Volume: 4 Issue: 2 Year: 2024 Research Article e-ISSN: 2578-8965

Evaluating Firm-Level Technology Adaptation: An Integrated Geometric Mean Model Based on the TOE Framework (M-BOOST)

Turan PAKSOY[1] Büşra YİĞİTOL[1*] Mustafa Atilla ARICIOĞLU[1] Sercan DEMİR[2]

[1] Necmettin Erbakan University, Konya, Türkiye
[2] Harran University, Şanlıurfa, Türkiye

Article Info

Received: 01.11.2024
Accepted: 19.12.2024
Published: 31.12.2024

Keywords:
Technology adoption,
TOE framework,
Firm-level adaption.

ABSTRACT

The speed and convenience brought by technology are critical for businesses and cannot be overlooked. Companies striving to maintain competitiveness are increasingly integrating technology to boost efficiency, enhance product quality, and reduce operational costs. The ability to leverage the advantages of technology is directly proportional to its adoption. Keeping up with technological advancements has become essential for all businesses, regardless of the sector, to remain competitive in the global market. Companies that quickly adopt new technologies gain a competitive edge over their rivals and solidify their market position. However, the rapid pace of technological change also demands a faster adaptation process. This study proposes a new model based on a revised Technology-Organization-Environment (TOE) framework to quantitatively measure technology adaptation performance at the firm level and present adaptation as a numerical output. The M-BOOST model consists of six dimensions—Disruption, Organization, Stakeholder, Behavior, Technology, and Management—each with its own parameters. Each dimension score is calculated as the arithmetic mean of its parameters, while the overall M-BOOST Technology Adaptation Score is determined by the geometric mean of the six dimension scores. The model allows for individual evaluation of each dimension. In addition to separate assessments, an overall adaptation score was calculated based on the proposed formulation, and a value was presented for the case study. Companies with an M-BOOST score below 1 are considered to have technology adaptation issues, those scoring between 1-3 are open to improvement, and those above 3 are deemed successful. Results from the case study application are presented in the conclusion, along with insights on the model's usability and recommendations for future research.

Firma Düzeyinde Teknoloji Adaptasyonunun Değerlendirilmesi: TOE Çerçevesine Dayalı Entegre Bir Geometrik Ortalama Modeli (M-BOOST)

Makale Bilgisi

Geliş Tarihi: 01.11.2024
Kabul Tarihi: 19.12.2024
Yayın Tarihi:31.12.2024

Anahtar Kelimeler:
Teknoloji adaptasyonu,
TOE çerçevesi,
Firma düzeyinde adaptasyon.

ÖZET

Teknolojinin getirdiği hız ve kolaylıklar, işletmeler için kritik öneme sahiptir ve göz ardı edilemez. Rekabet gücünü korumaya çalışan şirketler, verimliliği artırmak, ürün kalitesini geliştirmek ve operasyonel maliyetleri azaltmak için giderek daha fazla teknolojiye entegre olmaktadır. Teknolojinin sağladığı avantajlardan yararlanma yeteneği, doğrudan teknoloji benimsenmesi ile orantılıdır. Teknolojik gelişmeleri yakından takip etmek, sektör fark etmeksizin tüm işletmeler için küresel pazarda rekabetçi kalmanın anahtarı haline gelmiştir. Yeni teknolojileri hızla benimseyen şirketler, rakiplerine göre daha avantajlı bir konum elde etmekte ve piyasa pozisyonlarını sağlamlaştırmaktadır. Ancak, teknolojideki hızlı değişim, adaptasyon sürecinin de daha hızlı yürütülmesini gerektirmektedir. Bu çalışma, firma düzeyinde teknoloji adaptasyon performansını nicel olarak ölçmek ve uyum çerçevesini şirket bazında sayısal bir çıktı olarak sunmak üzere revize edilmiş bir Teknoloji-Organizasyon-Çevre (TOE) çerçevesine dayalı yeni bir model önermektedir. M-BOOST modeli, Alt Üst Etme, Organizasyon, Paydaş, Davranış, Teknoloji ve Yönetim olmak üzere altı boyuttan oluşmaktadır ve her boyut kendi parametrelerine sahiptir. Her bir boyutun skoru, bu parametrelerin aritmetik ortalaması olarak hesaplanırken, genel M-BOOST Teknoloji Adaptasyon Skoru, altı boyut skorunun geometrik ortalaması ile belirlenir. Model, tüm boyutların ayrı ayrı değerlendirilmesine olanak tanımaktadır. Ayrı değerlendirmeler yapılmasının yanı sıra, önerilen formülasyona göre genel bir uyum skoru belirlemek için bir hesaplama yapılmış ve örnek olay çalışması için bir değer ortaya konmuştur. M-BOOST skoru 1'in altında olan şirketler, teknoloji uyumunda sorun yaşayan şirketleri işaret ederken, 1-3 arasında bir değere sahip olan şirketlerin teknoloji uyumunda gelişime açık olduğu, 3'ün üzerinde bir değere sahip olan şirketlerin ise başarılı olduğu söylenebilir. Örnek olay uygulamasından elde edilen sonuçlar çalışmanın sonucunda yer verilmiş ve modelin kullanışlılığı ve gelecek çalışmalar için aktarımlar yapılmıştır.

To cite this article:

Paksoy, T., Yiğitol, B., Arıcıoğlu, M. A., & Demir, S. (2024). Evaluating firm-level technology Adaptation: An ıntegrated geometric mean model based on the TOE framework (M-BOOST). *Fivezero, 4*(2), 153-187. https://doi.org/10.54486/fivezero.2024.41

***Corresponding Author:** Büşra Yiğitol, *busra.yigitol@erbakan.edu.tr*

This article is licensed under a Creative Commons Attribution-NonCommercial 4.0 International License (CC BY-NC 4.0)

INTRODUCTION

Economic uncertainties, political and policy developments, and socio-economic transformation are changing business and enterprise paradigms. While such changes bring great opportunities, it should not be forgotten that they also carry some risks. One of the triggers of these paradigm shifts is technology. Regardless of the sector, all businesses constantly look for ways to improve their operational processes. Technology is at the forefront of these ways. To remain competitive, businesses rely on technology for every operation, from developing new products and services to streamlining operations (Fonseka et al., 2022). Although production, quality, speed, and cost together provide high competitive power, as is well known, technology is the common factor that individually develops these four elements. Even though competitive criteria change over time, it is no longer the produced goods but the technologies used that form the main element of competition (Huang, 2011; Pietrewicz, 2019; Teece et al., 1997).

In today's Information Age, mastering technology and possessing knowledge and skills also means having the ability to compete in the global market. The speed and diversity of technology in various fields test individuals' ability to use technology effectively. In today's business world, technological competencies are essential not only for specific sectors or positions but for almost every position and sector. Undoubtedly, companies that closely follow technological developments and trends quickly surpass their competitors and solidify their industry position. The speed and conveniences brought by technology hold undeniable importance for businesses. By implementing technological developments, businesses aim to reduce production costs and increase efficiency. In addition to improving efficiency, they aim to enhance the quality of the products and services they offer to their customers, provide infrastructure for developing technological products, and ultimately increase their competitive power. However, it should be noted that the spread rate of today's technologies is faster than that of older technologies (Aksak, 2022). Therefore, the adaptation process to technologies must also be carried out more quickly than before. The adaptation of businesses to technology includes new and existing technologies and technologies available in the market but not yet in use. Innovations that exist but are not yet utilized by the company also affect innovation (Baker, 2012). At this point, the context of technology is important in the process of adopting existing technologies by a company, as it broadly defines the scope and speed of technological change a company can undertake (Collins et al., 1988). Many factors can influence the process of adopting technology. Theories mapping out the factors associated with adopting innovations have been proposed and can offer a potentially useful perspective for understanding these theories (Reinders et al., 2019). In the literature, many models examine both the context of technology and other contexts in the adoption process of innovation by businesses and can guide businesses in this process. When looking at all the proposed models, they generally address the entire innovation process, from the adoption and application of innovations by users within a company context, in a comprehensive approach. In other words, they represent how the business environment affects the adoption and implementation of innovations within the context of the firm.

This study proposes a new quantitative technique to measure the Technology Adaptation performance at the firm level based on a revised TOE framework. With the proposed model, a firm's technology adaptation score can be determined, and a numerical output of the technology adaptation framework can be obtained. In this context, the technology, organization, and environment framework and other models in the literature will be explained, then the proposed new model will be detailed and its application will be provided.

CONCEPTUAL FRAMEWORK

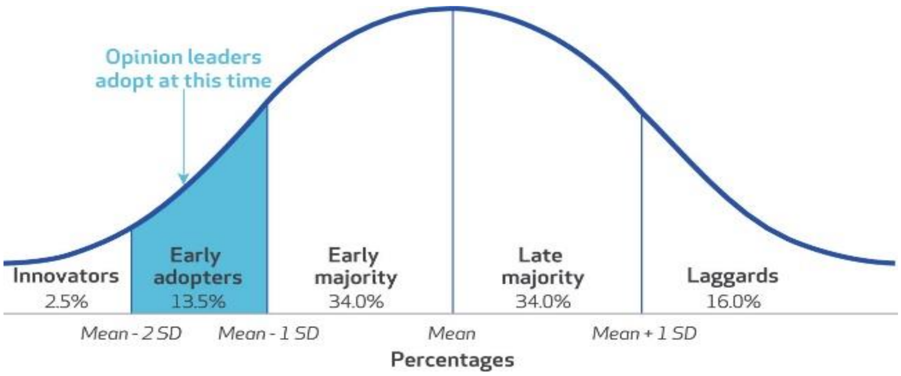
Technology Adaptation Models: A Comprehensive Review and Conceptual Framework

In this section, we provide a comprehensive review and conceptual framework for technology adaptation models.

Diffusion of Innovation (DOI)

Developed by Rogers in 1962, the "Diffusion of Innovations Theory" is one of the oldest social science theories and explains how and why new ideas and practices are adopted (Dearing and Cox, 2018). It explains this and aims to explain why adopting new ideas can spread over long periods (Rogers, 2003). Rogers bases the adoption processes of innovators on the classical normal distribution curve over time (Yasuda and Batres, 2012). He mapped the adoption process by highlighting that, in most cases, the first few people are open to new ideas and adopt their use. As these initial innovators 'spread' the news, more and more people become open to the innovation. This leads to the development of a critical mass. Over time, the innovative idea or product spreads among the population until a saturation point is reached. In this context, he identified a 5-stage adaptation process (Kaminski, 2011).

Figure 1
The Spread of Categories Embracing Innovation (Rogers, 2003)



In this framework, the groups that embrace innovation are categorized as innovators, early adopters, early majority, late majority, and laggards (LaMorte, 2022).

1. Innovators: These individuals are eager to be the first to try new things. They are adventurous and open to novel concepts. With a high tolerance for risk, they are often the originators of new ideas. Minimal effort is needed to capture the interest of this group.
2. Early Adopters: This group includes those who serve as opinion leaders. They thrive in leadership roles and are keen to embrace change. Already recognizing the need for innovation, they are quick to adopt new ideas. Effective strategies for engaging them include instructional guides and information on implementation; they do not require persuasion to embrace change.
3. Early Majority: Although they seldom lead, these individuals adopt new ideas sooner than the average person. They typically need assurance of an innovation's success before committing to it. Stories of successful use and evidence of effectiveness are key strategies to engage this audience.
4. Late Majority: This group tends to be cautious about change, adopting innovations only after the majority has done so. Strategies to connect with them focus on providing information about how many others have successfully adopted the innovation.

5. Laggards: These individuals are highly traditional and conservative, making them the most resistant to change. They require significant persuasion, often through statistics, fear-based appeals, and social pressure from other adopter groups, to consider adopting new ideas.

The stages of an individual's adoption and the spread of an innovation include recognizing the need for it, deciding to accept or reject it, initially using it to assess its effectiveness, and establishing its continued use. Five core factors influence the adoption process, each impacting the five categories of adopters differently (Minishi-Majanja and Kiplang'at, 2005).

