and adopters' values, experiences, and needs, facilitates adoption by meeting technological, social, and learning conditions, reducing the risk of slow uptake due to radical differences (Rogers, 2003; MacVaugh and Schiavone, 2010).

Complexity, inversely affecting adoption rates, encompasses product, process, and technological challenges (Hobday, 1998; Rogers, 2003), highlighting the importance of simplification to boost adoption and societal benefits.

Observability, which is how visible an innovation's effects are (Rogers, 2003), plays a key role in its adoption rate, as shown by Hayes, Eljiz et al. (2015) where animations helped staff quickly understand the potential impacts of new innovations.

Researchers have applied DIT to study a wide range of innovations (Rogers and Williams, 1983; Al-Jabri and Sohail, 2012; Hayes, Eljiz et al., 2015), tailoring the analysis by adding specific characteristics relevant to the product or service under investigation. Al-Jabri and Sohail (2012) previous research on mobile banking adoption considered it as a technological innovation and incorporated perceived risk as a factor, in addition to the five characteristics mentioned. Perceived risk involves an individual's evaluation of uncertainties and potential negative outcomes linked to adopting an innovation (Ram and Sheth, 1989; Al-Jabri and Sohail, 2012). Chang, Fu et al. (2016) proposed the incorporation of familiarity as a mediator in evaluating online shopping behaver. Individuals who are familiar with a particular product category tend to actively seek out new information to update their knowledge (Johnson and Russo, 1984). Familiarity is defined as the extent of understanding and knowledge one possesses about an entity (Gefen, Karahanna et al., 2003).

RESEARCH METHODS

This study seeks to address the existing research gap on interim innovation by analysing patterns within interim products via a multi-case study approach. This method enables a thorough examination of the subject's complexity and richness, capturing its diverse dimensions, perspectives, and nuances (Yin, 2018). Additionally, the literature review method is also utilized to explain this phenomenon.

The research methodology involves three key steps:

1) Initial Identification: This phase involves identifying interim products and their advanced counterparts to set a solid foundation for a detailed and systematic comparative analysis.
2) Categorization: Sorting the identified products into electronic and non-electronic categories is essential. Electronic products function with the use of electricity, while non-electronic products operate without any electrical power. This distinction recognizes the complex nature and technological sophistication of electronic products, setting the stage for a detailed and insightful analytical comparison.
3) Comparative Analysis: In this final phase, the study conducts a multi-case analysis to compare selected interim products with their innovative

counterparts. This comparative assessment leverages seven established innovation criteria: relative advantage, compatibility, complexity, trialability, observability, perceived risk, and familiarity, incorporating insights from Rogers (2003), Al-Jabri and Sohail (2012), Chang, Fu et al. (2016). This comprehensive comparison seeks to identify patterns, establish fundamental characteristics, and develop design guidelines and strategic insights.

The study includes six cases and their comparative evaluations—three focusing on electronic products and three on non-electronic ones. An additional step involves exploring an outlier to understand its distinctiveness.

RESULT

In this section, the study presents the results of seven case studies and their comparative analyses. Furthermore, by identifying patterns and characteristics of interim products, this study defines the concept of "interim innovation/product" and establishes corresponding design guidelines and strategies.

Electronic Products

In this section, three electronic products are analysed, including 1) standing desk converter, 2) electrical bike conversion kit, and 3) Airbar.

1) Electric bike conversion kits present a cost-effective alternative to complete electric bikes, which range in price from $1,500 to over $5,000 based on quality, and serve as a significant hurdle to widespread adoption (Dill and Rose, 2012, Jones, Harms et al., 2016). Electric bike conversion kits, priced from $75 to $700 for mid-drive types and $200 to $300 for front/rear wheel types, transform pedal bikes into motorized versions affordably. Mid-drive kits replace the crankset, while wheel kits necessitate changing the bike's wheel, with compatibility hinging on matching wheel sizes. Compared to electric bikes, conversion kits are more cost-effective and fit compatible pedal bikes, but they may be seen as having lower functionality, complex installation, and less aesthetic appeal, posing potential risks for consumers.

2) Electric standing desk converters, priced between $150 and $700, offer a cost-effective and convenient solution to upgrade existing desks with standing functionality, without the need for a new setup, unlike electric standing desks which can cost between $300 to $2000. However, compatibility with the existing desk's design and sufficient surface space are essential considerations, along with the potential for surface scratches from the converter's placement.

3) AirBar, priced between $59.99 and $72.99, provides an affordable solution for adding touchscreen functionality to non-touchscreen laptops. It uses magnets for attachment under the screen and a USB connection, creating an invisible light field for touch detection. However, it requires at least 22mm of flat space below the screen for installation, potentially affecting aesthetics. Users also need to detach it before closing their laptop to avoid damage.

