ELECTRONIC INVOICING SERVICE PROVIDER SELECTION USING A SOFTWARE QUALITY FUNCTION DEPLOYMENT-BASED DECISION APPROACH

(YAZILIM KALİTE FONKSİYON DAĞILIMI TABANLI KARAR YAKLAŞIMI KULLANILARAK ELETRONİK FATURA SERVİS SAĞLAYICISI SEÇİMİ)

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LIST OF SYMBOLS

EDI **:** Electronic Data Interchange
SME **:** Small and Medium Sized Enterprises
B2B **:** Business-to-Business
B2G **:** Business-to-Government
B2C **:** Business-to-Customer
B2T **:** Business-to-Tax
TRA **:** Turkish Revenue Administration
EU **:** European Union
PDF **:** Portable Document Format
TIFF **:** Tagged-Image File Format
JPEG **:** Joint Photographic Experts Group
IT **:** Information Technology
ERP **:** Enterprise Resource Planning
MCDM **:** Multi Criteria Decision Making
QFD **:** Quality Function Deployment
SQFD **:** Software Quality Function Deployment
YKFY **:** Yazılım Kalite Fonksiyonu Yayılımı
DEMATEL **:** Decision Making Trial and Evaluation Laboratory
HOQ **:** House of Quality
SDLC : System Development Life Cycle
CRs : Customer Requirements
TAs : Technical Attributes
CNs : Company Needs
SCs **:** System Characteristics

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ABSTRACT

Information technologies (IT) play an important role in accounting processes. Over the last years as a result of the technological developments, the accounting transactions have been transferred to digital platforms. Electronic invoice application is the most important indicator of this digitalization.

Electronic invoicing can be defined as sending or submitting an invoice and then storing it completely electronically. The e-invoice process should use fully structured data that can be automatically processed by senders, recipients and other interested parties. Transmitting an electronic image of an invoice document is by no means electronic invoicing. The main purpose of using the e-invoice application is to create a low cost, fast and safe method with certain standards between the seller and the buyer.

In recent years, the topic of e-invoicing has received a lot of attention from most countries around the world, realizing the benefits it brings in terms of full integration and dematerialization of business processes. Turkey is one of the leading countries of e-invoicing.

The aim of this paper is to propose a Software Quality Function Deployment (SQFD) based decision approach and implement it to the selection of e-invoicing service provider company because the service provider selection is an important decision for the companies.

In this study, opinions of the experts of e-invoicing in Turkey and earlier studies in the literature is evaluated in order to set user company's needs for selection the e-invoice service provider company. To calculate the importance degrees of company needs, DEMATEL method is used in this study. After that, e-invoicing system characteristics are identified to meet these needs. The relationship between company needs and system

characteristics is evaluated within the framework of Software Quality Function Deployment (SQFD) and relative importance of system characteristics are calculated with the help of SQFD. After setting target values for each system characteristic, e-invoicing service provider alternatives are evaluated with weighted distance metric and the most suitable alternative is determined.

This study consists of six parts. First of all, literature review is provided both in SQFD and e-invoicing. Next, the term e-invoicing is explained in detail followed by the situation in world and in Turkey. Section 4 presents the SQFD-based decision approach which is determined as main method to evaluate e-invoicing service provider selection. An illustrative application of this method in Turkey is provided in Section 5. Conclusions and guidance for future research are expressed in the last section.

ÖZET

Bilgi teknolojileri muhasebe süreçlerinde önemli bir rol oynar ve son yıllardaki teknolojik gelişmelerin bir sonucu olarak muhasebe işlemleri dijital platformlara taşınmıştır. Elektronik fatura uygulaması bu dijitalleşmenin en önemli göstergesidir.

Elektronik faturalama, bir faturanın gönderilmesi veya işlenmesi ve ardından tamamen elektronik olarak saklanması olarak tanımlanabilir. E-fatura sürecinde, gönderenler, alıcılar ve diğer ilgili taraflar tarafından otomatik olarak işlenebilen tam yapılandırılmış veriler kullanılmalıdır. Bir fatura belgesinin elektronik bir görüntüsünü iletmek hiçbir şekilde elektronik faturalama olarak sayılmamaktadır. E-fatura uygulamasının kullanılmasının temel amacı, satıcı ile alıcı arasında düşük maliyetli, hızlı ve belirli standartlarda güvenli bir yöntem oluşturmaktır.

Son yıllarda, e-fatura konusu, iş süreçlerinin tam entegrasyonu ve kaydileştirilmesi açısından getirdiği faydaların farkına vararak dünyanın birçok ülkesinden büyük ilgi görmüştür. Türkiye, e-fatura uygulamasının önde gelen ülkelerinden biridir.

Bu yazının amacı, Yazılım Kalitesi Fonksiyon Yayılımı (YKFY) tabanlı bir karar yaklaşımı önermek ve bunu e-fatura hizmet sağlayıcı firma seçimine uygulamaktır, çünkü hizmet sağlayıcı seçimi şirketler için önemli bir karardır.

Bu çalışmada, bir firmanın e-fatura servis sağlayıcısı seçimi konusundaki ihtiyaçlarını belirlemek için Türkiye'deki e-fatura uzmanlarının görüşleri ve literatürde yer alan çalışmalar incelenmiş ve kullanıcı firma ihtiyaçları olarak tanımlanmıştır. Bu çalışmada firma ihtiyaçlarının önem derecelerini hesaplamak için DEMATEL yöntemi kullanılmıştır. Daha sonra, bu ihtiyaçları karşılayacak e-fatura sisteminin özellikleri belirlenmiştir. Şirket ihtiyaçları ile sistem özellikleri arasındaki ilişki, Yazılım Kalitesi

Fonksiyon Yayılımı (YKFY) çerçevesinde değerlendirilmektedir ve YKFY yardımıyla sistem özelliklerinin göreceli önemi hesaplanmıştır. Her sistem özelliği için hedef değerler belirlendikten sonra e-fatura hizmet sağlayıcı alternatifleri ağırlıklı mesafe ölçüsü ile değerlendirilerek en uygun alternatif belirlenmiştir.

Bu çalışma altı bölümden oluşmaktadır. İlk olarak, YKFY ve e-fatura konusunda literatür araştırmasına yer verilmiştir. Daha sonra e-fatura terimi ayrıntılı olarak açıklanmakta ve ardından dünyadaki ve Türkiye'deki durum anlatılmaktadır. Bölüm 4, e-fatura hizmet sağlayıcı seçimini değerlendirmek için ana yöntem olarak belirlenen YKFY tabanlı karar yaklaşımını sunmaktadır. Bu yöntemin Türkiye'deki açıklayıcı bir uygulaması Bölüm 5'te verilmektedir. Sonuçlar ve gelecekteki araştırmalar için öneriler ise son bölümde ifade edilmektedir.

1. INTRODUCTION

In the light of the developments experienced in the technology age we are in, new concepts and new methods enter our lives day by day. Due to these technological changes, financial industry is changing rapidly.

The globalization of markets, technology and competition has increased business' requirements for flexibility, quality, cost-effectiveness and timeliness. A way of meeting these requirements, information technology (IT) has transformed the way business is done. (Burgess, 2020)

Usage of IT solutions in business-to-business (B2B) processes has affected accounting and finance activities intensively. With technological developments, methods of performing activities within the scope of accounting and accounting-related transactions have started to be made in digital environment.

One of the concepts in accounting created by technological development is the electronic invoicing system. Thanks to today's technological developments, recording, transferring and storage of invoices electronically are possible.

Electronic invoices is the electronic form of the traditional paper invoices. Electronic invoicing involves sending, receiving and processing invoices in the simplest way without manual intervention.

Due to the fact that the e-Invoice system legally functions in the same way as standard paper invoices and the advantages it has, this system has become quite widespread and has become a bigger need day by day. In this regard, numerous service providers offer solutions and software to help taxpayers that will start using e-invoicing system.

Choosing the most suitable service provider from a range of alternatives is a common problem faced by companies. The aim of this study is evaluating e-invoicing software companies' solutions by aligning company needs and software system's characteristics with Software Quality Function Deployment (SQFD).

This study was conducted in Turkey because it has advanced improvements in digital transformation and this field here is growing day by day. This paper determines customer needs affecting the selection process of electronic invoicing service provider from a review of relevant literature and from the interview with user companies. Importance degrees of company needs are calculated with DEMATEL. Also, e-invoicing system characteristics are identified in this thesis and their interactions with the needs of user companies are considered. System characteristics are prioritized with the help of SQFD. This study mainly focuses on selecting the suitable service provider by using weighted distance metric.

This thesis is divided into six main chapters. It begins with the theoretical background and literature reviews on e-invoicing and Software Quality Function Deployment. Secondly, the term e-invoice is described in detail, followed by the regulations of e-invoicing in the world. Then, the e-invoicing system in Turkey is disclosed. In the fourth section, the methodology to be used in this study is explained. An illustrative application of this method on an e-invoicing service provider selection problem is provided in Section 5. In the last part, conclusions and remarks for future research are expressed.

2. THEORETICAL BACKGROUND

In this section, literature review will be given on a basis of “electronic invoice” and “software quality function deployment”.

Although, there are many articles found about “electronic invoice” and “software quality function deployment”, to our knowledge, there is no study, which uses SQFD methodology in e-invoicing service provider selection. Therefore, this study aims to identify customer expectations from an e-invoicing solution, then, a link between customer needs and technical specifications has been established.

2.1. LITERATURE REVIEW ABOUT ELECTRONIC INVOICES

The first electronic invoices were sent over 30 years ago using electronic data interchange (EDI). (Keifre, 2011) According to the Commission Recommendation 1994/820/EC, EDI is essentially defined as an electronic transfer of data from computer to computer, using an agreed format, and processed automatically and unambiguously.

Electronic invoicing represents one of the most important and current part of EDI. After the Internet was employed to transferring the invoices, e-invoicing become a backbone for business activities. An invoice is considered as electronic if it is transferred between buyer and seller in a digital system.

Although its evolvement was steady and slow pace, e-invoicing has been widely researched from the European Commission to the independent research organizations. (Keifre, 2011)

With the purpose of reviewing the recent studies in the literature, works published until November 2020 on Web of Science, Science Direct, Research Gate and IEEE, and the key words “electronic invoice” and “e-invoice” are mainly reviewed. The articles found are summarized in chronological order.

Edelmann & Sintonen (2006) seeked to discover the reasons of the slow adoption rate of e-invoicing by small and medium sized enterprises (SME) in Finland. In order to find these reasons, the survey results were analyzed statistically first. The analysis was expanded with the Strategic Options Approach (SOA).

Penttinen & Hyytiainen (2008) focused on the adoption of electronic invoicing in Finnish enterprises. A case study is implemented to find out the success factors regarding to implementation projects in Finland. Interviews are made with six organizations on the main factors in the implementation of e-invoicing. In addition, problem areas with negative impacts have been identified.

Sandberg et al. (2009) aimed understand the adoption of e-invoicing in SMEs. A research model has been proposed and factors affecting e-invoicing in SMEs are grouped under four different factors. Data was collected from SME managers using a questionnaire to verify the model. The main results of the study show this kind of enterprises are ready for e-invoicing.

Moberg et al. (2010) provided information on the advantages and disadvantages of the transition from paper invoicing to electronic invoicing in Sweden in terms of environment. A screening life cycle assessment (LCA) is implemented to consider the environmental effects of e-invoicing. The results shows that the transition to electronic invoicing is beneficial regarding greenhouse gas emissions and cumulative energy demand.

Arendsen & van de Wijngaert (2011) discussed the question of whether the government can create a difference as the new customer of e-invoicing. According to the results of the large-scale research, it shows that companies doing business with government agencies are more prone to e-Invoice applications. As a result, it is suggested that governments should take these companies as their primary goal to speed up the spread of e-invoices.

Keifre (2011) investigated the effects of e-invoicing to other accounts payable automation projects. Also, it explores the potential benefits of organizations from the adoption of an e-invoicing program.

Myllynen (2011) studied electronic invoicing service provider selection problem. To identify the selection criteria, a study is conducted with the companies to understand their expectations. These criteria include Price, Quality, Services, End-user Usability, and Flexibility etc... A Discrete Choice Experiment is conducted with this purpose. It is found that criteria that focus on ongoing and future business are the important ones.

Hernandez-Ortega (2012) identified the main factors affecting the adoption and usage of e-invoicing. The main factors are ease of use, compatibility, usefulness and data security. Two group of companies in Spain are examined. The first group includes non-users of e-invoicing, the second group consists of those who have previously adopted e-invoicing and experienced its features.