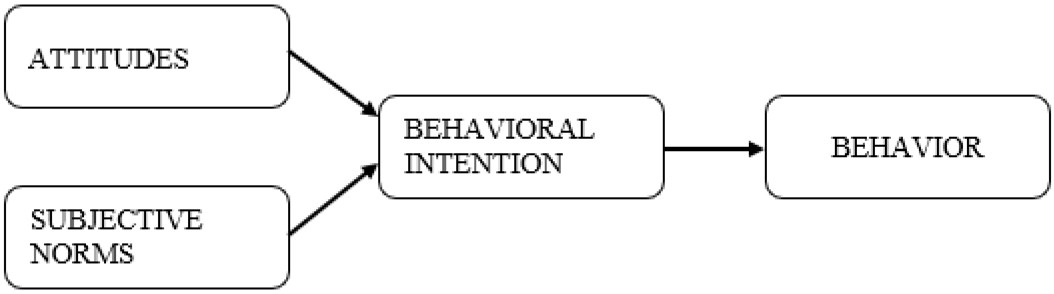
- Relative Advantage: The extent to which the innovation is perceived as superior to the previous idea, program, or product it aims to replace.
- Compatibility: The degree to which the innovation aligns with the values, experiences, and needs of potential users.
- Complexity: How challenging the innovation is to comprehend and/or utilize.
- Trialability: The ability to test or experiment with the innovation before fully committing to its adoption.
- Observability: The visibility of the innovation's results, allowing potential adopters to see its impact clearly.

Theory of Reasoned Action (TRA)

The Theory of Reasoned Action, formulated by Martin Fishbein and Icek Ajzen in 1975, posits that individuals typically act in a rational manner, carefully processing available information. According to Ajzen (1980), an individual's behavior is influenced by their intention to perform it. This intention is shaped by the anticipated outcomes they associate with the behavior (Salgues, 2016). The core component of the theory is behavioral intention, which represents the strength of a person's desire to engage in a specific action. A stronger intention increases the likelihood of the behavior occurring. When a person expects positive outcomes from performing a behavior, they develop a favorable attitude toward it. Behavioral intention is influenced by one's attitude towards the potential for the behavior to achieve the expected outcomes and by their subjective evaluation of the associated risks and benefits. Subjective norms pertain to the combination of perceived social expectations and the intention to align with them. A positive subjective norm arises when others view the behavior's results positively, and the individual is motivated to meet these expectations. Additionally, beliefs about the outcomes of engaging in the behavior contribute to forming a person's attitude toward it.

Figure 2

The Dimensions of Theory of Reasoned Action (TRA)

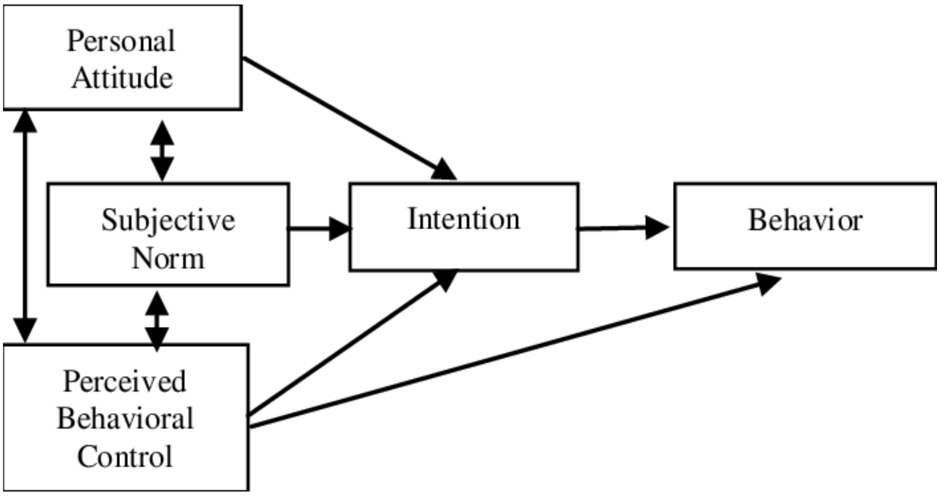


Theory of Planned Behavior (TPB)

The Theory of Planned Behavior (TPB) extends the Theory of Reasoned Action by addressing its limitations, particularly its inability to account for behaviors where individuals have limited control. The TPB suggests that an individual's behavioral intentions and actions are shaped by personal attitudes, subjective norms, and perceived behavioral control (Marangunić and Granić, 2015). At the theory's core lies the intention to engage in a specific behavior, which reflects the amount of effort an individual plans to invest to perform the action. Whether a person follows through on a behavior is largely determined by their intention, which is influenced by their attitude toward the behavior, societal expectations (subjective norms), and their confidence in their ability to carry out the behavior. However, behavior execution is only possible when the individual has volitional control, meaning they can freely choose to perform the behavior. The theory operates on the assumption that individuals make rational, systematic decisions based on accessible information, thus excluding unconscious motives from consideration.

Figure 3

The Dimensions of Planned Behavior Theory (TPR)

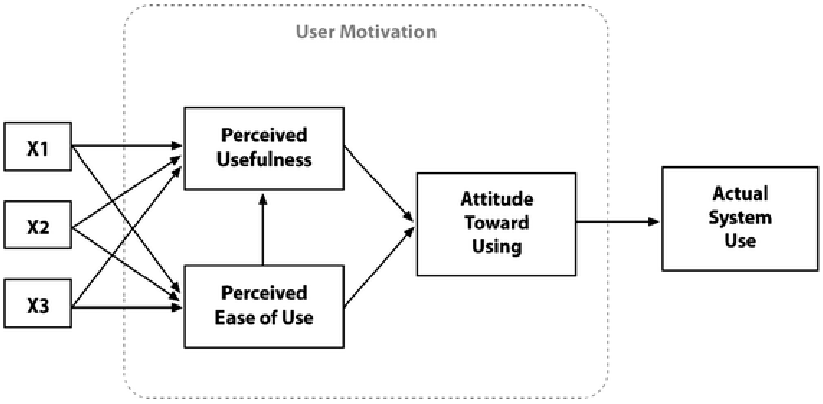


Technology Acceptance Model (TAM)

The "Technology Acceptance Model" (TAM), introduced by Davis in 1985, highlights key motivational factors—perceived ease of use, perceived usefulness, and attitudes toward technology—as well as outcome variables such as behavioral intentions and technology usage (Scherer et al., 2019). Among these, perceived usefulness (PU) and perceived ease of use (PEU) are regarded as central variables that directly or indirectly impact outcomes (Marangunić and Granić, 2015). TAM has become a leading model in examining the factors that drive technology acceptance. It posits that perceived ease of use and perceived usefulness serve as mediators in the complex interaction between system features (external variables) and potential usage. Stemming from the Theory of Reasoned Action (TRA) and the Theory of Planned Behavior (TPB), TAM has been instrumental in explaining user behavior toward technology. Davis posited that a user's attitude toward the system is a crucial factor in determining whether they will adopt or reject it. He suggested that this attitude is shaped by two primary beliefs—perceived usefulness and perceived ease of use—with perceived ease of use also having a direct effect on perceived usefulness.

Figure 4

The Dimensions of Technology Acceptance Model (TAM)



The Unified Theory of Acceptance and Use of Technology (UTAUT)

The Unified Theory of Acceptance and Use of Technology (UTAUT) marks a notable advancement in technology adoption research. Developed by Venkatesh, Morris, Davis, and Davis (2003), UTAUT identifies four core constructs to explain and predict users' acceptance of new technology. This model posits that actual technology usage is driven by behavioral intention (Marikyan, Davit and Papagiannidis, Savvas, 2023). UTAUT's framework comprises performance expectancy (similar to perceived usefulness), effort expectancy (similar to perceived ease of use), social influence, and facilitating conditions, which together are said to account for 70% of the variance in technology usage intention (van Raaij and Schepers, 2008).

- Performance expectancy: Defined as the extent to which an individual believes using the system will enhance their performance (Venkatesh et al., 2003).
- Effort expectancy: Refers to the perceived ease of using the system (Venkatesh et al., 2003).
- Social influence: Indicates the degree to which an individual perceives that important people believe they should use the system (Venkatesh et al., 2003).
- Facilitating conditions: The extent to which an individual believes there are sufficient organizational and technical resources to support system use (Venkatesh et al., 2003).

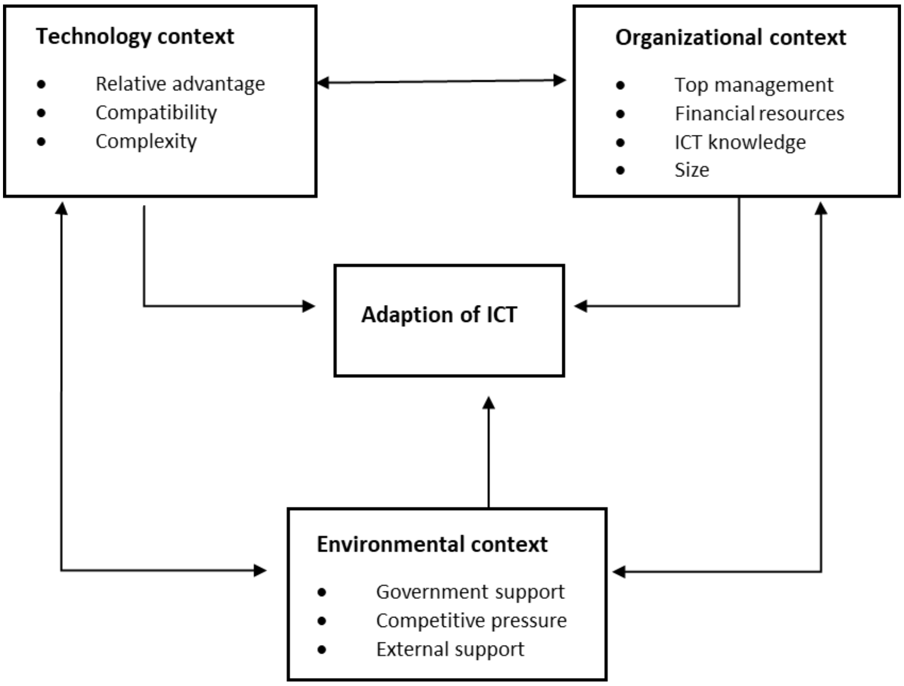
Age, gender, experience, and voluntariness of use moderate the strength of predictors on technology adoption intentions. Age lessens the impact of all four key predictors, while gender influences the relationships between effort expectancy, performance expectancy, and social influence. Experience adjusts the strength of relationships between effort expectancy, social influence, and facilitating conditions. Voluntariness of use specifically moderates the link between social influence and behavioral intention (Venkatesh et al., 2003). The likelihood of adopting technology is shaped by the direct effects of four core constructs: performance expectancy, effort expectancy, social influence, and facilitating conditions, with their influence being moderated by age, gender, experience, and voluntariness of use (Venkatesh et al., 2003).

Technology-Organization-Environment (TOE) Framework

The Technology-Organization-Environment (TOE) framework, proposed by Tornatzky and Fleischer (1990), is a theoretical model used in information systems to explain how various factors influence the adoption and utilization of new technologies within organizations (Baker, 2012). Widely applied in studies on technology adoption and implementation, the TOE framework provides insights into the dynamic interaction between technology, organizational factors, and environmental influences (Oliveira and Martins, 2010). It comprises three core components: technology, organization, and environment (Malik et al., 2021).

- **Technology:** This dimension encompasses the characteristics of the technology itself, such as functionality, complexity, compatibility with existing systems, and ease of use. It reflects both current technologies in use and emerging technologies that may be relevant to a firm.
- **Organization:** This aspect focuses on the internal environment in which the technology is implemented, including the organization's size, structure, culture, and available resources. It characterizes the firm in terms of its scope and capacity to support technological adoption.
- **Environment:** Referring to the external context, this component includes factors like market conditions, regulatory requirements, industry competition, and socio-cultural norms, representing the broader domain within which the organization operates (Nguyen et al., 2022).

Figure 5
The TOE Framework (Tornatzky and Fleischer, 1990)



One of the strengths of the TOE framework is that it provides a holistic perspective on technology adoption and implementation. The framework acknowledges that internal and external factors are significant in shaping the adoption and use of technology rather than focusing solely on the technology itself or the organizational context. This allows researchers to adopt a more nuanced approach to technology adoption and helps organizations better understand the complex interaction of factors influencing their technology decisions.

