Defining, Classifying and Identifying Addictive Patterns in Digital Products

Marta Beltrán, *Senior Member, IEEE*

***Abstract*—Understanding and regulating addictive patterns is essential for protecting users' rights and freedoms in the digital age. A strong framework is necessary to identify these patterns, ensuring that digital providers operate in ways that respect users' privacy, autonomy, and well-being. This paper aims to contribute to this effort by developing the FoSIP framework, which defines addictive design strategies, classifies them into a new three-level taxonomy, and proposes guidelines for identifying their presence in user interfaces. This framework will assist providers in designing ethical products and help users recognize these addictive patterns. Additionally, it will support supervisory, oversight, and enforcement authorities in monitoring compliance with regulations such as the General Data Protection Regulation or the Digital Services Act. By addressing the challenges posed by addictive patterns, the FoSIP framework promotes a safer, fairer, and more transparent digital environment.**

***Index Terms*—Addictive design, behavioral engineering, dark patterns, design guidelines, design patterns, user-centered design, user interfaces.**

I. Introduction

THE RISE of digital products, including social networks, online marketplaces, streaming services, video game platforms and Artificial Intelligence chatbots, has brought substantial societal benefits alongside complex challenges and implications for users' rights and freedoms [1], [2]. Concerning these implications, we are witnessing the emergence of an attentional economy [3] based on rabbit holes [4] and addictive patterns [5], which can profoundly impact users' behavior and well-being to the point of implying "enslavement by design" [6]. These phenomena refer to the design strategies employed by digital products to maximize user engagement, often leading to excessive and problematic use. These strategies can undermine users' privacy [7] and autonomy [8], infringe on their rights and freedoms [9], and contribute to broader societal harms such as mental health issues or polarization.

Public policies, regulatory frameworks, design standards and codes of conduct should address these issues by promoting transparency, accountability, and user protection [10]. Technological advancements can unexpectedly lead to adverse outcomes when implemented on a large scale, and all the involved stakeholders tend to react rather than proactively address them [11]. It is crucial to reflect, reason, discourse, observe and test all these design patterns to anticipate their impact on current and future users and regulate them accordingly.

There is an urgent need for a comprehensive framework to identify when these patterns are being used in digital products, including social networks, online marketplaces, streaming services, video game platforms, educational technology, mobile apps, and artificial intelligence chatbots. This framework would have multiple benefits. It would guide providers in designing products that prioritize users' rights and freedoms and comply with regulatory frameworks. Users would benefit from increased transparency and control over their online experiences. Furthermore, it would be a robust tool for regulators, supervisory, and enforcement authorities to monitor and ensure compliance.

This paper proposes an evidence-based framework called FoSIP (**Fo**rced action, **S**ocial engineering, **I**nterface interference, **P**ersistence). By doing so, it seeks to contribute to the ongoing discourse on digital regulation and the protection of rights and freedoms in the digital era. The main contributions of the proposed framework are: 1) a definition of addictive patterns as a subset of dark (or deceptive) patterns; 2) a three-level taxonomy of addictive patterns based on previous work classifying dark patterns, guaranteeing consistency in the vocabulary and connecting studies from different fields; 3) criteria to identify addictive patterns at different levels. These contributions involve a multi-pronged analysis of an everyday phenomenon. The technological dimension is used to produce the FoSIP framework, related to aspects of the design of digital products and their user interfaces, which directly impact the user experience.

The rest of this paper is organized as follows. Section II provides the relevant background and related work, and Section III explains the proposed research method. Section IV introduces the FoSIP framework, with the definition and taxonomy of addictive patterns. Section V proposes the criteria to identify addictive patterns within user interfaces, focusing on technological aspects. Section VI discusses the obtained results, and finally Section VII presents the conclusions and the most interesting lines for future research.

II. Background and Related Work

The rapid expansion of digital products has introduced complex risks, particularly in user experience design. Two critical issues that have emerged are the use of dark patterns

Received 11 November 2024; revised 14 April 2025; accepted 21 April 2025. Date of publication 5 May 2025; date of current version 17 July 2025.

The author is with the Scientific Unit - Innovation and Technology Division, Spanish Data Protection Authority (Agencia Española de Protección de Datos), 28001 Madrid, Spain (e-mail: mbeltran@aepd.es).

This article has supplementary downloadable material available at https://doi.org/10.1109/TTS.2025.3564840, provided by the authors.

Digital Object Identifier 10.1109/TTS.2025.3564840

and addictive patterns [12]. Digital providers employ these design strategies to conduct behavior engineering, manipulating users, impacting their autonomy, and often leading to negative consequences for their well-being.

A. On Dark Patterns

Dark patterns are deceptive design techniques that manipulate users into making decisions they might not otherwise make [13]. These patterns exploit cognitive biases and can obscure, subvert, or impair consumer choice and decision-making [14]. Examples include disguised advertisements, difficult-to-cancel subscriptions, or misleading consent banners [6]. Different studies such as [7], [15], [16], [17], [18], [19], [20], [21], [22], [23] or [24] have tried to propose different dark patterns taxonomies to systematically analyze and understand this kind of design features and their potential implications.

Other studies have focused on establishing connections between dark patterns and users' decision-making, trying to explain the mechanisms causing harm to users [25], [26], [27], [28]. The Federal Trade Commission (FTC) has highlighted the increasing sophistication of these patterns, which can trick or trap consumers into giving up their money or personal data [29]. The European Data Protection Board (EDPB) has also expressed concerns about the implications of these deceptive patterns for data protection and user autonomy [15]. The European Union has recognized the detrimental impact of dark patterns on consumer rights. It has taken steps to address them through regulations such as the Unfair Commercial Practices Directive (UCPD) and the General Data Protection Regulation (GDPR). The Digital Services Act (DSA) further aims to enhance transparency and accountability in digital services, providing a framework to combat dark patterns.