Haag et al. (2013) examined the reasons why they resist the use of electronic invoices by implementing a survey to 416 German companies that resist the use of e-invoicing. Especially among small-scale companies, the lack of information about e-invoicing is the most important impact factor, while relatively large companies do not attempt to change management, and it is considered as an obstacle to the use of e-invoices.

Hernandez-Ortega & Jimenez-Martinez (2013) analyzed company performance while using e-invoicing regularly. In this case, the effect of habit is searched. Habit is a concept that has been comprehensively studied in various fields, including social psychology. 100 companies is analyzed in Spain that use e-invoicing. As a result, it is found that habit creates a positive effect. Therefore, using e-invoicing frequently is proposed to the companies.

Joung et al. (2014) studied the e-invoicing system in Taiwan to assess its advantages, effects and barriers. Also, a comparison is made between the other companies' e-invoicing solutions. Similar and dissimilar points with Taiwan's solution were extracted and analyzed.

Vesela & Radimersky (2014) proposed an overview of development of electronic invoicing. Also, it aims to evaluate its implementation in Czech Republic. A survey is conducted with the companies. As a result, 49% of the companies surveyed stated that they do not send invoices to their customers electronically. While 31% of companies send some of their invoices to customers electronically, only 21% to all of their invoices to customers.

Chu et al. (2015) aimed to discuss an e-invoicing selection process as the solution can be built within the company or bought from a service provider. An ANP-based model is proposed for this selection. Cost and Effectiveness are determined to be the key determinants. Pairwise comparison is considered to calculate the relative importance. A case study is implemented from a Chinese company to demonstrate the proposed model.

Groznik & Anton (2015) focused on the regulations about e-invoicing in world and in Slovenia. The advantages of this solution are explained. Some difficulties and issues are also addressed while adapting e-invoicing to the business.

Marinagi et al. (2015) explored the rate of adoption and usage of electronic invoices in Greek companies. A questionnaire is conducted between 42 Greek organizations. The results confirm that the future of e-invoicing in Greece looks promising. Some businesses indicates that the advantages of e-invoice are not yet clear, however the majority of businesses agree that e-invoicing is important.

Lian (2015) conducted a study to search the key factors for the intention to adapt e-invoicing, especially cloud-based e-invoicing, in Taiwan. According to the results of the survey, it is found that effort expectations, security risks, trust in government and social influence have effects.

Poel et al. (2016) evaluated potential cost savings achieved with e-invoices in Belgium using the Standard Cost Model. It is found that the total annual billing cost for Belgian private sector businesses can be reduced to € 1.46 billion if all invoices are sent electronically. In addition, an invoicing index is developed to examine potential factors that affect e-invoicing usage. Based on the results, some policy measures are proposed to the Belgian government to help increasing the usage of electronic invoice.

Cuylen et al. (2016) presented a holistic map of electronic invoicing processes to show different levels of process integration and optimization. It implements a maturity model consisting of 4 parts (strategy, acceptance, processes & organization, and technology) and provides companies with a tool to identify their current situation and get recommendations to optimize it.

Koch (2017) published a report, which includes publicly available data about e-invoicing, market research, the author's experiences in consulting projects. It gives information about current trends, general expectations in the future and service providers.

Tanner & Richter (2018) searched the barriers and success factors when digitizing a business process, using an example of the transition from a paper-based transaction to electronic invoicing. In the study, companies were evaluated within the framework of the factors (economic, political, social, environmental, technological, and legal) of PESTEL analysis. As a result, it is stated that organizations should broaden their perspectives in order to take part in this digitization.

Koch (2019) published a report, which consolidates all available data and experience in e-invoicing market. This report gives some insights about the future of e-invoicing between 2019 and 2025.

Hangsten & Thomas (2020) examined the usage intensity of e-invoice among the companies in Sweden by investigating the effects of internal and external characteristics to the companies' decision in using. A two-part model is implemented. According to the results, the key determinants in using e-invoicing are number of invoices and number of B2G clients as internal factors. As an external factor, efficiency is important for the firms.

Table 2.1 A summary of literature review about e-invoicing

Year	**Authors**	**Journal**	**Findings**
2006	Edelmann & Sintonen	Int. J. Enterprise Network Management	This study searches the slow adoption rate of e-invoicing by SMEs in Finland.
2008	Penttinen & Hyytiainen	European Conference on	This paper focuses on the adoption of electronic invoicing in Finnish

		Information Systems (ECIS) Proceedings	enterprises. A case study is implemented to identify the success factors.
2009	Sandberg et al.	Engineering Psychology and Cognitive Ergonomics	The purpose of this study is to understand the adoption of e-invoicing in SMEs. A research model has been implemented.
2010	Moberg et al.	Progress in Industrial Ecology, An International Journal	The purpose of this article is to provide information on the advantages and disadvantages of electronic invoicing in Sweden in terms of environmental effects.
2011	Arendsen & van de Wijngaert	Electronic Government	This article seeks to answer the question of whether the government can make a difference as the new customer of e-Invoicing.
2011	Keifre	Journal of Payments Strategy & Systems	This paper investigates the effects of e-invoicing to other accounts payable automation projects.
2011	Myllynen	MSc. Dissertation Department of Information and Service Economy, Aalto University: FI	The author aims to identify the importance of criteria in an e-invoicing service provider selection. A form of Discrete Choice Experiment methodology is carried out.
2012	Hernandez-Ortega	Academia Revista Latinoamericana de Administración	The purpose of this study is to find out the main factors affecting the adoption and subsequent use of e-invoicing.
2013	Haag et al.	Electronic Government	This study examines the reasons of the resistance in the use of electronic invoices in German companies.

2013	Hernandez-Ortega & Jimenez-Martinez	Information Systems and e-Business Management	The purpose of this study is to analyze company performance while using e-invoicing regularly. In this case, the affect of habit is searched.
2014	Joung et al.	47th Hawaii International Conference on System Science	This article discusses Taiwan's e-invoice regulation and compares it with solutions in other countries.
2014	Vesela & Radimersky	Procedia Economics and Finance	This study proposes an overview of development of electronic invoicing. Also it aims to evaluate the level of its implementation in Czech Republic.
2015	Chu et al.	International Journal of u- and e-Service, Science and Technology	This paper focuses on the selection of the e-invoice solution. An ANP-based model is proposed and it is implemented on a case of Chinese company.
2015	Groznik & Anton	DIEM 2.1	The authors mentions the electronic invoicing regulations in the world in general, and explains its advantages.
2015	Marinagi et al.	American Institute of Physics	This article explores the rate of adaption and usage of electronic invoices in Greek companies.
2015	Lian	International Journal of Information Management	The author conducts a study to search the key factors for the intenion to adapt e-invoicing, especially cloud-based e-invoicing, in Taiwan.
2016	Poel et al.	The International Journal of Digital Accounting Research	This study evaluates potential cost savings achieved through the use of e-invoices in Belgium using the Standard Cost Model.

2016	Cuylen et al.	Electronic Markets	This article presents a holistic map of electronic invoicing processes to show different levels of process integration and optimization.
2017	Koch	Billentis Report	This is a report which is repeatedly published. This report consolidates publicly available data about e-invoicing, market research, the author's experiences in consulting projects.
2018	Tanner & Richter	Studies in Systems, Decision and Control	This article searches the barriers and success factors when digitizing a business process, using an example of the transition from a paper-based transaction to electronic invoicing to process invoices.
2019	Koch	Billentis Report	This is a report, which is repeatedly published. This report gives some insights about the future of e-invoicing between 2019 and 2025.
2020	Hangsten & Thomas	Journal of Cleaner Production	This paper examines the usage intensity of e-invoice among the companies in Sweden by investigating the effects of internal and external characteristics to the companies' decision in using.

2.2. LITERATURE REVIEW ABOUT SOFTWARE QUALITY FUNCTION DEPLOYMENT

The concept of SQFD was introduced in Japan in the 1984. When the Japanese began to discover their use in the development of embedded software, the concept of SQFD emerged and rapidly spread to the United States (Akao, 1990)

QFD's wide range of applications and literature is evolving in various fields. It has been applied in many industries around the world such as automobile, electronics, food processing, computer hardware and software. (Liu, 2000) SQFD represents the transfer of QFD technology from the traditional production environment to the software development environment. (Haag et al. 2013)

The number of published studies on utilizing QFD to software products are limited compared to QFD implementations in manufacturing.

With the purpose of reviewing the recent studies in the literature, works published until November 2020 on Web of Science, Science Direct, Research Gate and IEEE, and the key word “software quality function deployment” is searched and the articles found are summarized in chronological order. Also, in order to provide a detailed review, the keywords “software” and “quality function deployment” are searched together.

Ohmori (1993) discussed Quality Deployment Approach from a methodological perspective for a customer specific software solution and presented the usage of the relationship matrices like consistency analysis, buying-points analysis, desing-points analysis. A case about personal scheduling software tool is illustrated to demonstrate the applicability of QDA approach proposed in the study. This approach can be applied efficiently to complex software business systems because the system is separated into small and simple parts to make it more understandable.

Yoshizawa et al. (1993), who attempted an investigation about quality deployment status in Japanese software industry, have found that the researches are limited. They indicate that software quality deployment is important for the companies developing software to guarantee the quality.

Erikkson & McFadden (1993) focused on the usability of QFD methodology to software products. A case study is applied to demonstrate the results of QFD implementation in real-life problems. A laboratory called Metpath wanted to develope a computer system which link to their computers used in laboratories. A HoQ matrix is created based on the selected technical attributes and customer needs. After implementing the remaining

steps, the staff working at Metpath had an important guide to use while checking the quality of the system.

Barnett & Raja (1995) examined the methods presented in the literature to apply QFD on a software product. Also, they propose a requirements specification model based on QFD which provides more holistic framework. Four stage of House of Quality matrices are created to demonstrate the relationship.

Kekre, Krishnan & Srinivasan (1995) identified the key factors affecting customer satisfaction in software products. The research case is selected from the software projects of IBM. Customers are asked to fill a questionnaire to identify the factors. In 2,026 responses, seven factors are determined which are capability, reliability, usability, installability, maintainability, performance and documentation. The dependent variable is chosen as overall satisfaction. By applying the proposed model for QFD, capability and usability found as the most dominating factors.

Herzwurm, Mellis & Stelzer (1995) carried out a study of utilizing QFD to the CASE-tool aiming to show the use of QFD in software industry. The study starts with evaluating customer needs and technical features. The relationship between them is formed in a typical QFD diagram.

Haag, Raja & Schkade (1996) surveyed QFD applicability in software development phases. A study is conducted in MSV firms which develop and sell business software solutions. Some specific SQFD projects and their results are provided. Comparison between internal and external software quality cases are presented as well.

Karlsson (1997) shared his valuable experiences about QFD, gained at software projects of Ericsson Company. Prerequisites for utilizing QFD is defined. Also, the drawbacks they had in the project are listed.

Elboushi & Sherif (1997) applied QFD to an object-oriented software design. Three questionnaires are implemented to define WHATs and HOWs and to get a rank for each of them. The matrices are established as a step of QFD methodology. They indicate that QFD techniques are beneficial to use on all phases of a software development process.

Yilmaz & Chatterjee (1997) described SQFD as the 'Planning' phase for quality improvement in Shewhart's PDCA (Plan-Do-Check-Act) cycle, which is popularized by Deming. They performed a study about Deming and his philosophy about software development quality. Also, the term of SQFD is examined in detail.

Tan, Xie & Chia (1998) presented an application of QFD in designing WWW pages. The technical requirements, which is shown on the top of House of Quality matrix, are determined as standard page design, organization of pages, use of graphics etc… What it is called customer voices (WHATs) are categorized under three main specification: appearance, content, others. Then a relational matrix is established with the relationships between each WHAT and each HOW. Also, the correlation matrix is created. In this paper, the restrictions are not considered.

Carruthers (1999) carried out a study to examine QFD and SQFD from a theoretical perspective. The method proposed here includes both the simple SQFD models and the tools and techniques developed for Blitz QFD and Voice-of-Customer Analysis, as well as all the advantages of the traditional QFD set. Both functional and non-functional requirements are considered. At the end of the steps of methodology, required tasks are assigned to the employees to reach the company goals.

Gloger, Jockusch and Weber (1999) developed a procedure called the System Architecture Analysis (SAA) method that integrates the QFD and Design Space Approach. The SAA integrates the technical requirements and product functionalities into a modified "Quality House". It provides transparency in reviewing decisions and outcomes, also, encourages communication in all participating groups.

