Diffusion of Innovations

Diffusion of innovation studies aim to understand what stimulates the adoption of a resource, such as an idea or product, and how such a decision can affect a social structure and context.

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Theory Factsheet

Proposed By: Rogers, 1962

Related Theories: Technology organisation environment (TOE) framework

Discipline: Innovation

Unit of Analysis: Innovation, individuals, firms, clusters, social networks, and countries

Level: Macro-level

Type: Theory for Explaining and Predicting

Operationalised: Qualitatively / Quantitatively

Introduction

Rogers (Rogers, 2003) is credited with observing a series of general, common elements across early diffusion research from different disciplines. Accordingly, although Diffusion of Innovations is a communications theory, it drew upon different rational theories of organisational life, such as from economics and sociology (Ardis & Marcolin, 2017). In his 1962 seminal work on "Diffusion of Innovations", Rogers first proposed significant and universal factors that help explain how social change takes place. Rogers's observations and propositions on the diffusion of ideas and products have undergone different iterations and expansions as the Diffusion of Innovations theory has evolved and developed.

Theory

An innovation is any idea, practice, or object that is viewed as new by an individual or another unit of adoption such as a firm. Innovators can be individuals, firms, clusters, social networks, and even countries. (Meyer, 2004; Rogers, 2003) proposed five attributes of innovation. Individuals' perceptions of these attributes determine an innovation's rate of adoption, which shows the relative speed with which an innovation is adopted by individuals of a social system. The five perceived attributes of innovations are:

Relative advantage - refers to whether an innovation is viewed as better than the idea it supersedes. Compatibility - is the degree to which an innovation is viewed as consistent with the current values, previous experiences, and needs of prospective adopters. Complexity - is whether an innovation is perceived as relatively difficult to understand and to use. Trialability - refers to the degree to which an innovation may be experimented with on a restricted basis. Observability - represents the degree to which the outcomes of an innovation are visible to others.

Relative advantage, compatibility, trialability and observability of an innovation are positively related to its rate of adoption (Rogers, 2003). Complexity is the only factor that is negatively related to the rate of adoption.

Beside the perceived attributes of an innovation, other factors can also affect its rate of adoption. They include: the (a) type of innovation-decision, (b) the nature of the communication channels diffusing the innovation at different stages in the innovation-decision process, (c) the nature of the social system; and (d) the change agent, each of which are explained below.

Having an impact on the rate of adoption of innovation, the innovation-decision can be of different types: the first type is optional innovation decisions, which refer to choices to adopt or reject an innovation made by an individual, independent of the decisions of other individuals of the system. The second type is collective innovation-decisions, which are choices to adopt or reject an innovation made by consensus among the individuals of a system. The third type is authority innovation-decisions, which are choices to adopt or reject an innovation made by relatively few people in a system, who have power, status, or technical experience. There is also a fourth type that includes a sequential mixture of two or more of these three types of innovation decisions: Contingent innovation-decisions, which are choices to adopt or reject made only after a previous innovation-decision (Rogers, 2003).

Another factor that can also have an effect on the rate of adoption of innovation is the communication channel. This refers to the way through which messages about the innovation are transmitted from one person to another (Chakrabarti, Feineman & Fuentevilla, 1983). Individuals often assess an innovation not based on scientific research by experts, but through the subjective evaluations of near peers who have adopted the innovation. Such near peers represent a role model, whose innovation behaviour tends to be imitated by other individuals in their system. A distinguishing aspect of diffusion is that at least some degree of heterophily is usually present in communication about innovations. Heterophily represents the extent to which two or more individuals are different in certain characteristics, such as beliefs, education, and social status. The opposite of heterophily is homophily - the extent to which two or more individuals are similar in certain traits. The level of similarity among group members across which an innovation diffuses tends to accelerate the ease and speed with which the diffusion occurs. For instance, innovations spread faster among homophilous groups than among heterophilous groups (Cain, 2002).

