# Evaluation of Digital Transformation Success Factors in Air Cargo Industry using IFCM Approach

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## Abstract

In the last few years, the world has witnessed major events. While the world was struggling with the effects of COVID-19, on the other hand, people and companies tried to adapt to digital transformation (DT) with the acceleration in technological developments and the needs brought by COVID-19. The pandemic process has accelerated the world's adaptation to this transformation. The pandemic process has increased the growth rate of e-commerce, which is already growing rapidly, and increased its influence in the air cargo market. Moreover, market growth is not the only challenge facing the air cargo industry. Just as it affects every industrial area, DT has started to show its effects in this area as well. At this point, the competition has become fiercer than ever before. Air cargo companies need to adapt to DT to compete in the growing market, maintain or increase their market share, generate profits, and enable their sustainability. Therefore, air cargo companies must consider critical success factors to successfully implement the transformation. For this purpose, some critical success factors are collected through a literature review process and expert opinions. A case study is conducted using an intuitionistic fuzzy cognitive map (IFCM) approach to analyze these factors in the Turkish air cargo industry. Furthermore, an IFCM model of these factors is presented. The study results show that the most critical success factors are supply chain visibility, digital twin, and piece centricity among these interrelated factors.

## Keywords
Air Cargo Industry, Digital Transformation, Intuitionistic Fuzzy Sets, Intuitionistic Fuzzy Cognitive Map and Success Factors

## 1. Introduction

Recently launched digital technologies have initiated a new era called digital transformation (DT). It is seen as the tsunami of the 21st century by the senior executives of the companies. DT that is a holistic transformation process has changed the way the companies work. It has influenced many industrial fields such as healthcare, finance and banking, telecommunication, insurance, tourism, and hospitality (Büyüközkan et al., 2019a), including aviation, airline and (Büyüközkan et al., 2020a) and air cargo industry. World is changing and the expectations related to products and services have become digital more than ever. Launched digital technologies have transformed the way the companies do their jobs, business models, decision-making processes, strategies, and their agendas, organizational behaviors, workforce, and processes to meet the customers' expectations. This is valid not only B2C processes but also B2B processes. Today, various cargo types ordered by the companies are transported through the air cargo channels. Digital technologies such as digital platforms, software, IoT, big data and digital supply chain channels are used to perform air cargo processes.

Global trade plays a key role in promoting economic development, making countries more productive, supporting income growth and poverty reduction. Air cargo plays has a quite vital place in the trade ecosystem, and it enables countries to combine and move up global value chains (Shepherd et al., 2016). The value of air cargo accounts for 35% of global trade. When combined passenger and cargo airlines are considered together, cargo accounts for 9% of airlines' revenue. This amount is twice the revenue from the premium segment. Air cargo is vital for many aspects of modern life. Transporting perishable goods from one side of the world to another could not be imagined without air transport. Pharmaceutical industry relies on air cargo due to its delicate cargo types. Especially during the COVID-19 pandemic that shook the whole world and caused traumatic results the transportation of cargo by air transportation has once again emphasized the importance of the air cargo business. Live animals and electronic devices are transported using air cargo channels. Furthermore, e-commerce is directly related to air cargo business. Online retail sales in 2016 represented only 7.6% of global sales. This situation reveals the great growth potential in the coming years (IATA, 2017). Furthermore, when the air cargo growth rate of the regions in the world are forecasted for the 2018-2037-time interval, there is an increased growth trend expectation (Crabtree et al., 2018).

Air cargo industry has a key role in the world trade. It provides connectivity all around the world and the needs of the countries are met using this cargo transportation type in a secure and reliable way. Especially nowadays, population is growing. Demands of the growing population may be volatile and may require huge amounts. Time has become more important than ever. Air cargo can provide just-in time delivery. In addition to all these, the world went through an extraordinary process and faced the COVID-19 pandemic process. In this situation, which changed the way the world works and brought almost all processes to a halt, the air cargo industry played a major role in transporting pharmaceutical needs such as medicine, and fast-moving consumer goods to the point where they are needed on time. Moreover, the necessity to carry out all these processes remotely, through digital channels, forced the air cargo industry to better adapt to DT. Therefore, this study focuses on the air cargo industry and the effects of DT in this industry.