Krogstie (1999) discussed how tools such as QFD can help the development of high-quality requirements models that form the basis of information systems. Based on his experiences, the quality of requirements specifications can be improved with SQFD, especially when used with group software tools that support the whole process.

Liu (2000) sought to explain the SQFD methodology and its benefits for all stakeholders. A four-phase model is developed as SQFD framework. House of Quality matrix is described part by part. An example is also provided based on a study conducted from the students of University of MissouriRolla.

Richardson (2002) presented a novel model called Software Process Matrix which lists the characteristics that a software model should have for being used in a company. This proposed model is based on QFD. Implementing this model to a small software development company is discussed. Software process matrix is developed by identifying the relationship between processes and practices. Overall significance should be provided by the companies which attempt to use this method. As a result, the model provides a list of improvements that the company should implement.

Koski (2003) presented a detailed research on recent experiences about QFD in the literature. The aim is to make the method understandable for better further applications. Also, a case study is provided about upgrading enterprise resource planning (ERP) system of a global company. Although the results are not shared in the study, Koski focused to share the experiences of the company project team when using QFD. They found it applicable and easy to understand.

In Herzwurm & Schockert (2003)'s study, an overview of SQFD is provided. Differences between traditional QFD and Software QFD is shared. Also, commonly in use approaches (Zultner's, Shindo's etc.) for SQFD are presented.

González et al. (2004) used QFD approach in e-banking industry to measure customer satisfaction. As radical changes have occurred in service applications with the internet in the banking industry, establishing relationships with the customer as a bank is important. With this research, efficient usage of QFD technique is proved in banking industry.

Buyukozkan & Feyzioglu (2005) extended the QFD framework by presenting a fuzzy group decision making model. An illustrative example on a software is given to measure the proposed model. Customer needs are evaluated by users. Then, the relationship between customer needs and technical attributes are computed. Linguistic and numerical data is used, and customer needs' significances are determined on a fuzzy framework. As a result, preliminary documentation is ranked as first functional requirement that the software product should have.

Ramires, Antunes & Respicio (2005) proposed SQFD approach to validate a software's technical requirements. A groupware tool is developed which is integrated with SQFD.

An example with this tool is provided as well. Technical requirements are determined as functionality, reliability, usability, maintenance, portability.

Ahmed, Islam & Alwahaibi (2006) sought to identify the customer requirements in a healthcare software system. Here, customers are the employees working in a hospital in Oman. Analytic Hierarchy Process is used for weighting these user requirements obtained from the survey made between employees. As a result, a list of major requirements is obtained.

Liu et al. (2006) applied a novel quantitative method based on linear and non-linear techniques to technical target setting in SQFD. Existing methods are described and evaluated as well. This proposed model based on impact analysis is useful because there may be some conflicts between customer requirement and technical attributes. The quality degree aimed for a customer's requirement is achieved by determining the target values for the technical characteristics.

Kivinen (2008) carried out a thesis study about QFD application in a small-scale software environment. The aim is to help project managers and software teams because they need to understand the customer needs by considering their product's technical requirements. An example is provided about a code register project. Requirements are selected and prioritized by users. Targets are set for technical requirements. A brief summary of results is provided. Implementing QFD took approximately 40 hours in this kind of small-scale project.

Liu, Inuganti & Noguchi (2010) focused on technical target setting in SQFD which is a difficult step in the methodology. Their model considers technical trends for a specified timeframe. The aim is to provide competitive advantage for the company and high customer satisfaction by setting the technical targets from an objective perspective. Search engine designing is used as an example to evaluate the model.

Zhu & Liu (2010) searched the ways for linking the technical capabilities with customer's demands and determining targets of a web service design. A new method in QFD based on artificial neural network (ANN) for setting technical targets is proposed. The technical objectives of the design features are consistent with the relationships between design features and service quality requirements, whether linear or non-linear. This is

significantly different from the existing studies in the literature, because recent studies are based on the assumption that the relationship between the satisfaction levels of web service requirements and the technical values of design features is linear.

Sener & Karsak (2010) proposed a fuzzy regression and optimization methodology to set proper target levels in Software QFD. A mathematical model is established as well which uses the results obtained by fuzzy regression. Maximizing customer satisfaction is aimed with the proposed model. House of Quality matrix, one of the tools of SQFD, is used to translate customer needs into technical features. The proposed model applied to a search engine case. It is proved that fuzzy linear regression model is more suitable for software development because of the inherent uncertainty.

Sen & Baracli (2010) have discussed the ways of managing non-functional requirements in the software selection process as recent studies cannot completely define how to handle these kinds of requirements. This study provides a fuzzy QFD framework. A case at Audio Electronics proves the applicability of the proposed approach. A checklist, which includes more than 600 requirements, is proposed to the decision makers in Audio Electronics to understand what the company expects from an ERP system. After taking all the opinions of decision makers, house of quality matrix is created with functional requirements as WHATs and non-functional requirements as HOWs. By following the steps of the proposed fuzzy QFD, the non-functional criteria structure for the selection of an ERP system is built systematically.

Paghaleh (2011) presented an efficient combined model of QFD, Analytic Networking Process (ANP) and Bounded Goal Programming (BGP) to ensure the objectives of an organization and meet various customer needs in designing, manufacturing processes and after-sale services for software products. QFD defines the relationship between customer's requirements and the technical features and grades the technical requirements. By using HOQ matrix and ANP approach, determining and evaluating the relationship between customer needs and technical requirements of the product is aimed. A BPG model is used to determine the technical requirements and control points for the product's customer satisfaction. The model is applied to a case where satisfactory results have found through the proposed approach.

Sener & Karsak (2012) proposed a fuzzy linear regression model to determine target levels in SQFD by noticing importance degrees of customer requirements. Voice-of-Customer matrix is used to prioritize these requirements. In addition, future possible requirements are considered. That's why, the matrix is called future Voice-of-Customer. The data of the case study in Liu et al. (2006) is used to demonstrate the results of the proposed model.

Okonta et al. (2013) carried out a study on a new framework by developing the Quality Function Deployment. The new approach uses several "houses" to incorporate the customer's voice into the development processes. First house is about the design features of a product. The second one associates these design attributes to actions the company needs to take. QFD's third house can relate to decisions to implement action in areas such as manufacturing process operations. The last house links the implementation of decisions with software product development. The flexibility of the tool lets software teams to interface with all the software development tools and models while providing a holistic perspective.

Alrabghi (2013) carried out a study as a thesis paper about Software QFD to make it more understandable. A review of recent studies in the literatur is provided. Also, a quantitive example is applied in a company that wanted to develop a software for its GPS tool. HoQ matrix is developed. Through a technical evaluation, company's and its competitors' products are assessed. Also, the technical targets are determined by benchmarking.

The study of Yuen (2014) offers a hybrid framework of Fuzzy Cognitive Network Process, Aggregative Rating Clustering, and Quality Function Distribution for the evaluation and analysis of criteria in QFD. A fuzzy number applied to the QFD provides grading flexibility to address the uncertainty of the expert judgment. Fuzzy Cognitive Networking Process (FCNP) is used for weight / priority assessment of criteria. The Fuzzy Aggregative Grading Clustering (FAGC) classifies weights as rank degrees. The proposed approach has been applied to cloud software product development to demonstrate its validness and usability, as well as it can be used another new product development.

Table 2.2 A summary of literature review about SQFD

Year	Authors	Journal	Findings
1993	Ohmori	Software Quality Journal	This paper discussed Quality Deployment Approach for a customer specific software solution. A case about personal scheduling software tool is illustrated to show the applicability of QDA approach proposed in the study.
1993	Yoshizawa et al.	Quality Engineering	This paper investigated quality deployment status in Japanese software industry.
1993	Erikkson & McFadden	Information and Software Technology	This study focused on the usability of QFD methodology to software products. A case study is applied to demonstrate the results of QFD implementation in a laboratory called Metpath.
1995	Barnett & Raja	The International Journal of Quality & Reliability Management	The researchers examined the methods presented in the literature to apply QFD on a software product. In addition, they propose requirements specification model based on QFD that provides more holistic framework.
1995	Kekre, Krishnan & Srinivasan	Management Science	The authors identified the key factors affecting customer satisfaction in software products. The research case is selected from the software projects of IBM.
1995	Herzwurm, Mellis & Stelzer	Software Quality Management III	This study is about utilizing QFD to the CASE-tool aiming to show the use of QFD in software industry.
1996	Haag, Raja & Schkade	Communications of the ACM	This study surveyed QFD applicability in software development phases. A study is

			conducted in MSV firms which develop and sell business software solutions
1997	Karlsson	Software Quality Journal	The author shared his valuable experiences about QFD, gained at software projects of Ericsson company for a better understanding.
1997	Elboushi & Sherif	Journal of Systems and Software	This is an application of QFD methodology to an object-oriented software design.
1997	Yilmaz & Chatterjee	Business Horizons	This study is about Deming and his philosophy about software development quality.
1998	Tan, Xie & Chia	International Journal of Quality & Reliability Management	This paper presented an application of QFD in designing WWW pages.
1999	Carruthers	BSc. Dissertation Department of Computer Science, Edith Cowan University: AU	The method proposed here includes both the simple SQFD models and the tools and techniques developed for Blitz QFD and Voice-of-Customer Analysis, as well as all the advantages of the traditional QFD set.
1999	Gloger, Jockusch & Weber	Proceedings of the 5th International Symposium on Quality Function Deployment	This study showed that The System Architecture Analysis (SAA) method integrates structured elements from the QFD and Design Space Approach to develop a model to meet customer and market requirements.
1999	Krogstie	Proceedings of the Fifth International Workshop on Requirements	This paper discussed how tools such as QFD can contribute to the development of high-quality requirements models that form the basis of information systems.

		Engineering: Foundations for Software Quality (REFSQ'99)	
2000	Liu	IEEE Potentials, Institute of Electrical and Electronics Engineers (IEEE)	This paper explained the SQFD methodology and its benefits for all stakeholders.
2002	Richardson	Software Quality Journal	This study presented a novel model called Software Process Matrix which lists the characteristics that a software model should have for being used in a company. This proposed model is based on QFD. Implementing this model to a small software development company is discussed.
2003	Koski	MBA Dissertation Helsinki University of Technology Executive School of Business: FI	The author presented a detailed research on recent experiences about QFD in the literature. The aim is to make the method understandable for better further applications. In addition, a case study is provided about upgrading enterprise resource planning (ERP) system of a global company.
2003	Herzwurm & Schockert	The International Journal of Quality & Reliability Management	In this paper, an overview of SQFD is provided. Differences between traditional QFD and Software QFD is shared. Also, commonly in use approaches (Zultner's, Shindo's etc.) for SQFD are presented.

2004	González et al.	Managing Service Quality	The researchers used QFD approach in e-banking industry to measure customer satisfaction.
2005	Buyukozkan & Feyzioglu	Computers & Industrial Engineering	This paper shared an extended QFD framework by presenting a fuzzy group decision-making model. An illustrative example on a software is given to measure the proposed model.
2005	Ramires, Antunes & Respicio	Lecture Notes in Computer Science	This study proposed SQFD approach to validate a software's technical requirements. A groupware tool is developed which is integrated with SQFD. An example with this tool is provided as well.
2006	Ahmed, Islam & Alwahaibi	Int. J. Business Information Systems	It is an identification of the customer requirements in a healthcare software system. Case study is conducted in a hospital, in Oman.
2006	Liu et al.	Software Quality Journal	The authors applied a novel quantitative method based on linear and non-linear techniques to technical target setting in SQFD.
2008	Kivinen	M.Sc Dissertation Department of Computer Sciences, University of Tampere: FI	The author carried out a thesis study about QFD application in a small-scale software environment.
2006	Liu, Inuganti & Noguchi	Total Quality Management	This paper focused on technical target setting in SQFD. The model considers technical trends for a specified timeframe.

2010	Zhu & Liu	IEEE Transactions on Services Computing	A new method in QFD based on artificial neural network (ANN) for setting technical targets is proposed. A study is conducted about web service design.
2010	Sener & Karsak	Software Quality Journal	This paper proposed a fuzzy regression and optimization methodology to set proper target levels in Software QFD. A mathematical model is established which aims maximizing customer satisfaction.
2010	Sen & Baracli	Expert Systems with Applications	This study provided a fuzzy QFD framework to determine which non-functional requirements reported by previous studies are essential to a company's software selection decision based upon its functional requirements. A case at Audio Electronics proves the applicability of the proposed approach.
2011	Paghaleh	Australian Journal of Basic and Applied Science	This paper presented an efficient combined model of QFD, Analytic Networking Process (ANP) and Bounded Goal Programming (BGP) to ensure the objectives of an organization and meet various customer needs in designing, manufacturing processes and after-sale services for software products.
2012	Sener & Karsak	Concurrent Engineering: Research and Applications	The authors proposed a fuzzy linear regression model to determine target levels in SQFD by noticing importance degrees of customer requirements. Voice-of-Customer matrix is used to prioritise these requirements. Also, future possible requirements are considered.

