RESEARCH ARTICLE

Evaluation of Online Markets Considering Trust and Resilience: A Framework for Predicting Customer Behavior in E-Commerce

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ABSTRACT
The evolution of electronic commerce has led to expanding online markets due to convenience, online incentives, greater access to information, broader selections, competition, pricing, product quality, and lead time, i.e., the time that it takes to deliver the products after an order is placed. However, online markets have captured less attention in environments where consumers are concerned about the security and privacy of their personal data. Such concerns can be due to several reasons, from the reluctance in using electronic commerce to the lack of trust and reliability of web vendors. In this paper, we study trust and resilience engineering in such online markets and identify the most and least significant factors impacting online shopping systems. To tackle the inherent uncertainties of data used in our analysis, we propose a Fuzzy Data Envelopment Analysis (FDEA) model and validate our findings. Numerical examples show the efficiency of the proposed method in evaluating online and offline shopping systems with respect to trust and resilience.

KEYWORDS
Online shopping, traditional shopping, trust in markets, resilience engineering, fuzzy set theory

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1. Introduction
1.1 Introduction and Literature Review
In today’s world, many businesses have pursued the Internet as a means through which they can navigate their marketing activities for competing with their business rivals (S. J. Tan, 1999). It is because the Internet provided added value in markets by increasing processes efficiency, shortening lead times, and automating processes that previously required personnel (Mahmood et al., 2008). As a result, customers are inundated with countless analogous offerings. Nowadays, more than ever, customers insist on their needs to be instantly met, utterly and without paying any extra money (Ahn et al., 2005). Thus, practitioners believe that the most important challenging point in electronic commerce is to meet customers’ requirements, make them satisfied, and be competent at serving their customers (Ahn et al., 2005; Miremadi and Ghanadiof 2021a).

The growth of electronic commerce has rapid acceleration because of its advantages such as various choices, convenience, saving time, rapid price comparison, different product quality, and greater access to information (Keeney 1999; Riegelsberger et al., 2005). In fact, sales through online channels are increasing due to the increasing penetration of the Internet worldwide, consumer acceptance of the convenience of online shopping, and increasing emphasis on online shopping (Schubert et al., 2011). While the acceptance of electronic commerce continues to grow, customers’ concerns about privacy and security necessitate considering trust and reliability in online market activities (Urban et al., 2009). Such concerns come from customers due to insecurity and dissemination of the available information and the lack of trust and reliability of web vendors. Therefore, trust and reliability play crucial roles in such online interactions (Teo et al., 2007) to mitigate uncertainties in online shopping. The importance of trust is because of its effects on a number of essential factors to online transactions, such as security and privacy. Despite the fact that electronic commerce has advantages to not only customers but also vendors, it also has restrictions like the temporal separation.
between transaction parties. In order to decrease the blockades, a businessperson must create a trustworthy relationship to
develop customer loyalty (Teo et al., 2007; Ghanadiof 2021). The antecedent and background of trust empower us to realize the
relative importance of factors that affect trust. In e-commerce, although the importance of trust is completely recognized and
acknowledged, there are still many contradictions in online markets. The basis of these contradictions is because of having great
difficulties in defining trust, understanding the definition of trust and its antecedents and consequences, failing to consider both
trustee and trustor, and confusing levels of analysis due to lack of specificity of trust referents (Mayer et al., 1995; Miremadi and
Ghanadiof 2021b).

To incorporate trust in markets, Mayer (Mayer et al., 1995) offered a model combining both trust parties, trustor and trustee, and
considered the trustor’s perceptions related to the trustee’s characteristics. At the beginning of the advent of trust requirements,
trust among people and organizations attracted little attention. Actually, there were a few studies that considered consumer trust
in Internet shopping. Some researchers like Jarvenpaa (Jarvenpaa et al., 1999) pursued limited models which just focused on the
Internet merchant and, in the context of e-commerce, he examined whether some factors like reputation and size of internet stores
affect customers trust (Jarvenpaa et al., 1999). Consequences of trust and their effects on customers’ behaviors, intentions, and
attitudes have been investigated by some practitioners (Jarvenpaa et al., 1999; McKnight et al., 2000; Miremadi and Ghanadiof
2021c; Ghanadiof et al., 2021). The influence of channel integration of a multi-channel firm on customer loyalty has been reviewed
by Bendoly (Bendoly et al., 2005). Understanding the fact that design can influence customers’ trust (Nielsen, 1999) has led to the
development of some researches, such as computer supported cooperative work (CSCW) and human-computer interaction (HCI),
and providing systems and environments which are capable of creating, maintaining and increasing trust among consumers and
machines, and also among consumers themselves. (Corritore et al., 2003; Sillence et al., 2006).