B. On Addictive Patterns

Addictive patterns, on the other hand, are design features intended to maximize user engagement by exploiting psychological triggers [5]. This specific type of dark pattern can lead to excessive and compulsive use of digital products, often at the expense of users' well-being [21], [24]. Techniques such as infinite scrolling, content autoplay, and frequent notifications are designed to capture and retain user attention. Very few research papers focus on this type of pattern. But some very interesting work has been published discussing what can be considered addictive and the underlying psychological mechanisms [30], [31], [32], the potential implications for users [33], [34], [35] or the impact on the addictive design of technological advances such as artificial intelligence [36].

The European Parliament has called for comprehensive regulatory responses to address the issue of addictive design, emphasizing the need for guidelines and enforcement mechanisms to protect consumers [14]. The Parliament has explicitly called for new rules to address digital addiction, including banning techniques like infinite scrolling and autoplay, introducing a new digital "right to not be disturbed", and launching awareness campaigns to promote healthier online habits.

III. Methods

Document analysis [38] is selected as the primary method to produce the FoSIP framework. The core literature explicitly defining, classifying and analyzing dark patterns has been considered, which has been complemented by the analysis of several other documents, including technical reports and user experience designers' and developers' documentation. The aim is to synthesize findings, views, and examples from different domains to produce a new definition and a unified taxonomy for addictive patterns. As far as we know, this type of taxonomy does not exist. Still, since all addictive patterns are dark patterns, it can be produced from existing ones if the specific aspects that make a dark pattern addictive are identified.

Some analyzed papers, such as [22], introduce a three-level ontology for classifying dark patterns: high-level, meso-level, and low-level. We have selected this hierarchical framework due to its main advantages. It facilitates the development of automated and manual methods for classifying and detecting addictive patterns in the future, particularly at a low level. It also allows regulators and supervision authorities to target specific types of addictive patterns and develop more effective interventions. In addition, it helps raise user awareness of the different ways they can be manipulated online and empowers them to make more informed choices. By understanding the tactics designers employ, users can be more critical of the interfaces they encounter and less susceptible to manipulation. Furthermore, this granularity may help to understand how different patterns interact or can be combined and facilitate future updates of the proposed framework.

IV. Addictive Patterns Definition and Taxonomy

Fig. 1 shows how digital products are designed to perform well in terms of profit and metrics relevant to their provider's (and owners, partners, stakeholders, investors) business model. Decisions about design and content shape these digital products, which are configured by users and fed with their personal data. The specific impact on the user's health and well-being depends on who these users are, why they use the products, and how they use them: their needs, values, and behaviors.

A framework is needed that allows all stakeholders involved in the digital ecosystem to define, classify, and detect addictive design patterns so that each can exercise their obligations and responsibilities: self-protection in the case of users, avoidance in the case of providers, research in the case of scholars, regulation or control in the case of different authorities, etc.

Addictive patterns can be considered a subset of dark patterns because they share the fundamental characteristic of manipulating user behavior to achieve a specific outcome, often at the expense of the user well-being. While dark patterns encompass a broader range of manipulative tactics addictive patterns specifically focus on exploiting psychological mechanisms that foster compulsive engagement and dependence. Previous research provides several points of connection between addictive patterns and the broader framework of dark patterns, such as the impairment of user autonomy [15], [21], the exploitation of cognitive biases [19], the focus on engagement and retention [23] or ethical concerns and potential

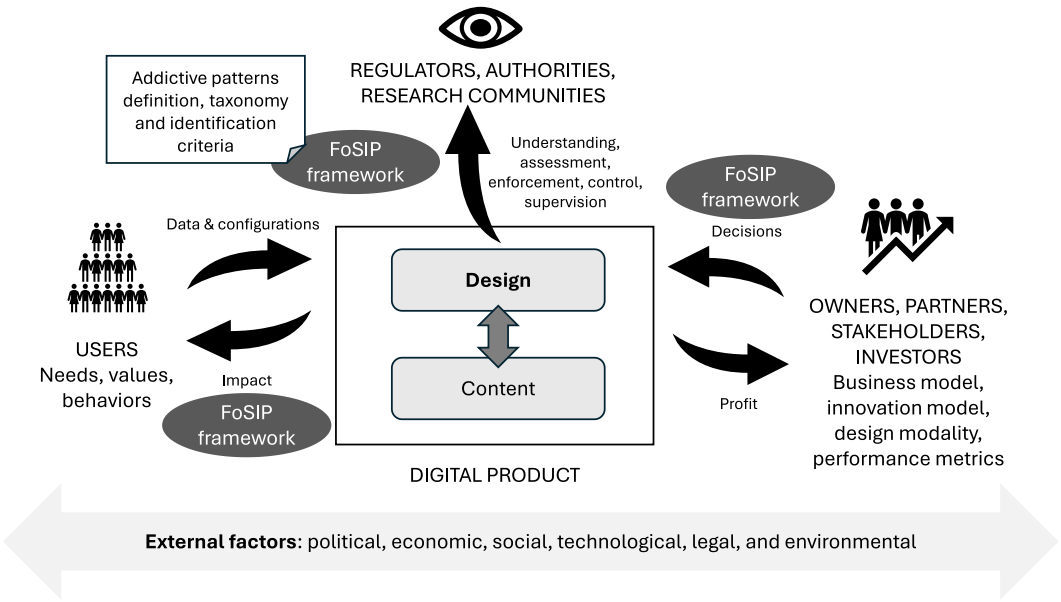

Fig. 1. The FoSIP framework.

harms, including privacy violations, psychological detriment, and financial and time loss.

We define an addictive pattern in this paper as: "A design feature, attribute or practice that determines a particular way of using digital platforms, applications and services intended to make users spend much more time using them or with a greater degree of commitment than what is expected, convenient or healthy for them". As with any other software, it is a reusable solution to a common problem or recurring challenge, a blueprint that outlines how to achieve a specific objective based on approaches proven effective.

This definition captures the main elements highlighted in the already mentioned international organizations' initiatives, regulatory frameworks, and previously published research. The addictive design aims to influence users' behaviors. It can hinder their ability to effectively protect their autonomy and well-being, making conscious choices when they may impact their rights and freedoms. Digital providers accumulate massive amounts of information about their users, which may be used to manipulate their behavior. This informational asymmetry makes it difficult for users to understand how they are being manipulated and to protect themselves from harmful design features.