One of the strengths of the TOE framework is its flexibility. The framework's applicability to various technologies and organizational contexts makes it a useful tool for researchers and practitioners in various fields. Additionally, the framework can be adapted to different research methods, including qualitative and quantitative approaches. A literature review shows that the TOE framework can be adapted to many fields. For example, Chatzoglou and Chatzoudes (2016) identified the dimensions supported by the antecedents of the TOE framework in the adoption process of e-business applications. Tajudeen et al. (2018) used the TOE framework to adopt social media use and understand customer needs to improve the organization. Chatterjee et al. (2020) used the TOE-TAM model to explain the applicability and adoption of Industry 4.0 technologies. Khan et al. (2021) used the TOE framework to determine the factors influencing firms' adoption processes of mobile payment systems. Hashimy et al. (2022) used the TOE framework to explain the adoption process of blockchain technology. As seen from the many examples in the literature, the TOE framework offers broad applicability and flexibility. The common point of all these studies is that the framework helps businesses focus on the original points for adopting innovation. The TOE framework's superior strength lies in clarifying internal and external factors within a single paradigm (Nguyen et al., 2022). Indeed, the TOE framework explains the behavioral intentions of businesses towards innovations from a solid perspective and has a strong theoretical foundation. Therefore, it is undisputed that the TOE framework is a pioneering approach to adopting innovations and is considered a reference point in developing new models. The TOE framework also allows for the development of new approaches within the environmental, technological, and organizational contexts in adopting innovations.

Table 1

Summary of Innovation-Adaptation Models

Model	Model Components
The Unified Theory of Acceptance and Use of Technology (UTAUT)	▪ Performance Expectancy ▪ Effort Expectancy ▪ Social Influence Facilitating Conditions
Technology Acceptance Model (TAM)	Basic variables: perceived ease of use, perceived usefulness, and attitudes towards technology Outcome variables: behavioral ıntentions, technology use
Theory of Planned Behavior (TPB)	▪ Attitude ▪ Subjective evaluation ▪ Behavioral intention (Attitude and subjective evaluation of risks and benefits affect behavioral intention)
Theory of Reasoned Action (TRA)	▪ attitude, ▪ subjective norms ▪ perceived behavioral control individual's behavioral intentions
Technology-Organization-Environment (TOE)	▪ Environment: market conditions, regulatory requirements, and social and cultural norms ▪ Technology: its functionality, complexity, compatibility with existing systems, and ease of use Organization: the organization's size, structure, culture, and resources

Advancements and Diversifications in TOE Frameworks in the literature

The Technology-Organization-Environment (TOE) framework has been explored in various contexts, though research in this area remains relatively limited. Significant advancements and adaptations have been made, showcasing the framework's evolution and application across different fields.

Baker (2012) defined the key components of the TOE framework, explaining its development and providing guidance for future research. Wallace et al. (2021) highlighted the limitations of the traditional TOE framework in cybersecurity applications, proposing an expanded model that includes new dimensions such as cyber catalysts and application standards. Similarly, Ullah et al. (2021) developed a risk management framework for sustainable smart cities, identifying 56 risk factors categorized under technological, organizational, and external dimensions.

Ngah et al. (2017) examined factors influencing the adoption of halal storage services in Malaysia, identifying customer pressure, perceived benefits, cost, and organizational readiness as significant contributors. Stjepić et al. (2021) investigated risks associated with adopting business intelligence systems (BIS) in SMEs, emphasizing internal organizational risks and external environmental factors. Ganguly (2022) studied blockchain adoption in the logistics sector, proposing a framework for real-time, data-driven management in supply chains.

Cruz-Jesus et al. (2019) analyzed CRM adoption and routinization across 277 firms, revealing that data quality, top management support, and competitive pressure significantly influence different stages of CRM implementation. Similarly, Abed (2020) explored social commerce adoption among SMEs in social media environments, identifying partner pressure (environmental), top management support (organizational), and perceived benefits (technological) as key determinants.

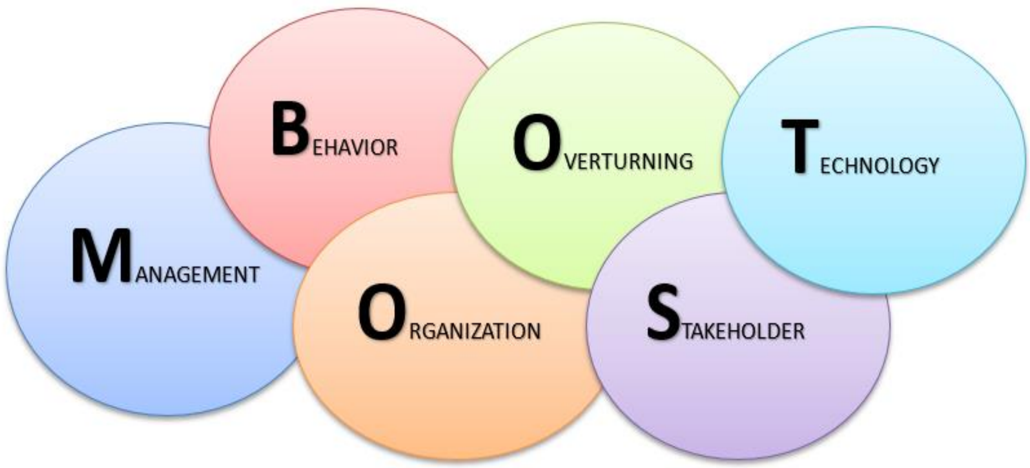
These studies demonstrate how the TOE framework can be adapted to different contexts and sectors, highlighting its capacity to evolve and meet emerging needs.

An Innovative Approach: Rethinking the TOE Framework

Numerous theories have been developed in the literature related to technology adaptation. However, this study proposes a new quantitative technique to measure the level of Technology Adaptation at the firm level. This proposal includes a scoring system called the M-BOOST Technology Adaptation Score.

Figure 6

A new model of technology adaptation (M-BOOST)



The parameters used in the proposed method are explained below.

Management: The higher the management's concern, the more difficult the adaptation becomes. In the proposed M-BOOST method, the abbreviation "M" is used to determine the management's level of concern and its impact on adaptation. It is included as a parameter in the formula as a factor that affects negatively in the denominator part.

Behavior: "Behavioral factors" that could influence technology adoption have been evaluated under three headings. Generally, behavior can have a significant impact on the adoption of technology. By understanding the factors that influence people's behavior, businesses can develop strategies to increase the adoption of new technologies. Therefore, the Behavior parameter works proportionally with the adaptation score. In the proposed M-BOOST method, the abbreviation "B" is used to determine the behavioral factors and their impact on adaptation, and it is included as a parameter in the formula as a factor that positively affects the "numerator" part.

Overturning: Schumpeter emphasized the significant role of innovation in the emergence of economic development. He defined the process as Creative Destruction, which continuously creates new ones by destroying the old, describing it as a revolutionary process (Sledzik, 2013). According to him, it is the mechanism that drives and sustains the capitalist system; new consumer goods, new production methods, new transportation methods, new markets, new types, and varieties of industrial organization... Every innovation that emerges creates a revolutionary atmosphere over the old system, and this entire process continues as the old factors are eliminated and new ones emerge. This system is the foundation of the capitalist order, and every enterprise, whether it wants to or not, must adapt to this order (Schumpeter, 1942). Schumpeter's definition of creative destruction perfectly explains today's technological developments. With the acceleration of technological advancements, the pace of the emergence of new technologies and the process of obsolescing existing technologies can now occur quickly. From this point, it can be said that the more disruptive a technology is, the faster it replaces old technology. This process underscores the need for technology adaptation to occur more rapidly. Another factor, disruptive technologies (Overturning), can have a significant impact on how people adopt new technologies. Disruptive technologies are those that fundamentally change our way of life and work. They can render existing technologies obsolete and create new markets and opportunities.

For example, the emergence and widespread adoption of smartphones have significantly impacted how people communicate, access information, and consume entertainment. Smartphones have enabled us to stay connected with friends and family wherever we are and have granted us access to vast amounts of information at our fingertips. This has led to a decline in the use of traditional technologies such as landlines, desktop computers, and newspapers. Moreover, traditional high-circulation newspapers have begun to abandon their printed forms.

Another example of disruptive technology is artificial intelligence (AI). AI is rapidly changing how we work and will likely have an even greater impact. AI is already being used in various sectors, including healthcare, finance, and manufacturing. It is utilized to automate tasks, increase efficiency, and make better decisions. As artificial intelligence continues to evolve, it will likely eliminate many jobs and create new ones.

In summary, the adoption/adaptation of disruptive technologies can be disruptive for individuals and businesses. It can be challenging to keep up with the pace of change, and investing in new technologies can be costly. However, disruptive technologies can also create new opportunities and improve our lives. It is important to be aware of the potential impact of disruptive technologies and be prepared for change.

Some ways in which disruptive technologies can affect the adoption of technology include:

- ***Rendering existing technologies obsolete or outdated:*** When a new technology emerges that is significantly better than its predecessor, it can quickly become obsolete. This can lead to a decrease in the use of old technology and an increase in the use of new technology.

- Creating new markets and opportunities: Disruptive technologies can create new markets and opportunities that did not previously exist, leading to increased investment in new technologies and new businesses.

It is important to be aware of the potential impact of disruptive technologies and prepared for change. By understanding the potential benefits and challenges of disruptive technologies, managers can make informed decisions about business strategies for adopting them using the proposed model (BOOST). In the proposed M-BOOST method, the abbreviation "O" is used to determine the level of technological disruptiveness, and it is included as a parameter in the formula as a factor that positively affects the "numerator" part.

Organization: The organizational structure has a significant impact on technology adaptation. In this context, factors such as how young, dynamic, and educated the team forming the organization is, how open the organization is to R&D and innovation ideas, and whether there are R&D centers can facilitate technology adaptation. Indeed, studies have shown that young workers have more pronounced attitudes toward using new technology in their initial acceptance decisions than older workers (Morris and Venkatesh, 2000; Sterns and Doverspike, 1989). In addition to the age of the team forming the organization, R&D activities within the organization also have a significant impact on technology adaptation. This is because the R&D department is the production center of innovation and plays a direct role in determining innovation success and the firm's innovation performance (Sun and Huo, 2005; Ebrahim and Bong, 2017). Due to the positive effects of organizational dynamics on technology and innovation, the proposed M-BOOST method includes the impact of the organization on technology adaptation, expressed by the abbreviation "O", and included as a parameter in the formula as a factor that positively affects in the "numerator" part.

Stakeholder: Stakeholders have a significant impact on the adaptation process of technology. Therefore, the more prepared stakeholders are for technological change and innovation, the easier the adaptation to the relevant technology becomes. There can be many factors influencing the readiness of stakeholders for technology. For example, national or international laws, regulations, climate change, etc., may compel stakeholders to adapt to technology. In this regard, the legal dimension may be effective for stakeholders. For instance, quality standards documents can be cited as an example here. In studies, the quality certifications that a company possesses can also impact the innovation processes of the business. In this context, the ISO 56002 quality certification can be cited as an example. ISO 56002 is an International Organization for Standardization (ISO) standard published under "Innovation Management — Innovation Management System — Guidance". This quality system is based on the assumption that an organization's ability to innovate is a key factor for sustainable growth, economic vitality, increased prosperity, and social development. Studies also suggest that adopting ISO 56002 improves firm innovation by managing, systematizing, and replicating the innovation process (da Silva, 2021; Kim et al., 2012). In addition to quality certifications, factors such as the flexibility of the IT technologies used by the company and the ease of integrating new innovations into the existing structure can be among the elements to be considered for technology compatibility in terms of structural flexibility. Furthermore, the education levels of stakeholders can be another important factor in this regard. In short, the more prepared stakeholders are, the easier the adaptation becomes.

In the proposed M-BOOST method, the abbreviation "S" is used to determine the readiness level of stakeholders and their impact on technology adaptation, and it is included as a parameter in the formula as a factor that positively affects the "numerator" part.

