The role of expectation in innovation evolution: Exploring hype cycles

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A B S T R A C T

Digitalisation has unleashed numerous and rapid technological, enterprise, and societal innovations. The complexity of social learning and action evidenced in these innovations (e.g., social media-based commerce) across the individual, organisational, and societal levels has multiplied since the introduction of superglue, radial tires, and televisions in the 1950s. Nevertheless, the diffusion S-curve model has remained dominant in innovation evolution research and practice for almost 60 years. Gartner's hype cycles introduce an alternative model and are increasingly used in high-tech management practice. Despite its popularity for over 20 years, the scant academic literature has offered little insight beyond verifying the existence of hype cycle phenomena. Building on the foundation of innovation diffusion and extant hype cycle literature and integrating it with perspectives across several diverse disciplines, this paper develops a conceptual framework for understanding hype cycles and connecting them with the S-curves. It establishes the role of expectation and presents its changes over the course of early-stage innovations leading to the initial adoptions. The paper concludes by highlighting contributions to and suggesting several directions for future research.

1. Introduction

A key part of the world's New Normal is the rise of digital economies (Ahlstrom et al., 2020). They evolve from Internet commerce to an expanding array of digital products and services to the ongoing digitalisation that disrupts and transforms traditional sectors and creates new ones (UNCTAD, 2019). For the last three decades, the rise of the digital economies has allowed us to witness unprecedented multiplicity and rapidity of technological innovation diffusions (Comin and Hobijn, 2010). However, not all diffusions conform to the classic innovation diffusion curves (Rogers, 1962). For example, consider the rapid rise of social media commerce, exemplified in Airbnb, Pinduoduo, TikTok, Uber, and WeChat. Alternatively, consider the fast-evolving manifestations of cryptocurrencies, from the archaic "peer to peer electronic cash system" by the mysterious Satoshi in 2008 (Corradi and Höfner, 2018). Through hypes, disappointments, scandals, and pivots, adopters of Bitcoin and its sibling cryptocurrencies have embraced a multitude of connotations of the Blockchain innovation from substitute of fiat currency to vehicle for secure and frictionless commerce to path to true democracy. Depicting the early-stage dynamics, such as those shown in the evolution of cryptocurrencies, the hype cycle model (Raskino and Fenn, 2009) has gained popularity among innovation management

practitioners. Nevertheless, understanding the hype cycle is limited primarily to descriptions of the hype phenomena (Dedehayir and Steinert, 2016). We do not understand how and why hypes rise and fall or how they link to the classic S-curve.

Management literature for more than half a century has utilised technological adoption curves, or S-curves, to describe, predict, and forecast the maturity, diffusion, and regeneration of innovations (Kucharavy and De Guio, 2011; Rogers, 1962, 2003; Slocum and Lundberg, 2001; Morrisson, 1995; Christensen, 1992; Brown, 1991). Adoptions have remained the dominant focus in the academic literature on innovation management (Van Lente et al., 2013), despite the popularity of the hype-cycle model among technology, management, and policy practitioners (Van Lente et al., 2013; O'Leary, 2009; Jarvenpaa and Makinen, 2008). Since its introduction in 1995 by Gartner, a technology consultancy, the concept of the hype cycle has evolved into one of the significant consulting models for the firm, which serves over 10, 000 companies, including most of the Global 500. Unlike the focus on perceptions generated based on previous adoptions in the diffusion models, the applications of the hype cycle model focus primarily on the dynamics of expectations in technological innovations leading to early adoptions to determine the state of development of technological fields and advise on strategic investment decisions (Van Lente et al., 2013;

Steinert and Leifer, 2010). As shown in Fig. 1c, the most significant parts of the hype curve (Fig. 1b) predate the beginning of innovation adoptions as depicted in the diffusion S-curve (Fig. 1a).

The hype cycle represents innovation differently from the conventional technology life cycle or S-curve, where the early phases of innovation are marked by a rapid rise in expectations of the innovation toward the peak of inflated expectations and then a rapid decline through the trough of disillusionment, leading to early adoptions and rapid market growth as depicted in the life cycle model. However, recognition of the hype phenomena and the significance of expectations in the evolution of early-stage innovations has not brought sufficient attention to the hype cycle model in academic literature beyond confirmatory investigations of the phenomena (Jun, 2012; Dedehayir and Steinert, 2016). In this paper, we argue that this is due to the absence of a theoretical framework that distinguishes expectations from perceptions on innovation diffusion. The traditional diffusion model focuses on the perception-adoption dynamics and does not explain how expectations drive or are driven by innovation evolutions. On the other hand, the extant hype cycle literature fails to connect where the hype cycle ends, and the life cycle begins.

Taking a small step towards understanding hype cycles better, we ask what characterises expectations in early-stage innovations, how expectations are institutionalised as collective beliefs or disbeliefs, and how expectation dynamics explain hype cycles that precede innovation adoptions, which in turn may shed light on early adoptions. Although by no means thorough or comprehensive, our literature review includes studies on innovation diffusion, hype cycles, and several relevant perspectives from neuroscience and psychology, communication and semiotic studies, and institutional and behavioural theories. We introduce in this paper a conceptual framework with three goals: establishing a typology of innovation expectations, articulating the role of emotional expectations in relation to their logical counterparts in early-stage innovations, and explaining why there is a higher level of social acceptance of positive expectations when scant logical expectations are present. Following the theory development, we report our initial empirical attempt and discuss ideas for further research.

2. Background

The concept of innovation diffusion predates that of the hype cycle by 30 years. Product and innovation diffusion theory evolved rapidly over a short span of just three years, beginning from an early prediction of market success of new grocery products by Fourt and Woodlock (1960). This work was followed by Mansfield's (1961) now-classic analysis of the rate of imitation in technical change. Quickly succeeding the analysis was Rogers' Diffusion of Innovations, a seminal book first published in 1962, which was thoroughly descriptive and largely literary. The Bass Model was first published a year later, introducing a mathematical theory of product and innovation diffusion (Bass, 1963). Common to these studies is imitation or, in Bass's framing, the probability of adoption by those who have not yet adopted in relation to those who had previously adopted. The improved Bass Model (1969) was built on Rogers's work on the spread of innovations in social systems due to word of mouth, assuming that sales of a new product are primarily driven by word-of-mouth from satisfied customers. In other words, adoption builds on a perception of satisfaction with the new product from the communicative practices of previous adopters.