On the other hand, the growth of the Internet has led to increasing overlap between different digital products. For example, social media platforms now include features like those in online games or gambling sites. Many potentially problematic online behaviors share common psychological mechanisms, and this convergence of design features and practices can make it even more difficult for users to control their online activity. Designers apply these features similarly in different digital products to the point that they can be considered design patterns. These features can exploit habit formation and incentive sensitization, two key processes involved in addictive behavior.

Previous research such as [7], [13], [15], [16], [17], [18], [19], [20], [21], [22], [23] and [24] has identified some specific dark patterns that promote uncontrolled and problematic online behavior in digital products. Therefore, that can be considered addictive patterns considering the proposed definition. Given these findings, the previously published taxonomies for dark patterns and the proposed method (see Section III), the taxonomy summarized in Table I has been proposed.

Addictive patterns have been organized using a three-level taxonomy, indicating the sources of the identified low-level patterns and clarifying the terminology used across different research work. In this three-level taxonomy, high-level patterns are broad strategies of manipulation at the most abstract level, which is how users are manipulated, coerced, or deceived. These patterns are context-agnostic and can be applied across various digital products.

Meso-level patterns are more specific approaches or "angles of attack". They describe the approach used to undermine user autonomy. Like high-level patterns, meso-level patterns are context-agnostic and can be interpreted differently depending on the specific product. Finally, low-level patterns are concrete implementations detectable in the user interface. They represent the taxonomy's most concrete and contextually dependent level, describing the specific elements and design choices that implement deceptive techniques. Low-level patterns are often detectable through manual or automated user interface analysis. So, they can be of great help in proposing the other component of the FoSIP framework: guidance to identify the use of addictive patterns in user interfaces.

V. Addictive Patterns Identification

Identifying addictive patterns in digital products can be challenging due to the constantly evolving nature of these products, the complex interplay of social dynamics, and the

TABLE I
THREE-LEVEL TAXONOMY OF ADDICTIVE PATTERNS

High-level pattern	Meso-level pattern	Low-level pattern
FORCED ACTION	Forced continuity	Pull to refresh: [23]
		Endless scrolling: [18], [23], [21] infinite scrolling, and [24] infinite scrolling
		Endless streaming: [18], [23]
		Timers: [21]
		Playing by appointment: [16], [24] socially driven game
	Gamification	Grinding and mere-exposure: [16], [18]
		Periodic rewards: [17] intermediate currency, [21] loot boxes, gamblification, [24] loot boxes, free gifts, point programmes
		Complete the collection: [16] achievements and badges
	Attention capture	Autoplay: [18], [21], [23], [24]
SOCIAL ENGINEERING	Scarcity	High demand: [19], [22], [21] scarcity and popularity claims
	Social proof	Social support, feedback and reward: [18], [21], [24] social reinforcement, likes, repost or forward functions
		Social pressure or comparison: [18], [21]
		Activity notifications: [19], [21], [22]
	Urgency	Alert messages and push notifications: [24], [17] pop-up messages
		Countdown timers: [19], [21], [22], [24]
	Shaming	Limited time messages: [19], [21], [22], [24] temporarily available information
	Fear of missing out	Regression to the mean: [23]
		Information renewability: [18] unpredictability, [23] interactive hooks
	Personalization	Confirm shaming: [19], [22]
		Social connectors: [23], [7] address book leeching, [16] friend spam, [21] friend spam, social pyramid, address book leeching
		Algorithmic recommendations: [18] show users of an app what they like), [24] AI-based algorithms, personalized recommendations
INTERFACE INTERFERENCE	Aesthetic manipulation	Misdirection: [15] visual prominence, look over there, [16] misrepresenting, [17] hidden information, false hierarchy, [19] visual interference
	Toying with emotion	Persuasive language: [15] motivational language, emotional steering, [21] (misleading actions)
		Cognitive overload: [15] overloading, [22] information overload
		Reduced friction and persistence: [23], [15] and [22] deceptive snugness
PERSISTENCE	Zeigarnik effect/ Ovsiankina effect	Progress bars: [24]
		Microinterruptions (nagging): [17], [23], [21] persistent and unwanted solicitations, [22] continuous prompting

difficulty in isolating addictive design elements from legitimate features. The guidance provided by the FoSIP framework can help identify these patterns by analyzing the available evidence.

A. Forced Action

The Forced Action pattern refers to situations where users must perform a specific action to access or continue using

desired functionality. This pattern limits user choice and coerces them into taking actions they might not otherwise choose.

This high-level pattern can be identified by looking for elements that limit choices. The interface presents users with only the actions that benefit the provider, restricting their freedom to choose. One alternative is restricting core functionality when essential tasks are blocked until a specific action is taken. In this way, the user cannot access content or use a feature unless they act in a specific way, or a specific amount of time passes. A different alternative is not providing alternative paths or opt-out options, the interface provides only one route to achieve the user's goal, including the undesired action. For instance, the only way to participate in a sale is to agree to do it at a specific moment in time. In addition, using negative consequences when dismissing or skipping the forced action leads to an undesirable outcome or the inability to continue. For example, the user cannot advance to the next game level if they do not complete a collection of badges first.

Elements that raise false expectations are often used too. The interface makes the user believe that complying with the forced action is the only way to achieve their goal. This may involve manipulative language or design that conceals the forced nature. The interface might use wording or visuals suggesting the action is optional or beneficial when it is mandatory. For example, a

button might say "Get Personalized Recommendations" when it is the only way to refresh content. Furthermore, forced actions can be disguised as other processes. The interface may embed forced actions within seemingly unrelated processes. This makes them harder to recognize, e.g., the user may need to watch an ad to start a new lesson.

It is essential to understand that Forced Action patterns often test well from a usability perspective because they streamline user flows and encourage specific actions. However, this comes at the cost of user choice and can be manipulative and promote addictive behaviors.

1) Forced Continuity: The Forced continuity pattern is a specific addictive pattern that exploits user inattention or inertia to keep users connected or using the digital product. This pattern relies on automatic gestures (or easily automatable) and the concept of "losing track of time". How to spot a Forced Continuity pattern? Looking for automatic gestures and constant renewal of content, lack of prominent reminders or notifications, and difficult termination.