Regarding the effect of cultural factors on trust, Hofstede (Hofstede, 1984) proposed four dimensions, particularly national culture.
Some structures of experimental trust-building processes have been proposed which demonstrate the significance of culture in the
expansion and development of trust (Doney et al., 1998; Miremadi and Ghanadiof, 2021b). In a similar vein, Jarvenpaa and
Tractinsky (Jarvenpaa et al., 1999) proposed that the antecedents of consumer trust in an online transaction can be affected by
cultural factors. Furthermore, cross-cultural e-commerce adoption models were proposed in the literature (Pavlou et al., 2002;
Ghanadiof 2021), which showed that customers’ attitudes could be directly influenced by trust in different cultures.

Mcknight and Chervany (Mcknight et al., 2012) have justified a parsimonious interdisciplinary typology of trust types, defining two
levels of trust construct, conceptual-level and operational-level. Walczuch and Lundgren (Walczuch et al., 2004) examined
Psychological antecedents of trust in e-vendors. Koufaris and Hampton-Sosa (Koufaris et al., 2004) proposed a model of initial
and used a questionnaire-based field study to empirically test the model, and results show that initial trust can be affected
directly by perceived reputation and inclination to customize products and services. Pennington (Pennington et al., 2003)
demonstrated the importance of some interventions that affect trust. Lee MKO (Lee et al., 2001) described a theoretical model and
emphasized the importance of merchant integrity in consumer trust Internet shopping.

In another stream of research, a few studies, i.e., (Gefen et al., 2003; Pavlou, 2003; Gefen & Straub, 2004; Ghashami and Kamyar,
2021), have proposed an integrated model of trust with technology acceptance and shown the importance of social presence on these
dimensions. Trust has been examined in different English-speaking countries and newly industrialized countries such as the
US (Kennedy et al., 2001), Australia (Jarvenpaa et al., 1999), US and Israel (Jarvenpaa et al., 1999), Japan and America (Yamagishi
1994), South Africa Gefen (Gefen et al., 2005; Miremadi et al., 2021b), and Singapore (Teo & Liu, 2007).

| Table 1. Literature review summary |
|----------------------------------|
| (McKnight & Chervany, 2012)      | (Tan, 2001; Miremadi and Ghanadiof 2021a) | (Tan, 2003; Miremadi and Ghanadiof 2021b) | (Gefen, 2003; Knell & Stix, 2010; Pavlou, 2003; Ghanadiof 2021) | This study |
| Typology of trust types          | √                                            |                                             |                                                         |            |
| Trust model                      |                                               | √                                            |                                                         |            |
| Trust & technology acceptance model |                                            |                                               | √                                            | √            |
| Impressive factors of trust      |                                               |                                               |                                                         | √            |
| Trust in traditional shopping    |                                               |                                               |                                                         | √            |
In addition to trust, evaluating the effects of resilience engineering (RE) is another important factor in online and traditional shopping systems. Resilience is the capability of recognizing, adapting to, and coping with unexpected events (Filabadi and Bagheri, 2021). RE provides provocative penetration into system safety as an aggregate of its various components, subsystems, software, organizations, human behaviors, and the way in which they interact (Hollnagel, 2011; Miremadi et al., 2021a, Sadighpour et al., 2022, Movahednia et al., 2021; Movahednia et al., 2022a). Resilience Engineering has arisen as a natural growth from the principles of organizational reliability (Reason et al., 1997; Weick et al., 2008) and a new comprehension of the factors behind human performance and also human error (Woods et al., 1994; Ghashami et al., 2021). Consequently, the new field is fostering ways to combine human and organizational risk in engineering tools of life cycle systems and to develop knowledge management tools that take the effects of human and organizational factors on risk (Filabadi and Bagheri, 2021; Movahednia et al., 2022b).

In the literature of online markets, as shown in Table 1, previous studies mainly focused on the impacts of trust in their analysis and considered only two main factors of trust, i.e., integrity and structural assurance, that have been mostly considered. However, researchers have shown there are two additional important factors of trust, such as benevolence and competence, and figuring out the effect of each individual factor can help users create appropriate measures to incorporate trust (Teo et al., 2007). In this paper, we consider four factors of trust and analyze the consequences of all factors of trust to predict customer behavior. Furthermore, we also consider resilience engineering, in addition to trust, in evaluating online markets and providing more accurate and comprehensive analysis. Particularly, in this paper, we investigate the effects of trust, management commitment, awareness, flexibility from the resilience engineering principles and use the concept of data envelopment analysis (DEA) method to evaluate the factors affecting trust and resilience and rank them based on their impacts. In addition, in order to address the potential uncertainties in input data, we propose a fuzzy model combined with the DEA method and evaluate our results. The contributions of this paper are highlighted as follows:

- We evaluate online markets considering four factors of trust such as benevolence, integrity, competence, and structural assurance, and also incorporate resilience engineering in our analysis, which is the first study that considers both trust and resilience in the evaluation model.
- We propose a fuzzy data envelopment analysis (FDEA) model to analyze the factors affecting trust and resilience and rank them based on their impacts considering the uncertainties in data.
- We provide a framework for predicting customer behavior which is beneficial in various businesses to find an optimal decision based on such prediction.