The diffusion models explain why individuals choose to adopt or reject an innovation based on their perceptions of the intrinsic characteristics of the innovation, such as relative advantage, ease of use, compatibility, image, result demonstrability, visibility, voluntariness, and trialability (Moore and Benbasat, 1991). These models yield a typical S-curve that tracks the spread of innovation over the course of its evolution and present a distinct pattern of innovation adoption (Fig. 1a) by members of a social system identified in the five adopter categories: innovators, early adopters, early majority, late majority, and laggards, after which the point of diminishing returns of adoption is reached (Rogers, 1962).

Over the years, the diffusion model has taken various other forms with stylised depictions such as product life cycle, technology life cycle, and industry life cycle (Dedehaiyr and Steinert, 2016). These models are used to manage numerous uncertainties inherent to any innovation system defined as a dynamic network of agents interacting under an institutional infrastructure and involved in the creation, diffusion, and utilisation of innovation (Carlsson and Stankiewicz, 1991). They have been applied for forecasting, prediction, and regeneration of innovations covering broadly component to architectural level technologies and innovations, including even approaches to inventive problem solving (Kucharavy and De Guio, 2011; Rogers, 2003; Slocum and Lundberg, 2001; Morrisson, 1995; Christensen, 1992). Many authors have also discussed the diffusion of innovations in technological and management fields (Newell et al., 2001; Carson et al., 2000; Westphal et al., 1997).

For three decades, these models had kept the fundamental conceptualisation of the adoption-perception relation via communication as the vehicle for the spread of information until the debut of the hype cycle model in 1995 by Gartner Inc., a technology management consultancy. The hype cycles centre on expectations of an innovation, which yield remarkably different and often more dramatic curves than the S-curves.
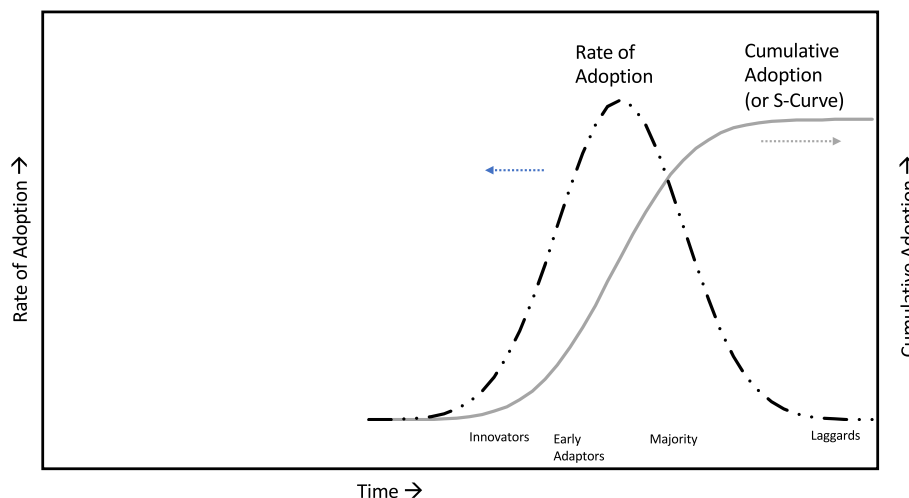

Fig. 1a. Innovation manifesting through adoption: S-curve (Rogers, 1962).
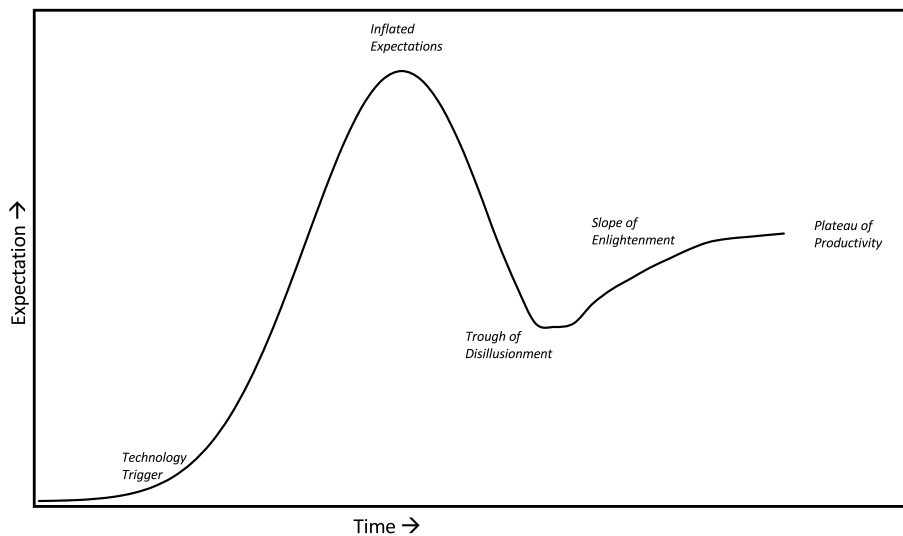
Fig. 1b. Innovation manifesting through expectations: Hype curve (Fenn and Linden, 2003).
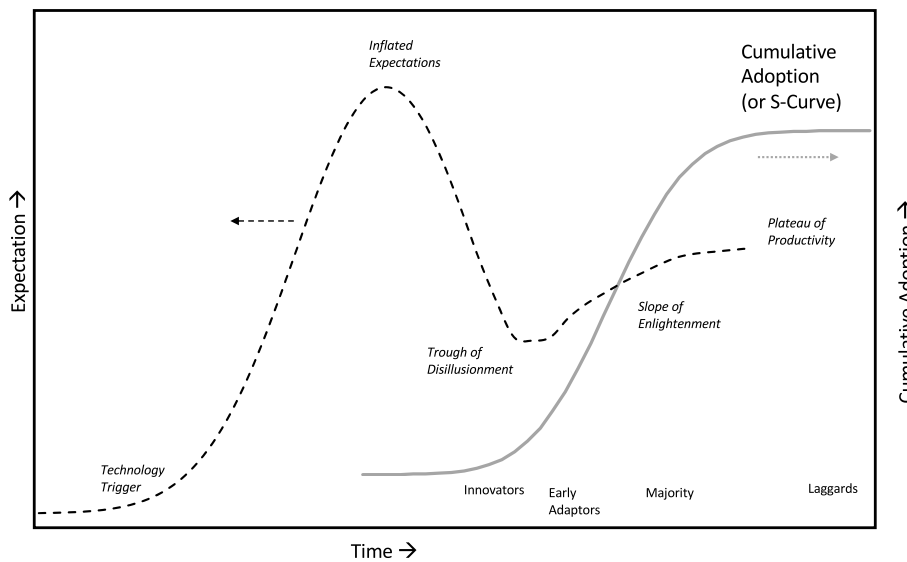

Fig. 1c. A conceptual compound representation of innovation diffusion (Fenn and Linden, 2003; Rogers 1962).