Concerning the low-level patterns in this category, the first one is **Pull to refresh**. This pattern is characterized by the user pulling down on a touchscreen to refresh the displayed content. It is a relatively straightforward feature to identify visually; the user typically sees a loading animation or icon while the content refreshes. **Endless scrolling** continuously loads new content as the user scrolls down the page, creating a seemingly infinite feed. This pattern constantly promises new, potentially rewarding content. **Endless streaming**, like endless scrolling, automatically plays the following video or piece of content in a sequence as soon as the current one ends. It contributes to user absorption, making it difficult to disengage from the platform.

In addition, **Timers** are based on visual elements that display a countdown to a specific event or deadline. They may indicate deadlines for sales, product reservations or offers, new content, etc. Some timers are deceptive, either resetting after the deadline with the same offer or falsely representing an actual deadline. Finally, **Playing by appointment** involves scheduling or restricting access to content or features at specific times. This can encourage repeated visits and engagement with a digital product.

2) Gamification: The Gamification pattern incorporates game-like elements and mechanics into non-game contexts to motivate user engagement and influence their behavior. To identify interfaces that include this kind of pattern, we should look for points, badges or leaderboards, levelling systems, challenges and quests, rewards and incentives (virtual currency, discounts, exclusive offers, early access to features or content, etc.), competitive elements, and storytelling/narrative.

Gamification can be used to exploit psychological vulnerabilities and encourage addictive behaviors relying on reinforcement mechanisms, restricting access to essential features or coercing users into spending money or time they would not otherwise choose to. Gamification may also trivialize complex issues or processes by reducing them to simple game mechanics.

Concerning the low-level patterns in this category, we can find **Grinding and mere exposure**. This pattern refers to a user's repetitive action to progress or unlock content within a product. Repeated action under specific reinforcement schedules can turn goal-oriented behaviors into automatic habits. This pattern requires the user to repeatedly perform the same actions, such as collecting resources, defeating enemies, or completing simple tasks, to make marginal progress. The difficulty may seem intentionally inflated to slow down users' progress. This might involve sudden difficulty spikes, limited resources, or challenging opponents that require excessive effort to overcome. In addition, some mechanisms may restrict users' actions or progress based on time, forcing them to wait extended periods to continue playing or accessing content.

Periodic rewards, on the other hand, involve providing rewards at set intervals or based on a schedule. To detect this pattern in a user interface, pay attention to daily bonuses (rewards for logging in each day, often displayed prominently upon launching the application), scheduled events offering rewards for participation or completion, streaks (mechanisms that track consecutive days of engagement or task completion) or loyalty programs (rewards for repeated purchases, interactions, or engagement over time with points, badges, or exclusive benefits).

Finally, **Complete the collection** is a pattern based on offering a complete set of items, achievements, or rewards. To detect this pattern, the user can check for visual indicators of a set of items to be collected, such as a progress bar, checklist, album, or display case, and look for elements of scarcity or exclusivity, such as rare items or achievements that are challenging to obtain and observe if completing the collection unlocks special rewards, content, or benefits.

3) Attention Capture: The Attention capture pattern relates directly to mechanisms that capture and hold a user's attention. Interfaces with this kind of pattern often include attention grabbers, which distract the user by presenting a competing element or attention hook. This distraction can lead users to forget or overlook their initial intention, effectively capturing their attention and steering them towards the provider's desired action, usually extending the session.

The main low-level pattern in this category is **Autoplay**. The interface is designed to play songs or videos without user intervention. Usually, Autoplay begins when the user stops for enough time on the page, frame, link, etc. Autoplay can be implemented in a way that interferes with the user interface, making it difficult to pause, stop, or control its execution. Or even to turn it off. Autoplay may consistently play content that aligns with the user's predicted preferences, aiming to keep them engaged for extended periods. In addition, it can be designed to disrupt a user's intended task or browsing behavior, capturing their attention and redirecting it towards the playing content.

B. Social Engineering

The Social Engineering pattern refers to situations where principles of social psychology or behavioral economics are used to influence user behavior. This design pattern often exploits users' inherent tendencies to conform to social norms or make decisions based on emotional cues rather than rational

evaluation. This high-level pattern can be identified by looking for elements to exploit emotional aspects. The interface creates a sense of urgency, scarcity, shame or fear to pressure users into making quick decisions without fully considering the implications. In addition, by looking for elements that explicitly rely on the social component. The interface leverages the influence of social norms and peer pressure by highlighting the actions or endorsement of others.

Different approaches can be implemented.

1) Scarcity: The Scarcity pattern relates to making a feature, content, or product seem more desirable by suggesting its limited availability. This tactic exploits the scarcity bias, the human tendency to value things more when restricted or rare. Interfaces including this kind of pattern can often be detected by looking for features and language concerning availability. Interfaces are designed to communicate high demand, low availability, expiration deadlines, etc. The most significant low-level pattern in this category is **High demand**. In this case, the interface suggests that features, content, or a product is in high demand and likely to become unavailable soon. It often uses messages like "In high demand," "Selling out quickly," or "Don't miss out." Different elements (counters, timers, messages, alerts) and language are used to pressure users into making a rushed decision.

2) Social Proof: Social proof relates to influencing user behavior by showing them what others are doing or what others think, leveraging the psychological tendency to conform to the actions of others or to get their attention or approval. Interfaces including this kind of pattern can often be detected by looking for information about other users: interfaces are designed to share others' actions, thoughts, reactions, performance, etc. Concerning the low-level patterns in this category, **Social support, feedback and reward** creates positive experiences related to interactions with other users. This pattern can manifest through various digital expressions of praise, affirmation, and good reputation, all aimed at encouraging specific user behaviors. Different elements can be used, such as reputation systems, comments and messaging, public awards and recognitions, reposting and share features, like or love buttons, etc. When relying on **Social pressure or comparison,** interfaces are designed to prominently display likes, shares, comments, follower counts, and other social engagement metrics. They are visually emphasized and easily accessible, often used to highlight the popularity of certain content or user accounts. Finally, with **Activity notifications** interfaces are designed to produce notifications and alerts drawing attention to social interactions or feedback. Notifications are designed to trigger feelings of excitement, anticipation, or validation. They are used to encourage users to check back frequently and engage more actively. They can even be personalized, prioritizing notifications from close friends.