2. Methodology

![Figure 1. A schematic diagram on the steps of our methodology](image-url)

| Trust in e-commerce | ✓ | ✓ | ✓ | ✓ |
|---------------------|---|---|---|---|
| Resilience in traditional shopping | ✓ | ✓ | ✓ | ✓ |
| Resilience in e-commerce | ✓ | ✓ | ✓ | ✓ |
In this paper, the methodology consists of data collection, statistical tests and modeling, sensitivity analysis, and performance evaluation. To do so, we use data envelopment analysis and fuzzy theory for identifying the most important factors in markets under uncertainty in data. Also, we use statistical tools to validate our results. Figure 1 shows a schematic diagram of the steps used in the methodology. Required details on each step are provided throughout this section.

2.1 Data envelopment analysis

Data envelopment analysis (DEA) is a non-parametric technique which is initially proposed by Charnes (Charnes, Cooper et al., 1978). This technique is used to evaluate the relative efficiencies of a set of homogenous decision-making units (DMUs). For ranking the efficiencies, a ratio of the weighted sum of outputs to the weighted sum of inputs is used as follows (Talluri 2000):

\[ E = \frac{\text{weighted sum of outputs}}{\text{weighted sum of inputs}} \]  

Consider the following notation.

- \( s \) : the number of DMUs
- \( y_{ki} \) : is the amount of output \( p \) produced by the \( i^{th} \) DMU
- \( x_{ij} \) : represents the amount of input \( j \) consumed by the \( i^{th} \) DMU
- \( v_j \) : represents the given weight to input \( j \)
- \( u_k \) : represents the given weight to output \( k \)

Charnes (Charnes et al., 1978) proposed a model to acquire the relative efficiency score of a test DMU (for example, the \( p^{th} \) DMU) where each DMU has the same \( m \) inputs and same \( s \) outputs. The proposed model is as follows:

\[
\begin{align*}
\text{Max} & \quad \sum_{k=1}^{s} u_k y_{kp} \\
\text{s.t.} & \quad \sum_{k=1}^{s} u_k y_{ki} \leq 1 \quad \forall \ i = 1, \ldots, n \\
& \quad \sum_{j=1}^{m} v_j x_{ji} = 1 \\
& \quad \sum_{k=1}^{s} u_k y_{ki} - \sum_{j=1}^{m} v_j x_{ji} \leq 0 \quad \forall \ i = 1, \ldots, n \\
& \quad v_j, u_k \geq 0
\end{align*}
\]  

Where (2) is the objective function to maximize the relative efficiency score. Constraint (3) ensures the relative efficiency scores are all at most 1, and constraint (4) is the non-negativity constraint to assign practical weights to inputs and outputs.

The proposed program is nonlinear due to objective function (2) and constraint (3). Therefore, we transform this program into a linear program as shown below:

\[
\begin{align*}
\text{Max} & \quad \sum_{k=1}^{s} u_k y_{kp} \\
\text{s.t.} & \quad \sum_{j=1}^{m} v_j x_{jp} = 1 \\
& \quad \sum_{k=1}^{s} u_k y_{ki} - \sum_{j=1}^{m} v_j x_{ji} \leq 0 \quad \forall \ i = 1, \ldots, n \\
& \quad v_j, u_k \geq 0
\end{align*}
\]

For measuring the efficiency of \( n \) DMUs, this program should be run for all DMUs \((n \times n)\) times. A DMU with a higher score (which is equal to 1 due to the design of the model) is considered to be efficient, and a DMU with a score of less than 1 is inefficient.

2.2 Fuzzy Data Envelopment Analysis (FDEA)

Data Envelopment Analysis is highly sensitive to the input data, and thus an inaccurate measurement of input and output data can lead to wrong analysis, such as choosing an inefficient DMU as the most efficient DMU. Data uncertainty is inevitable and has appeared in many applications such as business, network management (Filabadi and Bagheri, 2021), energy production (Dehghani Filabadi, 2019; Movahednia et al., 2020), power grids (Movahednia et al., 2021), etc.