DT may bring many benefits to air cargo companies, but companies need to look for ways to undergo a successful transformation process, considering the disruptive power of this transformation. Hence, this study aims to reveal the critical success factors for DT in air cargo industry and analyze them based on the assumption of the existence of relationship between the factors. DT success factors (criteria) concerning the air cargo industry are obtained through a literature survey based on the opinions of the experts who are decision makers (DMs). The cognitive map (CM) approach (Tolman, 1948) has been adopted to the study to deal with the relationship between the criteria. However, the CM approach has been expanded to intuitionistic fuzzy sets (IFS) (Atanassov, 1986) that are extensions of classical fuzzy sets (Zadeh, 1965) to eliminate the intuition, hesitation and uncertainty during the decision-making processes conducted by the DMs. Furthermore, IFCM allows to conduct scenario analysis based on its dynamical behavior (Büyüközkan et al., 2019b; Büyüközkan et al., 2020b; Büyüközkan et al., 2021a). Therefore, the obtained criteria are analyzed using intuitionistic fuzzy cognitive map (IFCM) approach (Papageorgiou and Iakovidis, 2013) in a case study in Turkish air cargo industry.

This study consists of following sections: A Literature review is conducted in Section 2. Section 3 explains the utilized IFCM approach. The case study is illustrated in Section 4 before the study is concluded in Section 5.

## 2. Literature Review

International Air Transport Association (IATA) cargo committee emphasizes safety & security, IATA's value proposition, visibility & digitization, and industry management & business transformation areas in the agenda of IATA Cargo considering safety enhancement, security improvement, trade facilitation, improved quality, cash protection, air cargo value proposition, efficiency, partnership enhancement and sustainability priorities based on the increased air cargo growth rates and forecasted growth trends (IATA, 2017).

Airport curfews, oil & fuel prices, lack of airport access, trade quotas & restrictions, industry relocation and currency revaluations are some of the forces influencing the air cargo growth. Besides, just-in time concepts, airline market research, new commodities, airline market & shipper education, new trade relationships and express market limits the air cargo growth (Crabtree et al., 2018). However, even though there are some threats such as new players, fuel costs, COVID-19, crowd shipping, unregulated supply chain participants, external shocks, and some weaknesses such as lack of attractiveness of young talent, lack of relationship with end-to-end customers, lack of investments for innovation, security, and complexity there are also many strengths and opportunities for the air cargo industry.

Air cargo industry is safe, and it provides reliability. Its potential regarding speed and security makes it preferable. Urbanization and mega cities, alternative fuel resources, growth of the economy and trade, increased capacities, new logistic concepts, willingness to have better collaborations, emerging new technologies such as mobile devices, drones, digital platforms, internet of things (IoT), automation, digital supply chain channels, and big data are seen as the new chances for the air cargo industry (IATA, 2017). These opportunities should be focused on to fulfill the customer expectation and increase the growth rate.

Digitalization and DT are the keys for efficiency, quality improvement, strengthening air cargo's value proposition, modernizing air cargo and its operations, and building sustainability. New technologies that have been launched in recent years have started the digitalization and DT process that has changed the way business and customer expectations in both B2B and B2C processes almost all over the world. The impact of digitalization forces the companies across the globe. Digitalization represents the increased influence of the emerging technologies in community based on the changed connection of the people and their behavior. However, DT is the adaptation and change management of the companies to ensure sustainable value creation through digitalized processes. Hence, action fields can be determined as customers, value proposition, operations, data, organization, and transformation management (Gimpel and Röglinger, 2015).