One of the factors also impacting the rate of adoption of innovation is the social system. This represents a set of interrelated units that are involved in joint problem solving to attain a common objective. A system has a structure, defined as the patterned arrangements of the units in a system, which provides stability and regularity to individual behaviour in a system. The social and communication structure of a system facilitates or hinders the Diffusion of Innovations in the system. In fact, the communication structure represents the differentiated elements that can be recognised in the patterned communication flows in a system. Such a structure includes the cliques within a system and the network interconnections among them that are provided by ties and links. Accordingly, individuals are identified as belonging to cliques based on the communication proximity, which means the extent to which two linked individuals in a network have personal

communication networks that overlap. A personal network includes those interconnected individuals who are related by patterned communication flows to a specific individual. Personal networks that are radial are more open to an individual's environment, and, thus, play a more important role in the Diffusion of Innovations. The information exchange potential of communication network links is negatively related to their degree of (1) communication proximity and (2) homophily. This generalisation represents Granovetter's theory of "the strength-of-weak-ties". People tend to be linked to others who are close to them in physical distance and who are relatively homophilous in social traits (Rogers, 2003).

Another aspect to highlight in relation to social structure is norms, the established behaviour patterns for the members of a social system. For instance, opinion leaders (individuals who are able to affect other individuals' attitudes or behaviour in a desired manner with relative frequency) conform more closely to a system's norms in comparison to their followers. When a social system's norms favour change, opinion leaders are especially innovative.

Finally, change agents aim to affect the innovation adoption decisions of individuals in the system in a direction considered desirable by the agent. There are 7 functions performed by change agents: creating a need for change on the part of clients; developing an information exchange relationship; diagnosing problems; developing an intent to change in the client; translating intentions into action; stabilising adoption and preventing discontinuance; and attaining a terminal relationship with clients. Change agents operate interventions, as actions with a coherent goal to bring about behaviour change with the purpose of generating identifiable outcomes. Targeting, which is based on customising the design and delivery of a communication program on the basis of the characteristics of an intended audience segment, is one way of segmenting a heterogeneous audience. Through this aforementioned approach, customised messages that fit each individual's situation are delivered. In terms of a change agent's relative success in ensuring the adoption of innovations by clients, it is positively related to factors such as the extent of the change agent's effort in contacting clients, a client orientation, rather than a change agency orientation, the level to which the diffusion program complies with clients' needs, and increasing clients' capability to assess innovations (Rogers, 2003).

DOI represents the process through which an individual moves from first knowledge of an innovation towards forming an attitude to it, to a decision to adopt or reject it, to implementation of the new idea, and to confirmation of this decision. The innovation decision process includes 5 phases (Rogers, 2003): knowledge, when the individual is exposed to the innovation's presence and understands how it works persuasion, when the individual creates a favourable or unfavourable attitude towards the innovation decision, when the individual gets engaged in activities that result in a choice to adopt or reject the innovation implementation, when the individual puts an innovation to use confirmation, when the individual seeks reinforcement for an innovation-decision already made, but may reverse the decision, if exposed to conflicting messages about it.

DOI makes it possible to take a process view of the innovation adoption, moving from pre-adoption, adoption decision, and post-adoption (Damanpour & Schneider, 2006). These stages are usually known as intention (persuasion stage), adoption (decision stage), and routinisation (implementation stage) (Chong & Chan, 2012;Zhu, Kraemer & Xu, 2006). The intention stage develops the baseline for the individual to move towards the effective adoption. In turn, the adoption results in its routinisation (Chan & Chong, 2013). In fact, as the individual becomes more competent and learns from the experience acquired through the intention phase to reap the advantages of the innovation effectively, they enter the adoption stage. Once integration is complete and full-scale deployment of the innovation across the adopter's different activities within the system is assured, the ?nal stage, routinisation, is reached (Martins, Oliveira & Thomas, 2016). Still, it is not always the case that an innovation will be utilised in the long term. In some cases, there may be a discontinuance. This

represents the decision to reject an innovation after having previously adopted it. There are two types of discontinuance: the replacement discontinuance, when an idea is rejected with the purpose of adopting a better idea which superseded it, and the disenchantment discontinuance, when an idea is rejected due to dissatisfaction with its performance.

The adoption of an idea occurs in an S-shaped curve (Cain, 2002; Rogers, 2003). More specifically, the adoption distribution exhibits an S-shaped curve over time and approaches normality. In fact, an innovation is firstly adopted by a few individuals or firms. As more use it, others observe its use, and if the innovation is better than what went previously, others start to adopt and use it. When the diffusion reaches a level of critical mass, it proceeds fast. The critical mass takes place at the point at which enough individuals in a system have adopted an innovation so that the innovation's further rate of adoption becomes self-sustaining (Cain, 2002; Rogers, 2003). Accordingly, it is based on such adoption behaviours that the S-curve and bell-shape curve are developed, and that (2003) grouped the adopters.