Uncertainty management has been the topic of research in the last decades. Several approaches such as the budget of uncertainty (Bertsimas and Sim, 2004), scenario-based stochastic programming (Asadi et al., 2022), and robust adjustable optimization...
Fuzzy DEA models, therefore, are capable of representing real-world problems in a more accurate way than the conventional DEA models. In this section, we implement the concepts of the fuzzy theory below (Azadeh et al., 2008) in the presented DEA model and represent an FDEA model as follows, where ‘∼’ in notations represents the fuzziness (the reader is referred to (Azadeh et al., 2008) for further details).

\[
\begin{align*}
\text{Max} & \quad \sum_{k=1}^{s} u_k \tilde{y}_{kp} \\
\text{s.t.} & \quad \sum_{j=1}^{m} v_j \tilde{x}_{jp} = 1 \\
& \quad \sum_{k=1}^{s} u_k \tilde{y}_{k i} - \sum_{j=1}^{m} v_j \tilde{x}_{ji} \leq 0, \quad \forall i = 1, \ldots, n \\
& \quad v_j, u_k \geq 0
\end{align*}
\]

Among several types of fuzzy numbers, fuzzy triangular numbers are more applicable (Azadeh et al., 2008). In this paper, the DMUs inputs and outputs are considered as fuzzy triangular numbers where a fuzzy number \( \tilde{a} \) that is subject to uncertainty is modeled using three numbers representing the mean \((m)\), lower \((l)\), and upper \((u)\) value of that number. In particular, for each fuzzy number \( \tilde{a} \), we model it by \( \tilde{a} = (a^m, a^l, a^u) \). Therefore, considering fuzzy numbers \( \tilde{x}_{ij} \) and \( \tilde{y}_{ij} \), we have

\[
x'_{ij} = (x^m_{ij}, x^l_{ij}, x^u_{ij}), \quad y'_{ij} = (y^m_{ij}, y^l_{ij}, y^u_{ij})
\]

And thus program of (5)-(8) can be written as follows:

\[
\begin{align*}
\text{Max} & \quad \sum_{k=1}^{s} u_k (y^m_{kp}, y^l_{kp}, y^u_{kp}) \\
\text{s.t.} & \quad \sum_{j=1}^{m} v_j (x^m_{kp}, x^l_{kp}, x^u_{kp}) = 1 \\
& \quad \sum_{k=1}^{s} u_k (y^m_{ij}, y^l_{ij}, y^u_{ij}) - \sum_{j=1}^{m} v_j (x^m_{ij}, x^l_{ij}, x^u_{ij}) \leq 0, \quad \forall i = 1, \ldots, n \\
& \quad v_j, u_k \geq 0
\end{align*}
\]

Program (14)-(17) is a linear mathematical program that can be solved easily using commercial solvers such as CPLEX in MATLAB or GAMS. We solve this program \( n \) times (each time for one DMU) and then determine the most efficient DMU based on the values obtained. This program properly addresses data uncertainty using 3 values for a fuzzy number.

3. Case Study and Numerical Results

Data are collected through questionnaires that have been handed to customers and workers of a shopping center that has both online and traditional types of business, which its central office is located in Tehran. The questionnaire consists of 28 trust-related questions and 10 resilience-related questions. The score (weight) to each question was assigned between 1 and 10, and also it includes fractional scores. For determining the validity of a questionnaire, two random samples, with a random number of elements from each factor, have been chosen, and a T-test has been applied. The reliability of the questionnaire has been determined using Cronbach’s Alpha. The reliability analysis of a questionnaire determines its ability to get similar results on different occasions and also concerns the consistency among the questions. Validity refers to whether the researchers actually measured what they were supposed to measure (Cooper et al., 2003).
The hypothesis is:

\[ H_0: \mu_1 = \mu_2 = \ldots = \mu_{11} \]
\[ H_1: \mu_i \neq \mu_j, \quad \forall i, j = 1, \ldots, 11, \quad i \neq j \]

According to the done normality test, in traditional shopping, lower bound efficiency is a good index for selecting the efficient factors, while in online shopping case, upper bound efficiency is better. The efficiency of DMUs has been calculated with different \( \alpha \)-cut (0.01, 0.05, 0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9, 0.95, 0.99, 1) to find the optimal \( \alpha \)-cut.

| \( a \) | Statistic | df | Sig. | Statistic | Df | Sig. |
|-------|-----------|----|------|-----------|----|------|
| a=0.01 | .086      | 89 | .104 | .953      | 89 | .003 |
| a=0.05 | .086      | 89 | .111 | .954      | 89 | .003 |
| a=0.1  | .087      | 89 | .091 | .954      | 89 | .003 |
| a=0.2  | .097      | 89 | .036 | .954      | 89 | .003 |
| a=0.3  | .103      | 89 | .021 | .953      | 89 | .003 |
| a=0.4  | .111      | 89 | .009 | .949      | 89 | .002 |
| a=0.5  | .112      | 89 | .008 | .948      | 89 | .001 |
| a=0.6  | .109      | 89 | .011 | .949      | 89 | .002 |
| a=0.7  | .102      | 89 | .200 | .952      | 89 | .002 |
| a=0.8  | .089      | 89 | .079 | .953      | 89 | .003 |
| a=0.9  | .084      | 89 | .168 | .956      | 89 | .004 |
| a=0.95 | .080      | 89 | .199*| .957      | 89 | .005 |
| a=0.99 | .078      | 89 | .199*| .958      | 89 | .006 |
| a=1    | .087      | 89 | .096 | .958      | 89 | .006 |

| Normal Q-Q Plot of VAR00050 |

**Figure 2.** Normal plot for \( \alpha \)-cut=0.7
According to the results (Figure 2 and Table 2), the optimal α-cut for the traditional shopping system is α-cut = 0.7 that is chosen for this model. Similarly, we carried out the same analysis using the data of online shopping. In what follows, we present the results for the online shopping in Figure 3 and Table 3, based on which we can conclude that the optimal α-cut for the Online shopping system is α-cut = 0.4.