Technology: The more complex and costly to acquire technology is, the more difficult the adaptation becomes. At this point, the difficulty of procurement can also be mentioned. In some cases, legal difficulties may also be encountered in the purchase and use of technology. Indeed, despite all the difficulties, even if such technologies are purchased, there may be difficulties in obtaining and employing suitable personnel to use complex technologies. Points such as security vulnerabilities or version updates also bring another challenge for complex technologies. Therefore, the Technology parameter works inversely proportional to the adaptation score. In the proposed M-BOOST method, the abbreviation "T" is used to determine the difficulty level of technology and its impact on adaptation, and it is included as a parameter in the formula as a factor that negatively affects the denominator part.

METHODOLOGY

The Formulation of M-BOOST Technology Adaptation Score

The Technology Adaptation Score encompasses these six parameters and is formulated using the geometric method. The primary reason for employing the geometric mean in the M-BOOST TAS formula is its ability to evaluate multiple factors multiplicatively, thereby providing a more balanced and fair representation. This approach ensures equilibrium among factors and proportionally reflects their impact on overall performance. Below is a detailed explanation of why this method is appropriate from both mathematical and practical perspectives:

- *Highlighting Interactional and Multiplicative Relationships*

The geometric mean effectively captures the interactional and multiplicative relationships between factors:

  - The M-BOOST TAS formula represents a system where factors such as Organization, Behavior, and Technology are combined multiplicatively to calculate the adaptation score.
  - This method ensures that a low value in one factor is proportionately reflected in the overall system performance. For instance, if "Technology" or "Management" is significantly weak, the overall adaptation score will naturally be lower, which is appropriately balanced by the geometric mean.

- *Pronounced Effect of Weak Factors*

The geometric mean is sensitive to the presence of weak links in the system:

  - Unlike summation or arithmetic mean, the geometric mean ensures that if one factor is close to zero or has a very low value, the overall performance is significantly affected.
  - For example, even if a business performs strongly in "Stakeholder Engagement" or "Organization," inadequate performance in "Technology" (e.g., Technology = 1) will result in a low overall adaptation score.

- *Equal Contribution of Factors*

The geometric mean provides a fair evaluation by assigning equal weight to all factors:

  - When factors like Organization and Technology are equally important, the geometric mean preserves this equal importance.
  - The multiplicative approach prevents extreme values from skewing the overall performance, ensuring no single factor overshadows the others.

- *Scale Transformation and Outlier Effects*

The geometric mean mitigates the effects of extreme values (outliers) and provides more reliable results:

- Its logarithmic structure allows for a balanced integration of values.
- This is particularly beneficial in systems where factors are measured on a multiplicative scale, such as a range of 1 to 5, optimizing the impact of each factor while minimizing distortions caused by extreme values.

- *Realistic and Accurate Results*

The geometric mean yields results that better reflect the system's overall performance:

- In systems where factors are interdependent, this method clearly illustrates how interactions function collectively.
- It accurately measures the impact of weak factors, fairly reflecting their influence on overall performance, unlike arithmetic mean, which tends to diminish the effects of low values.

In conclusion, the use of the geometric mean in the M-BOOST TAS formula acknowledges the multiplicative relationships between factors and their proportional contributions to overall system performance. This method effectively reflects the interplay between factors, highlights the influence of weak components, and enhances measurement accuracy by introducing a logarithmic weighting mechanism within the system.

The M-BOOST Technology Adaptation Score is calculated with the following formula:

$$\text{M-BOOST Technology Adaptation Score} = \frac{\sqrt[4]{Overturning\ x\ Organization\ x\ Stakeholderx\ Behavior}}{\sqrt[2]{Technology\ x\ Management}}$$

The scale of of technology adaptation (M-BOOST)

When assessing the obtained score, a detailed evaluation chart is utilized. The range that each variable can take is: **$1 \leq x \leq 5$**. How this range is determined is explained below;

- Numerator Calculation (Fourth Root):

Effect of the fourth root:

- For the **minimum value** of the product in the numerator: $1\times1\times1\times1=11$ and $\sqrt[4]{1}=1$
- For the **maximum value** of the product in the numerator: $5\times5\times5\times5=625$, and $\sqrt[4]{625}=5$

As a result, the range of the numerator is: $1 \leq \text{Numerator} \leq 5$

- Denominator Calculation (Square Root):

Effect of the square root:

- For the **minimum value** of the product in the denominator: $1\times1=1$, and $\sqrt{1}=1$
- For the **maximum value** of the product in the denominator: $5\times5=25$, and $\sqrt{25}=5$

As a result, the range of the denominator is: $1 \leq \text{Denominator} \leq 5$

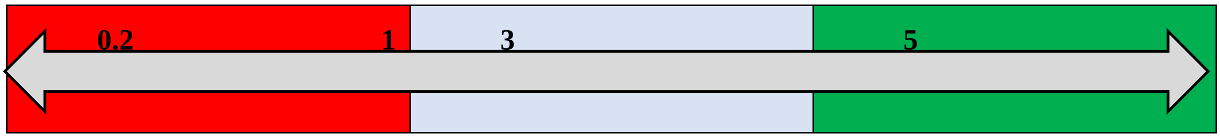
The score range depends on the ratio between the **Numerator** and the **Denominator** values:

- For the minimum score: M-BOOST TAS= $\frac{Numerator\ (Min)}{Denominato\ (Max)}=\frac{1}{5}=0.2$
- For the maximum score: M-BOOST TAS= $\frac{Numerator\ (Max)}{Denominato\ (Min)}=\frac{5}{1}=5$

The scale obtained as a result of these calculations is presented in the figure 7.

Figure 7

The scale of technology adaptation (M-BOOST)



In the study, the **1-3 range** is defined as the mid-level of adaptation. According to theoretical foundation, The M-BOOST score range is set between **0.2 and 5**, which can be divided into three main regions:

- **Low adaptation:** 0.2 - 1 (Very limited capacity)
- **Mid adaptation:** 1 - 3 (Potential exists but is not yet optimal)
- **High adaptation:** 3 - 5 (Strong adaptation performance)

This division provides a reasonable distinction when assuming a linear scale. According to practical rationale, the mid-level adaptation range (1-3) represents the following conditions:

- A stage where adaptation capabilities are **in development**.
- Systems show potential but require further optimization and management.
- It is a **critical transition zone** for strategic decisions and interventions.

For ease of evaluation and application, the following ranges are suggested:

- **Low adaptation:** 0.2 - 1
- **Mid adaptation:** 1 - 3
- **High adaptation:** 3 - 5

This scale can be adjusted sensitively to fit specific industries or technological contexts. Within this framework, the **1-3 range** can be effectively used as the critical and intervention-focused stage in the adaptation process.

Parameters of M-BOOST Technology Adaptation Score

Management (Management concerns)

Management Concerns Regarding Cost

In today's rapidly evolving digital environment, businesses need to continuously invest in technology to remain competitive and meet the increasing demands of customers. Whether upgrading hardware, implementing new software systems, or adopting the latest technologies, capital expenditure is essential for organizations to leverage innovation and achieve sustainable growth. Therefore, one critical factor in technological adaptation is the cost of technology (Seong and Kim, 2021). Indeed, uncertainty about initial costs tends to lead to a cautious approach to management. Therefore, the expression we will use here is as follows.

"As management, we are concerned about the costs of investing in new technologies and initial expenses."

Disruptive impact concern

Concerns may arise that it will disrupt the system and interfere with the current order (Marquardt et al., 2017; Millar et al., 2018). These concerns express the fear that new technology will disrupt workflows, processes, and the existing system (Disruptive fear). Therefore, the statement we will use here and expect decision-makers to scale is as follows:

"As management, we are concerned that new technologies will disrupt workflows, processes, and, in short, the existing system."

Management's Prejudice and Lack of Trust)

There is a prejudice against innovation in businesses (Asplund et al., 2021; Jensen and Webster, 2004). Due to the management's lack of experience with new technology, they may not feel comfortable. The reluctance to step outside their comfort zone and their lack of experience with this new technology create a "lack of trust." Therefore, even if they embrace creativity as a desired goal, they may often reject creative ideas (Mueller et al., 2012). Consequently, the expression we will use here is as follows.

"As management, we do not feel comfortable with new technology due to our lack of experience and are concerned that it does not seem reliable to us."

Employees' resistance to change

Resistance to change can be encountered in businesses (Lawrence, 1968; Watson, 1971). Management may not want to deal with employees' resistance towards innovation, and managers themselves may also resist change. Every change generates its own resistance within the organization, which creates a managerial problem. Management might be reluctant to deal with the issues arising from this resistance to change. Therefore, the expression we will use here is as follows.

"We are concerned about the resistance that will arise among employees in the organizational context due to innovation."

Learning Curve Effect

In businesses, especially in the manufacturing sector, as the production quantity or the number of repetitions of a task increases, the production time decreases by a certain proportion (Nadeau et al., 2010). Initially, production times are high due to a factor known as the learning effect. Regardless of whether they are white-collar or blue-collar workers, there is an improvement in employee performance depending on the number of repetitions of the task they perform. In other words, the effort/resource per production unit decreases (Wright, 1936). Therefore, inevitably, there will be productivity losses due to the learning effect when transitioning to a new system. Management may be concerned about this issue. Therefore, the expression we will use here is as follows.

"As management, we are concerned about the decrease in productivity in production due to the learning effect associated with transitioning to new technology."

Compliance problem in internal process

The existing machinery and systems may not be compatible with new technology. Companies need to make significant changes in their organizational structures, business processes, IT systems, and governing practices to achieve compatibility. Integration can be challenging and difficult (Schumm et al., 2010). Therefore, the expression we will use here is as follows.

"As management, we are concerned about the potential incompatibility of new technologies such as software with the existing system and the problems that may arise during the integration process."

Data security concerns

Due to new technology, management may have concerns about ensuring data security (M. S. A. Alqahtani and Erfani, 2021; Kemmerer, 2003). Adopting technology and security compliance, along with limitations and biases, can make the adaptation process difficult. Cybersecurity non-compliance is a major concern for organizations (M. Alqahtani and Braun, 2021). Therefore, the expression we will use here is as follows.

"As management, we are concerned that vulnerabilities in data security may arise with the transition to new technology."

Feasibility calculation difficulty

Calculating the return on investment and feasibility for new technology can be challenging due to uncertainties. There may be investment concerns because most of the data is new, making comparison difficult. Therefore, the expression we will use here is as follows.

"As management, we are concerned about the potential surprise costs and the financial profitability of the investment in the future due to the difficulty in feasibility assessment for new technology."

Behaviour (Motivating Technology Adoption)

Motivation/Benefits

The work culture within a business can encourage employees to adapt to new technologies. If appropriate motivations for transitioning to new technology can be created within the business, these motivations can influence the adoption of the technology. For example, if it will contribute to developing employees' skills or make their work easier, they will adopt the new technology more quickly. People are more likely to adopt a new technology if they believe it will help them achieve their goals or solve a problem (Davis, 1989). For instance, a person trying to lose weight is likelier to adopt a smart fitness tracking watch (such as an i-watch) if they believe it will help them track their progress and stay motivated. Therefore, the expression we will use here is as follows.

"I believe that our employees are sufficiently motivated to transition to new technologies in our company because the new technology offers them many benefits and advantages."

Ease of use

People are more likely to adopt a new technology if they perceive it as easy to use (Davis, 1989; Venkatesh, 2000). If a technology is difficult to learn or use, people are less likely to stick with or adapt to it. For example, a person not very knowledgeable about technology is likelier to adopt a smartphone if it has a simple user interface. Therefore, the expression we will use here is as follows.

"In our company, our employees find the use of new technologies simple and easy, and they are able to adapt quickly."

Social Influence

People are more likely to adopt new technology when they see others using it (Brown et al., 2002; Hausman and Stock, 2003; Kulviwat et al., 2009). This is known as social influence. For example, a person may be more likely to adopt a new social media platform (like TikTok) if their friends and family already use it. Similarly, older adults may prefer Facebook as their primary social media choice because their peers use it more frequently. Therefore, the expression we will use here is as follows.

"Our employees quickly adapt to new technologies because they see their friends, colleagues, and people in their social circles using these technologies."