2.1. The hype cycle model

The hype cycle model as an alternative depiction of innovation evolution has gained substantial attention among practitioners. The model was developed to show a different evolutionary path based on an expectation of the value of innovation (Raskino and Fenn, 2009). The difference between human perception and expectation is nuanced. Unlike perception, the word expectation lacks precise or general scientific definitions. The Merriam-Webster definition of *expectation* is simply the act or state of expecting, in other words, anticipation. Borup et al. (2006) describe the concept of expectation as the state of looking forward, a real-time representation of future technological situations and capabilities, and "wishful enactments of a desired future" (2006: 286).

In contrast, perception is the representation and understanding of external signals that go through the nervous system involving physical or chemical stimulation of the sensory system (Bernstein, 2010). Perception is not only generated passively from these signals but is also shaped by the recipient's learning, memory, expectation, and attention (Gregory, 1987:608). For example, it is common that vision of beauty involves light striking the retina of the eye. However, an extreme

alternative may involve specific memories triggered by other sensory signals such as smell or sound. Sohn et al. (2019) regard expectation as a prior belief that influences our perception of the world. Expectations help us make sense of what we perceive in the present, based on similar past experiences. An actual or perceived result that is better than the belief may give rise to the emotion of satisfaction and otherwise of disappointment, which changes the expectation and, in turn, the perception. The hype cycle model focuses on expectations during the early stage of innovation adoptions and reveals dynamics not shown in a typical S-curve. It depicts that expectations of innovations progress through successive turning points identified as the peak of inflated expectations, followed by a trough of disillusionment before climbing the gentler slope of enlightenment toward the plateau of productivity (Fig. 1b).

Today both the S-curve and the hype cycle models have been applied in managing strategic decision-making in the context of innovations where uncertainties are an inherent and essential characteristic. However, attempts to reconcile the theoretical differences between the two models of innovation evolution have not been successful (Dedehayir and Steiner, 2016). While the adoption model utilises a more tangible

measure of actual adoption, it suffers from the limitation of little or no predictive power prior to the first adoption of the innovation. In contrast, the hype cycle model utilises measures of expectation that provide insights into pre-adoption behaviours. However, it suffers from an equivocal operationalisation of the dependent variable with expectation or visibility (Steinert and Leifer, 2010; Raskino and Fenn, 2009), which has tenuous generalizability across all stakeholders.

While cognizant of the important notion of hype, which the traditional life cycle model ignores, Dedehayir and Steiner (2016) advocate the identification of hypes within the existing individual S-curves or life cycle models. Over-enthusiastic investments in R&D activities or a surge of patent activities may be explained by perceived competitive pressure or forecasted promise of technology. In addition, stakeholder-specific hypes may be associated with the different types of media that gain the attention of differing stakeholders. For example, innovators or early adopters pay more attention to technical publications, and late adopters follow mainstream media (Watts and Porter, 1997). In other words, hypes may be explained by the heterogeneity of perceptions by different stakeholders or media in an innovation system. This difference implies a broadened scope of perceptions of innovation to include past perceptions and suggests a narrower focus on only perceptions, which exclude or overlook expectations or prior beliefs that may shape and inform perceptions.

2.2. The role of expectation in innovation evolution

On the other hand, several authors assert the central role of expectation in explaining hype dynamics (Konrad, 2006; Konrad et al., 2012; Alkemade and Suurs, 2012). Konrad (2006) establishes the importance of collective expectations by regarding them as a social fact, a taken-for-granted prerequisite, an image pressure, and a protected space to engage a large set of heterogeneous actors to contribute to the introduction of innovation to society. Studying the strategic responses to the fuel cell hype, Konrad et al. (2012) present the mechanisms by which expectations affect innovation processes. Collective expectations motivate and guide innovation actors and coordinate many heterogeneous actors by providing a perceived common reference point. Moreover, the sociological institutionalism argument does not have to be at odds with individual rational behaviours, which drive the formation of a new institutional field or a prospective structure to be filled by agency (Van Lente and Rip, 2017). This dynamic view of expectations explains Konrad's (2006) other postulation that expectations may be turned around by interrelated project results that contradict the previous positive expectations, the expectation dynamics on competing innovations, or other factors such as the dynamics of financial markets, which may cause the retraction or collapse of the hype.

Alkemade and Suurs (2012) suggest that expectations about future performance drive decisions more than current performance because few instruments and indicators are available in the earliest phases or the exploratory phases of the technological life cycles. Recognising the role of expectations in shaping early-stage innovations, they analysed several thousand expectation events in the emerging Dutch biofuels innovation system between 2000 and 2008. They identified expectation patterns and found indications of hype cycle dynamics in all three biofuel technologies. These expectation patterns contribute to the guidance of the search function in the emerging innovation system through standard-setting, expressions of positive or negative expectations about the technology as well as promises or targets expressed by actors with the power to change institutions (Carlsson and Stankiewicz, 1991; Freeman, 1995 Lundvall, 1988). They may also reflect the socio-political processes in which some organisational routines are changed, but not others (Nigam et al., 2016), and the boundaries for innovation alternatives or the epistemic architecture for the value of innovation are being legitimised in an emerging institutional field (Jain and Ahlstrom, 2021).

