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Unlocking the Power: How Digital Transformation Fuels Intellectual Capital

Ayşe Aslı YILMAZ [a]
[a]Atılım University, School of Civil Aviation, Ankara, Türkiye.asli.yilmaz@atilim.edu.tr

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ABSTRACT

Purpose – This paper aims to explore the transformative impact of digitalization within the aviation sector, with a specific focus on airport terminal management. The primary objective is to understand how digitalization influences and reshapes the various facets of the industry, particularly in terms of intellectual capital.

Design/Methodology/Approach – This study employs a conceptual overview to examine the impact of digitalization on intellectual capital in aviation management. By analyzing the integration of digital technologies, the study explores their effects on human, structural, and relational capital. The conceptual framework is enhanced by detailed network analysis using the NetworkX library, offering an in-depth examination of the relationships between elements of intellectual capital and digital transformation criteria.

Findings – The study uncovers the intricate relationships defining TAV Holding and its subsidiary entities, providing insights into the dynamic interplay of power, influence, and intellectual capital within the aviation sector. It reveals how digital transformation criteria are crucial in enhancing intellectual capital, which includes human, structural, and relational capital. The findings emphasize the role of digital technologies in streamlining processes, improving decision-making, and fostering innovation.

Discussion – This paper contributes to the body of knowledge by highlighting the original value of studying the impact of digitalization on intellectual capital in the aviation sector. It underscores the importance of digital transformation criteria in enriching intellectual capital and fostering resilience in a rapidly evolving industry landscape. The discussion also addresses the broader implications of these findings for the aviation industry and its stakeholders, suggesting that embracing digitalization can lead to more effective and efficient airport terminal management.

1.Introduction

In the context of an open innovation strategy, it is crucial to identify the intellectual capital components related to the stakeholders engaged in the digital transformation process. Organisations are continuously involved in a dynamic process of evolution and advancement, motivated by the need to not only maintain their existence but also create value, increase their market share, exert influence in the market, and achieve growth by implementing sustainable competitive strategies.

This research primarily focuses on the examination of informal link networks that arise outside of formal contractual relationships, drawing upon the explanatory power of networks. The objective of this study is to explore strategies for efficiently building the physical framework of these networks. Simultaneously, the objective of this research endeavour is to fill theoretical gaps that presently exist in the understanding of network externalities and network effects in the formation of a genuine network structure.

This research lays considerable attention on giving a comprehensive description of the intellectual capital components intrinsic to sectoral stakeholders to better understand the complex link between network structure and its effect. Moreover, the objective of this study is to establish the interrelationships among these elements, providing important perspectives on their interactions. This study uses organisational network analysis to examine the relationship between criteria for digital transformation and the intellectual capital aspects of stakeholders. The process carefully discovers any components that are absent within this complex network of links and aims to organise the network with accuracy. In an environment characterised by intricate intricacy and ongoing transformation because of digital progress, it becomes crucial to acknowledge the flexibility of networks in real-world situations. The current competitive landscape is often described as being

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globalised, characterised by chaos, unpredictability, and intense competition. In this setting, the notion of intellectual property has gained significant prominence, attracting the interest of researchers, business executives, investors, and government authorities alike (Bagdadli et al., 2021:430). In the face of such intricate circumstances, corporations working within this environment must effectively use innovation to not only prosper but also get a competitive advantage over their competitors. According to Elberdin et al. (2018:16), in the current highly competitive corporate environment, innovation has become a fundamental factor for ensuring existence. The current dominant market economy places a strong emphasis on immediate financial gains. However, there is a growing recognition of the importance of intangible capital, such as the retention of key personnel and the utilisation of their expertise and innovative capabilities, in enhancing brand image and core equity (Antošová and Csikosova, 2011:113). The capital kinds that contribute to establishing the company's market value are depicted as figure 1.

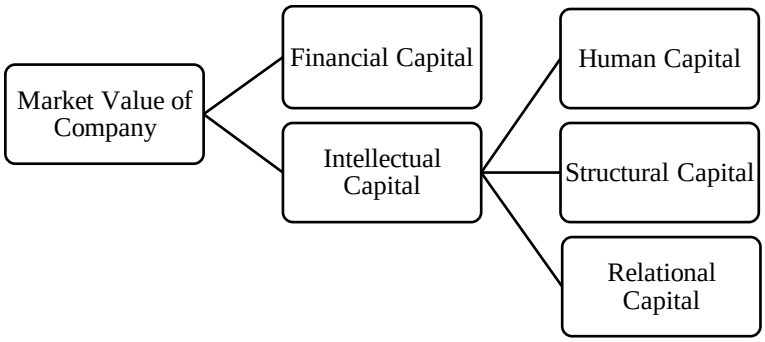


Figure 1: Process of organization value creating (Antošová and Csikosova, 2011:115).