DT has influenced almost every sector such as automotive, electricity, media, healthcare, logistics including aviation, air transportation and air cargo industries. Now, every company is a software company and understanding what the customers want has become a focus point. Today, customers expect personalized, purpose driven, convenient, on-demand, and mobility-based processes in air-cargo operations. Key success factors are indicated as transparent price comparison, 24/7 accessibility, accessibility across all digital platforms, automized processes, hyper-customization, and flawless transactions to ensure the customer satisfaction. Robustness level of the business models, organizations and customer relations to disruption, type of the information about the customers, competencies to avoid the digital disruption and utilization level of the technological convergence have become the new focus areas. New questions about adoption of on-demand customer centric experience, convenience of customer experience, availability of the services for the customer through the mobile channels, organization & processes, business models, and stakeholder collaboration have been raised (Rossan and Rasmussen, 2017).

It is seen that the digitalization will increase the speed of air cargo. E-cargo is at the center of the air cargo operations right now. Distributed and unstructured data-based analytics, APIs, digital platforms, IoT, and provide intermodal end-to-end data exchange. Furthermore, cloud and mobile technologies offer accessibility anywhere and anytime with the help of information technology organizations. IoT, APIs and mobile technologies is used for more transparency for e-tracking processes. Big data analysis is applied to fuel efficiency applications. Logistics data cloud that represents "one record" and provides high data quality, consistency, process elimination, early available data, increased speed related to real time is adopted as a vision for the next e-freight operations (Rossan and Göttelman, 2017).

## 3. Method

This section overviews the cognitive map (CM) and intuitionistic fuzzy cognitive map (IFCM) approaches briefly. Following that the intuitionistic fuzzy sets (IFS) are explained. The computational steps of the IFCM approach are detailed.

### 3.1 Overview of CM and IFCM approaches

CMs were first proposed by Tolman (1948) but CMs which represents existing causal relations between component of a given environment was emphasized by Axelrod (1976). These maps symbolize a cognitive process or thought (Eden, 1992). They include causal relations between factors which forms a network-like structures. But these causal relations have only signs according to type of existing relations in terms of positivity (+) or negativity (-). Due to its limited properties of CM approach, it was expanded to classical fuzzy sets [8]and the fuzzy cognitive map (FCM) approach was proposed (Kosko, 1986). Even though it has ability to deal with uncertainty and conduct scenario analyses for future conditions it was limited to deal with intuition and hesitation in the decision-making processes. Hence FCM approach was expanded to IF environment (Atanassov, 1986; Papageorgiou and Iakovidis, 2013). There are several applications of IFCM approach in the literature. A case study was conducted in healthcare industry for supplier selection using IFCM approach (Iakovidis and Papageorgiou, 2010). A risk analysis was performed based on digital supply chain perspective using interval valued IFCM (IVIFCM) (Büyüközkan and Göçer, 2018). Strategy selection was made for target marketing in a case study (Dogu et al., 21). A case study was conducted to evaluate success factors for banking industry (Dursun et al., 2020). Service quality analysis was performed in airline industry using IFCM approach (Büyüközkan et al., 2020b). Supply chain risks were analyzed in a case study (Büyüközkan et al., 2021a). A prediction for time series was performed through high-order IFCM approach (Xixi et al., 2022).

### 3.2 Overview of CM and IFCM approaches

Intuitionistic fuzzy sets (IFS) were proposed by Atanassov (1986) and to deal with obscurity and hesitancy (Boran et al., 2009). Let $A$ be an IFS in a finite set and it can be shown as in Eq. (1).

$$A = \{\langle x, \mu_A(x), \nu_A(x)\rangle | x \in E\} \tag{1}$$

Here, $\mu_A: E \to [0,1]$ and $\nu_A: E \to [0,1]$ indicates membership function and non-membership function, respectively. These functions meet the inequality condition shown in Eq. (2).

$$0 \leq \mu_A(x), \nu_A(x) \leq 1 \tag{2}$$

The third component of an IFS ($\pi_A(x)$) indicates the hesitancy and it can be obtained through Eq. (3).

$$\pi_A(x) = 1 - \mu_A(x) - \nu_A(x) \tag{3}$$

If the $\pi_A(x)$ parameter is greater, then it gives small amount of information concerning the $x$. On the other hand, smaller value of $\pi_A(x)$ parameter provides more information related to $x$. Additionally, different arithmetic operations such as summation and multiplication (Papageorgiou and Iakovidis, 2013) based on IFSs can be conducted.