Alkemade and Suurs (2012) operationalise expectation events as statements of public importance and analyse the different characteristics that shape the expectation patterns. This methodological treatment is consistent with Rogers' (1962) view of innovation as communication and the important view of innovation diffusion as driven by rhetorical justifications (Hoefer and Green, 2015; Green, 2004; Harley, 1999). Harley (1999) points out an important element in recent scientific studies, including medicine, is the analysis of the social rhetoric involved in constructing discipline and knowledge. Harley found an explicit use of rhetorical and semiotic frames of reference that had illuminated many aspects of the history of medicine and provided a unifying framework for the field. The conduct of patients and physicians frequently turns on the expectation of cure and the establishment of confidence. The diagnosis, treatment, and prognosis produce complex physiological effects required for successful healing in all cultures and at all times. The interactive processes create signs, narratives, and meanings upon which trust and expectation are established and enhanced. The history of medical interventions is a record of both medicines' physical effects and social rhetoric, a most recent example of which may be the various responses to curtail the Covid-19 pandemic. The acceptance rate of a particular intervention, from mask-wearing, social distancing to vaccination, is determined not only by its efficacy but also the rhetoric and collective expectations (Dada et al., 2021; Bhasin, 2020). Furthermore, the socio-cognitive process is not free from the influence of political actors. Jain and Ahlstrom (2021) present a case that illustrates how specific stakeholders shape innovation trajectories and the selection or deselection of chronic kidney disease therapies.

Hoefer and Green (2015) argue that the rhetoric of an actor performs a dual role of communication (public argument) and cognition (private argument) in the institutional decision-making process. Rhetoric shapes the reasoning and judgment of both speakers and listeners; the arguments reflect appeals to pathos (emotion), logos (logic), and ethos (values) that support or criticise decisions to act (Green, 2004). These appeals also shape beliefs that bind rationality. Li (2017) suggests a different kind of linguistically driven dynamics in the semiotic theory of institutionalisation in which the symbols (signifiers) an organisational actor uses may or may not signify the meanings (signified) intended, and the actions and practical examples (referents) may or may not illustrate either the symbols or the meanings. The tight or loose coupling of the three correlates of a sign is driven by two distinctive institutionalisation processes, denotational institutionalisation and connotational institutionalisation. Connotational processes yield heterogeneous symbols, meanings, and practical examples that are decoupled or loosely coupled with each other. In contrast, denotational processes homogenise the correlates of rhetoric.

In summary, we find that there is limited academic research on the hype phenomena or the hype cycle model, despite its popularity in technology management practice (Dedehayir and Steinert, 2016). The extant academic research provides little empirical work beyond confirmatory investigations and lacks a theoretical framework that explains the hype phenomena and their linkage to innovation diffusion (Jun, 2012; Dedehayir and Steinert, 2016). It focuses predominantly on empirically verifying the existence of hype cycles, using various measures of visibility such as patent activities, media coverage, or media search activities (Jun, 2012). Less emphasis is placed on distinguishing expectation from perception, specifying an analytical structure for expectations, or explaining how expectations drive or are driven by innovation evolutions. The innovation diffusion literature has remained oriented towards perception-adoption relations with little attention to expectations or their effect on innovation. There is neither a diffusion model based on expectations nor one based on the interplay of expectations and perceptions. Consequently, the hype cycle literature fails to connect meaningfully with the traditional life cycle model, while no diffusion models explain the hype dynamics.

Our literature review identifies potential areas to explore in advancing understanding about the role of expectations in innovation evolutions and possible interactions of the currently separate domains of

expectations and adoptions in the innovation literature. As shown in Fig. 2, we regard expectation and adoption as two manifestations of innovation, two sides of the same coin that need to be analysed together. Expectation patterns are identified and shown to be associated with strategic responses that collectively shape the innovation systems (Alkemade and Suurs, 2012); however, no mechanisms are proposed. Expectation, perception, and rhetoric are products of both agency and social construction. They affect innovation evolution (Green, 2004; Van Lente and Rip, 2017; Rogers, 1962); however, it remains unclear how expectations influence perceptions or vice versa, given rhetorical and semiotic frames by the actors of an innovation system. The following section discusses the literature that simultaneously illuminates both the "expectation" and "adoption" manifestations of innovation, which leads to a conceptual framework that addresses the research questions.

3. Theory development

The main task of this paper is to formalise the role of expectation in innovation evolution by analysing expectations in terms of rhetorical justifications and developing a conceptual framework that explains the different patterns of expectation over time. The development identifies relevant theories that provide a perspective on our research question. The research question of how the expectation of an innovation changes over time is deconstructed into three sub-questions. What are the types of expectation? How are they initiated and socialised? Moreover, how do they affect decision-making and choice? The proposed conceptual framework is then applied to a hype cycle of expectations regarding the value of innovation (Raskino and Fenn, 2009).

3.1. Types of expectations

We begin our theorising with the characterisation of expectation introduced by Alkemade and Suurs (2012). They operationalise the construct of expectation as expectation events, i.e., statements of public import made about an innovation in their study of the three emerging biofuels. These statements were analysed in terms of *direction* (expression of a positive or negative future performance), *specificity* (guidance regarding the general ability of the innovation or specific technical performance), *time horizon* (a reference to the near or a distant future), and *actor* (type of messenger in an innovation system such as entrepreneurs, researchers, policymakers or users). The results show interesting expectation patterns over time. For example, positive expectations outnumber negative ones. The number of positive expectations over time forms a curve that resembles a typical hype cycle much

greater than that of negative expectations. The number of specific or short-term guidance rises and falls sharply during the initial stage of development of the natural gas and hydrogen technologies. They achieve stably high numbers only several years later.

This characterisation of expectation takes a similar stance as the established life cycle model that views innovation diffusion as communication. Nevertheless, expectation is not restricted to only positive word of mouth, taking the theoretical premises of perception of satisfaction from previous adoptions (Bass, 1963; Rogers, 1962). In the classic diffusion model, positive perception and adoption must go hand in hand since adoption due to negative or no perception is counterintuitive. The Alkemade and Suurs (2012) characterisation also suggests analysing expectation's rhetorical and linguistic meaning, potentially providing a richer context for empirical studies than counting media coverage or search activities, which are the two most popular approaches to operationalise visibility, a surrogate for expectation. Furthermore, the analysis of rhetorical and linguistic meaning allows for exploring the mechanisms by which expectations arise, grow and subside.

