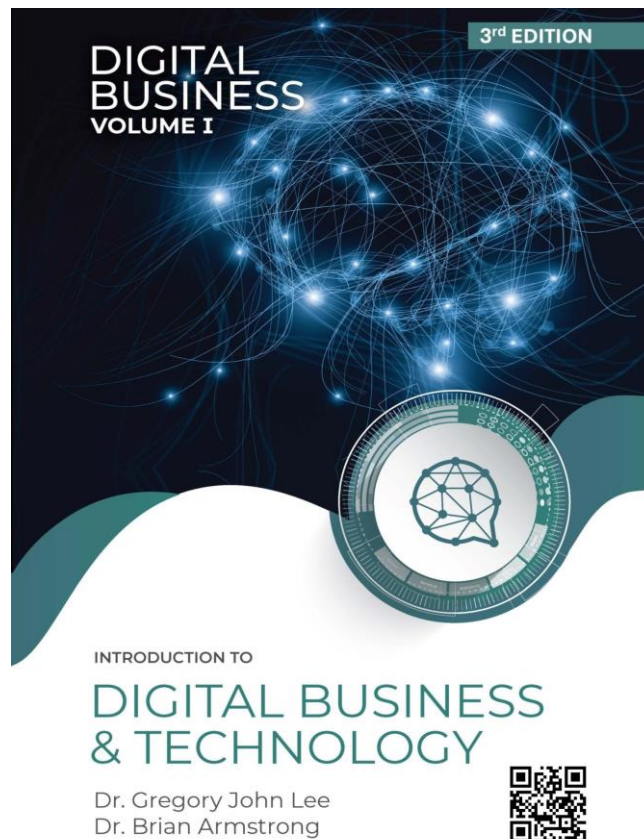


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Technology Adoption Models

From:



TECHNOLOGY ADOPTION MODELS

One of the most popular areas of study in the world of technology is adoption models. Adoption models are theories proposing why and how people, groups, or organizations adopt certain technologies.

The most practical outcome of adoption theories is that they can guide managers and others on *why* and *when* people or groups adopt innovations. This helps innovators, managers, and professionals to maximize the chances of a technological initiative (e.g., a new product or internal organizational system) being adopted and, therefore, disrupting the status quo. For this reason, this section focuses on the mechanisms that affect adoption. Many of these theories also describe *how* innovations get adopted, which is relevant to other questions but is not the focus here.

This section discusses a variety of adoption topics, with a focus on comparing and contrasting technology adoption theories. However, before we do this, we define adoption and discuss some important differentiators of the various theories which help to explain why the field has not developed one single, combined theory.

What do we Mean by ‘Adoption’?

The adoption of an innovation can have different elements in a natural decision process, including:

1. The initial *proposal* to use it.
2. The *decision* to adopt it, ranging from funding approvals to setting up elements of the organizational architecture for the innovation (e.g., teams to administer it) to decisions about specific technological and other choices (e.g., choices of specific software or hardware, vendor choices, etc.).
3. Initial *introduction* of the innovation, including initial trials of the innovation by the individual or organization.
4. The actual regular and continued *use* of it by an individual or widespread use by many individuals, teams, or units in the case of an organization.

Most definitions veer towards adoption, implying actual use in a meaningful, long-term manner rather than stopping at the earlier steps (e.g., Damanpour, 1991; Damanpour & Wischnevsky, 2006; Hameed et al., 2012). For instance, giving a definition that is specific to organizational adoption (see next), Hameed et al. (2012, p. 359) define adoption as:

*The adoption of innovation is a process that results in the introduction **and use** of a product, process, or practice that is new to the adopting organization.*

Features of Different Adoption Models

Before proceeding with this discussion, it is important to discuss a few important differentiators of various technology adoption models:

A. Unit of Analysis

Different technology adoption models were originally written for specific units of analysis (Damanpour & Schneider, 2009; King, 1990; Slappendel, 1996):

- **Individuals:** Some were written for individuals: it is likely that individual-level considerations may exist at this level, such as certain psychological factors.
- **Organizations:** In contrast, some models were developed for organizations; at this level, more strategic, economic, and other factors may predominate.
- **Groups:** In smaller groups, such as teams, we may also see sociological factors in play.
- **Countries:** Some work has been done on technological adoption by nations.

Therefore, different theories written for different units of analysis can logically differ. However, we can also see overlapping elements, especially since organizational or group technology adoption deliberations and decisions are also, ultimately, made by individuals.