Table 3. Tests of Normality for online shopping

|       | Kolmogorov-Smirnov a  | Shapiro-Wilk  |
|-------|-----------------------|---------------|
|       | Statistic  | Df  | Sig. | Statistic  | Df  | Sig. |
| a=0.01| .120      | 89  | .003 | .919       | 89  | .000 |
| a=0.05| .116      | 89  | .005 | .924       | 89  | .000 |
| a=0.1 | .114      | 89  | .006 | .927       | 89  | .000 |
| a=0.2 | .103      | 89  | .021 | .938       | 89  | .000 |
| a=0.3 | .092      | 89  | .063 | .949       | 89  | .002 |
| a=0.4 | .073      | 89  | .200* | .958   | 89  | .006 |
| a=0.5 | .073      | 89  | .199* | .964   | 89  | .014 |
| a=0.6 | .068      | 89  | .199* | .965   | 89  | .016 |
| a=0.7 | .065      | 89  | .199* | .971   | 89  | .046 |
| a=0.8 | .078      | 89  | .199* | .968   | 89  | .028 |
| a=0.9 | .069      | 89  | .199* | .968   | 89  | .027 |
| a=0.95| .079      | 89  | .199* | .967   | 89  | .024 |
| a=0.99| .079      | 89  | .199* | .967   | 89  | .024 |
| a=1   | .079      | 89  | .199* | .967   | 89  | .023 |

Figure 3. Normal plot for α-cut=0.4

The efficiency of DMUs is examined by DEA with optimal α-cut for both systems and by FDEA with α-cut = 1. The correlation results are summarized in Table 4, based on which we conclude that we can use the FDEA method instead of DEA. It is because we have a high correlation (1), which means the analysis allows us to use FDEA, and our results will remain valid.
Table 4. Validation of FDEA by DEA

|                      | DEA(α-cut=0.7) | FDEA(α-cut =1) | Correlation |
|----------------------|----------------|----------------|-------------|
| Traditional shopping lower bound |                |                |             |
| Online shopping Upper bound |                |                |             |

3.1 Sensetivity Analysis

To predict customer behavior, we would like to see the effect of various factors on the mean efficiency and FDEA value for the most efficient α_cut (i.e., α_cut=0.7). Such analysis would help users figure out the impact of each factor in both traditional and online markets. As a result, one can define various strategies for their online markets based on the most important factors identified. We have used the collected data and analyzed the effects of omitting all factors independently on the mean efficiency. The results are shown in Tables 5 and 6.

From Tables 5 and 6, one can conclude that integrity as a trust-related factor is the most important factor in traditional shopping systems (due to lower values of FDEA), which can influence people’s trust in traditional shopping systems. Furthermore, awareness is the most important factor among resilience-related factors in traditional shopping systems. In online shopping systems, to capture customers’ trust, we still need to pay important attention to integrity since it has the most impact among trust-related factors. However, in such online markets, management commitment plays an important role among resilience-related factors. Such analysis helps us understand that an online shop with a better management commitment store is more capable of attracting customers’ attention and making them loyal customers. Thus, in today’s world, one can conclude to design strategies to improve the level of management commitment and make the customers know that so that the business benefits from this factor.

Table 5. Sensitivity analysis Traditional shopping

| Correlation    | Competence | Integrity | Benevolence | Flexibility | Awareness | Management commitment |
|----------------|------------|-----------|-------------|-------------|-----------|-----------------------|
| FDEA α_cut=0.7 | 0.9948     | 0.9643    | 0.9751      | 0.9865      | 0.9017    | 0.9948                |
| Mean of efficiency | 0.7934    | 0.7709    | 0.7839      | 0.7865      | 0.7603    | 0.7934                |

Table 6. Sensitivity analysis online shopping

| Correlation    | Structural Assurance | Competence | Integrity | Benevolence | Flexibility | Awareness | Management commitment |
|----------------|----------------------|------------|-----------|-------------|-------------|-----------|-----------------------|
| FDEA α_cut=0.4 | 0.9767               | 0.9176     | 0.8389    | 0.8755      | 0.9874      | 0.9892    | 0.8389                |
| Mean of efficiency | 0.8822    | 0.8679    | 0.84921   | 0.9450      | 0.8837      | 0.8848    | 0.8492                |

We carried out further analysis to compare the efficiency of both online and traditional shopping systems. In particular, Table 7 compares online and traditional shopping systems from a high-level prospective where we combine the efficiency of trust and resilience factors. It is observed from the table that the online shopping system is more than 20% more efficient than traditional shopping systems, which is significant in competitive markets and provides suppliers with the opportunity to shift to online markets.