Technology Learning

Managers take various measures to ensure the successful adoption of new technology and reduce resistance. These measures include encouraging participation in decision-making, educating employees about innovations, implementing economic incentives, and strengthening relationships between functional units. Neglecting the importance of educating employees about new technology can be detrimental (Riddell and Song, 2017). Training employees and managers on the technological benefits and how to use them can accelerate technology adoption. Therefore, the expression we will use here is as follows.

"Our employees are provided with training on the use of new technologies and their benefits."

Organization (Influence of Team Attributes on Technology Adoption)

Technology savvy (Hiring skilled professionals)

If the team within the organization possesses the knowledge and skills that facilitate the use of new technology, such as IT capabilities, adaptation will be easier. Therefore, the expression we will use here is as follows.

"Our employees have the knowledge and skills to facilitate the use of new technologies in our business."

The average age of employees

The average age of employees can also have a significant impact on the adoption of new technologies. Compared to older employees, the technology use decisions of younger employees are more strongly influenced by attitudes towards using technology (Morris and Venkatesh, 2000). Younger people are more likely to adopt new technologies than older people. A younger team adapts to new technology more quickly because, despite having less experience, they have a more flexible mindset and faster learning abilities due to metabolic reasons than older individuals. Therefore, they can adapt to new technologies more easily. Additionally, generational differences can affect technology adaptation (Gafni and Geri, 2013; Volkom et al., 2014). Especially, Generation Z, being a generation that was born and grew up with technology, is naturally more advantageous in this area compared to previous generations. Therefore, the expression we will use here is as follows.

"The average age of our employees is low."

Educational level of employees

The educational level of employees has a significant impact on technology adoption. When businesses possess the foundational education required for new technologies, transitioning becomes easier. Moreover, the educational level can help employees develop a positive attitude toward innovation

(Morris and Venkatesh, 2000; Quazi and Talukder, 2011). Therefore, higher educational levels among employees can facilitate smoother technology adaptation and usage. Therefore, the expression we will use here is as follows.

"In our business, our employees have a higher level of education compared to the industry average."

The salary level of employees

If the salary level of employees is higher, it indicates that a more skilled team is being employed. Besides working with qualified personnel, higher salaries also facilitate access to new technologies for individuals with higher incomes. Indeed, individuals with higher incomes are more likely to adopt new technologies since they can more easily access them. Therefore, the expression we will use here is as follows.

"In our business, higher current wages are paid compared to the industry average."

Corporate advantage (Impact of corporate and well-established organization)

The company's reputation and brand attract technology firms to it. It demonstrates the ability to formulate long-term vision and strategic plans. If the company is a corporate company that has been operating for many years, it has already learned to deal with uncertainties and risks. Thus, they can better manage the uncertainties and risks that are likely to arise during the adaptation process to new technologies. They have broader business networks and establish contact with new technology vendors much faster and easier. Their existing infrastructures and systems become more stable, facilitating the integration of new technologies. Therefore, the expression we will use here is as follows.

"We have corporate capability and capacity to manage the uncertainties and risks brought by new technology."

Innovation and research and development (R&D) culture

The adoption of new technologies, their development and implementation, and activities closely related to technology, such as research and development, are tasks undertaken by research and development (R&D). Research and development (R&D) is one of the most important activities required for innovation. Therefore, the expression we will use here is as follows.

"In our business, there is a culture of innovation and R&D, and the Continuous Improvement (Kaizen) suggestion system is effectively utilized."*

**Based on the participants' annual proposed project numbers, respondents will select the following options respectively: Strongly Disagree for 0-9 projects, Disagree for 10-25 projects, Neutral for 26-50 projects, Agree for 51-75 projects, and Strongly Agree for 100 or more projects.*

Overturning (Disruptiveness and Change Response: Adapting Capacity to Disruption)

The disruption level of technology

The more disruptive a technology is - how quickly and powerfully it eliminates the old one - the faster the transition and adaptation to this new technology (Schumpeter, 1942). Therefore, the expression we will use here is as follows.

"The level of disruption of the new technologies we encounter in our business is quite high."

Response level to changes

Adapting to new technologies is not an easy process for every business. While this process can be very painful for some businesses, some businesses can react quickly to changing technologies. Even if the level of disruption of technology is high, businesses with sufficient skills and infrastructure can quickly abandon outdated technology and easily adapt and incorporate these emerging technologies into their organizations. The faster the response level, the faster the technology adaptation. Therefore, the expression we will use here is as follows.

"The level of reaction of our organization to changing technologies is high."

Stakeholders (Stakeholder Compliance Impact)

Regulatory Influence / Compliance with standards and regulations

Due to climate change and other factors, national or international laws and regulations may support or mandate this new technology. Regulators can support adaptation. For example, for the transition to electric vehicles, the EU has introduced bans on fossil fuel vehicles starting after a certain period of time (2025-2030). Thus, as a stakeholder, the legislator catalyzes the transition from fossil fuel vehicles to electric vehicles. Therefore, adherence to regulatory laws and other compliance resources has become a must-do activity for every organization for business transparency and more efficient operations (Hashmi et al., 2018). Compliance aims to gain a greater understanding of how businesses should operate more sustainably to continue providing their services without violating applicable regulations that can significantly affect their business operations (Olivieri, 2014; (Benedek, 2012). Therefore, the expression we will use here is as follows.

"Our business has the certifications and documents required by the stakeholders and sector. These certificates encourage us to transition and adapt to new technologies."*

**Based on the number of certificates the company holds, respondents will select the following options respectively: Strongly Disagree for 0 certificates, Disagree for 1 certificate, Neutral for 2 certificates, Agree for 3 certificates, and Strongly Agree for 4 or more certificates.*

Flexibility in Technology Integration

Adaptation is easy if the existing systems (infrastructure, technology, materials, etc.) can be easily changed and if the system is flexible. There are no compatibility problems. For example, a manufacturing business that uses open-source production management system software such as Linux, Arduino, or Python or works with an IT stakeholder that provides services in this way can easily add new technological investments such as IOT or MES to its infrastructure. Open-source software offers more effective solutions than other encrypted closed-box software. Even if there is a license right in open-source software, it is possible to access and modify the source code, provided the responsibility remains with the customer. However, a customer business that wants to make changes to the relational database (RDMS) in line with its needs in a commercial encrypted closed box software may have to pay considerable additional license fees to its IT solution partner. Therefore, businesses that do not use open-source software depend on an IT solution partner for any changes or improvements they want. Since the business does not have access to the source code, it cannot update this software and cannot change or customize it according to its own needs. This makes it difficult to adapt to new technologies. Therefore, the expression we will use here is as follows.

"The IT technologies we use are flexible."

Training/employee engagement

The higher the level of training of stakeholder employees in implementing and adapting to new technologies, the easier it is to implement and adapt new technologies. The fact that the stakeholder's employees are trained and competent in new technologies, especially IT technologies, makes it possible to easily deploy the technologies used in the main industry (buyer) and integrate them into the supply chain. Therefore, the expression we will use here is as follows.

"Our stakeholders' employees have a high level of education."

Financial capability

The stronger the stakeholder is financially, the easier it is to adapt to new investments and technology. In fact, the financial capability of the stakeholder business is the most important factor determining its capacity to invest in technology. A strong financial balance sheet gives the business the "luxury" to take risks and invest in new technologies. There is a linear correlation between financial strength and the investment appetite of businesses. Weak financial performance will lead to constraints on investment in technology. This will create a vicious circle, hindering the business's ability to maintain its competitive advantage and growth objectives. Adapting to technological transformations and being technologically up-to-date is also one of the most important elements for businesses to maintain their efficiency and competitiveness in the long run. Therefore, the expression we will use here is as follows.

"Our organization has the financial capability required by new investments and technology"

Stakeholders' Tech Knowledge and Aptitude

Suppliers' prior knowledge, familiarity, and experience with the new technology facilitate adaptation. Therefore, the expression we will use here is as follows.

"Our stakeholders have the knowledge, know-how, and aptitude for new technologies."

The fact that businesses have prior knowledge, predisposition, and experience with the new technology supports rapid adaptation. Employees can easily pass the adaptation process due to the knowledge gained from previous encounters with this technology. Moreover, this prior knowledge and experience also contribute to performance in adapting similar business processes.

Technology (Complexity of new technology and the challenges it creates)

Complexity level of new technology

The more complex a technology is, the more difficult it is to transition and adapt to this new technology. Therefore, the expression we will use here is as follows.

"The level of complexity of the new technologies we encounter in our business is quite high."

Difficulty in finding qualified personnel brought about by Technology Complexity

The more complex a technology is, the more difficult it is to find the personnel needed to transition and adapt to the new technology (Goulart et al., 2022). Complex technologies require highly specialized knowledge to operate (Bailey, 2014). To access this expert knowledge, the business may need to update its current salary policy and sacrifice high wages to employ qualified staff. Nevertheless, the company may still have difficulties in recruiting personnel due to reasons such as the sector of the company and the facilities of the city where it is located. It is common that an expert AI engineer does not want to settle in a remote or rural area of the country to live with his/her family and prefers metropolitan cities with high living standards and job mobility.

"Since the level of complexity of the new technologies we encounter in our business is very high, we have difficulty in finding qualified personnel to use this new technology."

Purchasing cost difficulties brought about by Technology Complexity

The more complex a technology is, the larger the procurement budget needed for transition and adaptation to this new technology. This makes it difficult for businesses to transition and adapt to new technology. Since complex technology usually involves advanced hardware and software, the costs are high, and businesses may find it difficult to invest in these new technologies.

"Since the level of complexity of the new technologies we encounter in our business is very high, we are struggling with the procurement budget we need to allocate to these new technologies".

Cyber security vulnerabilities brought about by Technology Complexity

The more complex a technology is, the more difficult it is to meet the security needs of this new technology (M. S. A. Alqahtani and Erfani, 2021; Kemmerer, 2003). Since the software and hardware are at a high level, the business has to keep its cyber security measures constantly updated. This means additional staff and resources.

"Because the level of complexity of the new technologies we face in our business is so high, we have concerns about taking the security risk of these new technologies and protecting against potential threats".

Update pressure of Technology Complexity

The more complex a technology is, the more frequent and difficult it is to update this new technology. Newly developed technologies need more frequent updates. Since software and hardware are at a high level, the business has to constantly invest to keep complex technology up to date.

"Since the level of complexity of the new technologies we encounter in our business is very high, we find it difficult to keep up to date with these new technologies and keep up with innovations."

Legal difficulties related to procurement and use permits)

Obtaining and deploying new technology presents significant legal challenges, primarily due to the stringent permit requirements issued by regulatory authorities. These permits are crucial for ensuring compliance with local regulations and environmental standards. Navigating these regulatory hurdles can often delay the implementation of new technologies within operations in some sectors.

"We encounter legal challenges obtaining and deploying new technology due to permits issued by authorities."

CASE STUDY: TESTING THE PROPOSED METHOD

The proposed method was implemented in an elevator manufacturer, utilizing the survey provided in Appendix 1. This section begins with an overview of the company and then presents test results.

Details of the company

Founded in 2018, the company was established to provide project, consultancy, and material supply to its customers by following the development of technology in the elevator manufacturing sector. The company continues to improve itself daily in the sector in which it operates and offers more reliable service. The company manufactures all kinds of elevator cabins, landing, and cabin doors. At the same time, it sells domestic and imported elevator equipment, elevator motors, control panels and all materials and spare parts required during the installation phase of the elevator. In addition, the company is committed to providing all kinds of technical support as soon as possible, as required by all domestic and foreign dealers using its products. The products produced and sold by the company are shown in Figure 8.

Figure 8

Products of the Company

Application at the test company

The Delphi method was utilized in the research's implementation phase. Accordingly, to test the proposed new technology adaptation model, an application was made with 5 managers of company X, and a consensus was reached in the third round. The results obtained are listed below.

Table 2 presents the values given by Company X to the parameters related to the management dimension. The management dimension is measured through 8 parameters, and the average of all parameters reveals the management's concern about technology adaptation. Accordingly, the management concern value of Company X was calculated as 3.56.