B. Focus on Different Technology Types

Different technology adoption models may apply to different technology types:

- Most technology adoption models have been written for the adoption of *information technology* or *information systems* technologies.
- However, these models may have less applicability when studying the adoption of other types of technology, such as industrial robots in factories, for example – this is a very different focus area and technology type.

Therefore, understanding the limitations of different models with regards to the appropriate technology areas is important.

C. Focus on Different Adoption Drivers

Different adoption models have also focused on different focal areas in the antecedents, or drivers, of adoption:

- The **innovation features focus** assumes that the nature of the innovation with regard to key features is a key driver of adoption (e.g., Rogers, 1995).
- The **individualist focus** assumes that adoption decisions predominantly lay with individuals and, therefore, that individual-level variables should be studied (Slappendel, 1996).
- The **structuralist focus** assumes that adoption and change is predominantly decided by organizational variables and, therefore, focuses on these.
- The **interactive process focus** essentially “regards innovation as either caused by individuals or structural factors through an analysis of their interconnection and would better explain organizational innovation adoption in different contexts” (Slappendel, 1996).

D. Overlapping Elements

The field of technology adoption models has arisen in an iterative fashion, with subsequent models building on earlier and other ones. As a result, there are various overlapping areas.

The following sections discuss a variety of the most-used and cited technology and innovation adoption models.

The Most Cited Technology Adoption Models

The following section gives a variety of the most-cited technology adoption models.

A. The Diffusion of Innovations Model (DOI)

First developed by Rogers in 1962 and subsequently developed (e.g., Rogers, 1995), the Diffusion of Innovations (DOI) model essentially proposes three things:

- Innovations tend to follow a predictable adoption and diffusion pattern.
- This pattern leads to different groups of individuals who are engaging with the diffusions at various stages in the overall diffusion pattern.
- The diffusion of the innovation is dependent on certain drivers.

The following sections unpack the innovation pattern as well as some of these drivers. It is worth noting that the DOI was initially developed to describe individual adoption and diffusion of innovations among individuals, but has subsequently been applied to organizations.

i. The DOI Diffusion Pattern

Rogers (1962, 1995) developed a proposed pattern for the diffusion of innovations in society that is shown in Figure 1. We focus here on the proposed drivers of adoption in the model.

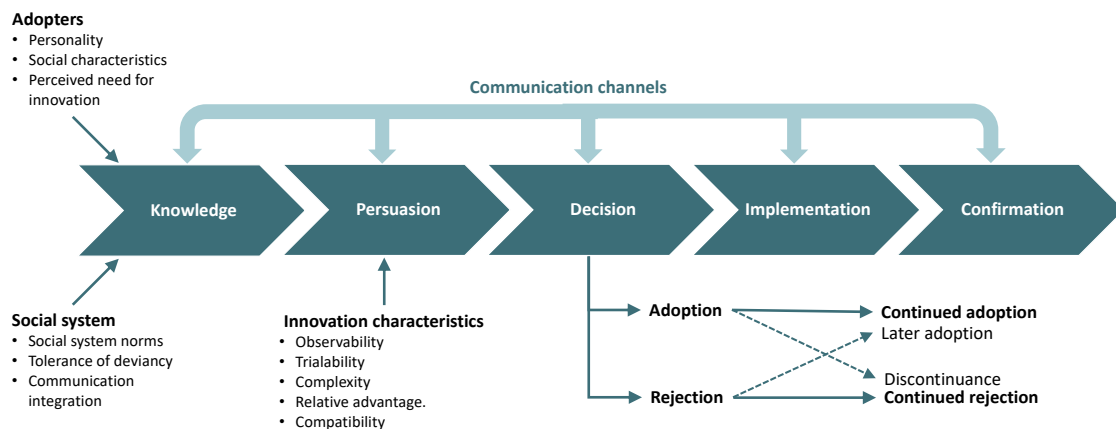


Figure 1: *Roger's diffusion of innovations pattern*

Source: Rogers (1995)

As seen in in Figure 1, the proposed pattern of diffusion of innovation progresses has five main stages:

- **Knowledge.** The process starts with *knowledge* of the innovation, which can be impacted by characteristics of the adopter and by social systems, as discussed below.
- **Persuasion.** The second stage is *persuasion*, in other words, a stage in which decision makers tally up arguments for or against the innovation adoption, which are based on the accumulation of knowledge, and may be based on the arguments of internal actors (e.g., managers) or external agents (e.g., vendors, consultants). In the DOI, persuasion is shaped especially by characteristics of the innovation itself, which we discuss further below.
- **Decision.** Persuasion is followed by the decision stage, which may lead to adoption or rejection. As seen in Figure 1, the process allows for reconsideration of these decisions (e.g., later adoption after rejection or later discontinuance after initial adoption), but the DOI does not explain what may guide these decision paths.
- **Implementation.** If the innovation is adopted, the fourth stage is implementation of that decision.
- **Confirmation.** Complete confirmation of the adoption occurs when the technology is settled into regular use.