Table 7. Comparison of two systems

|                      | Traditional Shopping | Online shopping |
|----------------------|----------------------|-----------------|
| Mean of efficiency   | 0.6675               | 0.8104          |

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Furthermore, to analyze the impacts of each trust and resilience factor individually, we carried out a further analysis which is summarized in Table 8. From Table 8, we conclude that trust factors are the most efficient factors in both traditional and online shopping systems. Thus, managers may prioritize their investment on trust and resilience factors based on such analysis. It is also observed that trust and resilience factors are significantly more efficient in online markets than traditional markets.

| Table 8. Mean of efficiencies          | Traditional shopping | Online shopping |
|----------------------------------------|----------------------|-----------------|
| Trust factors                          | 0.6957               | 0.7988          |
| Resilience factors                     | 0.6392               | 0.8221          |
| Mean of efficiency                     |                      |                 |

4. Conclusion
Considering the advantages of e-commerce to not only customers but also vendors, these days, many businesses are using the Internet as a means through which they are able to navigate their marketing activities for competing with their business opponents. Trust plays a crucial role in these interactions because of uncertainty and dependency, which exist in many social and economic interactions over the Internet and consumers’ concerns regarding the insecurity and dissemination of their personal information and also the lack of trust of web vendors. In this article, traditional and online systems from trust and resilience engineering factor points of view have been analyzed by using a questionnaire. Based on our comprehensive analysis, we conclude that trust and resilience factors are much more efficient and crucial in online shopping than traditional shopping. From a lower-level analysis, we have shown that integrity is the most important factor among trust-related factors in both traditional and online markets. However, it is more crucial in online markets. On the other hand, among resilience-related factors, awareness is the most important factor in traditional shopping, while management commitment is the most important resilience-related factor in online shopping systems. Thus, in today’s world, one can conclude to design strategies to improve the level of management commitment and make the customers know that so that the business benefits from this factor. Data in this research has been collected through a questionnaire in the form of qualitative data. A future research direction is to collect quantitative data and form our analysis using recent uncertainty modeling approaches (such as Ardestani-Jaafari and Delage, 2016; Filabadi and Azad, 2020; Filabadi and Mahmoudzadeh, 2022; Filabadi, 2022) as well as fuzzy approach. A comprehensive comparison using various approaches to address uncertainty would provide users with a framework that highlights the importance, applications, and limitations of each approach in the literature, which can be the direction for future research.

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**References**

[1] Ahn, T., Ryu, S., & Han, I. (2005). The impact of the online and offline features on the user acceptance of Internet shopping malls. *Electronic Commerce Research and Applications, 3*(4), 405-420.

[2] Asadi, A., Filabadi, M.D., Giahi, R., Ardakani, A.T., and Khoshkhoo, M. (2022). A New Stochastic Model for Bus Rapid Transit Scheduling with Uncertainty, *Future Transportation* (in press).

[3] Ardestani-Jaafari, A., & Delage, E. (2016). Robust optimization of sums of piecewise linear functions with application to inventory problems. *Operations Research, 64*(2), 474-494.

[4] Azadeh, A., Ghaderi, S., Javaheri, Z., & Saberi, M. (2008). A fuzzy mathematical programming approach to DEA models. *American Journal of Applied Sciences, 5*(10), 1352.

[5] Bendoly, E., Blocher, J. D., Brethauer, K. M., Krishnan, S., & Venkataramanan, M. (2005). Online/in-store integration and customer retention. *Journal of Service Research, 7*(4), 313-327.

[6] Bertsimas, D., & Sim, M. (2004). The price of robustness. *Operations Research, 52*(1), 35-53.

[7] Bhattacherjee, A. (2002). Individual trust in online firms: Scale development and initial test. *Journal of Management Information Systems, 19*(1), 211-242.

[8] Chames, A., Cooper, W. W., & Rhodes, E. (1978). Measuring the efficiency of decision-making units. *European Journal of Operational Research, 2*(6), 429-444.

[9] Cooper, D. R., & Schindler, P. S. (2003). *Business research methods*.

[10] Corritore, C. L., Kracher, B., & Wiedenbeck, S. (2003). On-line trust: concepts, evolving themes, a model. *International Journal of Human-Computer Studies, 58*(6), 737-758.

[11] Dehghani Filabadi, M. (2019). Robust optimization for SCED in AC-HVDC power systems, *Master's thesis, University of Waterloo*.