With touchscreen technology becoming more affordable and common, the AirBar's cost advantage has decreased.

Non-Electronic Products

This section analyses three non-electronic products: 1) ergonomic back support, 2) sunglasses clips and fit over sunglasses, and 3) universal stroller board.

1) Ergonomic back supports offer a budget-friendly way to enhance chair comfort, starting at $15 for mesh supports and $25 for cushions on Amazon. This alternative to expensive ergonomic chairs, which can cost up to $2000, provides similar benefits by transforming standard chairs into more ergonomic options. Despite their cost advantage, these supports may lack the premium look of ergonomic chairs and might not match well with existing furniture. Additionally, their effectiveness in providing ergonomic benefits is occasionally debated.

2) Sunglasses clips and fit over sunglasses, costing between $10 to $30, present a cost-effective alternative to prescription sunglasses, which range from $150 to $500. These solutions easily attach to prescription glasses, offering UV protection and reducing glare. Sunglasses clips magnetically attach, allowing for easy indoor to outdoor transition by flipping them up or down, while fit over sunglasses are designed to be worn directly over prescription glasses. Despite their affordability and functionality, both options have size constraints to ensure proper coverage and may compromise the aesthetic appeal of prescription glasses.

3) Universal stroller boards, priced from $50 to $100, offer a budget-friendly alternative to double strollers, which range from $150 to $300. They attach to most strollers with adjustable attachments, providing a standing platform for older children and accommodating families with kids in different mobility stages. While these boards are cost-effective and compatible with various stroller brands, safety and performance remain key considerations for any child-related product.

Exception

Wireless smart home products represent a notable shift in home automation, largely supplanting wired systems and highlighting a significant evolution in the industry's approach. Lutolf (1992) noted the 1990s wired smart homes' ease of connectivity with a single cable, streamlining the previous complex installation process. Yet, Harper (2006) pointed out that high installation costs still hindered smart home adoption. Stauffer (1991) mentioned that these systems were mainly for new constructions, with retrofitting options emerging. The late 2000s witnessed a significant shift towards smart home adoption, facilitated by the integration with smartphones and the advent of wireless technologies like RFID, Bluetooth, and Wi-Fi (Al-Qutayri and Jeedella, 2010, Yang, Lee et al., 2018). Wireless smart home technology simplified installation and fostered broader adoption.

Wireless smart home innovations, such as remote-controlled light switches, app-enabled SwitchBot, and smart locks with cameras, outpace wired systems by offering cost efficiency, simpler installation, broader compatibility, and enhanced functionality. Marking a significant shift driven by technological advancements (Verganti, 2008), these battery-operated solutions facilitate seamless integration into homes, positioning wireless products as mainstream preferences over wired alternatives. This transition highlights that wireless smart home products are unique exceptions among these cases, while still sharing common patterns and attributes.

Patterns and Characteristics

This strategy capitalizes on developing add-on products that enhance mainstream products with high-end features, offering a cost-effective route to innovation. By integrating with existing products, these add-ons provide immediate, recognizable benefits at a fraction of the cost of new technologies, promoting rapid market adoption. This approach not only extends the life cycle of current products but also minimizes waste, presenting a practical solution for consumers to upgrade their lifestyles efficiently. However, add-on products may be seen as inferior due to lower functionality, aesthetic discrepancies, and installation risks despite their economic advantages and compatibility with existing mainstream products.

The product life cycle and market position of add-on products are significantly influenced by the status and evolution of their high-end counterparts. As premium products become more accessible and shift towards the mainstream market due to increased competition and technological advancements, these add-on alternatives may quickly decline. For instance, AirBar's reduced market relevance aligns with the growing affordability of touchscreen technology. Similarly, the emergence of budget-friendly electric standing desks, offering varying qualities and sizes, has lessened the appeal of desk converters, undercutting their economic benefits and intensifying market competition.

Definitions

Due to the inferior features of these add-on products and their strategic positioning as alternatives to superior premium innovations, this study defines them as "interim innovations," also termed "interim products." Interim products serve as temporary solutions until the corresponding premium innovations become widely available in the mainstream market. This interval, during which premium innovations are yet to achieve mainstream adoption, is identified as "interim period". Throughout this time, interim products leverage their cost-effectiveness to secure a temporary yet profitable foothold in the mainstream and low-end market.

Design Guidelines to Interim Innovation/Product

This study proposes three guidelines for designing an interim product:

1) An interim product should offer advanced functions that are comparable to high-end products, delivering a similar innovative advantage.

2) An interim product should be priced competitively in both the mainstream and low-end markets, thus offering a relative economic advantage.
3) An interim product should be highly compatible and easily installable on a single type of mainstream products.