As seen in Figure 1, communication channels affect each stage.

ii. Adoption Groups

According to Rogers (1962), innovation adoption occurs in six sequential categories of users who adopt or engage with the innovation at different stages of its overall adoption pattern. These groups are:

- **Innovators**, who develop the actual innovation. Innovators would be a tiny proportion of the overall adopters.
- **Early adopters**, who assimilate the innovation in its early and, sometimes, premature phase. A danger of being an early adopter is that investments may be so premature that subsequent innovation and market changes may render the initial adoption problematic (e.g., if it involves fixed investments that become outstripped by changes in standards). However, early adopters sometimes gain significantly by being well ahead of the market with key new technologies.
- **Early majority**: At this stage, an initial large bulk of users adopt. The technology is typically still evolving, and may be more pricey. However, the earlier adoption may have competitive advantages.
- **Late majority**: A second bulk of users adopt into more settled technology, but may have lost competitive advantage to the prior groups.
- **Laggards** adopt after the vast majority have done so. One advantage is that they tend to adopt into significant demonetization and technological maturity. However, if the innovation is core to their competitiveness, they will have fallen behind the vast majority.
- **Leapfroggers**: This interesting group essentially misses the first generation of the technology and are early adopters of the next phase, thereby being among the first to the new technology iteration. They may have lost an entire cycle of competitiveness or

other advantages due to missing the prior phases, but gain by being early to the next phase and being able to learn from the earlier cycle. An example of leapfrogging can be found in the diffusion of telecommunications networks around the world. The most developed countries deployed 1G and 2G networks for initial cellular communications, and had to replace these with 3G in a phased and slower pattern (which was important as 3G was the first network built for mobile data). Some developing countries leapfrogged their developed peers and built 3G faster because they were developing networks from scratch in areas of their country, and 3G was the latest available standard. Leapfrogging may be a strategy for innovation adopters facing a late-stage innovation cycle where they can see a future iteration coming.

iii. Determinants of Adoption in the DOI Model

Figure 1 proposes that the diffusion of innovations, especially at the knowledge and persuasion stages, is dependent on various antecedents. This is an important point, because so far nothing of the DOI process described would assist managers or innovators to practically improve the diffusion of their innovations, whereas these antecedent may help to guide design or marketing of innovation. The following sets of antecedents were included:

- **Characteristics of the adopters:** Rogers (1995) suggests three individual characteristics that may affect the knowledge stage, namely personality of individuals, social characteristics, and perceived need for innovation (individuals with greater needs may search more intently for solutions).
- **Social systems:** Rogers (1995) also suggests three social system characteristics that may affect the knowledge stage, namely social system norms, tolerance of deviancy, and communication integration.
- **Characteristics of the innovation:** Rogers (1995) suggests five innovation characteristics that may affect persuasion, and these are amenable to improvement. Since these are more completely under the control of the organization, we give more detail. These five innovation characteristics are:
 - *Observability.* Innovations for which the results can be more easily observed are more likely to persuade adopters.
 - *Trialability.* Innovations which are easier to try out – for instance, for which there are realistic prototypes – are more likely to persuade adopters.
 - *Complexity.* Innovations that are more complex are less likely to be understood and, therefore, less likely to persuade adopters.
 - *Relative advantage.* The competencies of the technology relative to alternatives.
 - *Compatibility.* Innovations which are compatible with the existing state of potential adopters – for instance, with their existing processes or their culture – are more likely to persuade adopters.

The elements of the DOI have had profound influences on adoption studies. The following sections discuss various theories which have been built on other areas or approaches.