[12] Doney, P. M., Cannon, J. P., & Mullen, M. R. (1998). Understanding the influence of national culture on the development of trust. *Academy of Management Review, 23*(3), 601-620.

[13] Filabadi, M. D. (2022). A New Paradigm in Addressing Data Uncertainty: Discussion and Future research, *Academia Letters 2*(1).
References:

[14] Filabadi, M. D., & Azad, S. P. (2020). Robust optimisation framework for SCED problem in mixed AC-HVDC power systems with wind uncertainty. IET Renewable Power Generation, 14(14), 2563-2572.

[15] Filabadi, M. D., & Bagheri, P. (2021). Robust-and-cheap framework for network resilience: A novel mixed-integer formulation and solution method. arXiv preprint arXiv:2110.09694.

[16] Filabadi, M. D., & Mahmoudzadeh, H. (2022). Effective budget of uncertainty for classes of robust optimization. INFORMS Journal on Optimization (in press).

[17] Gefen, D., Karahanna, E., & Straub, D. W. (2003). Trust and TAM in online shopping: an integrated model. MIS Quarterly, 27(1), 51-90.

[18] Gefen, D., Rose, G. M., Warkentin, M., & Pavlou, P. A. (2005). Cultural diversity and trust in IT adoption: A comparison of potential e-voters in the USA and South Africa. Journal of Global Information Management (JGIM), 13(1), 54-78.

[19] Gefen, D., & Straub, D. W. (2004). Consumer trust in B2C e-commerce and the importance of social presence: experiments in e-products and e-services. Omega, 32(6), 407-424.

[20] Ghanadif, O. (2021). Customer loyalty and powerful brand in heavy machinery industry. European Journal of Business and Management Research, 6(3), 195-199.

[21] Ghanadif, O., Sanayei, A., & Emami, M. (2021). Effect of customer perception on salesperson owned commitment in customer-salesperson relationship. European Journal of Business and Management Research, 6(4), 137-142.

[22] Ghashami, F., & Kamyar, K. (2021). Performance evaluation of ANFIS and GA-ANFIS for predicting stock market indices. International Journal of Economics and Finance, 13(7), 1-1.

[23] Ghashami, F., Kamyar, K., & Riazi, S. A. (2021). Prediction of stock market index using a hybrid technique of artificial neural networks and particle swarm optimization. Applied Economics and Finance, 8(3), 1-8.

[24] Hofstede, G. (1984). Culture's consequences: International differences in work-related values 5(1).

[25] Hollnagel, E. (2011). Prologue: The scope of resilience engineering. Resilience engineering in practice: A guidebook.

[26] Jarvenpaa, S. L., Tractinsky, N., & Sararin, L. (1999). Consumer trust in an internet store: a cross-cultural validation. Journal of Computer-Mediated Communication, 5(2), 0-0.

[27] Keeney, R. L. (1999). The value of Internet commerce to the customer. Management Science, 45(4), 533-542.

[28] Kennedy, M. S., Ferrell, L. K., & LeClair, D. T. (2001). Customers' trust of salesperson and manufacturer: an empirical study. Journal of Business Research, 51(1), 73-86.

[29] Knoll, M., & Stix, H. (2010). Trust in Banks—Evidence from normal times and from times of crises.

[30] Koufaris, M., & Hampton-Sosa, W. (2004). The development of initial trust in an online business company by new customers. Information & Management, 41(3), 377-397.

[31] Lee, M. K., & Turban, E. (2001). A trust model for consumer Internet shopping. International Journal of Electronic Commerce, 6(1), 75-92.

[32] Mahmood, M. A., Gemoets, L., Hall, L. L., Lopez, F. J., & Mariadas, R. (2008). Measuring e-commerce technology-enabled business value: An exploratory research. International Journal of E-Business Research (IJEBR), 4(2), 48-68.

[33] Mayer, R. C., Davis, J. H., & Schoorman, F. D. (1995). An integrative model of organizational trust. Academy of Management review, 20(3), 709-734.

[34] McKnight, D. H., & Chervany, N. L. (2012). What trust means in e-commerce customer relationships: an interdisciplinary conceptual typology. International Journal of Electronic Commerce, 6(4), 35-60.

[35] McKnight, D. H., Choudhury, V., & Kacmar, C. (2000). Trust in e-commerce vendors: a two-stage model. Paper presented at the Proceedings of the twenty-first international conference on Information systems.

[36] Miremadi, A., & Ghanadif, O. (2021a). The excellent method of novel uncertainty predictor for risk assessment in E-financial institutions. European Journal of Humanities and Social Sciences, 7(4), 38-42.

[37] Miremadi, A., & Ghanadif, O. (2021b). CRM competitive strategy in financial institutions. European Journal of Business and Management Research, 6(3), 111-117.

[38] Miremadi, A., & Ghanadif, O. (2021c). The ultimate influences of brand equity dimensions on consumer decision in hi-tech market. Academic Journal of Research and Scientific Publishing, 6(4), 55-64.