2013	Okonta et al.	West African Journal of Industrial & Academic Research	It is about a new framework by developing the Quality Function Deployment. The new approach uses several “houses" to incorporate the customer's voice into the development processes.
2013	Alrabghi	M.Sc Dissertation Department of Computer Sciences, Kent State University: USA	The author carried out a study as a thesis paper about Software QFD to make it more understandable. A review of recent studies in the literature is provided. Also, a quantitive example is applied in a company that wanted to develop a software for its GPS tool.
2014	Yuen	Neurocomputing Journal	This study proposes a hybrid framework for Fuzzy Cognitive Networking, Total Classification Clustering, and Quality Function Distribution for the evaluation and analysis of criteria in QFD. The approach is utilized to a cloud software development.

3. ELECTRONIC INVOICING

Electronic invoice (e-Invoice) is simply transferring the standard paper invoice and invoicing process to digital media and sending and receiving invoices electronically. At first, it was designed to include only Business-to-Business (B2B) and Business-to-Government (B2G) segment. It is now applied not only to business-to-business (B2B), but also to business-to-consumer (B2C) transactions.

Electronic invoice is defined by European Commission in Directive 2014/55/EU, as "an invoice that has been issued, transmitted, and received in a structured electronic format which allows for its automatic and electronic processing".

E-invoice helps the existing invoicing processes to be carried out electronically instead of papers. It is an alternative to traditional invoices distributed on paper. Companies can create invoices, process invoice information, and send them to the relevant tax authorities for file verification and transmission to the recipients. The authenticity and integrity of the electronic invoice is guaranteed by electronic signature.

An e-invoice that is only scanned and transmitted as an image file (PDF, TIFF, JPEG, etc.) via fax, e-mail or e-mail attachment is considered a false e-invoice, since it is not suitable for automatic processing. (Marinagi et al., 2015)

Below methods/types are not considered as an electronic invoice.

- Unstructured invoice data organized in PDF or Word formats
- Images of invoices like JPEG or TIFF
- Unstructured HTML invoices on a web page or in an email
- Scanned paper invoices
- Paper invoices sent as pictures via fax machines

According to the EU Directive 2014/55/EU, “only machine-readable which can be processed automatically and digitally by the recipient should be considered to be compliant with the European standard on electronic invoicing”.

A common solution for enabling e-invoicing is to outsource the e-invoicing service to a service provider. European Union’s e-invoicing is enabled by many e-invoicing service providers that comply with legislations.

Electronic invoicing is a result of digitalization in finance and accounting services. In addition to its role among business partners, electronic invoices are also very important to the tax administration. Governments around the world are aware of the importance of using electronic invoicing in businesses and it is being increasingly supported by the governments. The reason why countries are promoting a regulation on e-invoicing is because the system is beneficial for both companies and governments.

The most important advantages of e-invoicing for the governments; ease of tax control, prevention of tax losses and evasions / informality (black economy), creation of a transparent data center and greater control of businesses.

The main driving force behind e-invoicing adoption comes from the government level. Acting with the desire of more revenue and more efficiency, tax authorities increasingly rely on digital platforms to gather and analyze the data of taxpayers. Therefore, relationship between tax authorities and taxpayers have been transformed, due to technological developments.

From the taxpayers’ perspective, electronic invoicing offers huge potential to streamline business-to-business (B2B) processes in terms of the manual amount of work, material, cost and time.

The figure below clearly shows the difference in processes between paper invoicing and electronic invoicing. The creation and delivery of paper invoices are highly manual and inefficient business processes for suppliers. These cause high costs, errors and late payments.

The main benefit of e-invoicing is that it eliminates the many steps of paper invoicing like invoice handling steps of printing, posting, sorting and registration.

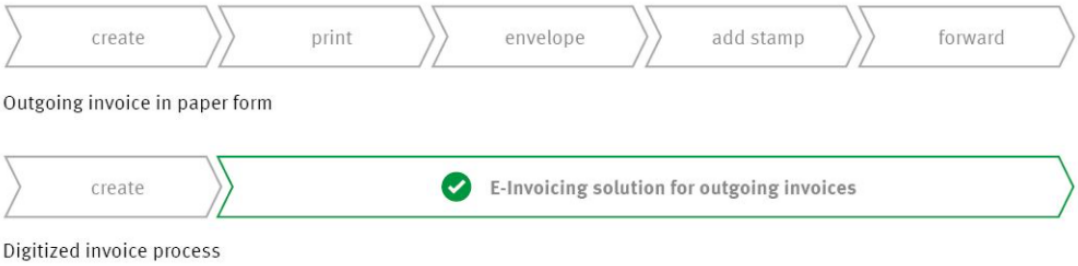

Figure 3.1 The comparison of processes in paper invoicing and electronic invoicing

The e-invoice application provides significant cost advantages to the parties that issue and accept invoices in terms of invoice issuance cost, invoice sending cost and many other issues. Within the European Union, an online survey was conducted with 15 EU Member States (Poland, Croatia, Ireland, Slovenia; Finland, Malta, Sweden; Slovakia, Hungary, Cyprus, Lithuania, Italy, Austria, Czech Republic, Luxembourg) in July 2019. Data collected from these countries show that the implementation of e-invoices contributes to more than 50% operational savings in any case. (European Commission, 2019)

In addition, industry experts point out that by utilizing e-invoicing, the potential savings in the EU's public sector are estimated to be at least 40 billion Euro of which today, less than 10% is exploited. (Koch, 2017)

In the survey of EU, the benefits of applying e-invoicing to the general administrative burden is mentioned. It shows that, with e-invoicing, delivery and communication times of e-invoicing is reduced.

On the other hand, although the volume of cross-border e-invoicing is currently low, according to that survey, EU countries are preparing their infrastructures for cross-border e-invoicing. That means these countries aim to be ready when e-invoicing becomes more widespread. Therefore, it can be said that e-invoicing provides international financial flow.

To conclude, the advantages of the e-invoice application to its users are generally as follows: (Kivijarvi et al, 2012)

- Decrease in printing and paper expenses due to the decrease in the use of paper invoices,
- Elimination in archiving costs,
- Elimination of problems arising from invoices between the buyer and seller,
- Easier inspection of information and documents,
- Shortening the process of recording invoices and reducing errors in registration,
- Providing instant access to sent and received invoices,
- Easier integration with international companies,
- Standardization in financial information,
- Prevention of tax losses and evasion,
- Faster and more effective tax audit,
- Contribution to the environment with the reduction of paper use.

However, there are some reasons preventing users from adopting the e-invoice application. These reasons can appear to be the disadvantages and obstacles of e-invoice application. The disadvantages of e-invoicing can be listed like below; (Sandberg et al, 2009)

- Difficult for smaller businesses, with the exception of some services directed only for them
- Demands volumes
- Different standards
- High investment and integration cost
- Data security concerns

Despite all the possible disadvantages, digital transformation and e-invoicing application is expanding worldwide and more companies are using electronic methods and software in their business activities.

3.1. ELECTRONIC INVOICING IN WORLD

With the astonishing improvements in technology, many countries in the world today have been taking steps towards digital transformation. Digital transformation can be defined as a concept of digitizing or reducing paper use (paperless) of the business of individuals. (Patel & McCarthy, 2000)

E-Invoice, one of the innovations in the field of digital transformation, is used in many countries around world, from America to Europe and from Africa to Asia. Figure 1 represents the situation of e-invoicing systems in the world. As can be seen on the Figure 3.2 that countries in Northern Europe and Latin America leads the electronic invoicing. This is because e-invoicing is a legal requirement in these countries and because national governments have made it an obligation for organizations to invoice electronically. In addition, regulations in many countries allow businesses to offer modern, low-cost, secure electronic invoices instead of traditional, expensive paper invoices.

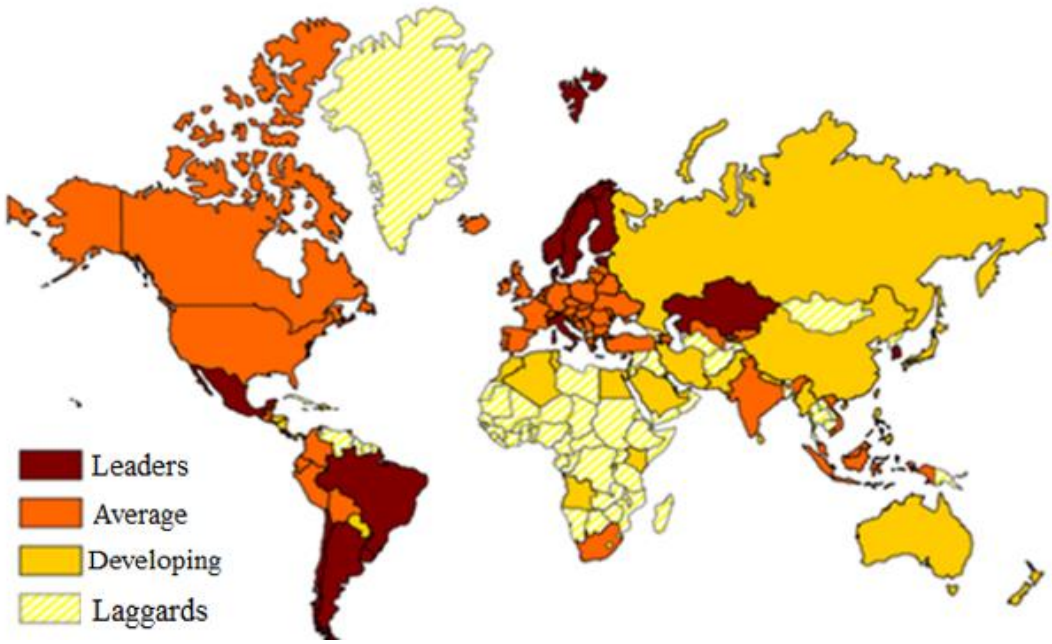

Figure 3.2 International E-Invoicing Market, 2020 (Koch, 2020)

Despite the Covid-19 pandemic, countries from all over the world has taken steps towards digitization in invoicing process in 2020. According to (Koch, 2019), who is an independent e-invoicing market analyst and consultant, the global market is expected to

cover 550 billion bills a year and quadruple by 2035. Although the type of businesses covered by the liability in each country varies depending on the income, the number of invoices or the sector, the main concepts and objectives of the e-invoice application are the same.

Below figure represents the roadmap of e-invoicing between 2020-2022 from a global perspective.

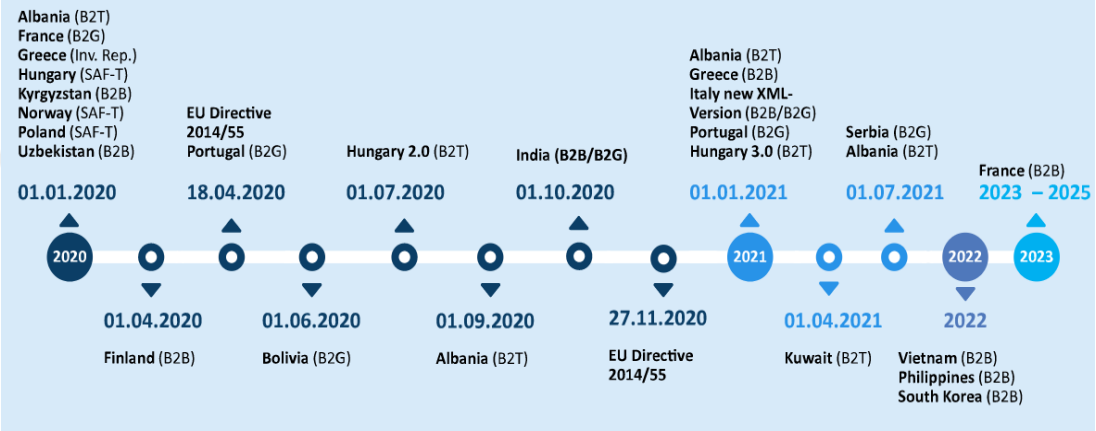

Figure 3.3 The roadmap of invoicing between 2020-2022 for some countries

In Europe, The European Commission set the development of e-Invoicing a target in both the 2002 and 2005 European Action Plans and set up the European Commission's Expert Group to develop a European Electronic Invoicing Framework (EEI) for the 2008-2009 period. EEI has a scope and goal of "providing the basis for the interoperability of e-Invoice solutions in the public and private sectors" and "helping to strengthen positive business incentives for electronic commerce instead of manual paper-based processes". (Vanjak et al, 2008)

In addition, with the Europe 2020 strategy launched in March 2010, the European Commission expresses its vision to make electronic invoicing the predominant invoicing method in Europe by 2020. (Kreuzer et al., 2013)

From that day, EU has had great success in e-invoicing, especially in B2B business and ic sector. The implementation of the Directive 2014/55/EU and the EN aim to

harmonize the way e-Invoices are exchanged and to allow interoperability across the EU. (European Commission, 2020)

In Europe, countries such as Denmark, Finland and Sweden have pioneered the adoption of e-invoice. The main purpose is to reduce transaction costs and in particular to increase financial process optimization and efficiency. (Wu, 2013)

Denmark authorities receive invoices in electronic format since February 2005, and this is prescribed by law. (Paghaleh, 2011) Similarly, since July 2008, Swedish government authorities have agreed to handle invoices (incoming and outgoing) electronically. (Moberg et al., 2008) In Finland, the first electronic invoice was sent in October 1999 and e-invoicing to the public sector has been mandatory since 2010 in Finland. (Edelmann & Sintonen, 2006)

Italy, which has the largest VAT deficit among EU members, was the first European country to implement a mandatory e-invoice model for all business transactions. Italy has launched an e-invoice model for domestic transactions, including B2B and B2C, as of 2019.