B. The Technology Adoption Model (TAM)

The Technology Adoption Model (TAM) began with an initial model developed by Davis (1989) as seen in Figure 2 below. The TAM was initially developed to examine individual adoption of computers, but has been extensively used in subsequent wide-ranging technology adoption research. In fact, Rad et al. (2018) found that it had been used in 160 of the 330 adoption studies that they surveyed (so, almost 50%), making it the most popular.

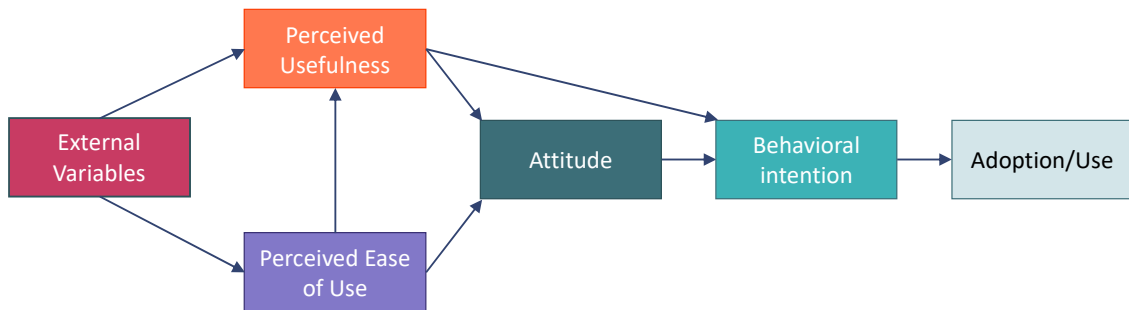


Figure 2: *The first Technology Adoption Model (TAM1)*

Source: Davis (1989)

As can be seen in Figure 2, the core determinants of user adoption of technology are behavioral intentions to adopt, which is preceded by a positive attitude towards the technology. However, it is the antecedents before this which really matter. Davis (1989) positioned two core elements of the innovation as being the main determinants of the subsequent adoption steps:

- **Perceived usefulness:** How functional and useful does the user consider the technology in the light of their needs? This dimension speaks to the capabilities of the technology.
- **Perceived ease of use:** How easy/convenient does the user find it to engage with the technology?

As will be seen below, these core drivers permeate other influential models.

TAM is useful because these innovation characteristics (usefulness and ease), like those in the DOI, can be worked on by organizations to increase the rate and likelihood of adoption. Of course, exactly what is meant by usefulness or ease is probably very specific to the product and the context.

We also see in Figure 2 that Davis (1989) proposed that perceived ease of use could enhance perceived usefulness, which makes intuitive sense. Secondly, he proposed that perceived usefulness could directly affect behavioral intention, such as when users make impulse adoption decisions based on attractive proofs of concept.

Davis (1989) also proposed external variables which may affect perceived usefulness or ease. These are, for instance, system characteristics, training, user involvement in design, and the nature of the implementation process (Venkatesh & Davis, 1996).

There were two major extensions to TAM. In TAM2, Venkatesh and Davis (2000) extended it by adding image, subjective norms, output quality, result demonstrability, and job relevance in addition to two moderators, voluntariness and experience. Bagozzi (2007) added further detail in what is sometimes termed TAM3, which integrates some of the external variable and includes emotional antecedents.

TAM was important more because it introduced what are probably the two main predictors of ultimate adoption, namely, perceived usefulness and ease of use. It is also useful because the model can be used for both individual- and group- or organization-level technology adoption. TAM1 is almost certainly too simplistic, and later elaborations were rather patchwork in what they added. However, importantly, TAM led to UTAUT as discussed below.

C. The Unified Theory of Acceptance and Use of Technology (UTAUT2)

TAM is a particularly simplistic model of adoption and can easily be critiqued for omissions. An alternative set of models began to emerge after the TAM era, named the Unified Theory of Acceptance and Use of Technology (UTAUT) which built on the basic TAM foundations but added more systematic elements.

Venkatesh et al. (2003) developed the initial model, now called UTAUT1. However, this was superseded by the development of the expanded UTAUT2 (Venkatesh et al., 2012). As seen in Figure 3, the drivers of behavioral intention to adopt and use the technology are:

- **Performance expectancy:** Similar to perception of usefulness in TAM, this measures the extent to which the individual expects the technology to perform well in its intended tasks and, therefore, assist the individual to perform.
- **Effort expectancy:** Similar to perception of ease of use in TAM, this variable measures the ease of using the system.
- **Social influence:** Venkatesh et al. (2012) define social influence as “[t]he degree to which an individual perceives that important others believe he or she should use the new system.”
- **Price value:** Obviously, this describes the relative price of the technology relative to its value. See the discussion on Perceived Value Model below for more on this.
- **Hedonic motivation** refers to the extent to which the user enjoys using the technology.
- **Facilitating conditions:** Are there external factors that facilitate or inhibit adoption of the technology?
- **Habit:** Has using this technology already become a habit?