In particular, there is a typical shape for a diffusion curve when innovations are developed successfully and stay undisturbed in a social system. At the outset, the adoption rate is low, but it then increases gradually and decreases again towards the end. If it is presented graphically as a curve of percentages, it normally takes the form of an S-curve (Figure 1 below). If the rates of adoption are taken as an absolute number of adopters per unit of time rather than in percentages, the outcome is a bell-shaped or wave curve, similar to a normal distribution (Figure 2 below).

Figure 1: The Diffusion S-curve. / Adopted from Rogers (2003)
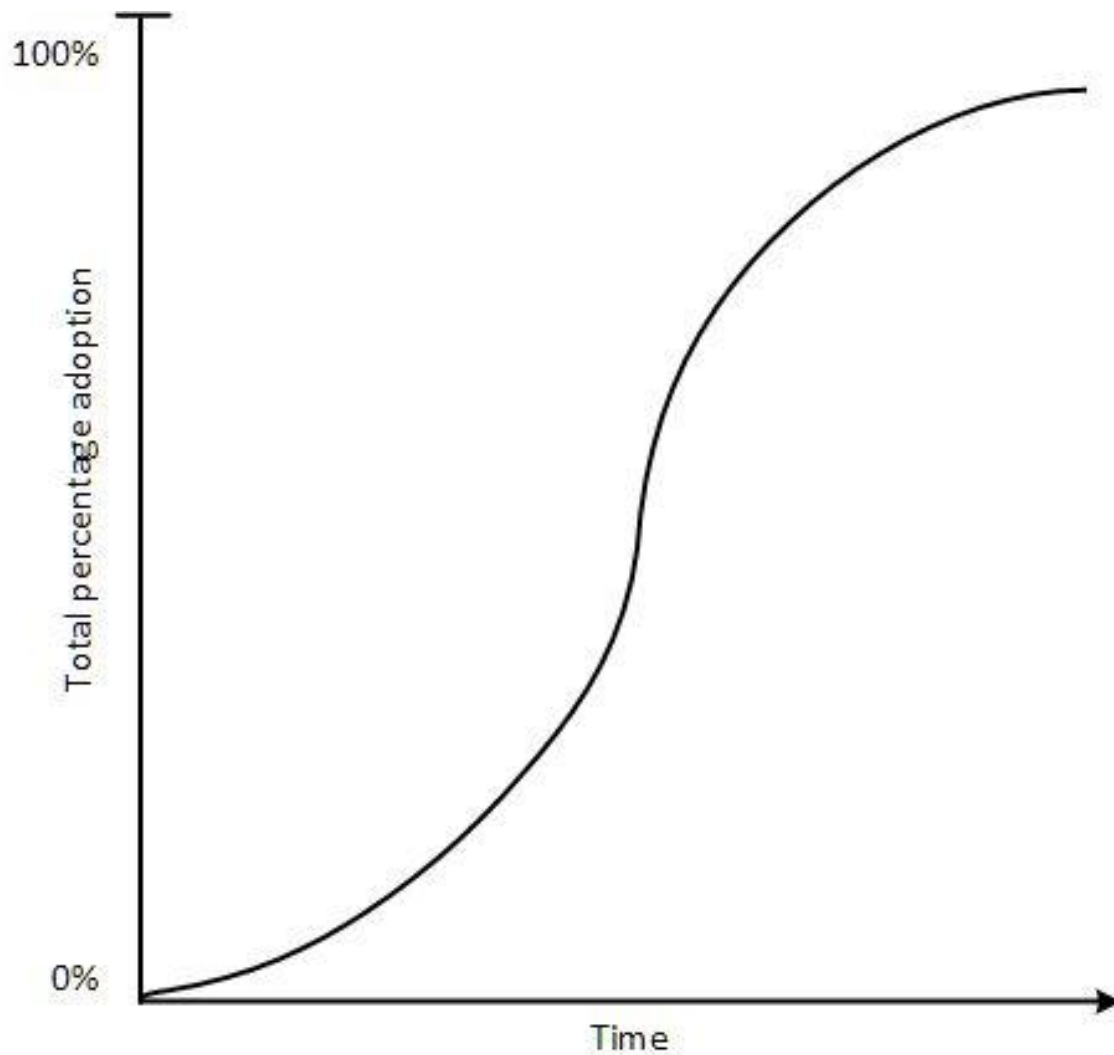
Classified according to the rates of adoption of innovations, the adopter categories represent the classifications of the members of a social system in relation to the level to which an individual or other unit of adoption is relatively earlier in adopting new ideas in comparison to other members of a system. These five adopter categories are the innovators, early adopters, early majority, late majority and laggards. Starting with the innovators, they are among the first 2.5% in the population to adopt the innovation and show an adventurous, cosmopolitan nature. As for the early adopters, they fall into the next 13.5% of adopters and are closely integrated into the social network. They are often opinion leaders. The early majority are the next 34% of adopters, viewed as deliberate followers. The late majority are the next 34%, who are often sceptical of the innovation at first. However, they eventually succumb to peer pressure. The laggards are the final 16%. They tend to be more traditional and isolated in comparison to early adopters. People who are among the last to adopt an innovation often demonstrate the longest decision-making processes before choosing to adopt the innovation. In addition, late adopters are more likely to discontinue innovations than are early adopters. Early knowers of an innovation, when compared to late knowers, are characterised by more formal education, higher social status, higher exposure to mass media channels of communication, higher exposure to interpersonal channels of communication, as well as higher change agent contact, higher social participation, and higher cosmopolitanness. Early adopters are also different from late adopters in terms of personality factors. They have more empathy, less dogmatism, a higher capability to deal with abstractions, higher rationality, higher intelligence, a