As of April 2020, compliance with the standards specified in the E-Invoice Directive 2014/55/EU has been made mandatory by all countries in the European Union. These standards are designed to streamline differences in the e-invoice format, thus reducing confusion and reducing transaction costs. All e-invoices must meet these basic standards, but rules specific to each country will still apply.

In 2020, new regulations with different scopes are in place for some European countries such as Croatia, Hungary, Estonia and France, Portugal and Germany. According to the law that entered into force in Germany in November 2018, from November 2020, public sector customers, namely municipalities and public institutions, are obliged to start processing e-invoices. In addition, the EU has some further plans, such as introducing regulations on B2B e-invoicing for Portugal by 2022. (Koch, 2020)

While electronic invoicing is growing at a slower pace in North America; in Latin America, Chile, Brazil and Mexico are the market leaders of e-invoicing. The e-invoicing applications were initiated in Chile in 2003. In 2008, Brazil adopted an electronic invoice model where the country's tax authority must receive and clear an invoice before a supplier can issue it to the payer. Then, in mid-2017, Argentina, Ecuador, Peru and Uruguay were also involved in this advanced process. (Barreix & Zambrano, 2018) Today, a majority of Latin American countries mandates for e-invoicing. In 2020, while Bolivia, Columbia and Guatemala are extending their scope of e-invoicing regulations, other Latin American countries such as Dominican Republic, El Salvador, Honduras, Panama, Paraguay and Peru are preparing for e-invoicing roll-outs. (Koch, 2020)

In Asia & Pacific region, tax authorities to eliminate tax evasion through better verification and control mechanisms have initiated e-invoicing projects. (Joung et al, 2014) Although it has yet to be standardized like in Latin America or Europe, several countries in Asia- Pacific are joining this transformation with new projects in 2020. While China is preparing for mass-market rollout for B2C and B2B segments, electronic invoice registration became mandatory in Kyrgyzstan and Uzbekistan in 2020. (Koch, 2020) Some other improvements in this region's countries are as follows.

- From July 2022, electronic invoicing will be mandatory in Vietnam for companies and individuals providing goods or services.
- From January 2021, any commercial company in Taiwan will have to issue invoices electronically.
- Singapore launched its invoicing system with European infrastructure in 2019, making it the first country outside of Europe to use the network to exchange electronic invoices between private companies. In 2020, e-invoice expanded into the B2G.
- The B2G e-invoice obligation came into effect in India in 2020. From 2021, a B2B e-invoice obligation will also be added.

3.2. ELECTRONIC INVOICING IN TURKEY

According to the legislational frame of e-invoicing, Turkey is one of the leading countries of e-invoicing besides Latin America countries. In Turkey, the e-Invoice system appears as an important part of a process called electronic transformation (e-Transformation).

Turkish Republic Ministry of Treasury and Finance initiated the e-transformation program in the accounting area in order to identify the informal economy, prevent tax losses, increase tax revenues, accelerate tax audit processes and facilitate easy access to information.

The main reason for the transfer of accounting to the electronic environment is to ensure the establishment of the appropriate infrastructure in our country's compliance with national and international standards. Another aim is to increase voluntary tax compliance. (Tektüfekçi, 2013) With this e-transformation in the accounting field, applications such as e-Invoice have come into use.

E-Invoice has entered the accounting life in Turkey with the notification number 397 of the Tax Procedure Law published by Turkish Revenue Administration (TRA) and started to be used as of 2010. With this law, the obligation for taxpayers with a gross turnover of 25 million Turkish Liras (TL) to be included in the e-invoice system was imposed. Since 2010, the scope of the taxpayers who are obliged to apply e-invoices has been expanded.

As of today, the year 2020 is of great importance in terms of the mandatory transition to e-transformation applications. With the notification number 509 of the Tax Procedure Law published by TRA, the scope of e-transformation applications has been expanded both as an application and as taxpayers. According to this law, taxpayers with a gross sales revenue of 5 Million TL or more for the 2018 or 2019 accounting period were obliged to use the e-invoice application as of 1 July 2020.

Although e-invoicing is legally binding for some companies, depending on their annual revenues or sectors, it is possible for the taxpayers who are outside of the scope specified in the law to use the e-Invoice application upon their requests. Taxpayers who want to use the e-invoice application can issue invoices only to those who are registered in the e-

invoice system. In other words, taxpayers who want to issue e-invoices or receive e-invoices have to be registered e-invoice users in TRA system. (Kara & Yılmaz, 2017) According to TRA, as of January 1, 20201, 328,000 taxpayers are registered in the e-invoice system.

Businesses to be included in the e-invoice application must have a financial seal or digital signature before the e-invoice application phase. Businesses with financial seal or digital signature can start using the e-invoice application after the e-invoice application process is deemed appropriate by TRA. (Demirkan, 2013)

Following the application made to the Turkish Revenue Administration (TRA), taxpayers defined on the system transmit the electronic invoices created in accordance with the determined standards via TRA. TRA is the center of the transmission process of electronic invoices. Sending and receiving electronic invoices and messages between sender and recipient must be done through TRA.

There are three different methods of using e-invoice and companies can proceed with one of these options.

1. **TRA e-Invoice Portal:** E-Invoice transactions can be carried out through a portal provided by the Turkish Revenue Administration. The free and simplest method, TRA e-Invoice Portal, is a suitable method for users with low invoice volume. This portal, which was developed to enable users who do not have sufficient infrastructure, is a web application that includes the basic functions of the e-Invoice Application. The disadvantages of this method are as follows:
    - Invoices are issued manually, not automatically.
    - Users can issue up to 5.000 e-Invoices per month.
    - Invoices on the portal are deleted from the system backwards every 6 months. For this reason, taxpayers using this method should download their invoices and get their backup.

2. **Direct Integration:** It is the method preferred by companies that have more than 5,000 invoices per month and sufficient information technology infrastructure. If

the company sends and receives a large number of invoices and also wants to archive invoices in its own system, they can integrate their own system with the TRA system. Companies must obtain approval from the Turkish Revenue Administration for the applications and services developed by themselves. In case of selecting direct integration method, the taxpayer is responsible for the 7x24 operation, security, backup, virus control and similar infrastructural requirements of this system. Therefore, companies need to invest more in their information technologies.

3. **Special Integrator:** It is the recommended method for companies that issue more than 5,000 invoices per month and have insufficient information technology infrastructure or do not want to make extra development in this direction. In this method, the company works with an e-invoice service provider called a special integrator which are announced by the TRA. As of December, 2020, there are 185 service provider in Turkey that have permission. Companies that have received special integration permission from the TRA, open their e-invoice software and hardware infrastructures to taxpayers. Companies working with a special integrator give the responsibility of e-invoice systems (archiving, 7x24 accessibility etc.) to the integrator companies.

Below figure shows the structure of these three method. As indicated before, in Turkey, all invoices based on the e-invoice structure are transmitted and received through the TRA system. Whether the taxpayer connects to the TRA system with direct integration, or uses a special integrator or GIB e-Invoice Portal system, the responsibility of the e-Invoice belongs to the company receiving the invoice. (Tektüfekçi, 2018)

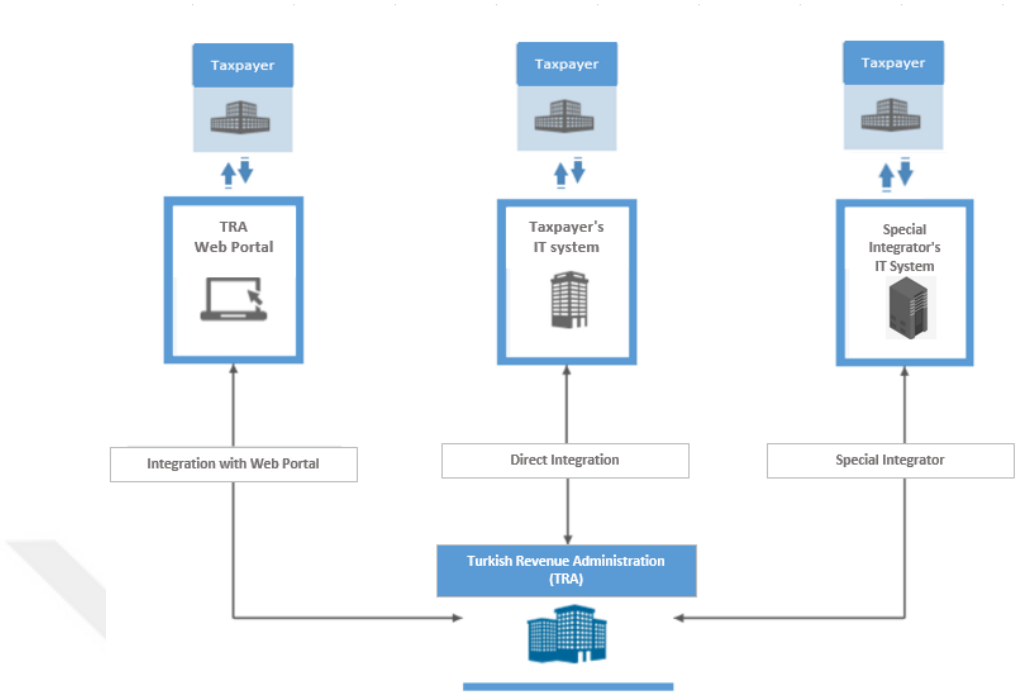

Figure 3.4 Methods of enabling e-invoicing in Turkey

In Turkey, an application called “e-archive” is also made obligatory with the notification number 433 of the Tax Procedure Law. E-Archive represents electronic invoices sent to individuals and organizations not registered in the e-Invoice system; it includes B2C and B2B transactions.

As mentioned before, e-invoice can only be used among those registered in the e-invoice system. In e-archive invoicing, the sender must first be registered to the e-invoice application. The receiving party consists of companies that do not obliged to use e-invoices and do not voluntarily use e-invoices, as well as individual customers. According to TRA, as of January 1, 2021, 317,000 taxpayers are registered in the e-archive invoice system.

In the e-archiving system, unlike e-invoice, the created invoices are not transmitted to the recipient via TRA. Although it is possible to send the invoice as paper to the other party, it is usually sent by mail to reduce the use of paper. Since TRA is not between the receiver and the sender in the e-archive invoice flow, the taxpayers only submit a report to TRA at the end of each month.

Below table shows the comparison between e-invoice and e-archive invoice systems.

Table 3.1 Comparison between e-invoice and e-archive invoice systems

e-Archive	**e-Invoice**
B2B, B2C	B2B
Electronic environment / paper invoice	Electronic environment
TRA is informed with an end of report.	Every invoice sent to its recipient is forwarded to TRA.
TRA Portal, Direct Integration or Special Integration methods can be used.	TRA Portal, Direct Integration or Special Integration methods can be used.

To conclude, in Turkey, applications in digital transformations are developing day by day. It can be said that these practices will continue by expanding the coverage area for the purposes such as detecting the informal economy, preventing tax evasion, performing the audit quickly and with high quality, facilitating access to information and providing cost savings.