UTAUT2 suggests that all of the drivers affect behavioral intention, which in turn affects use and adoption behaviors. In addition, the model suggests that facilitating conditions and habit can directly influence use and adoption behaviors. Facilitating conditions can bypass intention since they define non-cognitive limitations on adoption. Habit can lead to subconscious scripting of behavior that tends to bypass the types of cognition involved in behavioral intention.

Finally, as seen in Figure 3, Venkatesh et al. (2012) included various demographic moderators of these paths, namely age, gender, and experience (the figure shows where they propose moderation). In other words, they proposed ways in which these three variables could strengthen or weaken the main proposed relationship. See Venkatesh et al. (2012) for details on how they propose these moderations operate.

It is important to note that Venkatesh et al. (2012) very much designed UTAUT2 for individual consumer adoption and use of technology. Many of the variables such as hedonic motivation and habit do not lend themselves to organizational technology adoption decisions.

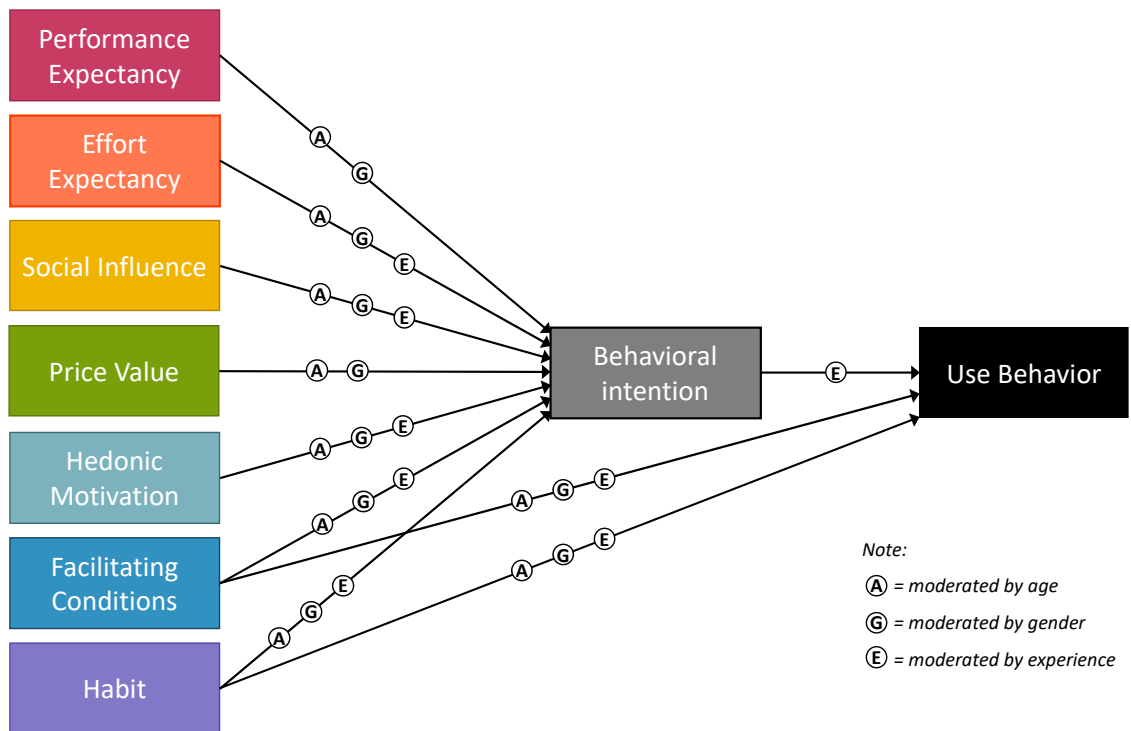


Figure 3: The UTAUT2 model
 Source: Adapted from Venkatesh et al. (2012)

D. The Technology-Organization-Environment Model (TOE)

Tornatzky and Fleischer (1990) developed the Technology-Organization-Environment framework (TOE) to help describe organizational developments and adoptions of innovations. As seen in Figure 4, TOE considers three characteristics of an enterprise affecting the adoption of innovation, including the environment, organization, and context of technology.