Green (2004) sees innovation diffusion as taken-for-granted acceptance of discursive reasons or rhetorical justifications. There are three types of rhetorical justifications or appeals, each of which has a distinct pattern of social acceptance and abandonment. First, rhetoric that appeals to individual emotions elicits fast acceptance and abandonment. Second, rhetoric that appeals to a desire for rational decision making and choice engenders slower acceptance and abandonment since it takes time and prior knowledge for individuals to engage the prefrontal cortex of their brain to make sense of the rhetorical justification. Lastly, rhetoric with the appeal of a new norm or ethics takes even longer to gain acceptance since it involves complex social cognitive processing, although once accepted, moral justification is more difficult to abandon. Therefore, to simplify our conceptual framework development and presentation in the context of early-stage innovations, we limit our scope of discussion to emotional and logical justifications.

The difference in speed of social acceptance and abandonment between emotional and logical justifications may be explained further by the semiotic theory of institutionalisation (Li, 2017). The theory posits that the three distinct correlates of social reality (doing, saying, and meaning) correspond to the semiotic triangle: referent, signifier, and signified. These contribute to an understanding of institutionalisation processes. Specifically, two kinds of institutionalisation processes are identified when combining the semiotic triangle and the chain of signification of a semiotic symbol. A denotational process entails coupling of the referent, signifier, and signified, while the connotational
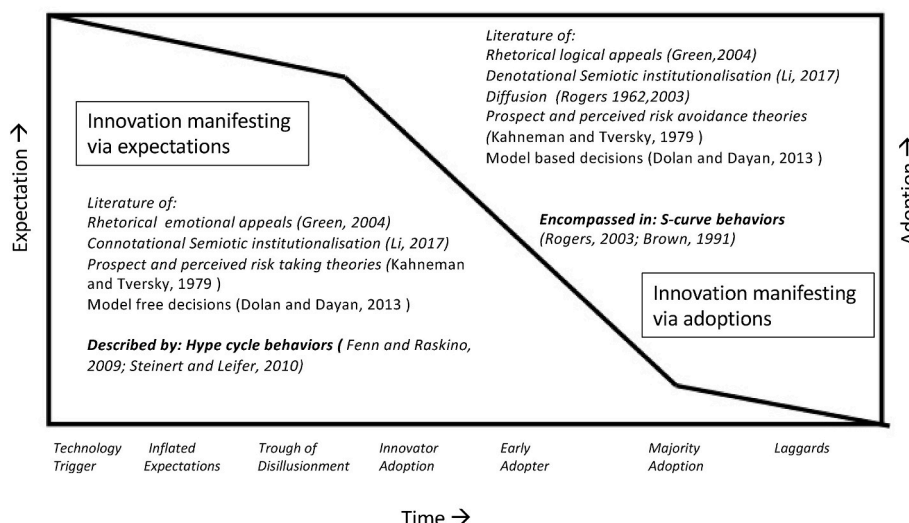
Fig. 2. The interplay between innovation expectations and adoption.

process involves decoupling or weak coupling among the three. For a symbol to acquire significance through coupling involves phenomenological processes such as *typification*, *objectification*, and *theorisation*, which coincide with the longer process of producing a new logical justification and replacing an existing one. Alternatively, significance can be acquired through decoupling the three components of a symbol involving *emptification* and *imaginization*, in which actors empty the given meaning of the symbol and infuse it with additional meanings based on their ideological or cultural leaning. This connotational institutionalisation takes less time and results in greater heterogeneity, which resembles faster social acceptance of emotional justifications (Li, 2017). For example, while a clear picture about the effect of Bitcoin mining on the global energy production and consumption is years away, Bitcoin's various connotations, including substitute of fiat currencies, alternative store of value, unrivalled trust mechanism, and many more, have generated multiple rounds of excitement and disappointment for the last decade.

Building on the characteristics of expectations suggested in the Alkemade and Suurs study (2012), we propose a new way to characterise expectation through the lenses of rhetorical justification and semiotic institutionalisation. Specifically, we suggest retaining one of their four dimensions (*direction*) while integrating the other three (*specificity*, *horizon*, and *actor*). We argue that rhetorical justifications, emotional and logical with the future inclusion of moral justifications, encompass the characteristics fundamental to the role of expectation in innovation evolution (Alkemade and Suurs, 2012). Emotional justifications associate and encourage meanings with little shared specification and vague time horizons, often among people who rely more on beliefs than on rational inquiries. On the other hand, logical justifications stimulate specific understandings about matters in a non-distant future among more deductive inquirers than those who rely more on beliefs. With this understanding, we further propose four basic types of innovation expectation: *positive emotional*, *negative emotional*, *positive logical*, and *negative logical*. As an outcome of semiotic institutionalisation, emotional expectation follows the connotational institutionalisation process that tends to generate heterogeneous rhetorical justifications faster at social acceptance and abandonment. Logical expectation follows the denotational process that generates homogenous rhetorical justifications at a slower pace of social acceptance and abandonment. Table 1 summarises the differences between emotional and logical expectations. Fig. 3 provides a visual representation of the expectation types; the composite of the two types implies a hype cycle.

3.2. Emotional expectation and decision making

The significance of our proposed characterisation of expectation lies in its dichotomous treatment of emotional and logical expectations and the recognition of their differences in influencing innovation evolution. Van Kleef et al. (2009) point out that the popularity of studying the functional approaches to emotion has manifested mainly at the intrapersonal level of analysis. They argue that a primary function of emotion is interpersonal. Emotional expectation provides social information that produces interpersonal effects by triggering affective reactions and inferential processes. The interpersonal function of emotion is evident across various domains of social influence such as negotiation, leadership, attitude change, compliance, and conformity in groups. Hareli and Rafaeli (2008) further identify the mimicry of emotions of others, which

Table 1
Expectation type and social acceptance/abandonment.