4. METHODOLOGY

In this section, first, Software Quality Function Deployment and then, DEMATEL method will be explained. After that, the proposed SQFD based design approach will be defined.

4.1. SOFTWARE QUALITY FUNCTION DEPLOYMENT

Due to the rapid growth of the software industry, increasing the quality of software development has become important. For this reason, the software industry focused on improving software quality to meet customer needs.

Software Quality Function Deployment (SQFD) is applying Quality Function Deployment (QFD) to software development. Its main focus is on improving the quality of the software development process by implementing quality improvement techniques during the requirements solicitation phase of the system development life cycle (SDLC). (Haag et al, 1996)

SQFD uses House of Quality (HOQ), the most commonly used matrix in the traditional OFD tool. The HOQ consists of matrices to organize and correlate pieces of data. (Liu, 2000) It translates subjective and qualitative customer requirements (CRs) into software technical attributes (TAs). (Şener & Karsak, 2010)

The concept of the House of Quality consists of six basic steps: (Edelmann & Sintonen, 2006)

1. identify customer's attributes or requirements,
2. identify technical features (counterpart characteristics) of the requirements,

3. relate the customer's requirements to the technical features,
4. conduct an evaluation of competing products,
5. evaluate technical features and
6. develop targets,
7. determine which technical feature to deploy in the remainder of the production process.

The horizontal part of the matrix includes information about the customer. The vertical portion of the matrix contains technical information that responds to customer input. The steps of creating the HOQ matrix are as follows: (Haag et al, 1996)

Step 1: The benefits that the customer wants in a software product in their own words are known as customer requirements (CRs). Customer requirements are identified with the question "What do customers want?" and placed on the left y-axis. The customers can be from the end users, managers, and anyone else who would benefit from the use of the software product.

Step 2: The requirements are translated into technical and measurable statements of the software product and placed on the upper x-axis. Some customer requirements can create multiple technical product feature. In addition, technical attributes (TAs) must be somewhat measurable. It can be a numerical based metric or it should be measured using "Yes" or "No".

Step 3: The QFD team are requested to complete the correlation matrix by determining the importance of the relationships between customer requirements and technical product features.

Step 4: Based on customer survey data, requirement priorities are developed for specified customer requirements or priorities are determined by calculating the weights of requirements using various weighting methods. These are placed on the right y-axis.

Step 5: This process involves the development of technical attributes' priorities (bottom x-axis) by summing the results of multiplying the correlation values between CRs and TAs with the weight of CRs.

4.2. DEMATEL

Decision making trial and evaluation laborator (DEMATEL) method was originally developed by the Science and Human Affairs Program of the Battelle Memorial Institute of Geneva between 1972 to 1979, with the purpose of examining the complex and nested problematic group. This method is useful and applicable in analyzing and forming the relationship of cause and effect among evaluation criteria or deriving interrelationship among factors. (Kashi, 2015)

The DEMATEL method is used to construct interrelations between criteria/ factors and to find the central criteria to represent the effectiveness of factors/aspects. . It is regarded as one of the best tools to solve the cause and effect relationships among evaluation criteria. It has been successfully applied in many areas, especially in real-world problems which contains imprecise and ambiguous information. (Si et al., 2018)

The steps of the applying DEMATEL are summarized below. (Mad Ali et al., 2016)

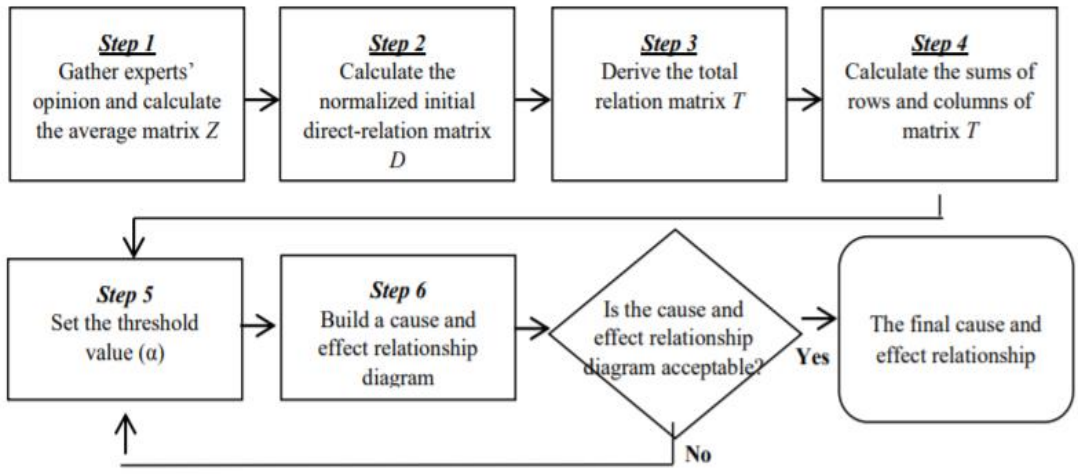

Figure 4.1 Implementation steps of DEMATEL

Step 1: Generation of direct-relation matrix

Let's suppose a group of *m* experts and *n* factors in a system. Experts have been given a list of factors organized into sets of *i* and *j*. Next, they will be asked to indicate the degree of influence of the factors on each other (pair-wise comparison); how does factor *i* affects factor *j*. This is done with the help of an scale "no influence (0)," "low direct influence (1)," "medium direct influence (2)," "high direct influence (3),"and "very high direct influence (4)".

The degree to which the expert believe factor i affects factor j is denoted as x_{ij}. For each respondent, an *n x n* non-negative matrix is formed, where *k* is the expert number of attending in evaluation process with $1 \leq k \leq m$. The mathematical notation can be formulated like below:

$$X = \begin{bmatrix} 0 & \cdots & x_{1n} \\ \vdots & \ddots & \vdots \\ x_{n1} & \cdots & 0 \end{bmatrix} \quad (4.1)$$

Each element of the matrices is indicated with x_{ij} representing the impact degree *i* has on factor *j*. Since DEMATEL does not evaluate the influence of factors by itself, the diagonal elements of each matrix are set to zero.

Each participant will directly generate a matrix, and then an average matrix is created from the average of the same factors / items in the various direct matrices of the experts. This matrix can be called as matrix Z = $[z_{ij}]$

Step 2: Normalizing the initial direct-relation matrix

In the second step, the normalized direct relationship matrix D will be computed from the mean Z-matrix. Each item is divided by the largest row sum of the average matrix.

The value of each element in this normalized direct relationship matrix D will vary between [0,1]. The calculation to get the average matrix is as shown:

$$D = Z/s \tag{4.2}$$

Where,

$$s = max_{1 \le i \le n} \sum_{j=1}^{n} z_{ij} \tag{4.3}$$

Step 3: Total relation matrix

The total relation matrix-T can be shown as:

$$T = D(I - D)^{-1} \tag{4.4}$$

Step 4: Prominence and Relevance

Vector R and D are defined by the following formulas that represent the sum of rows and sum of columns from the total effect matrix. Let vector R be "n x 1" and D be "1 x n".

$(D_1, \dots, D_n)$ with $D_j = \sum_{i=1}^{n} t_{ij}$ where *(j= 1, 2, …, n)* (4.5)

On the other hand, the sum of the column will be computed as follows:

$$\begin{bmatrix} D_1 \\ \vdots \\ \vdots \\ D_n \end{bmatrix}$$ with $D_i = \sum_{i=1}^{n} t_{ij}$ where i= *1, 2, …, n)* (4.6)

It shows both direct and indirect effects of factor *i* on other factors.

In a similar way, if R_j is the sum of the *j*th column in the matrix T, then:

$$\begin{bmatrix} D_1 \\ \vdots \\ \vdots \\ D_n \end{bmatrix} \text{ with } D_i = \sum_{i=1}^{n} t_{ij} \text{ where i= } 1, 2, \ldots, n) \quad (4.7)$$

It shows the direct and indirect effects that factor *j* gets from the other factors. When *i* = *j*, the sum (D_i + R_i) summarizes the total effects given and taken by factor *i*. It is called "Prominence" and is illustrated as below:

$$(D_i + R_i) = \sum_{j=1}^{n} t_{ij} + \sum_{k=1}^{n} t_{ik} \quad (4.8)$$

It presents the importance of factor *i* in the entire system.

The difference shows the net effects that factor *i* contributes to the system. It is called "Relevance" and is formulated as below:

$$(D_i - R_i) = \sum_{j=1}^{n} t_{ij} - \sum_{k=1}^{n} t_{ik} \quad (4.9)$$

Consequently, if $(D_i - R_i)$ is positive, the influence factor *i* is affecting other factors, while if $(D_i - R_i)$ is negative, factor *i* is a is being influenced by other factors.

4.3. PROPOSED SQFD-BASED DECISION APPROACH

In this section, a SQFD-based decision approach proposed in this study will be described. The steps of the approach are as follows. Also, Figure 4.3 shows the steps of proposed approach.

Step 1: Identification of user company needs (CNs)

The QFD process starts with the determination of customer needs. CNs should be collected in terms of customers' perceptions and linguistic evaluation.

Step 2: Identification of system characteristics (SCs)

SCs, the means of satisfying these CNs, are defined in this step. This methodology allows using benefit-type and cost-type system characteristics.

Step 3: Calculating the relative importance of "CNs"

In real life, limited budgets force companies to compromise on their expectations. At this point, there is a need for a tool that will rate company needs according to each other and create a relative importance level. The proposed methodology overcomes this problem using DEMATEL.

Step 4: Defining relationships between "CNs" and "SCs"

The relationship in this approach are defined through e-invoicing experts' opinion as strong-medium-weak in 1-3-9 scale.

Step 5: Calculating relative importance ratings of "SCs"

The weights of system characteristics can be determined by (Bevilacqua et al., 2006):

$$Weight\ (SC)_i = V(SC)_{i1}\ x\ imp(CN_1) + \ldots + V(SC)_{in}\ x\ imp(CN_n) \quad (4.10)$$

where $V(SC)_{in}$ is the correlation value of SC_i with CN_n, and $imp(CN_n)$ represents the importance of CN_n.

Step 6: Determination of attribute values for each alternative for each "SC" in the selection process and determination of target values for each "SC"

In this methodology, while some system characteristics can get quantitative values, some of them can be evaluated with performance values. For performance values, a numerical value is assigned in a scale of 1-5.

Also, in this step, target values for each "SC" should be defined. According to attribute values and target values, alternatives in the selection process can be eliminated.

Step 7: Normalizing the attribute and target values

In order to avoid problems in calculation due to scale differences, the values are normalized with linear normalization scheme to make them unit-free and comparable values. The normalized data takes value in the range of [0,1]. System characteristics that take a value closer to 1 are considered more suitable.

The normalized values for benefit-type "SC" and cost-type "SC" are calculated as stated in Equation 4.11 and 4.12. (Karsak, 2002)

$$r_{ij} = \begin{cases} \frac{x_{ij} - x_j^-}{x_j^* - x_j^-}, & j \in B \\ \frac{x_j^* - x_{ij}}{x_j^* - x_j^-}, & j \in C, \end{cases} \tag{4.11}$$

where B and C are the set of benefit-type and cost-type, respectively, $x_j^* = max_i x_{ij}$ and $x_j^- = mn_i x_{ij}$.

Step 8: Alternative evaluation using a weighted distance metric

In order to evaluate alternatives, a weighted distance metric based measure is used which is represented in the study of (Alptekin & Karsak, 2011).

$$d_p^k = \left\{ \sum_j \lambda_j (max\left(0, \left(x_j^* - x_{jk}\right)\right))^p \right\}^{1/p}, p = 1, 2; k = 1, 2, \dots, s \tag{4.13}$$

where j is the weight of the jth system characteristic, x_j^* is the target value of the jth system characteristic. x_{jk} is the value of the jth system characteristic for the kth e-

invoicing solution alternative, d_p^k is the distance metric for the kth e-invoicing solution alternative which is based on the p-order lower partial moment.

The e-invoicing solutions alternative with the minimum value of the considered distance metric is determined as the best, and the e-invoicing solutions can be ranked according to d_p^k in ascending order.