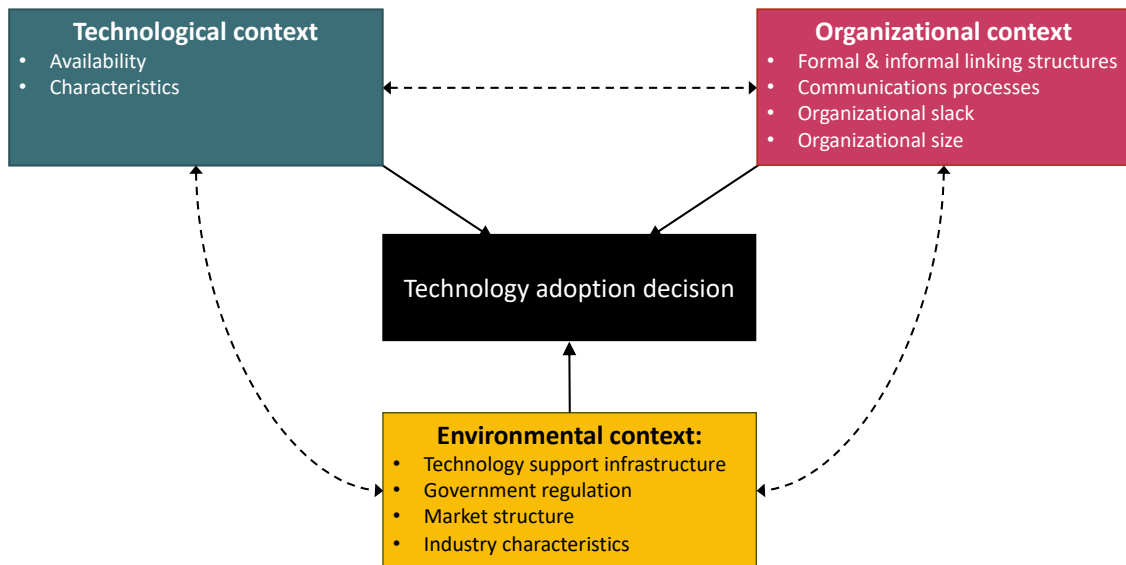


Figure 4: *The Technology-Organization-Environment model of technology adoption*

The environmental dimension includes competitors, market elements, and the regulatory environment. The organizational context includes the process of communication among employees, resources (slack and human resources), and descriptive characteristics of the firm (including firm size, the degree of centralization, organizational structure, managerial structure). The technological dimension repeats some of the salient aspects of the innovation, such as the characteristics and availability of the innovation.

E. Some Other Explanatory Adoption Models

There exist many other theories which have been used to explain adoption of innovations, such as new information systems or technologies. The following are condensed explanations of some of these (based on the survey of the field by Rad et al., 2018 and following their progression with some omissions).

i. *The Theory of Planned Behavior (TPB)*

The Theory of Planned Behavior (Fishbein & Ajzen 1975 and Ajzen, 1991) suggests that the intention to act – in this case, to adopt technology – is controlled by the adopter’s *attitude* toward doing the action, the perception of the person that they can *control* the behavior more or less easily, and *subjective norms* regarding the action. Intention is correlated positively to actual choice and action, in this case, actual adoption and use. Rad et al. (2018) estimated that TPB was used in about 9.4% of adoption studies.

ii. *Theory of Reasoned Action (TRA)*

Also arising from the work of Ajzen and Fishbein (e.g., Ajzen & Fishbein, 1980), Rad et al. (2018, p. 366) note that:

TRA originated from social psychology and is widely applied in different contexts. It assumes that people are relatively rational beings who systematically use the information that is available for them. This theory claims that an individual’s belief

about consequences of a particular behavior, in addition to evaluation of outcome of that act, defines his or her attitude.

TRA has been used as a basis for adoption theories such as TAM (Davis, 1989). Rad et al. (2018) estimated that TRA was used in about 5.8% of adoption studies.

iii. The IS Success Model (ISS)

DeLone and McLean (1992) suggested the ISS model, which was updated in 2003. Rad et al. (2018) found 12 adoption studies deploying it.