3) Urgency: The Urgency pattern relates to pressuring users to make quick decisions by creating a sense that immediate action is required. Interfaces including this kind of pattern can often be detected by looking for features and language concerning time. Interfaces are designed to communicate urgency, expiration deadlines, etc. Concerning the low-level patterns in this category, **Alert messages and push notifications** are based on interfaces that notify users about events, updates, or messages, often accompanied by sounds or visual cues designed to grab attention and prompt users to check the service or app immediately. This can lead to impulsive actions, such as replying to messages without thinking or spending more time on the platform than intended. Notifications often use emotionally charged language or exaggerate the importance of events to pressure users into immediate action. They are even sent at times likely to interrupt users, such as during work or sleep. **Countdown timers** visually display a dwindling time limit, counting down until the deadline expires. The timer's placement usually involves visual prominence to create anxiety or pressure users into making a quick decision.

4) Shaming: The Shaming pattern involves leveraging negative emotions, such as guilt or fear of social judgment, to steer users toward specific actions. Interfaces that include this kind of pattern can often be detected by looking for features and language concerning embarrassment. Interfaces are designed to communicate responsibility, public exposition, expiration deadlines, etc. The low-level pattern in this category is **Limited time messages**. Interfaces use messages only available for a limited time; the deadline may be preset or vary with the message. Users tend to believe there is a real urgency to read and interact with the message because if they do not do it in time, the sender, the group, the followers, etc., will know that they have not done it.

5) Fear of Missing Out: The Fear of Missing Out (FoMO) pattern relates to driving users to stay constantly connected and engaged with social trends, events, or experiences for fear of missing out on something important or exciting. Interfaces including this kind of pattern can often be detected by looking for features and language concerning fear, designed to communicate social trends and their importance, relevance, etc., and, at the same time, to create in users the fear of social exclusion, curiosity or the sense of missing out on valuable experiences. Concerning the low-level patterns in this category, **Regression to the mean** is a pattern where the interface is designed to use, show, and repeatedly offer trendy features, content or products so the user can be sure of not missing out on something other users have liked. The initial excitement or novelty of a new experience or trend will likely diminish over time. Still, users allow something to be offered to them repeatedly because they don't care if it is tagged as important or trending. In **Information renewability**, on the other hand, the interface is designed to refresh new posts, content, etc. constantly. This contributes to FoMO by creating a sense that there is always something new to see or experience. This can pressure users to check back frequently and stay engaged for fear of missing out on the latest updates. Elements such as visual cues, counters of missing items or "Now trending" suggest ongoing activity, even when the user is not actively participating. These indicators are designed to grab attention and trigger a sense of curiosity.

6) Personalization: The Personalization pattern relates to tailoring the user experience to their data, preferences, or past behaviors to exploit their specific vulnerabilities and steer them

toward decisions that are not always beneficial. Personalization can make other addictive patterns more effective; it is usually combined with the rest of the categories in the taxonomy. And it can be a very powerful pattern when fed with artificial intelligence models. Interfaces including this pattern can often be detected by looking for features explicitly asking about the user. Interfaces are designed to gather user information, preferences, habits, tastes, contacts, etc. Concerning the low-level patterns in this category, **Confirmshaming** uses guilt or shame to influence user choices, sending messages tailored to exploit users' insecurities or values. For example, if a user has expressed interest in environmental issues, a confirmshaming message might emphasize the negative ecological impact of their choice. **Social connectors** are based on interfaces that encourage users to connect with friends or family. Prompts and tools allow users to invite other users, import contacts, and connect with people from other products. These features are often presented as essential for a complete or enjoyable experience. Finally, **Algorithmic recommendations** personalize the user experience by suggesting content, connections, or activities. Recommendations are not always clearly labelled as such, and there is often a lack of transparency into how the recommendation algorithm works and what data it uses. In addition, it is rare to find options to customize or diversify recommendations. While seemingly helpful, personalization can limit user exposure to diverse contacts, perspectives, and information. This can create filter bubbles where users are only presented with content that aligns with their existing beliefs or preferences, reinforcing biases and potentially limiting their understanding of the world.

C. Interface Interference

Interface interference refers to situations where the user interface is designed to manipulate the user, prioritizing specific actions over others, potentially confusing them or making it harder for them to find essential functionalities. This pattern often exploits users' expectations about the habitual way of interacting with interfaces. This pattern can be identified by looking for elements that generate stimuli to confuse or guide the user. The interface is designed to guide the user towards specific choices or to be subtly pressured into taking or not taking specific actions despite an excess of information or stimuli. Different approaches can implement these patterns.

1) Aesthetic Manipulation: The Aesthetic manipulation pattern relates to manipulating visual elements (size, color, placement, contrast, etc.) to draw attention to specific actions while obscuring others. Interfaces with this kind of pattern can often be detected by looking for a visual hierarchy. They are designed to make certain elements stand out more than others or to be visually de-emphasized; there is a straightforward visual priority. The main low-level pattern in this category is **Misdirection**, when the most important user journeys within the interface include visual cues to guide the user's attention. Buttons, labels, instructions, and error messages are crucial.

2) Toying With Emotion: The Toying with emotion pattern relates to mechanisms focused on emotional steering, where wording or stimuli are used to evoke strong positive or negative emotions in users. This pattern aims to influence users' emotional states to make them more likely to act against their own interests. This pattern can be identified because it is based on exploiting emotional aspects. The interface tries to create positive or negative feelings to pressure users into making decisions without fully considering the implications. Particular design elements try to trigger strong emotional responses.