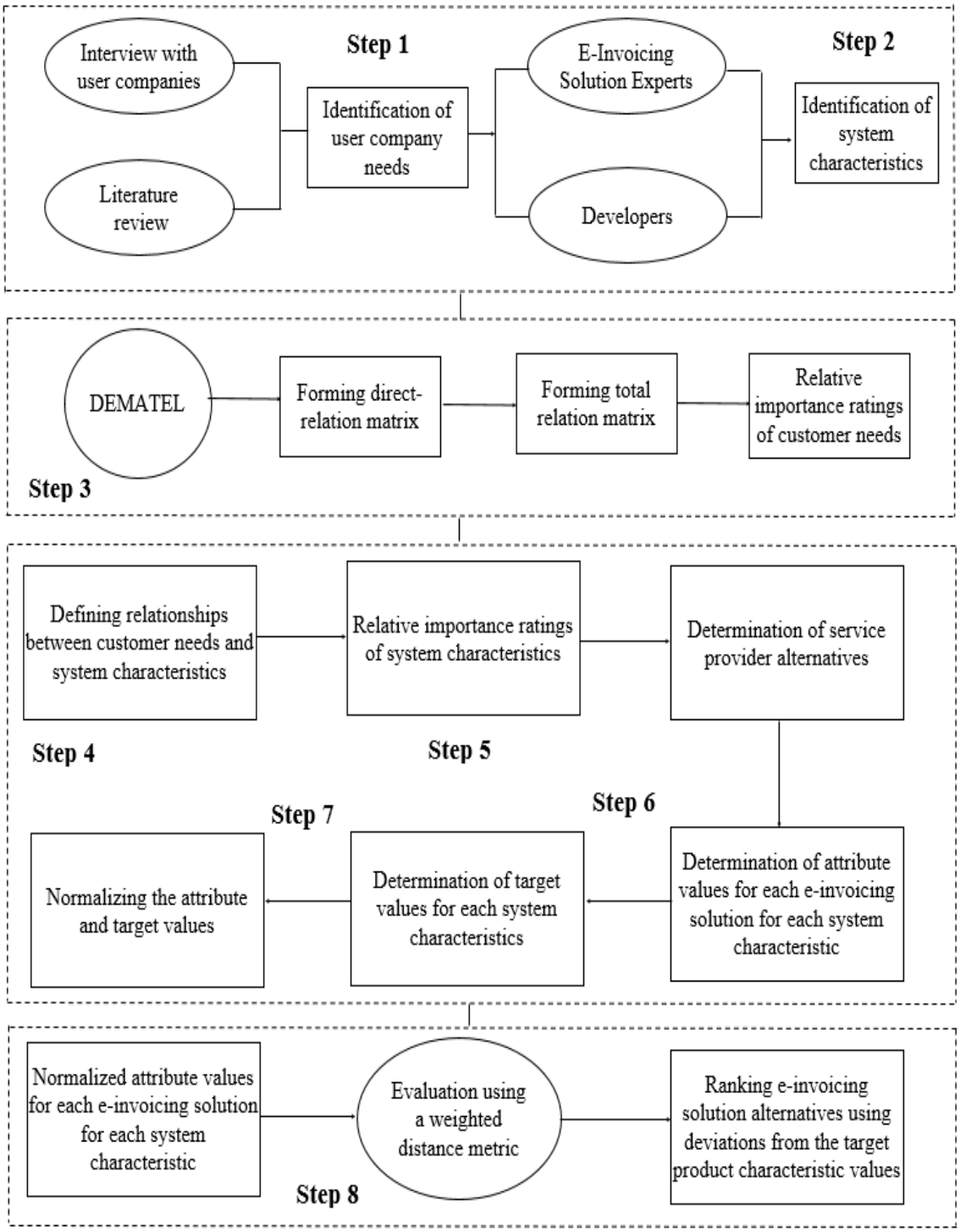

Figure 4.2 Representation of the proposed decision approach

5. ILLUSTRATIVE APPLICATION IN TURKEY

In this section, the e-invoicing service provider selection problem will be defined and the proposed method will be applied to the illustrative problem.

In today's rapidly changing environment, companies have to reduce their costs to protect their existence in high competition. Costs can be reduced significantly with the use of information technologies (IT) and legal requirements that require companies to change their business processes. This digitalization has brought important challenges such as ensuring security in electronic transactions and ensuring the integrity of information. An e-invoicing service provider is a key partner for companies as they handle sensitive electronic information.

The implementation of e-invoicing can be considered as an IT project. This paper uses Software Quality Function Deployment (SQFD) approach in e-invoicing industry to maximize customer satisfaction and validate the technical requirements of service provider companies in Turkey.

Problem here will be evaluated from user company view. This company is selected as an multinational company.

The aims of the this application are as follows:

1. To identify "user company needs" and "system characteristics of e-invoicing solution" that are part of the QFD methodology as applied to e-invoicing service providers' solutions in Turkey.
2. To find out what attributes that need be used and has to be eliminated in order to obtain a suitable e-invoicing solution, which meets the need of the company.

Based on this purpose, a House of Quality (HOQ) matrix is created which can be used in the development phase of many software products. (Koch, 2017)

To obtain the data to form the HOQ, literature review and interviews with the key-informants of both customer and service provider companies are conducted. Also, service providers' documents such as project reports and marketing brochures are extensively reviewed.

Step 1: First, the six customer needs are selected which are listed in below table.

Table 5.1 List of company needs

CN1	Total cost of ownership
CN2	User friendliness
CN3	Flexibility
CN4	Easy and fast project implementation
CN5	Support quality
CN6	Value-added services

The four of user company needs are selected from the articles in the literature. Others are determined based on author's experience and experts' opinions in this field.

Table 5.2 Literature review for company needs

Company Needs	Author(s)	Publication Year
Total cost of ownership	Karsak, E. E. & Ozogul, C. O.,	2009
	Arendsen, R., Van de Wijngaert, L.	2011
	Myllynen, N.	2011
	Chu, H., Chai, Y., Liu, Y., & Sun, H.	2015
	Penttinen, E., Halme, M., Lyytinen, K., & Myllynen, N.	2018
User friendliness	Karsak, E. E. & Ozogul, C. O.	2009
	Liu, X., Inuganti, P., & and Noguchi	2010
	Myllynen, N.	2011
	Hernandez-Ortega, B.	2012
	Sener, Z. & Karsak, E.	2012
	Alrabghi	2013
	Lian, J.W.	2015
	Penttinen, E., Halme, M., Lyytinen, K., & Myllynen, N.	
Flexibility	Karsak, E. E. & Ozogul, C. O.	2009
	Myllynen, N.	2011
Support quality	Buyukozkan, G., & Feyzioglu, O.	2005
	Karsak, E. E. & Ozogul, C. O.	2009
	Myllynen, N.	2011
	Chu, H., Chai, Y., Liu, Y., & Sun, H.	2015

Total cost of ownership consists of cost components including software, hardware, consulting, training, implementation team, etc. (Karsak & Özoğul, 2009) According to (Koch, 2019), e-invoicing projects result in a payback period of 0.5-1.5 years. Companies should consider this payback period before dealing with a service provider.

User friendliness is important since intuitive and self-explained screens and menus would ease the adaptation process for end-users and reduce the time of the needed user trainings. (Karsak & Özoğul, 2009)

Flexibility is also essential for the companies. In this case, the concept of flexibility have multiple aspects. For example, some companies, especially global ones, can use different ERP systems within their organization. These companies may want to combine their e-invoice processes under a single structure. Even if they do not use different ERP systems, a group of companies can belong to the same organization. In this situation, too, this group of companies may want to combine their e-invoicing processes under the same structure.

Also, *flexibility* means international scope in this case. As time goes on, e-invoice regulations are being implemented in different countries. For the companies, which have global operations and cooperate with international suppliers, they want to be sure that their invoices comply with the different tax and regulatory laws in those countries. Companies want to combine their operations in different countries under the same structure. Therefore, an e-invoice software should provide a practical and simplified solution and automatically ensure compliance. In short, companies need a flexible e-invoicing solution that will adapt if they decide to use another ERP system or establish new companies within their organization.

On the other hand, *flexibility* means no dependency on the service provider when companies want to adapt their own developments and application functions to the solution. Finally, ways to cope with the increase in the number of service users is also included under the need for *flexibility*.

Easy and fast project implementation makes it quick and painless for companies to start using e-invoices. Especially in the countries which using e-invoicing is mandatory, companies must be included in the e-invoice system within the legal deadlines. That's why, project duration is so critical. Experienced project team, development and training durations affect this project duration.

Also, *support quality* is important as well as the project quality because they will continue their e-invoicing processes with them after the implementation project is over.

Companies needs a fast, accurate and accessible support. The aim of a company is to make profit. Issuing an invoice is the first way of taking their money as a result of their business so invoices are critical and they do not want to delay this process because of a poor-quality support.

Also, according to the According to the article 229 of the Tax Procedure Law No. 213, it has been decided that the invoice will be issued within a maximum of seven days from the date of delivery of the goods or the service, and invoices not issued within this period will not be deemed to have been issued at all. Therefore, companies required a high quality support if they have any problem while issuing their invoices electronically.

Value-added services are the extra specifications, which an e-invoicing solution can provide. These can be a report or a tool within the solution and ease the companies' e-invoicing processes. It is crucial for the companies as they do not want to need another tool to have fully automated e-invoicing. For example, the companies want to have the ability of creating the invoices manually on a digital platform to fasten their business processes. A service provider company is preferable if they offer a solution like this. It can be a web-based solution or a tool within ERP systems.

E-Invoice service providers that has not guaranteed regulatory compliance and data security are not a feasible alternative, so they are not included in the selection process.

Regulatory compliance is an indispensable feature, as some companies use e-invoices because it is legally mandatory for them. Since the companies do not want to receive incompatibility penalties, they want an e-invoice solution, which leaves no room for human error. Data security is also very important to the companies when working with a service provider as the e-invoice is a valuable asset for the companies and includes confidential information.

Step 2: Secondly, the e-invoicing system characteristics given in Table 5.3 are identified.

Number of customers (SC1), company's experience (SC3), report variety and performance (SC5), number of solution partners (SC7), allowance of other integrations (SC10), operating country fit (SC11), online support system performance (SC12), open code percentage (SC13), offering digital signature software (SC14) are called as benefit

type criteria, for which the greater the value the more its preference. N*umber of screens in the package (SC2), average project duration (weeks) (SC4), percentage of extra developments (SC6), average duration of user training (man/hour) (SC8), average response time to tickets (hours) (SC9)* are called as cost type criteria, for which the greater the value the less its preference.

Table 5.3 List of system characteristics

No	Definition	SC Type
SC1	Number of customers	Benefit
SC2	Number of screens in the package	Cost
SC3	Company's experience (years)	Benefit
SC4	Average project duration (weeks)	Cost
SC5	Report variety and performance	Benefit
SC6	Percentage of extra developments	Cost
SC7	Number of solution partners	Benefit
SC8	Average duration of user training (man/hour)	Cost
SC9	Average response time to tickets (hours)	Cost
SC10	Allowance of other integrations	Benefit
SC11	Operating country fit	Benefit
SC12	Online support system performance	Benefit
SC13	Open code percentage	Benefit
SC14	Offering digital signature sofware	Benefit

Number of customers gives an idea to the customer about vendor's references. The customer can understand how many of other companies have been using the same e-invoicing solution, and at the end, it shows the reliability of the vendor. (Karsak & Ozogul, 2009) (Myllynen, 2011)

Number of screens in the package is a technical feature, which mainly shows the ease of use of the e-invoicing solution. More screens creates more confusion on user's mind as in terms of the complexity of the solutions.

Company's experience (years) is another measure of the service provider's reliability. It can be said that if a service provider exists in this e-invoicing field for many years, it will create a positive impression on customer's mind.

Average project duration (weeks) is important as e-invoicing is legally binding for some taxpayers. They do want a fast e-invoicing project implementation in order to avoid penalties for not using e-invoices on the date specified by the government. Also, companies that do not have legal obligations to use e-invoices will also want a quick return of their investment in the e-invoice solution.

Report variety and performance is an additional service within e-invoicing solution as user companies may want various and high performance reports for an efficient invoicing process.

Percentage of extra developments can be count as a technical measure which shows the compliance of the product to the user companies invoicing process. If a e-invoicing tool requires extra developments to meet the process requirements, it mainly related with its lack of flexibility.

Number of solution partners gives an idea about the vendor's company size and reliability. A vendor with more solution partners can produce quick solutions to user company's problems. (Karsak & Ozogul, 2009)

Average duration of user training (hours) represents the complexity of the solution. If a tool requires more time to give users a training, it can be said that it is more complicated to be understood by users. (Karsak & Ozogul, 2009)

Average response time to tickets (hours) helps to understand their support quality. In general, this characteristic is included in the contract as a clause its validity is preserved under it. As invoicing is a critical process for the companies, they expect quick solutions when they have problems.