Table 2

Parameters of management concern

Items	Value
M1. *"As management, we are concerned about the costs and start-up costs of investing in new technologies."*	*5*
M2. *"As management, we are concerned that new technologies will disrupt workflows, processes, in short, the existing system."*	*2*
M3. *"As management, we are worried that we do not feel comfortable with the new technology because we do not have experience with it, it does not seem reliable to us."*	*2*
M4. *"We are worried that the resistance that will occur in employees with the innovation will create problems in the organizational context."*	*5*

***M5**. "As management, we are worried about the decrease in productivity in production due to the learning effect with the transition to new technology."*	*4*
***M6**. "As management, we are concerned that new technologies such as software etc. may be incompatible with the existing system and problems that may arise in the integration process."*	*2*
***M7**. "As management, we are concerned that vulnerabilities in data security may arise with the transition to new technology."*	*3*
***M8**. "As management, we are concerned about the possible surprise costs that may arise in the future and the financial profitability of the investment, as it is difficult to make feasibility of the new technology."*	*4*
Mean	***3.56***

"Behavioral factors" that may affect technology adoption are measured through 4 parameters. The values given by Company X to the behavioral parameters are presented in Table 3. The average of the four parameters is calculated as 2.25.

Table 3

Behavior Dimension Parameters

Items	Value
B1. *"I think that employees in our organization are sufficiently motivated to adopt new technologies because new technology offers them many benefits and advantages."*	*2*
B2. *"In our organization, our employees consider the use of new technologies as simple and easy and can adapt to them quickly."*	*2*
B3. *"Employees in our organization can quickly adapt to new technologies because their friends, colleagues and people in their social environment use these technologies."*	*2*
B4. *"In our organization, employees are trained on the use of new technologies and the benefits of new technologies."*	*3*
Mean	***2.25***

"Organizational factors" that may affect technology adoption are measured through 6 parameters. The values given by Company X to the organizational parameters are presented in Table 4. The average of the parameter is calculated as 3.50.

Table 4

Organization dimension parameters

Items	Value
O1. *"Employees in our organization have the knowledge and skills to facilitate the use of new technologies."*	*3*
O2. *"The average age of our employees is low."*	*4*
O3. *"Our employees in our enterprise have a higher level of education compared to the sector average."*	*3*
O4. *"Our organization pays higher current wages than the sector average."*	*3*
O5. *"We have the ability and capability to manage the uncertainties and risks brought by new technology."*	*4*
O6. *"There is a culture of innovation and R&D in our organization, and the continuous improvement (Kaizen) suggestion system is used effectively."*	*4*
Mean	***3.50***

The "Overturning dimension" that may affect technology adoption is measured through 2 parameters. The values given by Company X to the parameters are presented in Table 5. The average of the parameter is calculated as 2.50.

Table 5

Overturning size parameters

Items	Value
OT1. *"The level of disruption of the new technologies we encounter in our organization is quite high."*	*2*
OT2. *"The level of reaction of our organization to changing technologies is high."*	*3*
Mean	***2.50***

The "Stakeholder dimension" that may affect technology adoption is measured through 5 parameters. The values given by Company X to the parameters are presented in Table 6. The average of the parameter is calculated as 3.40.

Table 6

Stakeholder dimension parameters

Items	Value
S1. *"Our business has the certifications and documents required by the sector"*	*3*
S2. *"The IT technologies we use are flexible"*	*4*
S3. *"Employees of our stakeholders have a high level of education."*	*3*
S4. *"Our organization has the financial competence required by new investments and technology"*	*3*
S5. *"Our stakeholders have the knowledge, know-how and aptitude for new technologies."*	*4*
Mean	***3.40***

The "Technology dimension" that may affect technology adoption is measured through 6 parameters. The values given by Company X to the parameters are presented in Table 7. The average of the parameter is calculated as 3.00.

Table 7

Technology dimension parameters

Items	Value
T1. *"The level of complexity of the new technologies we encounter in our business is quite high."*	*3*
T2. *"Since the level of complexity of the new technologies we encounter in our business is very high, we have difficulty in finding qualified personnel to use this new technology".*	*3*
T3. *"Since the level of complexity of the new technologies we encounter in our organization is very high, we have difficulties with the purchasing budget we need to allocate for these new technologies".*	*5*
T4. *"Since the level of complexity of the new technologies we encounter in our organization is very high, we have concerns about taking the security risk of these new technologies and providing protection against potential threats".*	*2*
T5. *"Since the level of complexity of the new technologies we encounter in our organization is very high, we have difficulties in keeping these new technologies up to date and keeping up with innovations".*	*3*
T6. *"We have legal difficulties in purchasing and using new technology".*	*2*
Mean	***3.00***

The average of Company X's responses to the parameters related to all dimensions provides a general perspective to evaluate each dimension. The average of all dimensions is summarized in Table 8.

Table 8
Arithmetic Mean Value

M	B	O	OT	S	T
3.56	2.25	3.50	2.50	3.40	3.00

The technology adaptation score was calculated using the averages of all dimensions. The technology adaptation score was determined using the following formula.

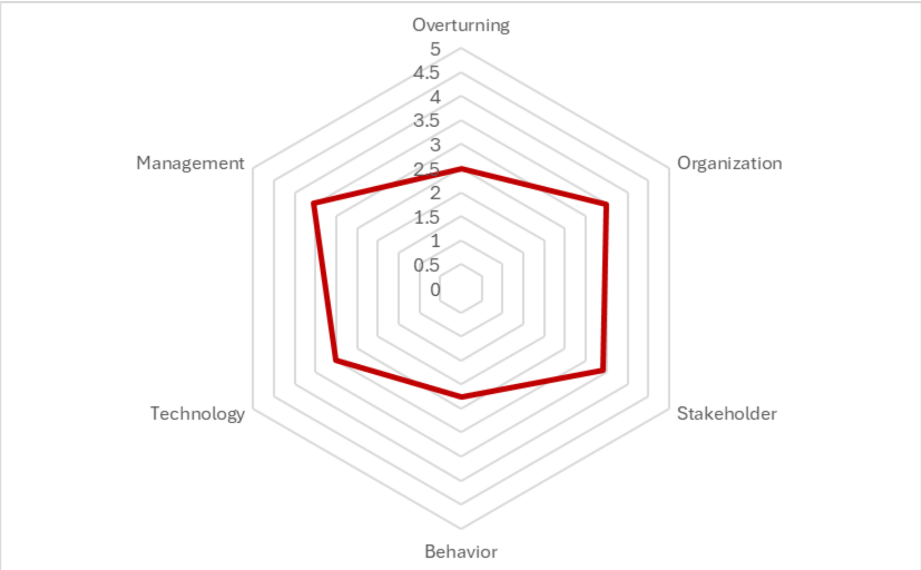
$$\textbf{M-BOOST Technology Adaptation Score} = \frac{\sqrt[4]{Overturning\ x\ Organization\ x\ Stakeholderx\ Behavior}}{\sqrt[2]{Technology\ x\ Management}}$$

Accordingly, M-BOOST Technology Adaptation Score calculation;

$$\textbf{M-BOOST} = \frac{\sqrt[4]{2.50\ x\ 3.50\ x\ 3.40\ x\ 2.25}}{\sqrt[2]{3.56\ x\ 3}} = \frac{\sqrt[4]{66.94}}{\sqrt[2]{10.68}} = \frac{2{,}86}{3{,}27} = \textbf{0.875}$$

The M-BOOST Technology Adaptation Score of Company X was calculated as 0.875. Figure 9 presents the company's technology adaptation score as a radar graph based on dimensions.

Figure 9
M-BOOST scores of company X



RESULTS AND DISCUSSION

Innovation is a necessity for ensuring continuity in human life. It is possible to see innovation as a reflection of the fact that man is a living being. In this respect, it is undeniable that innovations and renewal are essential for quality of life. In addition to the fact that innovation is an indispensable value of life, it should also be underlined that there is no standard reaction to innovations. With the emergence of innovation, the reactions given by individuals and organizations may vary. Just as it is impossible to evaluate all people through the same patterns, it is impossible to explain the adoption of innovations through a single concept (https://www.duendedijital.com/yeniliklerin-yayilmasi-kurami/). At this point, it should not be forgotten that the acceptance of innovation by users can be realized depending on many factors. Many models produced to explain innovation adoption also focus on these differences. In this study, a new model for innovation adoption is proposed and a sample application of the model is made on a company operating in Konya.

The M-BOOST Technology Adaptation model has 6 dimensions: Overturning, Organization, Stakeholder, Behavior, Technology and Management. Each dimension has its own sub-parameters. In determining the dimensions that make up the model, the existing models of innovation adoption were taken as a starting point and aimed to propose a new quantitative technique to measure the level of adaptation by expanding the scope of existing models. In this context, the management dimension deals with how the management receives the innovation. As a matter of fact, in the process of acceptance and adaptation of the innovation, some concerns of the management about the innovation make the adaptation process difficult. At this point, cost and technology's destructive effect can be considered the main concerns that technological innovation will create for managers. The uncertainty about the initial cost leads the management to take a hesitant attitude. Concerns may also be that it will disrupt the system and the existing order.

Such effects may create prejudice against innovation in businesses. In some cases, there may be a reluctance to deal with the resistance that may arise in the adoption of the innovation, and this may be exacerbated by the concern that the innovation may lead to a loss of productivity due to the learning curve over time. This hesitation may be the main result of employee resistance as well as uncertainty about the compatibility of the new technology with existing internal processes. Like the existing models in the literature, this study also includes the technology factor in innovation adoption. How complex the new technologies are and how high the acquisition costs are have a significant impact on innovation adoption. The higher the level of complexity and cost, the more difficult adaptation is. The complexity of the technology also creates difficulties in finding qualified personnel. At the same time, the complexity of the technology raises security concerns. Another factor related to the adaptation of innovation is behavioral factors. Like the existing studies, behavioral factors are also included in this model.

At this point, it can be said that the motivation of employees to adapt to new technology has a positive effect as much as the convenience that the technology will provide. In addition, while technology adaptation can be facilitated by technical training provided to employees, social impact also has effects that cannot be ignored. Other dimensions included in the model are overturning, organization, and stakeholder dimensions. The organizational dimension is a dimension that is also included in the adaptation models in the literature, and factors such as the structure of the organization and the quality of its resources are among the factors affecting adaptation to new technology. In this context, points such as whether employees have the knowledge and skills to facilitate technology adaptation, the average age of employees, the education level of employees, and Research and Development (R&D) activities are included in this dimension. In the overturning dimension, it was aimed to measure the level of disruption of technology and the level of reaction of the firm in terms of adaptation to new technologies. Finally, in the stakeholder dimension, the impact of stakeholders on technology adaptation is discussed. National and international laws, infrastructure flexibility of stakeholders, education levels of stakeholder employees, and financial competence of stakeholders are analyzed under this dimension. The new model was tested on a company for validation.

When the answers given to the parameters of the management dimension in the case study are evaluated, it is seen that the managers have a relatively high level of concern about investment costs, employee resistance, and loss of productivity and are concerned about the other parameters. When the overall value of the management dimension is analyzed, it can be seen that there is a high level of concern. When we look at the parameters that make up the technology dimension, which is another element of the model, it is seen that significant problems are felt in terms of the high complexity of the new technology and the purchasing budget, the difficulty in finding qualified personnel to use this technology, and the difficulties in keeping the technologies up-to-date. When the overall value of the technology dimension is analyzed, it can be seen that there is a negativity above the average. When the answers given to the parameters that make up the behavioral dimension are examined, it is seen that there is an evaluation tendency close to the average. Similar to the behavioral dimension, the parameters that make up the overturning dimension also show an evaluation tendency close to the average. When the answers given to the parameters that make up the stakeholder dimension of the organizational dimension are examined, it is seen that an evaluation above the average is made.

The model allows all dimensions to be evaluated separately in this way. In addition to making separate evaluations, a calculation was made on the proposed formulation to determine an overall adaptation score, and a value was put forward for the case study. The score obtained was calculated as a value below 1. While companies with an M-BOOST score below 1 indicate companies with troubled technology adaptation, it can be said that companies with a value between 1-3 are open to improvement in technology adaptation, and companies with a value above 3 are successful. Accordingly, since the M-BOOST score value of company X is below 1, it is seen that technology adaptation is a problem. One of the main reasons for this low value may be that the technology used by the sector in which the firm operates is not high technology.