Concerning the low-level patterns in this category, **Persuasive language** is based on interfaces that carefully select the language tone used in choice points. Positive framing can be used with language emphasizing the benefits of choosing a particular option, often using superlatives, promises of reward, or appealing to positive emotions like happiness, security, or belonging. On the other hand, negative framing can be used by relying on language that emphasizes the drawbacks of not choosing a particular option, potentially using fear, guilt, shame, or social pressure as motivators. Wording may also create a sense of urgency or scarcity, with warnings about missing out. The impact of persuasive language can vary depending on the target audience. Vulnerable groups, like children or older adults, might be more susceptible to specific language tactics.

Interfaces implementing **Cognitive overload** are designed to bombard users with excessive requests, information, options, or possibilities. The goal is often to discourage users from carefully considering their choices, leading them to make decisions that might not align with their preferences. This pattern can be detected by looking for excessive choices or settings, complex and convoluted navigation, repetitive and intrusive prompts, large amounts of dense, technical, or legalistic information, etc. **Reduced friction** is based on interfaces designed to influence the effort required to complete different actions. The default settings and the number of steps needed to perform specific actions should be examined. Design choices may nudge users towards particular options by making them seem more attractive or framing the alternatives in a negative light.

D. Persistence

The Persistence pattern refers to situations where users feel urged to finish initiated tasks. This pattern pushes users towards task completion. This high-level pattern can be identified by looking for elements to manipulate progress perception. Interfaces can be designed to create a heightened sense of progress or incompleteness. For example, visual elements can be included to represent progress in a more or less realistic way visually. Also, by looking for elements to frame specific decisions as losses, presenting task abandonment as a "loss" of progress, effort, or advantage could trigger loss aversion, motivating users to persist even if the perceived "loss" is insignificant. Interfaces could be designed, for example, to emphasize the effort or resources already invested in a task, making users reluctant to abandon it even if continuing is no longer beneficial. Reminding users how much time they have already spent on a task could make them feel obligated to see it through, even if it is no longer enjoyable or serving their needs.

1) Zeigarnik Effect/Ovsiankina Effect: These effects describe the tendency for incomplete or interrupted tasks to be more easily remembered and create a feeling of tension that motivates users to return and complete them. Interfaces exploiting these effects rely on intentional task interruption and progress visualization. Concerning the low-level patterns in this category, **Progress bars** include a visual element letting users know how close they are to completing a task. Once they know that something is "half-done", they are more likely to spend the time required to finish. Bars (or equivalent elements such as checklists) contribute to a sense of continuous progression and reward, potentially encouraging prolonged engagement. **Microinterruptions (nagging)** rely on an interface causing microinterruptions during users' connection, making them jump from one site, content or task to another. For example, they use ads, messages, pop-ups, prompts, or content suggestions. At some point, the user needs to recover the path followed to finish consuming all the content or the tasks left unfinished.

VI. Discussion

Regulators, authorities and research communities have sometimes created their own terminology for dark and addictive patterns, leading to inconsistencies and difficulties in connecting different domains. The first component of the FoSIP framework provides a clear definition that allows us to identify which dark patterns are also addictive. Furthermore, the proposed taxonomy maps the most common terminology so that it is easy to identify when different terms actually refer to the same pattern.

Regarding the taxonomy, it is impossible to propose a definitive and complete classification of addictive patterns due to the constantly evolving nature of technology and design practices. As new technologies and user interfaces emerge, new forms of addictive patterns are likely to be created, rendering any existing taxonomy outdated. The proposed three-level taxonomy can help update the taxonomy in a simple way since, in many cases, what will have to be done is to add new low-level patterns corresponding to new interfaces or new products. Patterns at the high and meso levels will need to be updated much less frequently.

The inherent subjectivity in classifying what constitutes an addictive pattern further complicates categorization. More research is required to gather evidence on the potential impacts of the different patterns. The context in which a design pattern is used, its implementation, and the target audience all contribute to the degree of "addictiveness." In addition, addictive patterns rarely exist in isolation. They often involve a combination of design elements working together to create a compelling and potentially addictive user experience.

Summarizing, this fluidity and context dependency make it challenging to create a taxonomy that captures all potential addictive patterns and remains relevant over time. However, the proposed taxonomy has been very useful in proposing guidance on the identification of addictive patterns in user interfaces, which can also be updated in the future whenever it is needed. This guidance provides a structured approach to comprehending the diverse nature of addictive patterns and the underlying manipulative strategies employed. This knowledge helps recognize and categorize addictive patterns based on their technical characteristics and intended impact on user behavior.

Clear guidance on specific elements, design features, or language commonly used in addictive patterns improves the ability to detect them effectively and conduct user-centered design. Passing a manual checklist could do that. However, we hope the proposed framework facilitates the development of automated detection tools by pinpointing user interface elements and features characteristic of these addictive practices.

The FoSIP framework can be utilized to create or improve design standards, industry codes of conduct, certification criteria, and filtering mechanisms for digital products in different ways. Design standards and codes of conduct could serve as a framework for ethical design practices, promoting users' privacy, autonomy and well-being. These codes could mandate transparency in user interface design, involve clear communication about the purpose and consequences of specific design choices and provide users with easy-to-understand and accessible controls over their experiences and decision-making. In addition, codes of conduct could include the explicit prohibition of addictive patterns in specific contexts. For example, recognizing children's vulnerability to addictive design and avoiding exposure to potentially harmful patterns within digital products targeted towards young audiences [39], [40].

The PEGI system [41] and other rating, labelling or certification schemes could integrate addictive patterns assessment as part of their evaluation criteria. Similar to how these systems evaluate content for age-appropriateness, they could assess the presence and severity of addictive patterns, ensuring that rated, labelled, or certified products adhere to ethical design principles.

Finally, app stores and similar digital marketplaces could implement automated tools to flag or even remove apps that employ addictive patterns. Furthermore, app stores could enhance user reporting and review systems, allowing users to flag apps employing addictive patterns. This community-driven approach would complement automated detection methods, providing valuable insights into user experiences and identifying emerging design practices until the moment the taxonomy is updated.

The framework proposed in this paper focuses mainly on the technical dimension. The human relative to the effects that design decisions may have on the users' rights and freedoms, and legal dimensions concerning the current and future regulatory framework have been recently addressed from a data protection point of view in [42], relying on the definition and taxonomy proposed in this research.