[39] Miremadi, A., Golchobian, M. M. A., & Ghanadif, O. (2021a). Requirement and architecture of organization development. European Journal of Business and Management Research, 6(4), 55-64.

[40] Miremadi, A., Kenar Roudi, J., & Ghanadif, O. (2021b). Evaluation on role of electronic word of mouth (EWOM) ads in customers' emotions and choices in E-shops. International Journal of Industrial Marketing, 6(1), 56-80.

[41] Movahednia, M., Karimi, H., & Jadid, S. (2020). Optimal hierarchical energy management scheme for networked microgrids considering uncertainties, demand response, and adjustable power. IET Generation, Transmission & Distribution, 14(20), 4352-4362.

[42] Movahednia, M., Kargar, A., Ozdemir, C. E., & Hagen, S. C. (2021). Power grid resilience enhancement via protecting electrical substations against flood hazards: A stochastic framework. IEEE Transactions on Industrial Informatics, 18(3), 2132-2143.

[43] Movahednia, M., & Kargar, A. (2022a). Flood-aware optimal power flow for proactive day-ahead transmission substation hardening. arXiv preprint arXiv:2201.03162.

[44] Movahednia, M., Karimi, H., & Jadid, S. (2022b). A cooperative game approach for energy management of interconnected microgrids. arXiv preprint arXiv:2201.03179.

[45] Nielsen, J. (1999). Trust or bust: Communicating trustworthiness in web design. Jacob Nielsen’s Alertbox.

[46] Pavlou, P. A. (2003). Consumer acceptance of electronic commerce: integrating trust and risk with the technology acceptance model. International Journal of Electronic Commerce, 7(3), 101-134.

[47] Pavlou, P. A., & Chai, L. (2002). What drives electronic commerce across cultures? Across-cultural empirical investigation of the theory of planned behavior. Journal of Electronic Commerce Research, 3(4), 240-253.

[48] Pennington, R., Wilcox, H. D., & Grover, V. (2003). The role of system trust in business-to-consumer transactions. Journal of Management Information Systems, 19(3), 197-226.

[49] Reason, J. T., & Reason, J. T. (1997). Managing the risks of organizational accidents (Vol. 6): Ashgate Aldershot.
[50] Riegelsberger, J., Sasse, M. A., & McCarthy, J. D. (2005). The mechanics of trust: A framework for research and design. *International Journal of Human-Computer Studies*, 62(3), 381-422.

[51] Sadighpour, A., Dolatkhah, N., Khanzadeh, S., Binazir, M.B., Heidari, F. (2022). The prevalence and determinant factors of high-risk behaviours among medical students in North-West of Iran, *International Journal of Health Promotion and Education*, 11(3), DOI: 10.1080/14635240.2021.2014345

[52] Schubert, P., Williams, S. P., & Woelfle, R. (2011). Sustainable competitive advantage in e-commerce and the role of the enterprise system. *International Journal of Enterprise Information Systems (IJEIS)*, 7(2), 1-17.

[53] Sillence, E., Briggs, P., Harris, P., & Fishwick, L. (2006). A framework for understanding trust factors in web-based health advice. *International Journal of Human-Computer Studies*, 64(8), 697-713.

[54] Tan, S. J. (1999). Strategies for reducing consumers’ risk aversion in Internet shopping. *Journal of Consumer Marketing*, 16(2), 163-180.

[55] Tan, Y.-H., & Thoen, W. (2001). Toward a generic model of trust for electronic commerce. *International Journal of Electronic Commerce*, 5(5), 61-74.

[56] Tan, Y.-H., & Thoen, W. (2003). Electronic contract drafting based on risk and trust assessment. *International Journal of Electronic Commerce*, 7(3), 55-72.

[57] Teo, T. S., & Liu, J. (2007). Consumer trust in e-commerce in the United States, Singapore and China. *Omega*, 35(1), 22-38.

[58] Urban, G. L., Amyx, C., & Lorenzon, A. (2009). Online trust: state of the art, new frontiers, and research potential. *Journal of Interactive Marketing*, 23(2), 179-190.

[59] Walczuch, R., & Lundgren, H. (2004). Psychological antecedents of institution-based consumer trust in e-retailing. *Information & Management*, 42(1), 159-177.

[60] Weick, K. E., Sutcliffe, K. M., & Obstfeld, D. (2008). Organizing for high reliability: Processes of collective mindfulness. *Crisis Management*, 3(3), 81-123.

[61] Woods, D. D., Johannesen, L. J., Cook, R. I., & Sarter, N. B. (1994). Behind human error: Cognitive systems, computers and hindsight: DTIC Document.

[62] Yamagishi, T., & Yamagishi, M. (1994). Trust and commitment in the United States and Japan. *Motivation and Emotion*, 18(2), 129-166