Allowance of other integrations shows the solution's flexibility. It is importants for large organizations, which has complex e-invoicing systems that needs integration different systems. (Penttinen et al., 2018)

Operating country fit has a significant meaning for multinational organizations because e-invoicing becomes common in the world, therefore this kind of companies need a standardized solution in their operating countries. In short, if a service provider can provide solutions in user companies' all operating countries, they will get competitive advantage. (Karsak & Ozogul, 2009)

A service provider's *online support system performance* shows that they work systematically. It helps the customer to track their problems which need to be solved by vendor.

Open code percentage can be evaluated from many aspects. Basically it is related with vendor's technical quality and standardization. It is important for the companies that have their IT teams as they want to access a development made in their systems and expect them to meet certain standards. Also, it gives customers the oppurtunity of making their own developments within e-invoicing process and this reduces dependency on the supplier, and can provide support needs with its own internal resources.

Offering digital signature sofware is required legally to use e-invoicing, that's why if a vendor provides this software within their solution, it eliminates the need for a signature software.

Step 3: The importance weights of the customer needs are calculated with DEMATEL method.

Table 5.5 represents the direct-relation matrix of company needs. These relations are defined with 0-4 scale.

Table 5.4 Pairwise Comparison Scale

Value	Definition
0	No impact
1	Low impact
2	Medium impact
3	High impact
4	Very high impact

Table 5.5 Direct-relation matrix of customer needs

	CN1	**CN2**	**CN3**	**CN4**	**CN5**	**CN6**
CN1	0	1	2	1	1	2
CN2	2	0	4	3	1	0
CN3	4	3	0	2	0	0
CN4	2	2	0	0	0	0
CN5	2	0	0	0	0	0
CN6	3	3	1	1	0	0

After implementing Equation 4.4, total relation matrix is formed and shown in Table 5.6.

Table 5.6 Total relation matrix

	CN1	**CN2**	**CN3**	**CN4**	**CN5**	**CN6**
CN1	0,210	0,230	0,271	0,202	0,111	0,186
CN2	0,414	0,207	0,440	0,383	0,125	0,064
CN3	0,506	0,383	0,202	0,318	0,068	0,078
CN4	0,250	0,221	0,109	0,090	0,036	0,038
CN5	0,186	0,035	0,042	0,031	0,017	0,029
CN6	0,433	0,378	0,265	0,243	0,062	0,067

By implementing DEMATEL, the weights of user company needs is calculated. Below table represent these weights. According to this, total cost of ownership is found as the most important customer need.

Table 5.7 Weights of company needs

Total cost of ownership	0,231
User friendliness	0,216
Flexibility	0,203
Easy and fast project	0,146
Support quality	0,053
Value-added services	0,151

Step 4: This is the step of identifying the relationship between company needs and system characteristics. Then, a numerical scale (1-3-9) is assigned as strong, medium or weak to show the strength of the relationship between system characteristics and company needs. Table 5.8 represents the relation matrix.

Table 5.8 Relation matrix of user company needs and system characteristics

		SC1	**SC2**	**SC3**	**SC4**	**SC5**	**SC6**	**SC7**	**SC8**	**SC9**	**SC10**	**SC11**	**SC12**	**SC13**	**SC14**
		Number of customers	Number of screens in the package	Company's experience (years)	Average project duration (weeks)	Report variety and performance	Percentage of extra developments	Number of solution partners	Average duration of user training (man/hour)	Average response time to tickets (hours)	Allowance of other integrations	Operating country fit	Online support system performance	Open code percentage	Offering digital signature software
CN1	Total cost of ownership	9		9	3			3		3	3	3	3		9
CN2	User friendliness	1	9		1	3			9		3	1			
CN3	Flexibility			1			9				9	9		3	3
CN4	Easy and fast project	1		3	9		3	3	3					3	
CN5	Support quality	1		3				1		9			9	1	
CN6	Value-added services					9							1		9

Step 5: The importance weights of the system characteristics are calculated by using sum of importance weights of company needs and the relationship scores. The results can be shown in Table 5.9.

Table 5.9 Importance weights of system characteristics

SC1	Number of customers	2,498
SC2	Number of screens in the package	1,948
SC3	Company's experience (years)	2,882
SC4	Average project duration (weeks)	2,221
SC5	Report variety and performance	2,004
SC6	Percentage of extra developments	2,260
SC7	Number of solution partners	1,184
SC8	Average duration of user training (man/hour)	2,385
SC9	Average response time to tickets (hours)	1,175
SC10	Allowance of other integrations	3,167
SC11	Operating country fit	2,734
SC12	Online support system performance	1,326
SC13	Open code percentage	1,098
SC14	Offering digital signature software	4,044

According to the calculation, offering digital signature sofware is found as the most important criteria in this e-invoice service provider selection process.

Step 6: There are four hypothetical alternatives in this selection process. In this step, the attribute values for each SC is hypothetically assessed. Where SC5, SC10, SC12 are evaluated on a scale of 1-5 based on their performance values,only SC14 gets a binary value among all. The other ones like SC1, SC2 etc.are evaluated in quantitative values.

Also, target values are hypothetically assessed for each system characteristics by taking into account if it is a benefit type or cost type.

Below table shows the attribute and target values for each system characteristic.

Tablo 5.10 Attribute values for each alternative and target values for each SC

System Characteristics			Alternatives				Target
SC No	**SC Definition**	**SC Type**	**A1**	**A2**	**A3**	**A4**	**Value**
SC1	**Number of customers**	**Benefit**	150	400	725	350	725
SC2	**Number of screens in the package**	**Cost**	3	5	3	2	3
SC3	**Company's experience (years)**	**Benefit**	2	6	8	5	8
SC4	**Average project duration (weeks)**	**Cost**	8	14	10	12	11
SC5	**Report variety and performance**	**Benefit**	2	4	5	3	5
SC6	**Percentage of extra developments**	**Cost**	35	20	10	25	22,5
SC7	**Number of solution partners**	**Benefit**	6	12	10	8	12
SC8	**Average duration of user training (man/hour)**	**Cost**	2	4	8	2	4
SC9	**Average response time to tickets (hours)**	**Cost**	2	8	4	4	2
SC10	**Allowance of other integrations**	**Benefit**	1	5	5	5	5

SC11	**Operating country fit**	**Benefit**	80	100	100	80	100
SC12	**Online support system performance**	**Benefit**	1	5	5	1	5
SC13	**Open code percentage**	**Benefit**	0	80	100	10	100
SC14	**Offering digital signature software**	**Benefit**	1	1	1	0	1

As can be seen in Step 5, *offering digital signature software (SC14)* is found as the most important criteria. Therefore, Alternative 4 is excluded from the selection process as their solution do not have this characteristics. On the other hand, this characteristic take the same value for Alternative 1, 2 and 3 because their solutions all have this feature. That's why, *offering digital signature software (SC14)* is not included in the selection process. Below table shows the system characteristics used as decision criteria in the selection process.

Table 5.11 The system characteristics used in selection process

SC1	Number of customers
SC2	Number of screens in the package
SC3	Company's experience (years)
SC4	Average project duration (weeks)
SC5	Report variety and performance
SC6	Percentage of extra developments
SC7	Number of solution partners
SC8	Average duration of user training (man/hour)
SC9	Average response time to tickets (hours)
SC10	Allowance of other integrations
SC11	Operating country fit
SC12	Online support system performance

SC13	Open code percentage

Step 7: In order not to have problems due to scale differences of the values of SCs, the values are normalized with linear normalization scheme.

Data of *number of customers (SC1), company's experience (SC3), report variety and performance (SC5), number of solution partners (SC7), allowance of other integrations (SC10), operating country fit (SC11), online support system performance (SC12), open code percentage (SC13),* for which the grater the value the more its preference, are normalized with Equation 4.11. Data of *number of screens in the package (SC2), average project duration (weeks) (SC4), percentage of extra developments (SC6), average duration of user training (man/hour) (SC8), average response time to tickets (hours) (SC9),* for which the greater the value the less its preference, are normalized with Equation 4.11. Target values are also normalized with these equations according to the SC type.

The normalized data takes value in the range of [0,1]. System characteristics that take a value closer to 1 are considered more suitable. Table 5.12 represents the normalized values for attribute values and target values. The normalized data will be user in Step 8 for calculating distances.

Tablo 5.12 Normalization of attribute and target values

System Characteristics			Alternatives			Target Value
No	**Definition**	**SC Type**	**A1**	**A2**	**A3**	
SC1	**Number of customers**	**Benefit**	0	0,435	1	1
SC2	**Number of screens in the package**	**Cost**	1	0	1	1
SC3	**Company's experience (years)**	**Benefit**	0	0,667	1	1
SC4	**Average project duration (weeks)**	**Cost**	1	0	0,667	0,5
SC5	**Report variety and performance**	**Benefit**	0	0,667	1	1
SC6	**Percentage of extra developments**	**Cost**	0	0	1	0,5
SC7	**Number of solution partners**	**Benefit**	0	1	0,667	1
SC8	**Average duration of user training (man/hour)**	**Cost**	1	0,667	0	0,667
SC9	**Average response time to tickets (hours)**	**Cost**	1	0	0,667	1
SC10	**Allowance of other integrations**	**Benefit**	0	1	1	1
SC11	**Operating country fit**	**Benefit**	0	1	1	1
SC12	**Online support system performance**	**Benefit**	0	1	1	1
SC13	**Open code percentage**	**Benefit**	0	0,8	1	1

Step 8: By employing Equation 4.10, d_1^k and d_2^k are computed. The results are given in Table 5.13 present that the rank-order of the e-invoicing service provider company alternatives.

Table 5.13 Distance metrics for e-invoicing solution alternatives

	$\boldsymbol{d_1^k}$	$\boldsymbol{d_2^k}$
Alternative 1	18,023	4,178
Alternative 2	7,494	2,250
Alternative 3	2,377	1,150

According to both d_1^k and d_2^k, e-invoicing solution offered by Alternative 3 is determined as the most suitable e-invoicing solution alternative.

6. CONCLUSION

Quality Function Deployment (QFD) is a multi-attribute decision making method designed to select the most suitable alternative conforming to customer needs and requirements. Software Quality Function Distribution (SQFD) is the adaptation of Quality Function Distribution (QFD) to software development and focuses on improving the quality of the software development process.

This paper presents a SQFD-based decision approach and includes the implementation of this methodology to the e-invoicing service provider selection. In order to determine customer needs, a literature review was made and expert opinions were taken into account. These customer needs are defined as “Total cost of ownership”, “User friendliness”, “Flexibility”, “Easy and fast project implementation”, “Support quality” and “Value-added services”.

The requirements are translated into technical and measurable statements of the software product and called as "system characteristics". There are 14 system characteristics determined in this study. *Number of customers (SC1), company’s experience (SC3), report variety and performance (SC5), number of solution partners (SC7), allowance of other integrations (SC10), operating country fit (SC11), online support system performance (SC12), open code percentage (SC13), offering digital signature software (SC14)* are called as benefit type criteria, for which the greater the value the more its preference. N*umber of screens in the package (SC2), average project duration (weeks) (SC4), percentage of extra developments (SC6), average duration of user training (man/hour) (SC8), average response time to tickets (hours) (SC9)* are called as cost type criteria, for which the greater the value the less its preference.

The weights of customer needs are calculated by using DEMATEL. According to this, “total cost of ownership” is found as the most important customer need. The importance weights of the system characteristics are calculated by using sum of importance weights of company needs and the relationship scores. According to this, “offering digital signature software” is determined as the important technical value. Therefore, Alternative 4 that has not offer digital signature software is not included in the selection process.

After determining the alternatives, hypothetical target values are set for system characteristics and each service provider alternative is hypothetically evaluated for each system characteristics according to their attribute values. While some system characteristics can get quantitative values, some of them are evaluated with performance values. In order to avoid problems, the values are normalized with linear normalization scheme to make them unit-free and comparable values. The normalized data takes value in the range of [0,1]. System characteristics that take a value closer to 1 are considered more suitable.

At the end, by using a weighted distance metric based measurement is used to rank order the alternatives and select the most suitable one. As a result, the same rank-order is obtained for both distance metrics and Alternative 3 is selected as the most suitable service provider.

In future researches, the proposed methodology can be extended using fuzzy QFD and it can be applied to a real-world problem using real data. Also, the usage of blockchain applications and its effect to e-invoicing can be researched because the use of blockchain technology in the field of accounting has many benefits such as prevention of fraudulent financial reporting, real-time accounting transactions and continuous auditing. These benefits can help to improve e-invoicing benefits from the governments’ perspective.

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