Let $\tilde{A}_1 = \left\{\langle x, \mu_{\tilde{A}_1}(x), \nu_{\tilde{A}_1}(x)\rangle \middle| x \in E\right\}$ and $\tilde{A}_2 = \left\{\langle x, \mu_{\tilde{A}_2}(x), \nu_{\tilde{A}_2}(x)\rangle \middle| x \in E\right\}$ be two IFSs.

$$\tilde{A}_1 \oplus \tilde{A}_2 = \left\{[x, \mu_{\tilde{A}_1}(x) + \mu_{\tilde{A}_2}(x) - \mu_{\tilde{A}_1}(x).\mu_{\tilde{A}_2}(x), \nu_{\tilde{A}_1}(x).\nu_{\tilde{A}_2}(x)] | x \in E\right\} \tag{4}$$

$$\tilde{A}_1 \otimes \tilde{A}_2 = \left\{[x, \mu_{\tilde{A}_1}(x).\mu_{\tilde{A}_2}(x), \nu_{\tilde{A}_1}(x) + \nu_{\tilde{A}_2}(x) - \nu_{\tilde{A}_1}(x).\nu_{\tilde{A}_2}(x)] | x \in E\right\} \tag{5}$$

### 3.3 Computational Steps of the IFCM Approach

This section provides the steps concerning the calculation process of the IFCM approach. The adopted computational steps that are shown in Fig. 1 can be given as follows (Büyüközkan et al., 2020b; Büyüközkan et al., 2021a) (Figure 1):

**Step 1.** Construction of the group of experts: A group of experts are selected based on their academic backgrounds, competencies, work experience, skills, and knowledge level. Determined experts are the decision makers (DMs) in the decision-making process.

**Step 2.** Determination of the evaluation concepts: Evaluation concepts (criteria) are obtained through a detailed literature survey based on the opinions of the DMs.

**Step 3.** Calculation of importance degrees of the DMs: The weights of the DMs are computed using Eq. (6) based on the linguistic variables given in Table 1. Here, $\lambda_k$ is the weight of the $k^{th}$ DM and $\sum_{k=1}^{K} \lambda_k = 1$.

$$\lambda_k = \frac{\left(\mu_k + \pi_k\left(\frac{\mu_k}{1-\pi_k}\right)\right)}{\sum_{k=1}^{K}\left(\mu_k + \pi_k\left(\frac{\mu_k}{1-\pi_k}\right)\right)} \tag{6}$$

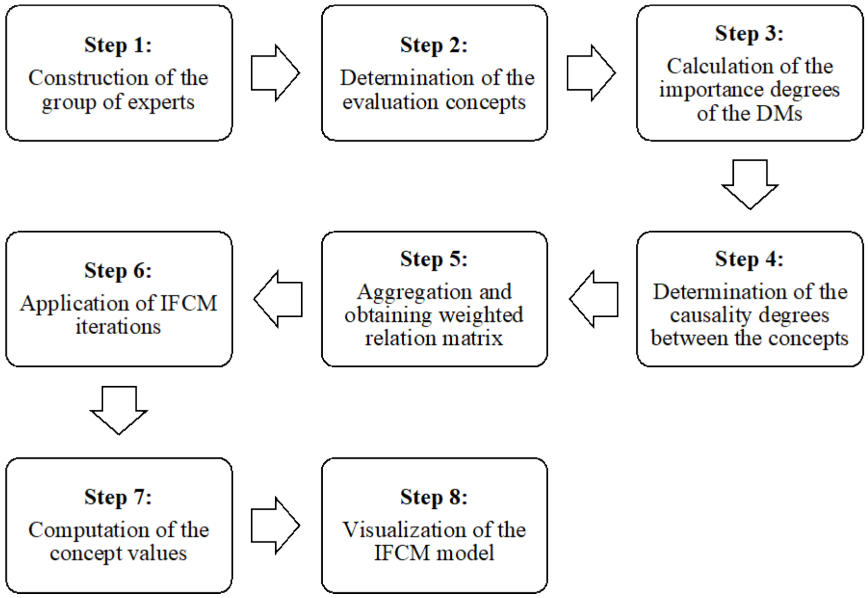


Figure 2. The computational steps of the IFCM approach (Büyüközkan et al., 2020b)