Design Strategies to Interim Innovations/Product

This study outlines strategies to mitigate risks for interim products, focusing on functionality, ease of use, compatibility, aesthetics, and timely market entry:

1) Functional Equivalence: Interim products should closely mirror the functionalities of high-end innovations, offering users a similar experience at a lower cost.
2) Ease of Integration: Simplifying the integration process with intuitive attachment mechanisms can make interim products more appealing. For example, the straightforward attachability of standing desk converters contrasts with the complex installation of electric bike conversion kits.
3) Broad Compatibility: Designing for maximal compatibility is vital, as success hinges on an interim product's adaptability to various mainstream product sizes and designs, like the general fit of standing desk converters.
4) Aesthetic Versatility: Given the wide range of mainstream product designs, interim products should feature versatile aesthetics to blend in seamlessly.
5) Timely Launch: The development and market introduction of interim products should be strategically timed to precede the mainstream adoption of premium innovations, maximizing their market relevance and financial viability.

Design Process to Interim Innovation/Product

The development of interim products in a postsecondary setting requires a thorough strategy that examines both the general application and the finer details. A concise outline of this process is provided below:

1) High-end innovation selection: Identify a high-end innovation with attractive features, ensuring it remains in the high-end market for an extended interim period.
2) Mainstream product identification: Determine the mainstream counterpart of the high-end innovation, like ordinary desks for electric standing desks.
3) Mainstream product analysis: Analyze mainstream products for characteristics like size, material, and design to ensure the interim product fits a wide range. For example, design fit-over sunglasses in common prescription glasses sizes for broad applicability. Consider international variances for enhanced adaptability.
4) Interim product ideation: Leverage insights from mainstream product analysis to create practical interim solutions, focusing on ease of use and minimizing risks such as installation damage or aesthetic discord.

5) Review and enhancement: Evaluate the interim product against design guidelines and strategic objectives, refining it to meet quality standards and ensure broad market appeal.

DISCUSSION

Exploring the patterns and characteristics of interim innovations is an important topic for academic research. Interim innovations provide affordable yet innovative enhancements to existing mainstream products, making them pivotal elements. This strategic positioning allows them to leverage the established market presence of high-end counterparts and address the critical gap in consumer demand. The discussion explores their implications, challenges, and broader impacts on market dynamics and consumer behavior.

Strategic Implications of Interim Innovations

Applying innovation diffusion theory to interim innovations reveals their key function in connecting high-end innovation with mainstream accessibility (Rogers, 2003). Interim innovations offer a cost-effective solution to access advanced features by upgrading existing products at less than half the cost of premium alternatives, eliminating the need for significant investment or complete product replacement. While offering an affordable path to enhanced functionality, these innovations face challenges like reduced functionality and compatibility issues. Adhering to design guidelines that emphasize functional equivalence, aesthetic compatibility, and ease of integration is crucial for their successful development and market acceptance.

Consumer Behavior and the Lifecycle of Interim Innovations

The lifecycles of interim innovations are closely influenced by the tech and market shifts of their high-end counterparts, with changes in technology or consumer preferences quickly affecting their market relevance. However, wireless smart home products distinguish themselves by utilizing advanced wireless technology for seamless integration, leading to their rapid adoption and the displacement of wired versions. This case underscores the significance of further examining technology-push interim innovations (Verganti, 2008).

Additionally, the success of interim products hinges on their development and launch timing. The "interim period" defines the duration during which these innovations remain relevant to the market, making it a vital determinant of their success. To capitalize on this period, design and development must be quick and adaptable. This underlines the importance of strategic planning in the creation and introduction of interim innovations.

Socio-Economic Implications

Interim innovations not only navigate market dynamics and strategic imperatives but also bear socio-economic benefits by fostering sustainable consumption. By enhancing the utility of existing products and diminishing the demand for complete replacements, they help in reducing technological waste, aligning with increasing consumer consciousness about sustainability

and the environmental footprint of technology. However, their role in possibly encouraging a cycle of incremental upgrades, as opposed to promoting truly sustainable consumption patterns, merits careful scrutiny.

Future Directions

The study uses descriptive analysis and case studies to identify interim products' patterns and characteristics but lacks quantitative data for deeper insights. Investigating how innovation diffusion theory intersects with the life cycles of interim and premium products presents an intriguing research direction. Further analysis on interim innovations' roles in promoting sustainability and inclusivity could significantly enhance their market and societal contributions.

CONCLUSION

The analysis of interim innovations reveals a complex landscape shaped by strategic development choices, market dynamics, and broader socioeconomic factors. The success of these products lies not just in their ability to bridge technological gaps but also in navigating the intricate interplay between innovation, consumer behavior, and sustainability considerations. As such, the study of interim innovations offers valuable insights into the mechanisms of technology diffusion, the evolution of consumer preferences, and the pursuit of more sustainable technological ecosystems.