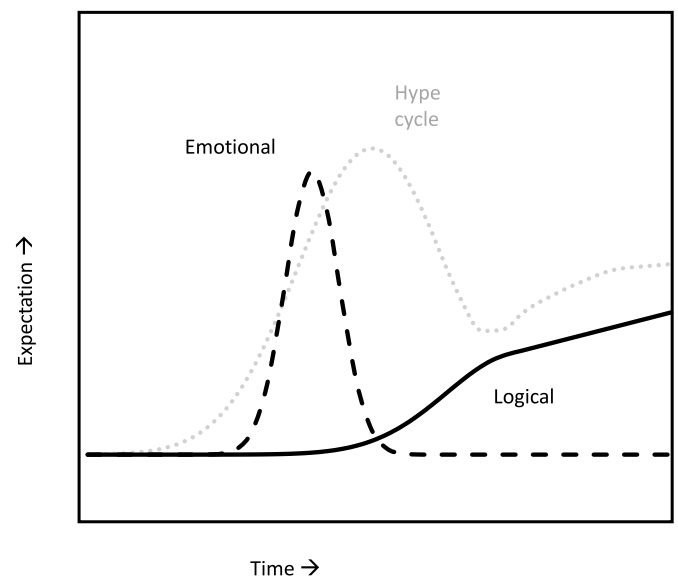| Socialisation	Emotional expectation	Logical Expectation
Effort Required	Low	High
Speed	Rapid	Slow
Capacity	Numerous	Limited
Convergence	Heterogeneous	Convergent

Fig. 3. Expectation Type and speed of Acceptance/Abandonment.

extends the social presence of a specific emotion or a range of emotions present. People can draw attributions and extract meanings from others' emotions to justify embracing the same emotions. They also form heuristics from others' emotions and use the heuristics to inform their decisions. In an empirical study of the effect of emotional heuristics on consumption decisions under uncertainty, Voon (2013) found that the consumption model with anticipatory feelings (emotional heuristics) performed significantly better than pure income-based consumption models (mental accounting). The presence of both rational and emotional pathways in decision-making is well established scientifically. However, it is less so in the innovation literature.

The two different types of expectations should not lead to separate attributions to innovation evolution. We argue that emotional and logical expectations correspond to two basic mechanisms of reinforced learning (RL) that simultaneously influence innovation evolution from social information to individual decision-making and choice. The two mechanisms are model-based RL and model-free RL or, in the large body of neuroscience and psychology literature, reflective and reflexive, goal-directed and habitual, or prospective and retrospective RL (Dolan and Dayan, 2013; Daw et al., 2006). These mechanisms coexist as offering efficient solutions to the demands of complex and changing environments throughout decision making and choice. Deployment of a specific mechanism at any moment may be determined by the value of information shaping the understanding of the relative uncertainties of the system. The value of information is the tradeoff between the less noisy (more precise) but more calculation intense model-based mechanism and the noisy (less precise) and more rapidly formed model-free mechanism. The latter has a higher utility when drawing on prior belief, even though this may not be specific to the problem and is merely connotational. Model-based RL has increased value when resources to perform the burdensome calculations are available (Daw et al., 2006; Dickinson, 1985). Keramati et al. (2011) suggest that model-free values are fast to compute but potentially inaccurate, whereas model-based values are slow to compute but typically more accurate. The model-free mechanism is deployed when model searching yields uncertain expected benefits while incurring a high expected cost. In this case, the emotional pathway becomes a primary pathway for decision making and choice under uncertainty.

Emotional expectations are based on heterogeneous connotations and contain less accurate information about an innovation than logical ones. Nevertheless, they are instrumental in decision making when logical expectations are less available and searching one or more is

costly and takes time, most notably at the earliest phase of an innovation. Over the course of innovation evolution, logical expectations become more available and attainable in conjunction with the progress in technical and system-level performance, as argued in the innovation diffusion literature. As a result, the values of logical expectations in decision-making also increase. In other words, emotional expectations are essential to understanding innovation evolution, particularly in its early stages when logical expectations are scant or challenging to attain. However, overlooking emotional expectations ignores the early history of an innovation, a part missed in the traditional S-curve and yet integral in a hype cycle.

3.3. Positive emotional expectation in early-stage innovation

Accounting for emotional expectations alone does not offer a good explanation for the hype phenomena since emotional expectations involve both the positive and negative types. A hype is caused by a surge of shared positive expectations or the social acceptance of rhetorical justifications that possess positive emotional appeals (Green, 2004). Assuming both positive and negative emotional expectations exist in the earliest stage of an innovation, we argue that the positive ones are favoured in forming heuristics whether or not they may lead to deviations from optimal decisions. According to prospect theory, such selection bias is a basic human behavioural condition (Kahneman, 2003; Tversky and Kahneman, 1986; Kahneman and Tversky, 1979). People evaluate the potential value of losses and gains using specific heuristics. Prospect theory predicts risk-seeking behaviours when losses are almost inevitable or the probabilities of gains are low. This situation is typical during early-stage innovation, where a concept or a lab prototype is conceived, but no working prototype has yet been fabricated; a solution is envisaged in a business context, but no customers or suppliers courted. At this early stage, financial projections are made, but even the most risk-tolerant venture investors are not ready (Fenn and Linden, 2003). This situation is conducive to risk-seeking behaviours. Positive emotional expectation as social information is a manifestation of such behaviours. Any gap between such expectations and proven potentials is more likely to be perceived with biases towards positive expectations; on the other hand, prospect theory also predicts risk-averse behaviours when gains are more certain, or the probabilities of losses are lower. This situation manifests when an innovation matures. Examples may be that a first-generation product is ready for early adopters. In the case of business innovation, business models have matured and are ready to scale. Further capital requirements appeal to investors with lower risk-reward inclinations. The potential gains to both innovators and early adopters have higher probabilities of materialising, while the probability of losing everything decreases. Consequently, decision biases veer toward risk aversion and away from risk-seeking. Logical expectations centring on the early product and business model prototypes become more attainable and more available. Logical expectations increase their presence in the overall social expectations of innovation, supplanting some of the positive emotional expectations while creating room for negative emotional expectations against deviations from the emerging prototypes.

3.4. A conceptual framework of hype cycles

We see the dominance of positive emotional expectations and their substitution by fewer and homogenising logical expectations as the key to understanding hype cycles of innovation and early-stage innovation adoptions. This observation is consistent with models of individual and social behaviours in the realm of unfolding rationality. For example, studying the commonality in the Jesuit practices of spiritual self-accountability and administrative accounting and recording keeping, Quattrone (2015) introduces the concept of unfolding rationality which describes the purposeful procedural logics in rhetorical practices that invent, recall, classify and connect justifications to improve the

relationships between behavioural means and ends. Unfolding rationality encompasses analytic methods of knowledge ordering and composition of imageries, motivating ritual, and means of moral scrutiny (Quattrone, 2015: 422). Similarly, in investigating 30 decisions to commercialise platform biotechnology inventions, Maine et al. (2015) found similar behaviours of unfolding rationality whereby the scientist-entrepreneurs shift from effectuation to causation in their iterative opportunity generation and decision making.