VII. Conclusion and Future Work

The FoSIP framework proposed in this paper provides a common language among scholars, regulators, legal professionals, users and designers. This consistency is essential for addressing regulation, enforcement, training, or awareness issues. A standardized definition, a taxonomy and guidance

for identifying addictive patterns are crucial for regulatory bodies to take appropriate action. It also allows for consistent interpretation and application of existent regulation designed to curb these practices. The FoSIP framework may encourage designers to be more mindful of the ethical implications of their choices, consciously avoiding addictive patterns and prioritizing user-centered design principles. This awareness would promote the creation of interfaces that respect user privacy, autonomy and well-being. Finally, knowledge of addictive patterns enables users to be more critical and informed when interacting with digital products. By recognizing the signs of manipulation, they can make more conscious choices. This awareness may also empower users to report addictive patterns and hold tech companies accountable for their design practices and their impact on their rights to integrity, protection of personal data or non-discrimination, to mention only some examples.

There are two exciting lines of future work. The first, mentioned in the previous section, is technical and involves the development of automated tools that identify addictive patterns in user interfaces. The second, in the healthcare domain, consists of understanding the complex interplay between individual vulnerability and addictive design patterns. This would be crucial for a comprehensive assessment of addiction risk. Our taxonomy focuses primarily on technical features, and while it might help identify patterns with addictive potential, it cannot predict how specific individuals will respond to those patterns. Factors such as personality traits, pre-existing mental health conditions, and social support systems should be analyzed to understand all the potential impacts on users' physical and psychological integrity.

ACKNOWLEDGMENT

The author wants to thank the entire AEPD team and specifically the Innovation and Technology Division staff for their involvement in this project and all their generous comments and contributions.

REFERENCES

[1] G. De Gregorio, "From constitutional freedoms to the power of the platforms: Protecting fundamental rights online in the algorithmic society," *Eur. J. Legal Stud.*, vol. 11, no. 2, p. 65, 2018.

[2] B. Custers, "New digital rights: Imagining additional fundamental rights for the digital era," *Comput. Law Security Review*, vol. 44, Apr. 2022, Art. no. 105636.

[3] J. Schoenherr, "The currency of the attentional economy: The uses and abuses of attention in our world," *IEEE Technol. Soc. Mag.*, vol. 41, no. 1, pp. 11–14, Mar. 2022.

[4] K. Woolley and M. A. Sharif, "Down a rabbit hole: How prior media consumption shapes subsequent media consumption," *J. Market. Res.*, vol. 59, no. 3, pp. 453–471, 2022.

[5] F. Esposito and T. M. C. Ferreira, "Addictive design as an unfair commercial practice: The case of hyper-engaging dark patterns," *Eur. J. Risk Regulation*, vol. 15, pp. 999–1016, Dec. 2024.

[6] R. Abbas, K. Michael, M. Michael, C. Perakslis, and J. Pitt, "Machine learning, convergence digitalization, and the concentration of power: Enslavement by design using techno-biological behaviors," *IEEE Trans. Technol. Society*, vol. 3, no. 2, pp. 76–88, Jun. 2022.

[7] C. Bosch, B. Erb, F. Kargl, H. Kopp, and S. Pfattheicher, "Tales from the dark side: Privacy dark strategies and privacy dark patterns," in *Proc. Privacy Enhanc. Technol.*, 2016, pp. 237–254.

[8] S. Ahuja and J. Kumar, "Conceptualizations of user autonomy within the normative evaluation of dark patterns," *Ethics Inf. Technol.*, vol. 24, no. 4, p. 52, 2022.

[9] C. Montag and J. D. Elhai, "On social media design, (online-) time well spent and addictive behaviors in the age of surveillance capitalism," *Current Addict. Rep.*, vol. 10, no. 3, pp. 610–616, 2023.

[10] P. Berthon, L. Pitt, and C. Campbell, "Addictive de-vices: A public policy analysis of sources and solutions to digital addiction," *J. Public Policy Marketing*, vol. 38, no. 4, pp. 451–468, 2019.

[11] C. J. Andrews, "Better anticipating unintended consequences," *IEEE Trans. Technol. Soc.*, vol. 5, no. 2, pp. 205–216, Jun. 2024.

[12] A. Narayanan, A. Mathur, M. Chetty, and M. Kshirsagar, "Dark patterns: Past, present, and future: The evolution of tricky user interfaces," *Queue*, vol. 18, no. 2, pp. 67–92, 2020.

[13] H. Brignull, "Dark patterns: User interfaces designed to trick people," 2018. [Online]. Available: http://darkpatterns.org/

[14] K. V. Sparrentak, "On addictive design of online services and consumer protection in the eu single market," Committee on the Internal Market and Consumer Protection, 2023. [Online]. Available: https://www.europarl.europa.eu/doceo/document/A-9-2023-0340EN.html

[15] "03/2022 on deceptive design patterns in social media platform interfaces: How to recognise and avoid them," EDPB, Guidelines, 2022. [Online]. Available: https://www.edpb.europa.eu/system/files/2023-02/edpb_03-2022_guidelines_on_deceptive_design_patterns_in_social_media_platform_interfaces_v2_en_0.pdf

[16] J. P. Zagal, S. Björk, and C. Lewis, "Dark patterns in the design of games," in *Proc. Found. Digit. Games*, 2013, pp. 1–8.

[17] C. M. Gray, Y. Kou, B. Battles, J. Hoggatt, and A. L. Toombs, "The dark (patterns) side of UX design," in *Proc. CHI Conf. Human Factors Comput. Syst.*, 2018, pp. 1–14.

[18] C. Montag, B. Lachmann, M. Herrlich, and K. Zweig, "Addictive features of social media/messenger platforms and Freemium games against the background of psychological and economic theories," *Int. J. Environ. Res. Public Health*, vol. 16, no. 14, p. 2612, 2019.

[19] A. Mathur et al., "Dark patterns at scale: Findings from a crawl of 11k shopping Websites," *Proc. ACM Human-Comput. Interact.*, vol. 3, pp. 1–32, Nov. 2019.