Table 1. Linguistic variables to compute the weights of the DMs (Büyüközkan et al., 2020b)

| Linguistic Variables | μ | ν | π |
|---|---|---|---|
| Very Important (VI) | 0.900 | 0.050 | 0.050 |
| Important (I) | 0.750 | 0.150 | 0.100 |
| Somewhat Important (SI) | 0.600 | 0.250 | 0.150 |
| Medium Important (MI) | 0.500 | 0.300 | 0.200 |
| Somewhat Unimportant (SU) | 0.300 | 0.350 | 0.350 |
| Unimportant (U) | 0.200 | 0.400 | 0.400 |
| Very Unimportant (VU) | 0.050 | 0.450 | 0.500 |

**Step 4.** Determination of the relationships: Degree of causality concerning the evaluation concepts (criteria) are assigned by the DMs using the linguistic variables given in Table 2.

Table 2. Linguistic variables for degree of causality (Büyüközkan et al., 2020b)

| Linguistic terms | μ | ν | π |
|---|---|---|---|
| Negatively Very Strong (NVS) | 0.000 | 0.950 | 0.050 |
| Negatively Strong (NS) | 0.050 | 0.900 | 0.050 |
| Negatively Medium (NM) | 0.250 | 0.700 | 0.050 |
| Negatively Weak (NW) | 0.350 | 0.600 | 0.050 |
| Zero (Z) | 0.500 | 0.500 | 0.000 |
| Positively Weak (PW) | 0.600 | 0.350 | 0.050 |
| Positively Medium (PM) | 0.750 | 0.200 | 0.050 |
| Positively Strong (PS) | 0.900 | 0.050 | 0.050 |
| Positively Very Strong (PVS) | 0.950 | 0.000 | 0.050 |

**Step 5.** Aggregation and obtaining weighted relation matrix: The aggregated weight matrix is obtained through the intuitionistic fuzzy weighted averaging (IFWA) operator proposed by Xu (2014). In this way, separate evaluations of the DMs are integrated into a group decision matrix and weighted relation matrix is obtained. The weights of the relationships in the matrix are calculated using IFWA operator using the formula given in Eq. (7).

$$w_{ij} = IFWA_\lambda\left(w_{ij}^{(1)}, w_{ij}^{(2)}, \dots, w_{ij}^{(k)}\right) = \lambda_1 w_{ij}^{(1)} \oplus \lambda_2 w_{ij}^{(2)} \oplus \cdots \oplus \lambda_k w_{ij}^{(k)} = \left[1 - \prod_{k=1}^{K}\left(1 - \mu_{ij}^{(k)}\right)^{\lambda_k}, \prod_{k=1}^{K}\left(\nu_{ij}^{(k)}\right)^{\lambda_k}, \prod_{k=1}^{K}\left(1 - \mu_{ij}^{(k)}\right)^{\lambda_k} - \prod_{k=1}^{K}\left(\nu_{ij}^{(k)}\right)^{\lambda_k}\right] \quad (7)$$

**Step 6.** Application of IFCM: The equation of IFCM that is shown in Eq. (8) is run to compute the concept values at each iteration until the convergence.

$$A_i^{(t+1)} = f\left(A_i^{(t)} + \sum_{j \neq i, j=1}^{n} A_j^{(t)}\left(\mu_{ij}(w) - \pi_{ij}(w)\right)\right) \quad (8)$$

Here, the value of the concept $C_i$ is $A_i^{(t+1)}$ at iteration $(t+1)$, where $f(x)$ shows the threshold function. $A_i^t$indicates the initial concept value at iteration $t$. The sigmoid threshold function is shown in Eq. (9). The growth rate in the threshold function is set to ($\alpha$=-0.1). $\left(\mu_{ij}(w) - \pi_{ij}(w)\right)$ is applied to reach the weight matrix.

$$f(x) = \left(\frac{1}{1+e^{-ax}}\right) \quad (9)$$

**Step 7:** Computation of the concept values: Concept values are computed based on the weight matrix.

**Step 8:** Visualization: IFCM model of the evaluation concepts is obtained through a visualization process using nodes, edges, concept values, relationships between the concepts and the weights.