The preceding discussion directs hype cycles toward a case of unfolding rationality in which human learning, communication, and risk behaviours dictate that different expectations take priority throughout an innovation evolution. During the early stage of a new idea, technology, or innovation in general, the significance of the innovation is communicated through rhetoric with more emotional than logical justifications, therefore creating more emotional than logical expectations. Emotional expectations are created at a faster pace through the institutionalisation process that decouples the three correlates of an innovation symbol, i.e., the symbol itself and its reference and the meaning (Li, 2017). Actors create meanings of an innovation based on their cultural or institutional background. As a result, the model-free understandings tend to be more abundant, more heterogeneous and attained more quickly than the model-based ones. Conversely, logical expectations rise more slowly through the institutionalisation process that couple the correlates of an innovation symbol. The model-based understandings are thus fewer in quantity, more homogenous, and attained more slowly over time.

The presence of more emotional expectations does not impose higher or lower barriers for individual decision-making and choice since rationality is not necessarily predicated on the existence of logical models (Voon, 2013). Instead, model-free decision-making is part of the unfolding rationality that relies on emotional expectation to provide an optimal value of information. Thus, the vital role of emotional expectations is one of the distinct features of early innovations in our conceptual framework. The other feature of the conceptual framework is that positive expectations are more likely embraced by risk-seeking actors, adopters, or non-adopters alike. In other words, unfolding rationality as an institutional logic for organising early-stage innovation favours emotional expectations, especially those with positive outlooks.

Proposition 1. *An increase of overall positive expectation of an innovation during its early stage is associated with multitudes of emotional expectations and a higher proportion of emotional expectations.*

Proposition 2. *Decrease of overall positive expectation and increase of overall negative expectation in an innovation hype cycle is associated with a decrease of emotional expectations and increase of logical expectations.*

The propositions above explain the two parts of a hype cycle, the part from the initial innovation trigger toward the peak of inflated expectations and the part with subsequent reduction of expectations toward the trough of disillusionment (Raskino and Fenn, 2009). They present the varying socialisation of expectations from a penchant for positive emotional expectations to their increasing abandonment, as logical expectations emerge to influence individual decision-making and collective sense-making (Weick, 1979). This transition reduces the number of expectations by discrediting those that have deviated from the fewer and more established logical expectations. These abandoned positive emotional expectations may be perceived as failures and invoke negative emotional expectations. On the other hand, the convergence or retention of fewer expectations and a higher proportion of logical expectations introduce the initial proven potentials or perceptions of satisfaction that may trigger risk aversion decision biases as certainties of some gains increase and possibilities of total losses decrease.

Fig. 4 illustrates the composite of the two propositions and the interplay of early-stage innovation expectations in terms of the emotional and logical types, the selection biases, and the perceptions underlying early adoption. Early adopters' decision to adopt is informed by perception built on a prior belief shaped by decreasing emotional
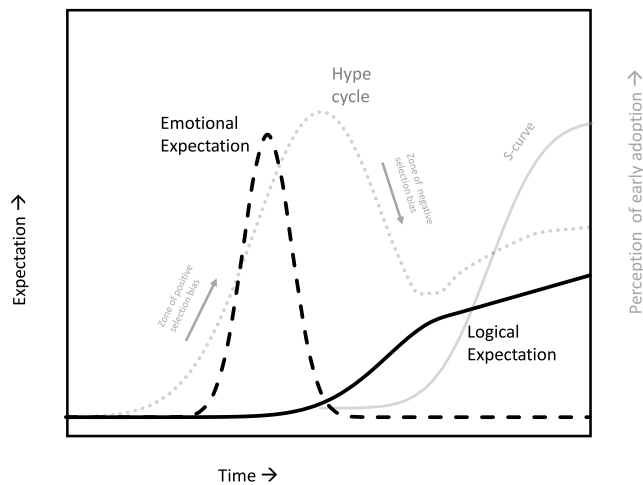
Fig. 4. Evolving expectation, rhetoric and connotation.

expectation and increasing logical expectation. Unlike the perception of satisfaction by previous adopters, early adopters' perceptions are organisation specific. When their adoption experience is successful, their adoptions become references for the adopters that follow them. In other words, Fig. 4 illustrates the important role of changing expectations in early innovation adoptions. The history of diffusion begins with expectation when the perception of adoption success does not exist.

4. Discussion

This paper develops a conceptual framework to account for the expectation dynamics that predate the beginning of innovation adoption when initial adoption success snowballs through the perception of increasing success by cumulative adoptions. Such perception influences late adopters' expectations and increasingly shapes what may be legitimately expected from innovation. In studying Total Quality Management (TQM) adoptions by 2700 U.S. hospitals, Westphal and others (1997) found that early adopters customised their quality practices to the unique problems and opportunities of the organisations for technical efficiency gains, rather than conforming to standard accepted approaches to TQM for increased social legitimacy. Increasing conformity is found among hospitals that are late adopters of TQM. Conformity increases over time as the motivation of an innovation adoption along with the emergence of the normative pattern of innovative practices. Early adopters hold expectations specific to their unique organisational situations, while perceptions of successes from earlier adoptions normalise the late adopters' expectations. The successful innovators that demonstrate minimal expectation-performance gaps create some expectations among the non-adopters.

However, the multitudes of organisation-specific expectations do not reduce the uncertainty, complexity, and ambiguity associated with an early-stage innovation for non-adopters who are caught between a rock and a hard place. On the one hand, they are yet to receive proven potentials specific to their organisations. On the other hand, the early-stage institutional field offers minimal social legitimacy from innovators. Thus, adoptions are determined not only by the perception of success by innovators and earlier adopters but expectations on both emotional and logical accounts. The propositions argued in this paper may shed light on the turning from non-adopters to adopters in an early-stage innovation.

Additionally, we report in this paper our preliminary attempt at empirical exploration to support the propositions. We conducted semi-structured interviews with experts knowledgeable about the recent history of impact investing, a new concept and practice to channel financial capital to solving pressing global problems such as environmental degradation or extreme poverty. Using the critical incident, template, and thematic analysis techniques (Miles et al., 2014; Waring

and Wainwright 2008; King 2004; Flanagan 1954), we coded the interview record for occurrences of key communicative events (critical incidents) in impact investing from 2005 to 2018 on how they might appeal the public emotionally or logically. The results indicated changing expectation types over the remembered history of impact investing, with high positive emotional expectation peaking around 2009 and subsiding afterwards and logical expectation steadily increasing over the period. Thus, our preliminary experiment shows the varying pace of emergence of emotional and logical expectations of an innovation and the feasibility of studying expectations throughout the evolution.