CONCLUSION

In this study, we propose a new technology adaptation model named the M-BOOST Technology Adaptation model, which comprises six dimensions: Overturning, Organization, Stakeholder, Behavior, Technology, and Management. Each dimension includes its own parameters. The score of each dimension is calculated by the arithmetic average of these parameters. The M-BOOST Technology Adaptation Score is calculated by averaging these six dimensions' scores geometrically. This study tested the M-BOOST Technology Adaptation Score for a firm in Konya. As a result of the calculations, M-BOOST Technology Adaptation Scores are calculated for the sample firms over the dimensions of Overturning, Organization, Stakeholder, Behavior, Technology, and Management. The proposed model provides a scorecard showing the technology adaptation levels of firms. To better understand the model proposed in the research and better interpret the values obtained, it is recommended that the model be tested on firms with different technological levels, and the scores of the firms obtained should be evaluated and presented comparatively.

Ethics Committee Approval

The study does not require ethical approval.

Author Contributions

Research Design (CRediT 1): Author 1 (40%) – Author 2 (25%) – Author 3 (30%) – Author 4 (5%)

Data Collection (CRediT 2): Author 1 (30%) – Author 2 (30%) – Author 3 (30%) – Author 4 Demir (10%)

Research - Data Analysis - Validation (CRediT 3-4-6-11): Author 1 (40%) – Author 2 (40%) – Author 3 (10%) – Author 4 (10%)

Manuscript Writing (CRediT 12-13): Author 1 (40%) – Author 2 (30%) – Author 3 (20%) – Author 4 (10%)

Text Editing and Improvement (CRediT 14): Author 1 (25%) – Author 2 (25%) – Author 3 (25%) – Author 4 (25%)

Finance

There is no financial support.

Conflict of Interest

There is no conflict of interest among the authors.

Sürdürülebilir Kalkınma Amaçları (SDG)

Sürdürülebilir Kalkınma Amaçları: 9 Sanayi, Yenilikçilik ve Altyapı

Sürdürülebilir Kalkınma Amaçları: 16 Barış, Adalet ve Güçlü Kurumlar

REFERENCES

Abed, S. S. (2020). Social commerce adoption using TOE framework: An empirical investigation of Saudi Arabian SMEs. *International Journal of Information Management*, *53,* 102118. https://doi.org/10.1016/j.ijinfomgt.2020.102118

Ajzen, I. (1980). *Understanding attitudes and predicting social behavior.* Englewood Cliffs: Prentice-Hall.

Aksak, O. (2022). İşletmelerde teknoloji. Fhome Bilişim. https://www.fhomebilisim.com/blog /isletmelerde-teknoloji.htm

Ale Ebrahim, N., & Bong, Y. (2017). Open innovation: A bibliometric study. *International Journal of Innovation (IJI), 5*(3).

Alqahtani, M. S. A., & Erfani, E. (2021). Exploring the relationship between technology adoption and cybersecurity compliance: A quantitative study of UTAUT2 model. *International Journal of Electronic Government Research (IJEGR), 17*(4), 40–62. https://doi.org/10.4018/IJEGR.2021100103

Alqahtani, M., & Braun, R. (2021). Reviewing the influence of UTAUT2 factors on cybersecurity compliance: A literature review. *Journal of Information Assurance & Cyber Security.*

Asplund, F., Björk, J., Magnusson, M., & Patrick, A. J. (2021). The genesis of public-private innovation ecosystems: Bias and challenges☆. *Technological Forecasting and Social Change, 162,* 120378. https://doi.org/10.1016/j.techfore.2020.120378

Bailey, J. L. (2014). Non-technical skills for success in a technical world. *International Journal of Business and Social Science, 5*(4).

Baker, J. (2012). The technology–organization–environment framework. In Y. K. Dwivedi, M. R. Wade, & S. L. Schneberger (Eds.), *Information systems theory: Explaining and predicting our digital society, Vol. 1* (pp. 231–245). Springer. https://doi.org/10.1007/978-1-4419-6108-2_12

Brown, S. A., Massey, A. P., Montoya-Weiss, M. M., & Burkman, J. R. (2002). Do I really have to? User acceptance of mandated technology. *European Journal of Information Systems, 11*(4), 283–295. https://doi.org/10.1057/palgrave.ejis.3000438

Chatterjee, S., Nguyen, B., Ghosh, S. K., Bhattacharjee, K. K., & Chaudhuri, S. (2020). Adoption of artificial intelligence integrated CRM system: An empirical study of Indian organizations. *The Bottom Line, 33*(4), 359–375. https://doi.org/10.1108/BL-09-2020-0071

Chatzoglou, P., & Chatzoudes, D. (2016). Factors affecting e-business adoption in SMEs: An empirical research. *Journal of Enterprise Information Management, 29*(3), 327–358. https://doi.org/10.1108/JEIM-03-2014-0033

Collins, P. D., Hage, J., & Hull, F. M. (1988). Organizational and technological predictors of change in automaticity. *Academy of Management Journal, 31*(3), 512–543. https://doi.org/10.2307/256459

Cruz-Jesus, F., Pinheiro, A., & Oliveira, T. (2019). Understanding CRM adoption stages: Empirical analysis building on the TOE framework. *Computers in Industry, 109,* 1–13. https://doi.org/10.1016/j.compind.2019.03.007

da Silva, S. B. (2021). Improving the firm innovation capacity through the adoption of standardized innovation management systems: A comparative analysis of the ISO 56002: 2019 with the literature on firm innovation capacity. *International Journal of Innovation, 9*(2), 389–413. https://doi.org/10.1108/IJI-02-2021-0003

Davis, F. D. (1985). A technology acceptance model for empirically testing new end-user information systems: Theory and results (Doctoral dissertation, Massachusetts Institute of Technology). https://dspace.mit.edu/handle/1721.1/15192

Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly, 13*(3), 319–340. https://doi.org/10.2307/249008

Dearing, J. W., & Cox, J. G. (2018). Diffusion of innovations theory, principles, and practice. *Health Affairs, 37*(2), 183–190. https://doi.org/10.1377/hlthaff.2017.1104

Fonseka, K., Jaharadak, A. A., & Raman, M. (2022). Impact of e-commerce adoption on business performance of SMEs in Sri Lanka: Moderating role of artificial intelligence. *International Journal of Social Economics, 49*(10), 1518–1531. https://doi.org/10.1108/IJSE-03-2021-0187

Gafni, R., & Geri, N. (2013, February). Generation Y versus generation X: Differences in smartphone adaptation. In *Learning in the technological era: Proceedings of the Chais conference on instructional technologies research* (pp. 18–23).

Ganguly, K. K. (2024). Understanding the challenges of the adoption of blockchain technology in the logistics sector: The TOE framework. *Technology Analysis & Strategic Management, 36*(3), 457–471. https://doi.org/10.1080/09537325.2024.1212345

Goulart, V. G., Liboni, L. B., & Cezarino, L. O. (2022). Balancing skills in the digital transformation era: The future of jobs and the role of higher education. *Industry and Higher Education*, *36*(2), 118–127. https://doi.org/10.1177/09504222211058303

Güngör, T. (2018). *Endüstri 4.0 çerçevesinde inovasyon ve teknoloji temelli büyüme* (Master's thesis, Anadolu University).

Hameed, W. U., Basheer, M. F., Iqbal, J., Anwar, A., & Ahmad, H. K. (2018). Determinants of firm's open innovation performance and the role of R & D department: An empirical evidence from Malaysian SMEs. *Journal of Global Entrepreneurship Research, 8*(1), 1–20. https://doi.org/10.1186/s40497-018-0094-8

Hashimy, L., Jain, G., & Grifell-Tatjé, E. (2023). Determinants of blockchain adoption as decentralized business model by Spanish firms: An innovation theory perspective. *Industrial Management & Data Systems, 123*(1), 204–228. https://doi.org/10.1108/IMDS-05-2022-0341

Hashmi, M., Governatori, G., Lam, H. P., & Wynn, M. T. (2018). Are we done with business process compliance: State of the art and challenges ahead. *Knowledge and Information Systems, 57*(1), 79–133. https://doi.org/10.1007/s10115-017-1110-1

Hausman, A., & Stock, J. R. (2003). Adoption and implementation of technological innovations within long-term relationships. *Journal of Business Research, 56*(8), 681–686. https://doi.org/10.1016/S0148-2963(01)00253-2

Huang, K. F. (2011). Technology competencies in competitive environment. *Journal of Business Research*, *64*(2), 172–179. https://doi.org/10.1016/j.jbusres.2010.02.003

Jensen, P. H., & Webster, E. (2004). Examining biases in measures of firm innovation. Melbourne, Australia: Melbourne Institute of Applied Economic and Social Research, University of Melbourne.

Kaminski, J. (2011). Diffusion of innovation theory. *Canadian Journal of Nursing Informatics, 6*(2), 1–6.

Kemmerer, R. A. (2003, May). Cybersecurity. In *25th International Conference on Software Engineering, 2003. Proceedings.* (pp. 705–715). IEEE. https://doi.org/10.1109/ICSE.2003.1201242

Khan, N. A., Khan, A. N., Bahadur, W., & Ali, M. (2021). Mobile payment adoption: A multi-theory model, multi-method approach and multi-country study. *International Journal of Mobile Communications, 19*(4), 467–491. https://doi.org/10.1504/IJMC.2021.115242

Kim, D. Y., Kumar, V., & Kumar, U. (2012). Relationship between quality management practices and innovation. *Journal of Operations Management, 30*(4), 295–315. https://doi.org/10.1016/j.jom.2012.03.003

Kulviwat, S., Bruner II, G. C., & Al-Shuridah, O. (2009). The role of social influence on adoption of high-tech innovations: The moderating effect of public/private consumption. *Journal of Business Research, 62*(7), 706–712. https://doi.org/10.1016/j.jbusres.2007.04.014

LaMorte, W. W. (2022). Behavioral change models: Diffusion of innovation theory. Boston University School of Public Health. https://sphweb.bumc.bu.edu/otlt/mph-modules/sb/behavioralchangetheories/behavioralchangetheories4.html

Lawrence, P. R. (1968). How to deal with resistance to change. *Harvard Business Review*.

Malik, S., Chadhar, M., Vatanasakdakul, S., & Chetty, M. (2021). Factors affecting the organizational adoption of blockchain technology: Extending the technology–organization–environment (TOE) framework in the Australian context. *Sustainability*, *13*(16), 9404. https://doi.org/10.3390/su13169404

Marangunić, N., & Granić, A. (2015). Technology acceptance model: A literature review from 1986 to 2013. *Universal Access in the Information Society, 14*(1), 81–95. https://doi.org/10.1007/s10209-014-0348-1

Marikyan, D., & Papagiannidis, S. (2023). Technology acceptance model—TheoryHub—Academic theories reviews for research and T&L. *Technology Acceptance Model: A Review*. https://open.ncl.ac.uk/theories/1/technology-acceptance-model

Marquardt, K., Just, V., Geldmacher, W., Sommer, M., & Pamfilie, R. (2017). Disruptive innovations, their characteristics and implications on economy and people. *New Trends in Sustainable Business and Consumption - 2017,* 410–418.

Millar, C., Lockett, M., & Ladd, T. (2018). Disruption: Technology, innovation, and society. *Technological Forecasting and Social Change, 129*(4), 254–260. https://doi.org/10.1016/j.techfore.2017.10.020

Minishi-Majanja, M. K., & Kiplang'at, J. (2005). The diffusion of innovations theory as a theoretical framework in library and information science research. *South African Journal of Libraries and Information Science, 71*(3), 211–224. https://doi.org/10.7553/71-3-605

Morris, M. G., & Venkatesh, V. (2000). Age differences in technology adoption decisions: Implications for a changing workforce. *Personnel Psychology, 53*(2), 375–403. https://doi.org/10.1111/j.1744-6570.2000.tb00206.x

Mueller, J. S., Melwani, S., & Goncalo, J. A. (2012). The bias against creativity: Why people desire but reject creative ideas. *Psychological Science, 23*(1), 13–17. https://doi.org/10.1177/0956797611421018

Nadeau, M. C., Kar, A., Roth, R., & Kirchain, R. (2010). A dynamic process-based cost modeling approach to understand learning effects in manufacturing. *International Journal of Production Economics, 128*(1), 223–234. https://doi.org/10.1016/j.ijpe.2010.06.003

Ngah, A. H., Zainuddin, Y., & Thurasamy, R. (2017). Applying the TOE framework in the Halal warehouse adoption study. *Journal of Islamic Accounting and Business Research, 8*(2), 161–181. https://doi.org/10.1108/JIABR-05-2015-0024

Nguyen, T. H., Le, X. C., & Vu, T. H. L. (2022). An extended technology-organization-environment (TOE) framework for online retailing utilization in digital transformation: Empirical evidence from Vietnam. *Journal of Open Innovation: Technology, Market, and Complexity, 8*(4), 200. https://doi.org/10.3390/joitmc8040200

Oliveira, T., & Martins, M. F. (2010, September). Information technology adoption models at firm level: Review of literature. In *The European Conference on Information Systems Management* (pp. 312). Academic Conferences International Limited.