## 4. Case Study

Air cargo companies need to adapt to DT to compete in the growing market, maintain or increase their market share, generate profits, and enable their sustainability. Therefore, air cargo companies need to consider critical success factors to successfully implement the transformation. For this purpose, a case study is conducted in Turkish air cargo industry using the introduced steps of the IFCM approach. The followed steps in this study are explained below. Three DMs are selected based on their academic backgrounds, competencies, work experience, skills, and knowledge level to construct the group of experts. The evaluation concepts are collected through a literature survey and experts' opinions. The obtained concepts are shown in Table 3.

Table 3. The sources of the determined evaluation concepts

| Evaluation Concept | Source |
|---|---|
| Collaboration ($C_1$) | (Buvat et al., 2018) |
| Linked data ($C_2$) | (IATA, 2020) |
| Digital twin ($C_3$) | (IATA, 2020) |
| Change management ($C_4$) | (Büyüközkan et al., 2021b) |
| Customer insights ($C_5$) | (Zoghby and Schneider, 2013) |
| Digitally maturing ($C_6$) | (Kane et al., 2017) |
| Digital readiness ($C_7$) | (Nasution et al., 2018) |
| Interoperability ($C_8$) | (Büyüközkan et al., 2020a) |
| Piece centricity ($C_9$) | (IATA, 2020) |
| Source of truth ($C_{10}$) | (IATA, 2020) |
| Digitally interaction ($C_{11}$) | (Cooper, 2015) |
| Efficient knowledge transfer ($C_{12}$) | (Stoyanov, 2017) |
| Digital transformation strategy ($C_{13}$) | (Büyüközkan et al., 2021c) |
| Supply chain visibility ($C_{14}$) | (IATA, 2017) |
| Proactive cyber defense ($C_{15}$) | (Doughton, 2017) |

All the DMs in the decision-group are highly qualified and their importance degrees are assigned as Very Important (VI) based on Table 1. The weights of the DMs are computed using Eq. (6) and obtained as 0.3333. The linguistic variables given in Table 2 are used the determine the degree of causality between the evaluation concepts. To illustrate this process, linguistic evaluations of $DM_1$ are presented in Table 4.

The aggregated weight matrix is computed using IFWA operator that is given in Eq. (7). Eq. (8) and Eq. (9) are utilized to compute the concept values at each iteration until the convergence. For this purpose, the growth rate $\alpha$ is set to -0.1 and the concept values converged at the 15th iteration. The concept values are computed based on the weight matrix at the end of the iterations. Obtained results are shown in Table 5. Finally, the IFCM model of the evaluation concepts is presented in Figure 2 based on the nodes, edges and the weights of the edges using SocNetV software (https://socnetv.org/) that is a social network visualizer.