more favourable attitude toward change, a higher capacity to deal with uncertainty and risk, a more favourable attitude toward science, less fatalism, higher self-efficacy, higher aspirations for formal education, and higher-status roles. It is worth noting that the distinct characteristics of the five adopter categories indicate that these adopter categories can be helpful in audience segmentation, a strategy in which several communication channels and/or messages are referred to, to reach each sub-audience (Rogers, 2003).

Figure 2: (1) The innovator as trouble maker (2) The critical phase (3) Transition to self-sustaining process (4) Final phase of the wave / Adopted from Rogers (2003)
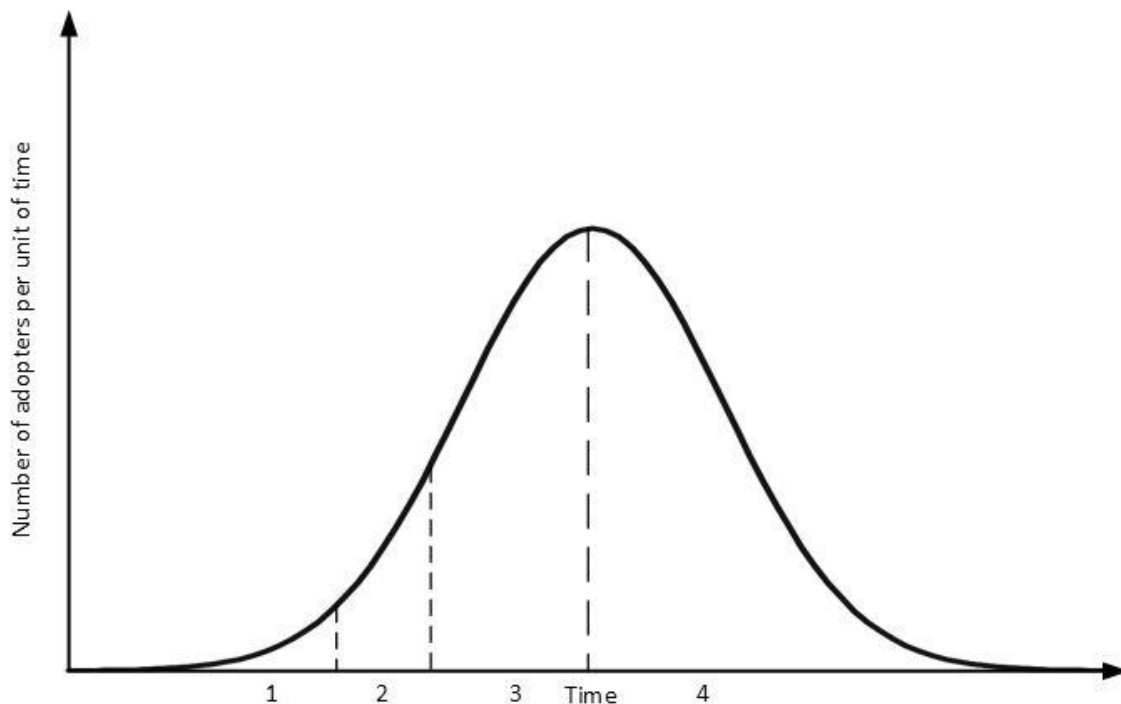
Applications