Olivieri, F. (2014). Compliance by design: Synthesis of business processes by declarative specifications (Doctoral dissertation, Griffith University). https://iris.univr.it/handle/11562/772161

Pietrewicz, L. (2019). Technology, business models and competitive advantage in the age of Industry 4.0. *Problemy Zarządzania, 17*(2 (82)), 32–52. https://doi.org/10.7172/1644-9584.82.2

Quazi, A., & Talukder, M. (2011). Demographic determinants of adoption of technological innovation.

Journal of Computer Information Systems, 52(1), 34–42.

Reinders, M. J., Banovic, M., & Guerrero, L. (2019). Introduction. In *Innovations in Traditional Foods* (pp. 1–26). Woodhead Publishing. https://doi.org/10.1016/B978-0-08-100596-5.00001-5

Riddell, W. C., & Song, X. (2017). The role of education in technology use and adoption: Evidence from the Canadian workplace and employee survey. *ILR Review, 70*(5), 1219–1253. https://doi.org/10.1177/0019793916660060

Rogers, E. (2003). *Diffusion of innovations* (5th ed.). New York: Simon & Schuster.

Salgues, B. (2016). Acceptability and diffusion. In *Health Industrialization* (pp. 53–69). Elsevier. https://doi.org/10.1016/B978-1-78548-175-3.50007-5

Scherer, R., Siddiq, F., & Tondeur, J. (2019). The technology acceptance model (TAM): A meta-analytic structural equation modeling approach to explaining teachers' adoption of digital technology in education. *Computers & Education, 128,* 13–35. https://doi.org/10.1016/j.compedu.2018.09.009

Schumm, D., Leymann, F., Ma, Z., Scheibler, T., & Strauch, S. (2010). Integrating compliance into business processes. In *Multikonferenz Wirtschaftsinformatik* (Vol. 2010, p. 421).

Schumpeter, J. A. (1942). *Capitalism, socialism and democracy.* Routledge.

Seong, H. E., & Kim, B. Y. (2021). Critical factors affecting venture capital investment decision on innovative startups: A case of South Korea. *International Journal of Management (IJM), 12*(3), 768–781.

Sterns, H. L., & Doverspike, D. (1989). Aging and the training and learning process. In I. L. Goldstein (Ed.), *Training and development in organizations* (pp. 299–332). Jossey-Bass.

Stjepić, A. M., Pejić Bach, M., & Bosilj Vukšić, V. (2021). Exploring risks in the adoption of business intelligence in SMEs using the TOE framework. *Journal of Risk and Financial Management, 14*(2), 58. https://doi.org/10.3390/jrfm14020058

Sun, W., & Huo, J. (2005). Essential factor analysis on the cluster-based technological innovation. In *Fourth Wuhan International Conference on E-Business: The Internet Era & The Global Enterprise* (Vols. 1 and 2, pp. 1469–1474). Alfred University.

Şimşek, O. (2023, November 10). Teknolojik yetkinlik: Çalışanların sürekli öğrenme yolculuğu. *IIE Enstitü.* https://www.iienstitu.com/blog/teknolojik-yetkinlik-calisanlarin-surekli-ogrenme-yolculugu

Tajudeen, F. P., Jaafar, N. I., & Ainin, S. (2018). Understanding the impact of social media usage among organizations. *Information & Management, 55*(3), 308–321. https://doi.org/10.1016/j.im.2017.08.004

Teece, D. J., Pisano, G., & Shuen, A. (1997). Dynamic capabilities and strategic management. *Strategic Management Journal, 18*(7), 509–533. https://doi.org/10.1002/(SICI)1097-0266(199708)18:7<509::AID-SMJ882>3.0.CO;2-Z

Tornatzky, L., & Fleischer, M. (1990). *The process of technology innovation.* Lexington Books.

Ullah, F., Qayyum, S., Thaheem, M. J., Al-Turjman, F., & Sepasgozar, S. M. (2021). Risk management in sustainable smart cities governance: A TOE framework. *Technological Forecasting and Social Change, 167,* 120743. https://doi.org/10.1016/j.techfore.2021.120743

Uyumaz, M. (2002). Organizasyonların teknolojik gelişmelere uyum sağlama yolları (Master's thesis, Anadolu University).

Van Raaij, E. M., & Schepers, J. J. (2008). The acceptance and use of a virtual learning environment in China. *Computers & Education, 50*(3), 838–852. https://doi.org/10.1016/j.compedu.2006.09.001

Venkatesh, V. (2000). Determinants of perceived ease of use: Integrating control, intrinsic motivation, and emotion into the technology acceptance model. *Information Systems Research, 11*(4), 342–365. https://doi.org/10.1287/isre.11.4.342.11872

Volkom, M. V., Stapley, J. C., & Amaturo, V. (2014). Revisiting the digital divide: Generational differences in technology use in everyday life. *North American Journal of Psychology, 16*(3).

Wallace, S., Green, K., Johnson, C., Cooper, J., & Gilstrap, C. (2021). An extended TOE framework for cybersecurity adoption decisions. *Communications of the Association for Information Systems, 47*(2020), 51. https://doi.org/10.17705/1CAIS.04703

Watson, G. (1971). Resistance to change. *American Behavioral Scientist, 14*(5), 745–766. https://doi.org/10.1177/000276427101400503

Wright, T. P. (1936). Factors affecting the cost of airplanes. *Journal of the Aeronautical Sciences, 3*(4), 122–128. https://doi.org/10.2514/8.155

Yasuda, R., & Batres, R. (2012). An agent-based model for analyzing diffusion of biodiesel production schemes. In *Computer Aided Chemical Engineering* (Vol. 30, pp. 192–196). Elsevier. https://doi.org/10.1016/B978-0-444-59428-0.50039-1

APPENDIX 1: MBOOST Technology Adaptation Scale

MBOOST Parameters	***Linguistic Scale***				
M / Management (Management concerns)	***Strongly Disagree***	***Disagree***	***Neutral***	***Agree***	***Strongly Agree***
M1. Management Concerns about Cost					
"As management, we are concerned about the costs of investing in new technologies and initial expenses."	1	2	3	4	5
M2. Distruptive impact concerns					
"As management, we are concerned that new technologies will disrupt workflows, processes, in short, the existing system."	1	2	3	4	5
M3. Management bias and lack of trust					
"As management, we do not feel comfortable with new technology due to our lack of experience and are concerned that it does not seem reliable to us"	1	2	3	4	5
M4. Employee resistance to change					
"We are concerned about the resistance that will arise among employees in the organizational context due to innovation"	1	2	3	4	5
M5. Learning curve effect					
"As management, we are concerned about the decrease in productivity in production due to the learning effect with the transition to new technology."	1	2	3	4	5
M6. Compliance in internal processes / Compliance problem in internal process					
"As management, we are concerned about the potential incompatibility of new technologies such as software with the existing system and the problems that may arise during the integration process."	1	2	3	4	5
M7. Data security / Data security concern					
"As management, we are concerned that vulnerabilities in data security may arise with the transition to new technology."	1	2	3	4	5
M8. Feasibility calculation difficulty					
"As management, we are concerned about the potential surprise costs and the financial profitability of the investment in the future due to the difficulty in feasibility assessment for new technology."	1	2	3	4	5

B / Behaviour (Motivating Technology Adoption)					
B1. Motivation/Benefit					
"I believe that our employees are sufficiently motivated to transition to new technologies in our company because the new technology offers them many benefits and advantages."	1	2	3	4	5
B2. Ease of use					
" In our company, our employees find the use of new technologies simple and easy, and they are able to adapt quickly."	1	2	3	4	5
B3. Social Impact					
"Our employees quickly adapt to new technologies because they see their friends, colleagues, and people in their social circles using these technologies."	1	2	3	4	5
B4. Technology Learning					
"Our employees are provided with training on the use of new technologies and their benefits."	1	2	3	4	5
O / Organization (Influence of Team Attributes on Technology Adoption)					
O1. Technology savvy (Hiring skilled professionals)					
"Our employees have the knowledge and skills to facilitate the use of new technologies in our business."	1	2	3	4	5
O2. Average age of employees					
"The average age of our employees is low."	1	2	3	4	5
O3. Education level of employees					
"In our business, our employees have a higher level of education compared to the industry average."	1	2	3	4	5
O4. Wage status					
"In our business, higher current wages are paid compared to the industry average."	1	2	3	4	5
O5. Corporate advantage (Impact of corporate and well-established organization)					
"We have corporate capability and capacity to manage the uncertainties and risks brought by new technology."	1	2	3	4	5
O6. Innovation and R&D culture					
"In our business, there is a culture of innovation and R&D, and the Continuous Improvement (Kaizen) suggestion system is effectively utilized." *Number of suggestions per year* **(1)** 0-9 **(2)** 10-25 **(3)** 26-50 **(4)** 51-75 **(5)** 100 + *(Please make your evaluation on the linguistic scale using this ruler.)*	1	2	3	4	5
O / Overturning (Disruptiveness and Change Response: Adapting Capacity to Disruption)					
OT1.Level of Technology Disruption					
"The level of disruption of the new technologies we encounter in our business is quite high."	1	2	3	4	5
OT2. Response Level to Changes					
"The level of reaction of our organization to changing technologies is high."	1	2	3	4	5
S / Stakeholders (Stakeholder Compliance Impact)					
S1. Regulatory Influence / Compliance to standards and regulations					
"Our business has the certifications and documents required by the stakeholders and sector. These certificates encourage us to transition and adapt to new technologies. " *Number of certifications we have is…* **(1)** 0 **(2)** 1 **(3)** 2 **(4)** 3 **(5)** 4 + *(Please make your evaluation on the linguistic scale using this ruler.)*	1	2	3	4	5
S2. Flexibility in Technology Integration					
"The IT technologies we use are flexible"	1	2	3	4	5
S3. Training / employee engagement:					
"Our stakeholders' employees have a high level of education."	1	2	3	4	5
S4. Financial capability					
"Our organization has the financial capability required by new investments and technology"	1	2	3	4	5
S5. Stakeholders' Tech Knowledge and Aptitude					
"Our stakeholders have knowledge, familiarity and aptitude for new technologies."	1	2	3	4	5
T / Technology (Complexity of new technology and the challenges it creates)					
T1. Complexity Level of Technology					
"The level of complexity of the new technologies we encounter in our business is quite high."	1	2	3	4	5
T2. Difficulty in finding qualified personnel brought about by Technology Complexity					
"Since the level of complexity of the new technologies we encounter in our business is very high,	1	2	3	4	5

we have difficulty in finding qualified personnel to use this new technology."					
T3. Purchasing cost difficulties brought about by Technology Complexity					
"Since the level of complexity of the new technologies we encounter in our business is very high, we are struggling with the procurement budget we need to allocate to these new Technologies."	1	2	3	4	5
T4. Cyber Security vulnerabilities brought about by Technology Complexity					
"Because the level of complexity of the new technologies we face in our business is so high, we have concerns about taking the security risk of these new technologies and protecting against potential threats".	1	2	3	4	5
T5. Update pressure of Technology Complexity					
"Since the level of complexity of the new technologies we encounter in our business is very high, we find it difficult to keep up to date with these new technologies and keep up with innovations."	1	2	3	4	5
T6. Legal difficulties related to procurement and use permits					
"We encounter legal challenges obtaining and deploying new technology due to permits issued by authorities."	1	2	3	4	5