Table 4. Causality degrees assigned by $DM_1$

| **Concepts** | **$C_1$** | **$C_2$** | **$C_3$** | **$C_4$** | **$C_5$** | **$C_6$** | **$C_7$** | **$C_8$** | **$C_9$** | **$C_{10}$** | **$C_{11}$** | **$C_{12}$** | **$C_{13}$** | **$C_{14}$** | **$C_{15}$** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **$C_1$** | Z | PVS | PS | PW | Z | PS | PW | PW | Z | Z | PW | PVS | PS | Z | PW |
| **$C_2$** | PS | Z | PVS | PS | Z | PVS | Z | Z | Z | Z | PS | PVS | PVS | Z | Z |
| **$C_3$** | PVS | PM | Z | Z | PS | PS | Z | Z | Z | Z | PW | PVS | PVS | Z | Z |
| **$C_4$** | PS | Z | Z | Z | PVS | PVS | PVS | PVS | PS | PS | PVS | Z | Z | Z | PS |
| **$C_5$** | PS | Z | Z | PS | Z | PVS | PVS | PVS | PVS | PVS | PVS | PS | PW | Z | PS |
| **$C_6$** | PVS | Z | Z | Z | PVS | Z | Z | Z | Z | Z | PVS | Z | Z | Z | Z |
| **$C_7$** | PS | PS | Z | PVS | PVS | PVS | Z | PS | PS | PS | PVS | Z | Z | Z | Z |
| **$C_8$** | PS | Z | Z | PS | PVS | Z | PVS | Z | Z | Z | PS | Z | Z | Z | PS |
| **$C_9$** | PS | Z | Z | PVS | Z | PVS | PVS | Z | Z | PS | Z | Z | Z | Z | Z |
| **$C_{10}$** | Z | Z | Z | PVS | PVS | PW | PVS | Z | Z | Z | PVS | PS | Z | Z | PM |
| **$C_{11}$** | PS | Z | Z | PVS | PVS | Z | Z | Z | Z | Z | Z | PS | Z | Z | Z |
| **$C_{12}$** | PVS | PM | Z | Z | Z | PVS | PS | PS | Z | Z | PS | Z | Z | Z | PS |
| **$C_{13}$** | Z | Z | Z | Z | Z | Z | Z | Z | Z | Z | Z | Z | Z | Z | Z |
| **$C_{14}$** | Z | Z | Z | Z | Z | Z | Z | Z | Z | Z | Z | Z | Z | Z | Z |
| **$C_{15}$** | Z | PM | PW | PW | Z | Z | PS | Z | Z | Z | PS | PS | PS | PS | Z |