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REFERENCES

Al-Jabri, I. and M. S. Sohail (2012). "Mobile banking adoption: Application of diffusion of innovation theory." Journal of electronic commerce research 13(4): 379–391.

Al-Qutayri, M. A. and J. S. Jeedella (2010). "Smart homes: technologies, applications and challenges." International Journal of Computer Aided Engineering and Technology 2(2-3): 125–144.

Chang, H. H., et al. (2016). "Modifying UTAUT and innovation diffusion theory to reveal online shopping behavior: Familiarity and perceived risk as mediators." Information Development 32(5): 1757–1773.

Christensen, C., et al. (2013). Disruptive innovation, Harvard Business Review Brighton, MA, USA.

Dan, Y. and H. C. Chieh (2008). A reflective review of disruptive innovation theory. PICMET'08-2008 Portland International Conference on Management of Engineering & Technology, IEEE.

Dill, J. and G. Rose (2012). "E-bikes and transportation policy: Insights from early adopters." Transp. Res. Rec 2314: 1–6.

Dosi, G. (1988). "Sources, procedures, and microeconomic effects of innovation." Journal of economic literature: 1120–1171.

Gefen, D., et al. (2003). "Trust and TAM in online shopping: An integrated model." MIS quarterly: 51–90.
Harper, R. (2006). Inside the smart home, Springer Science & Business Media.
Hayes, K. J., et al. (2015). "Trialability, observability and risk reduction accelerating individual innovation adoption decisions." Journal of health organization and management 29(2): 271–294.
Hobday, M. (1998). "Product complexity, innovation and industrial organisation." Research policy 26(6): 689–710.
Johnson, E. J. and J. E. Russo (1984). "Product familiarity and learning new information." Journal of consumer research 11(1): 542–550.
Jones, T., et al. (2016). "Motives, perceptions and experiences of electric bicycle owners and implications for health, wellbeing and mobility." Journal of transport geography 53: 41–49.
Kuisma, T., et al. (2007). "Mapping the reasons for resistance to Internet banking: A means-end approach." International journal of information management 27(2): 75–85.
Lianto, B., et al. (2018). "Continuous innovation: a literature review and future perspective." International Journal on Advanced Science Engineering Information Technology 8(3): 771–779.
Lutolf, R. (1992). Smart home concept and the integration of energy meters into a home based system. Seventh international conference on metering apparatus and tariffs for electricity supply 1992, IET.
MacVaugh, J. and F. Schiavone (2010). "Limits to the diffusion of innovation: A literature review and integrative model." European journal of innovation management 13(2): 197–221.
Norman, D. A. and R. Verganti (2014). "Incremental and radical innovation: Design research vs. technology and meaning change." Design issues 30(1): 78–96.
Oldenburg, B. and K. Glanz (2008). "Diffusion of innovations." Health behavior and health education: Theory, research, and practice 4: 313-333.
Ram, S. (1987). "A model of innovation resistance." ACR North American Advances.
Ram, S. and J. N. Sheth (1989). "Consumer resistance to innovations: the marketing problem and its solutions." Journal of consumer marketing 6(2): 5–14.
Reinhardt, R. and S. Gurtner (2015). "Differences between early adopters of disruptive and sustaining innovations." Journal of Business Research 68(1): 137–145.
Rogers, E. M. (2003). "Elements of diffusion. Diffusion of innovations." Free Press 5: 18–46.
Rogers, E. M., et al. (2014). Diffusion of innovations. An integrated approach to communication theory and research, Routledge: 432–448.
Rogers, E. M. and D. Williams (1983). "Diffusion of." Innovations (Glencoe, IL: The Free Press, 1962).
Rubin, G. D. and R. G. Abramson (2018). "Creating value through incremental innovation: Managing culture, structure, and process." Radiology 288(2): 330–340.
Stauffer, H. B. (1991). "Smart enabling system for home automation." IEEE Transactions on Consumer Electronics 37(2): xxix-xxxv.
Tellis, G. J. (2006). "Disruptive technology or visionary leadership?" Journal of Product Innovation Management 23(1): 34–38.
Verganti, R. (2008). "Design, meanings, and radical innovation: A metamodel and a research agenda." Journal of Product Innovation Management 25(5): 436–456.

Veryzer Jr, R. W. (1998). "Discontinuous innovation and the new product development process." Journal of Product Innovation Management: an international publication of the product development & management association 15(4): 304–321.
Yang, H., et al. (2018). "IoT smart home adoption: the importance of proper level automation." Journal of Sensors 2018.
Yin, R. K. (2018). Case study research and applications, Sage Thousand Oaks, CA.