DOI has been applied empirically across different disciplines over the years, evolving and continuing to be applied to emerging innovations and social issues (Dearing, 2009). The different disciplines where DOI has been applied include, for instance, agriculture, medicine, education, communication, and marketing (Greenhalgh et al., 2005). In the education context, for example, Cervero and Rottet (1984) studied the effectiveness of continuing professional education, while (Raman et al., 2021) studied DOI in the adoption of online software to monitor university students' screens in online exams during COVID-19. In the health care context, researchers investigated the adoption and use of new drugs by doctors (Leslie & Rosenheck, 2002). Also, within the health care context, they studied DOI in intervention development (Dearing, 2009), and in laparoscopic colectomy adoption and diffusion in England (Barrenho et al., 2021).

DOI has also been applied to studies related to energy, such as the adoption of renewable heating systems (Franceschinis et al., 2017). In addition, DOI has been used in information systems studies. For instance, prior research has considered the 5 innovation characteristics in the adoption and diffusion of Internet-based technologies (Koenig-Lewis, Palmer & Moll, 2010; Papies & Clement,

2008). DOI has also been applied to cloud computing adoption studies (Alshamaila, Papagiannidis & Li, 2013; Sayginer & Ercan, 2020; Carreiro & Oliveira, 2019), and to different studies on mobile applications such as mobile banking adoption (Al-Jabri and Sohail, 2012) and transportation (Min, So & Jeong, 2019; Nordhoff et al., 2021).

Limitations

When discussing the limitations in relation to the DOI theory, it is worth discussing first the limitations or shortcomings of the diffusion research itself, based on which some limitations of the theory itself can be understood and explained, as below.

The four major criticisms of diffusion research discussed by Rogers are:

 The pro-innovation bias: the implication of most diffusion research is that an innovation should be diffused to and adopted by all individuals of a social system, that it should be diffused rapidly, and that the innovation should be neither re-invented nor rejected. This indicates that the way innovation is diffused, communicated, and the way people are convinced to adopt it, tends to create some bias. Accordingly, people will miss the chance to express their opinion (advantages/disadvantages) about the innovation. The individual-blame bias: the tendency to hold individuals responsible for their problems of not having sufficient understanding about the innovation, rather than the system of which the individual is a part. The recall problem in diffusion research, which can result in inaccuracies when respondents are asked to remember the time at which they adopted a new idea. However, this particular criticism is more a "research design" concern. The issue of equality in the Diffusion of Innovations, as socio-economic gaps among the members of a social system are often widened due to the spread of new ideas and how they are adopted by different groups.

Ardis and Marcolin (2017) state that researchers have to carefully identify the complex, networked, and learning intensive aspects of technology. They should also understand the role of institutional regimes, putting emphasis on process aspects (involving histories) and the main players in the diffusion area. They have to create multi-layered research designs that factor out mappings between different layers and locales. Also, they have to utilise different viewpoints involving political models, institutional models and theories of team behaviour. They have to use different time scales when crafting accounts of what happened and what the reason behind it is. DOI theory does not provide specific variables to deal with collective adoption behaviours (e.g., the critical role of standards, critical mass, network externalities, sunk costs, path dependence). The Diffusion of Innovations researchers have to be cautious when examining the role of institutional policies and regimes, the effect of the industrial policies and strategies, and the significance of the installed base and learning inertia.

Concepts

Relative Advantage (Independent): The degree to which an innovation is viewed as better than the idea it supersedes. (Rogers, 2003)

Compatibility (Independent): The degree to which an innovation is viewed as consistent with the current values, previous experiences, and needs of prospective adopters. (Rogers, 2003)

Complexity (Independent): The degree to which an innovation is viewed as relatively difficult to understand and to use. (Rogers, 2003)

Trialability (Independent): The degree to which an innovation may be experimented with on a restricted basis. (Rogers, 2003)

Observability (Independent): The degree to which the outcomes of an innovation are visible to others. (Rogers, 2003)

Innovation-decision Type (Independent): The innovation-decision type refers to whether this is an optional, collective, or authority innovation-decision. (Rogers, 2003)

Communication Channels (Independent): A communication channel is the way through which a message gets from a source to a receiver. (Rogers, 2003)

Rate of Adoption of Innovations (Dependent): The relative speed with which an innovation is adopted by individuals of a social system. (Rogers, 2003)

Timing of Adoption (Dependent): The measurement of how early a given subject adopts new ideas relative to other individuals of their social system. (Rogers, 2003)

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