There are many communicative artefacts across various media about almost every new idea, product, technology, or innovation in general. Advancing technologies in data storage, processing, and analysis promise to help us make better sense of these artefacts with scale and speed. As a result, our positive emotional expectation about predicting the evolution of an innovation by observing changing expectation dynamics may be much less fantastical than in 1995, when the hype cycle model was first introduced.

5. Conclusion

This paper focuses on expectation dynamics in early-stage innovations to explain the hype cycle phenomena that precede innovation adoptions. We present a typology of innovation expectations, articulate the role of emotional expectations in relation to their logical counterparts in early-stage innovations, and argue why there is a higher level of social acceptance of positive emotional expectations when scant logical expectations are present. With that foundation, this paper develops a conceptual framework to explain mechanisms contributing to hype cycles and the emergence of first adopters of innovation.

Although the hype cycle is utilised extensively in management practice, we identify insufficiencies in the current innovation management literature that addresses the hype phenomena. This situation serves as an opportunity for us to explore the relevant aspects of several other fields of academic inquiry, including rhetoric and semiotic theories, neuroscience and psychology theories on reinforced learning and decision making, and institutionalisation as unfolding rationality. Our conceptual framework highlights the role of expectation in innovation evolution, particularly the evolving role of emotional expectation in shaping a hype cycle and early-stage innovation adoption, an area often overlooked in innovation diffusion and non-existent in typical S-curve models. Expectation can be considered to form a triangle along with perception and adoption. Together they help develop a better understanding of the dynamics of innovation evolution from innovation trigger to the plateau of productivity. Without expectation, the innovation diffusion narratives miss the early history and depict it as collections of predominantly winning ideas, products, technologies, or industries.

The neglected history, through which emotional expectations initially play a dominant role and gradually yield to rising logical expectations, which trigger initial adoptions, needs further research for theory development and improvement of practice in innovation management. In fact, the adoption of the S-curve and the hype cycle of expectation are different. S-curve deals with socialised action, and the hype cycle reflects socialised learning. The persistent disparity between the two in academic research needs to be bridged. Moreover, where the effect of expectation ends and that of perception begins is often unclear. For example, Zbaracki (1998) demonstrates that the rhetoric of success about TQM, a management innovation, is consumed by managers who not only develop their own TQM program but furthermore filter their experiences and generate an overly optimistic expectation of the very program they develop. In other words, expectation, perception, and the reality of adoption mesh and reinforce each other.

The contributions of this paper are threefold. The first is the definition of innovation expectations as prior social beliefs and a parsimonious

two-by-two typology (positive/negative and emotional/logical) to categorise them. The second contribution is establishing the importance of positive emotional expectations in shaping early-stage innovations. Finally, the third contribution is proposing an approach to studying innovation evolution by examining the changing expectations. In other words, our conceptual framework lays out empirically testable propositions that associate the rise and fall of emotional and logical expectations with not only the shape of the hype cycles but also the onset of innovation adoptions.

5.1. Limitations and future research

While we hope our conceptual framework could shed light on the disparities among the numerous hype cycles that have been documented, we recognise the monumental undertaking of any such empirical studies required to account for numerous factors. For example, Van Lente et al. (2013) discover dramatically different hype curves across Internet telephony, gene therapy, and high-temperature superconductivity, using the number of articles in the New York Times as the hype measure. The gene therapy hype took twenty years to peak, while the second peak surpassed the first one by more than 20%. Similarly, Carson et al. (2000)) found significant differences in the hype curves among management fashions such as program evaluation and review techniques, quality circles, and reengineering. The specific history of each of the fashions matters. So does the history of interactions and successions of these management fashions. It shows the complexity of the social expectation clusters in the field of management.

Similarly, we are interested in furthering the understanding of the temporal dynamics of innovation institutionalisation from a power perspective. Green (2004) describes the transition from reason to persuasion in the legitimisation of value in a management idea that is being disseminated. The dissemination evolves with convergence and selection from heterogenous rhetorical justifications, creating a bandwagon effect that later adopters are compelled to join (Van Lente et al., 2013). This process does not always have a slow or smooth start; Lawrence et al. (2001) argue that the pace and stability of institutionalisation depend on the mechanism used by agents to support the institutionalisation processes. They identify four mechanisms: influence, force, discipline, and domination, resulting in not all of the mechanism-dependent adoption curves following the typical S-curve (2001: 634). Instead, some adoption curves resemble a typical hype curve. This anomaly may serve to further our empirical understanding of the relationship between expectation, perception, and adoption, particularly in terms of the effect of elites (e.g. celebrities, top management, influential consultants) and the nature of their rhetoric on the hype cycles and diffusion of innovation. As examples, Mary Meeker, a Silicon Valley venture capitalist and former Wall Street securities analyst, her Internet Report were the "prophet and bible" for the dot com boom (Green 1999), and Elon Musk, who revived the concept of all-electric vehicles and made them economically viable, has carried his outsized influence across to the field of cryptocurrencies. Another area of related enquiry is the changing role of expectation through the course of an innovation evolution and the changing requirements for actors executing the innovation. For example, the evolution of the complex network of expectation, perception and adoption may require changing rhetoric and actions that fewer start-up founders could manage well, which may explain the phenomenon that few high-tech start-up founders remained CEOs after their companies had gone public.

While studying changing expectations may shed light on the micro-dynamics in innovation decision-making and the social expectations as macro-order, we see value in the complementary analysis at a meso level of legitimacy assemblage in which institutional actors, materials and methods collectively set boundaries for alternative innovations and advance the epistemic architecture for establishing the value of innovation (Jain and Ahlstrom, 2021). Thus, future work adopting a multi-level analysis of expectations shaped by both socio-cognitive and socio-political processes may yield a more robust understanding of the role of expectations in innovation as unfolding rationality (Quattrone, 2015). In addition, the omnipresence of data that is increasingly captured from multitudes of virtual human networks offers ample information and opportunities to study and understand the evolutionary intricacies of innovations. We hope our expectation-centered hype cycle model offers a little assistance in exploring these opportunities.

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