[20] C. M. Gray, S. S. Chivukula, and A. Lee, "What kind of work do 'asshole designers' create? Describing properties of ethical concern on Reddit," in *Proc. ACM Designing Interact. Syst. Conf.*, 2020, pp. 61–73.

[21] "Dark commercial patterns," Working paper, OECD, Paris, France, 2022. [Online]. Available: https://www.oecd.org/en/publications/dark-commercialpatterns44f5e846-en.html

[22] C. M. Gray, C. Santos, and N. Bielova, "Towards a preliminary ontology of dark patterns knowledge," in *Proc. CHI Conf. Human Factors Comput. Syst.*, 2023, pp. 1–9.

[23] T. Mildner, G.-L. Savino, P. R. Doyle, B. R. Cowan, and R. Malaka, "About engaging and governing strategies: A thematic analysis of dark patterns in social networking services," in *Proc. CHI Conf. Human Factors Comput. Syst.*, 2023, pp. 1–15.

[24] M. Flayelle, D. Brevers, D. L. King, P. Maurage, J. C. Perales, and J. Billieux, "A taxonomy of technology design features that promote potentially addictive online behaviours," *Nat. Rev. Psychol.*, vol. 2, no. 3, pp. 136–150, 2023.

[25] K. Bongard-Blanchy, A. Rossi, S. Rivas, S. Doublet, V. Koenig, and G. Lenzini, "'I am definitely manipulated, even when I am aware of it. It's ridiculous!' Dark patterns from the end-user perspective," in *Proc. ACM Design. Interact. Syst. Conf.*, 2021, pp. 763–776.

[26] A. M. Roffarello and L. De Russis, "Towards understanding the dark patterns that steal our attention," in *Proc. Extended Abstracts CHI Conf. Human Factors Comput. Syst.*, 2022, pp. 1–7.

[27] L. Alberts, U. Lyngs, and M. Van Kleek, "Computers as bad social actors: Dark patterns and anti-patterns in interfaces that act socially," *Proc. ACM Human-Comput. Interact.*, vol. 8, no. CSCW1, pp. 1–25, 2024.

[28] M. Brenncke, "A theory of exploitation for consumer law: Online choice architectures, dark patterns, and autonomy violations," *J. Consum. Policy*, vol. 47, no. 1, pp. 127–164, 2024.

[29] "Bringing dark patterns to light," 2022, [Online]. Available: https://www.ftc.gov/system/files/ftcgov/pdf/P214800

[30] O. Lopez-Fernandez et al., "Perceptions underlying addictive technology use patterns: Insights for cognitive-behavioural therapy," *Int. J. Environ. Res. Public Health*, vol. 19, no. 1, p. 544, 2022.

[31] P. Helm and T. Matzner, "Co-addictive human–machine configurations: Relating critical design and algorithm studies to medical-psychiatric research on 'problematic Internet use,'" *New Media Soc.*, vol. 26, no. 12, 2023, Art. no. 14614448231165916.

[32] A. Hans, N. T. Singh, R. Kumar, A. Kumar, A. Choubey, and Suresh, "The psychology behind addictive applications in technology," in *Proc. IEEE Int. Conf. Comput. Power Commun. Technol.*, vol. 5, 2024, pp. 669–672.
[33] C. Hsu, "Unconsciousness by design: Addictive technologies and the escape from freedom," 2017. [Online]. Available: https://openresearch.ocadu.ca/id/eprint/1743/7/Hsu_Cheryl_2017_MDES_SFI_MRP.pdf
[34] S. Scales, "Autonomy and addictive design," *Int. J. Ethics Biol. Eng. Med.*, vol. 12, no. 1, pp. 141–160, 2021.
[35] V.-M. Karhulahti, "Vitality structures in 'addictive' game design," *Open Res. Europe*, vol. 4, p. 47, Oct. 2024.
[36] R. Chianella, "Addictive digital experiences: The influence of artificial intelligence and more-than-human design," in *Proc.* 14^{th} *Int. Conf. Eur. Acade. Design*, 2021, pp. 1–12.
[37] (WHO, Geneva, Switzerland). *Public Health Implications of Excessive Use of the Internet, Computers, Smartphones and Similar Electronic Devices*. (2015). [Online]. Available: https://www.who.int/publications/i/item/9789241509367
[38] L. M. Given, *The SAGE Encyclopedia of Qualitative Research Methods*. Thousand Oaks, CA, USA: SAGE Publications, 2008.
[39] R. Farthing, K. Michael, R. Abbas, and G. Smith-Nunes, "Age appropriate digital services for young people: Major reforms," *IEEE Consum. Electron. Mag.*, vol. 10, no. 4, pp. 40–48, Jul. 2021.
[40] K. Michael, "Mitigating risk and ensuring human flourishing using design standards: IEEE 2089–2021 an age appropriate digital services framework for children," *IEEE Trans. Technol. Soc.*, vol. 5, no. 4, pp. 342–354, Dec. 2024.
[41] J. Bänsch, "PEGI, the European system of harmonised age ratings for video games," in *Savegame: Agency, Design, Engineering*. Cham, Switzerland: Springer, 2019, pp. 289–295.
[42] (AEPD, Madrid, Spain). *Addictive Patterns in the Processing of Personal Data: Implications for Data Protection*. (2024). [Online]. Available: https://www.aepd.es/guides/addictive-patterns-in-processing-of-personal-data.pdf

Marta Beltrán (Senior Member, IEEE) received the first master's degree in electrical engineering from the Universidad Complutense of Madrid, Spain, in 2001, the second master's degree in industrial physics from UNED, Spain, in 2003, and the Ph.D. degree from the Department of Computing, Universidad Rey Juan Carlos, Madrid, in 2005. She is currently the Chief of the Scientific Unit with AEPD (the Spanish Data Protection Authority) and an Associate Professor on distributed systems, cybersecurity and privacy with the Universidad Rey Juan Carlos (on leave). One of her current research interests is risk analysis and management in high-risk personal data processing, with a special focus on the impacts for citizens' rights and freedoms.