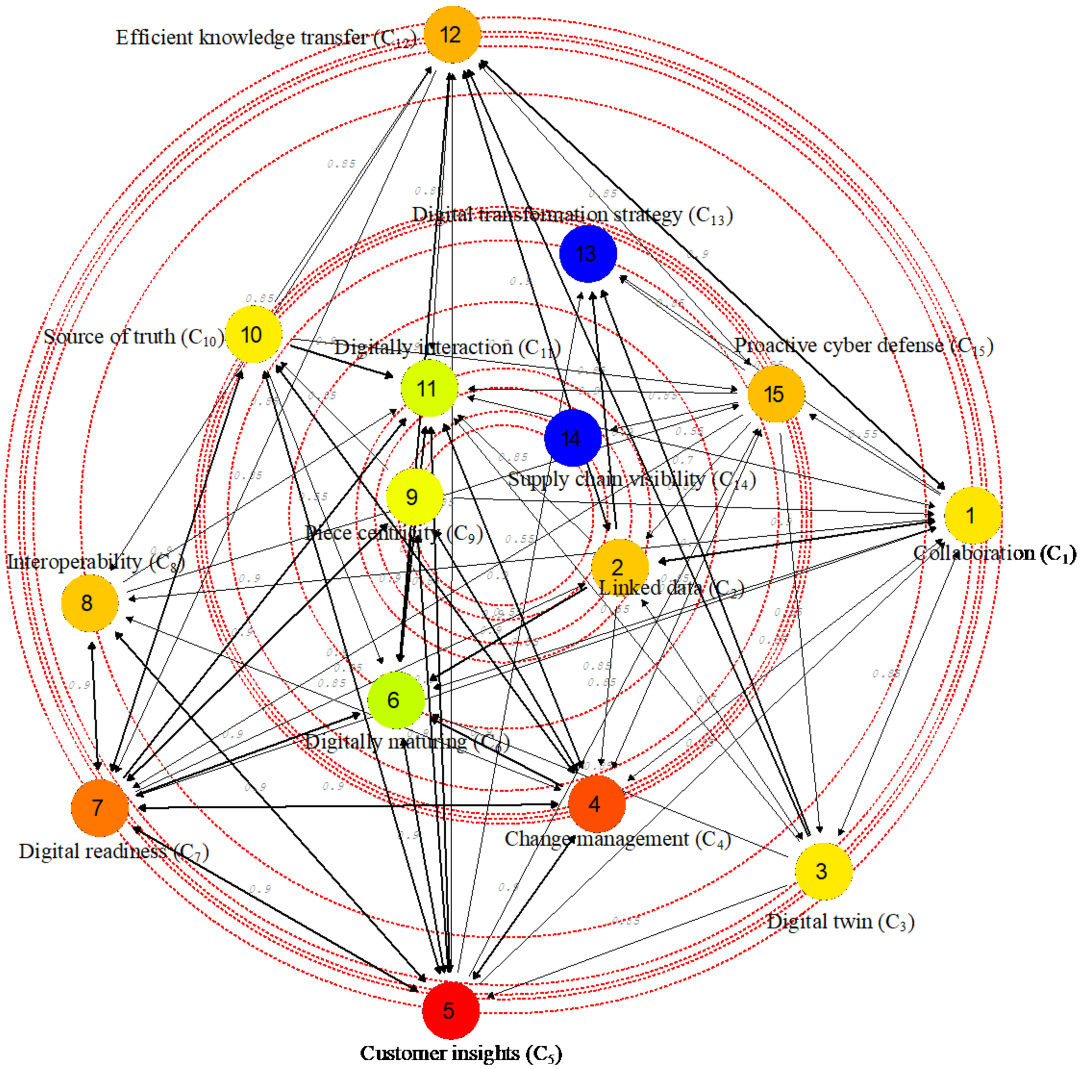


Figure 2. IFCM model of DT success factors in air cargo industry

Table 5. Obtained results.

| Concept No | Concept | Concept Value | Order |
|---|---|---|---|
| $C_1$ | Collaboration | 0.3822 | 15 |
| $C_2$ | Linked data | 0.4035 | 4 |
| C3 | Digital twin | 0.4085 | 2 |
| $C_4$ | Change management | 0.3904 | 11 |
| $C_5$ | Customer insights | 0.3905 | 10 |
| $C_6$ | Digitally maturing | 0.3868 | 13 |
| $C_7$ | Digital readiness | 0.3903 | 12 |
| $C_8$ | Interoperability | 0.4017 | 6 |
| $C_9$ | Piece centricity | 0.4058 | 3 |
| $C_{10}$ | Source of truth | 0.4025 | 5 |
| $C_{11}$ | Digitally interaction | 0.3836 | 14 |
| $C_{12}$ | Efficient knowledge transfer | 0.3918 | 9 |
| $C_{13}$ | Digital transformation strategy | 0.4014 | 7 |
| $C_{14}$ | Supply chain visibility | 0.4127 | 1 |
| $C_{15}$ | Proactive cyber defense | 0.4007 | 8 |

The obtained results showed that the most important factor is *supply chain visibility* for successful implementation of DT in air cargo industry. *Digital twin* and *piece centricity* are the following factors, respectively. *Linked data* and *source of truth* are the two of the most important five success factors. The companies in air cargo industry needs a road map for DT since the DT is a holistic transformation process. The IFCM model showed that the factors are interrelated and there is a causality between them. The air cargo industry is a multi-faceted and complex supply chain structure and the IFCM structure supports this. Companies should focus on these critical factors and the complexity of the system for the successful implementation of DT.

## 5. Conclusions and Perspective

DT is an undeniable reality of today. The impact of technology on both human life and the business world will be even greater. This situation has begun to affect all sectors from end to end. One of these sectors is the air cargo industry, which keeps the supply chain in the world alive and makes great contributions to the economy of both countries and the world. The air cargo industry, which has grown in line with the demands and needs, has turned into an ecosystem where competition is intense with the DT. Therefore, it's more important than ever to focus on the successful sustainability of the transformation. In this study, some of the critical factors that need to be considered for the successful implementation of DT are investigated and analyzed by the IFCM approach on a real case in the Turkish air cargo industry. The obtained results are in line with the points emphasized by the companies in their research reports. Scenario and sensitivity analyses can be performed in future studies. The scope and the number of the evaluation criteria can be expanded. The results can be compared by making calculations based on different extensions. Results from analytical techniques based on the assumption of independence of criteria can be examined.

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