The ISS uses measures of multi-dimensional and inter-dependent factors to gauge information systems success. Dimensions measured include a) the effectiveness or impact of the information on the receiver (system quality), b) the 'semantic dimension', which assesses the information's success in producing the intended meaning (i.e., information quality), c) use, and d) user satisfaction.

iv. Task Technology Fit (TTF)

Also featuring in 12 studies, the TTF model is proposed by Goodhue and colleagues (Goodhue, 1995; Goodhue & Thompson, 1995; also see Zigurs & Buckland, 1998).

TTF theory proposes that technology (IT in the original conceptions) is more likely to be adopted and positively affect individual performance if the capabilities of the technology align with the tasks and processes that the user needs to perform.

Goodhue and Thompson (1995) proposed 8 technology factors that will affect task fit, namely, quality, locatability, authorization, compatibility, ease of use/training, production timeliness, systems reliability, and relationship with users.

Zigurs and Buckland (1998) subsequently extended this theory from the original focus on individuals to a focus on groups. Various other modifications to the TTF have been developed since then.

v. Expectation Confirmation Theory (ECT)

ECT was developed by Oliver (1977 & 1980) as a general cognitive theory which seeks to explain satisfaction after adoption or purchase. Antecedents of satisfaction were a) perceived performance, b) expectations, and c) disconfirmation of beliefs. Rad et al. (2018) found the theory to have been used in 8 information systems adoption studies.

vi. Uses and Gratifications (U&G) Theory

As noted by Rad et al. (2018, p. 366):

U&G is a theoretical framework to study how mass communications media, including newspapers, radio, and television, and now social media, are utilized to fulfill the needs of individual users with different goals. The main purpose of U&G is to explain the reasons why individuals choose a specific medium over alternative communication media in order to gain an understanding of social and psychological needs, and to explicate users' motives when engaging with computer-mediated communications (CMC) media including social media.

vii. Social Cognitive Theory (SCT)

Social Cognitive Theory (SCT) was developed by Bandura (e.g., Bandura, 1977). The theory describes how individuals learn through social means such as observation, modeling, or vicarious experience. It has been applied to adoption of technology (e.g., Compeau et al., 1999; Rad et al., 2018 detail three more applications to technology adoption).

The SCT explains actions such as adoption using dimensions such as:

- Affect (whether the individual likes the technology).
- Expectation of performance outcomes (e.g., whether the individual believes the technology will perform in its use).
- Self-efficacy (the user's own ability to use the technology).
- Anxiety toward the technology or its effects.
- Expectations of one's personal outcomes (individual esteem and accomplishment).

viii. Trust Models

Trust has formed an increasing focus in adoption models, often in conjunction with risk.

ix. Perceived Value Model

This model strives to understand individual decisions such as adoption or purchasing as a function of the trade-off between price and quality (e.g., value for money). Users may perceive different value based on factors such as usefulness, convenience, quality, and volume, and consider this against factors such as cost, effort, and time to adopt.

x. Inter-Organizational Relationship (IOR) Theory

Clark (1965) proposed IOR theory in order to explain relationships between two or more organizations as a separate and influential level of analysis. In terms of technology adoption, interactions between organizations may lead to adoption, for instance, where one organization is able to observe the implementation and outcomes of technology in another organization.

xi. Other Adoption Theories

Rad et al. (2018) also identify the following list because each was only used once in their survey of 330 adoption papers; however, this does not mean that these should be discarded as they may be relevant or underutilized: a) theory of consumption values, b) cultural theories, c) the theory of organizational information services (TOIS), d) mental accounting theory, e) the model of innovation resistance (MIR), f) the decomposed TPB, g) social support theory, h) the branding-association-trust model (BATM), i) the technology readiness index (TRI), j) decisional control on state anxiety theory, k) psychological reactance theory, l) social exchange theory (SET), m) Triandis's theory of organizational culture, n) the resource-based view (RBV), o) self-efficacy theory, p) perceived risk theory (PRT), q) the model of adoption of technology in households (MATH), r) self-concept-based motivation theory, s) protection motivation theory (PMT), t) rough set theory (RST), u) expectancy-value theory, v) benefit-cost framework, w) transaction cost economics (TCE), x) institutional framework theories, y) status quo bias theory, and z) the decomposed theory of reasoned action.

There are many other theories which have or can be applied to technology adoption. For instance, Rad et al. (2018) find more than one article using several general psychology theories, such as the big five personality factors, flow theory, and social identity theory to explain technology adoption. They also find several articles using social capital theory, which is not detailed here.

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