The study conducted by Antošová and Csikosova (2011:115) highlights the significance of intellectual capital in comprehending the intricate dimensions of a company's market value. The present discourse explores the scholarly viewpoint about the interaction between financial and intellectual capital within organisational contexts.

Financial capital, being an essential element, comprises physical assets of a monetary kind, including cash and securities. On the other hand, intellectual capital denotes the accumulation of wealth resulting from the application of organisational knowledge. The concept of intellectual capital encompasses the processes of knowledge acquisition and transfer within an organization (Chattopadhyay, 2012:26). Recognizing the importance of intellectual capital is crucial, as it includes intangible assets that significantly influence internal processes and add substantial value to the organization. Additionally, intellectual capital involves data related to the quality and relevance of connections, both within and outside the organization (Chattopadhyay, 2013:38).

The scholarly discourse places emphasis on the recognition that firms hold two separate types of assets that need careful monitoring and evaluation: physical and intangible resources (Tsareva and Boldyhanova, 2020:82). Significantly, a considerable proportion of a corporation's market valuation is constituted by intangible assets, which are not overtly represented in financial statements. Within the given setting, intellectual capital is categorised as one of the intangible assets. The scholarly work conducted by Manzari et al. (2012:43) emphasises the similarity between intellectual capital and other intangible assets, while also emphasising its crucial role in contributing to a company's competitive edge.

Numerous scholarly inquiries, encompassing both theoretical and empirical approaches, have continuously affirmed that the competitive advantage of a corporation is derived from the distinctive combination of intellectual capital and physical assets it utilises (Ali et al.,2022:109). This amalgamation refers to the collective human resources of an organisation, including its personnel, operational procedures, and network of relationships. In addition, it is important to note that intellectual capital encompasses more than just the internal resources of an organisation. It also encompasses the external relationships and connections that an organisation has with stakeholders, including consumers, suppliers, and research and development partners. The intangible assets mentioned are often known as intellectual capital, which may be classified into three main categories: human, structural, and relational capital.

In brief, the scholarly discussion around intellectual capital highlights its importance in enhancing a firm's market worth, with a specific focus on its intangible characteristics and its ability to shape competitive advantage via human, structural, and relational elements. In addition, it offers a fundamental comprehension of the complex mechanisms that form the basis of an organization's market value.

2. Exploring the Interplay Between Digital Transformation and Intellectual Capital

The contemporary academic literature presents an in-depth analysis of the origins and evolution of intellectual capital as both a focal point of scholarly inquiry and a managerial practice (Al-Khoury et al.,2022:114). In its early stages, the concept of intellectual capital was predominantly associated with the intangible assets of organizations. However, as the notion has matured and undergone further refinement, its scope has expanded beyond corporations to encompass countries, regions, and locales (Choong,2008:621). In the current era marked by rapid technological advancements and globalization, the concept of intellectual capital emerges as a crucial determinant. To gain a nuanced understanding of this phenomenon, it is imperative to acknowledge and consider both physical and intangible assets. It is widely acknowledged that organizations possess two distinct types of assets necessitating evaluation: tangible assets, formally recorded in financial statements such as balance sheets, and intangible assets, despite their lack of physical presence, holding substantial monetary worth (Manzari et al., 2012:46). Intangible assets exhibit a robust correlation with intellectual capital concerning their influence on an organization's market price.

Market value, essentially the amalgamation of financial and intellectual capital, underscores the categorization of intellectual capital into human, structural, and relational components, which is subject to modification in response to changing conditions (Bagdadli et al., 2021:445).

Human capital includes a wide range of attributes that enhance individuals' productivity and effectiveness in the workplace. These attributes encompass knowledge, which refers to the theoretical understanding and information individuals possess; skills, which are the practical abilities and techniques acquired through training and experience; work experience, which provides context and practical insights into various job functions and industries; competencies, which are the combination of knowledge, skills, and abilities that enable individuals to perform their roles effectively; and emotional intelligence, which involves the ability to recognize, understand, and manage one's own emotions and those of others, thereby fostering better interpersonal relationships and communication(Băcilă et al.2018:23). Structural capital consists of elements that provide the framework and support for an organization's operations. This includes management philosophy, which encompasses the principles and beliefs that guide decision-making and leadership practices within the organization(Wang et al.,2014:53). Organizational culture refers to the shared values, norms, and behaviors that shape the work environment and influence how employees interact and collaborate. Intellectual property includes patents, trademarks, copyrights, and other proprietary knowledge that provide a competitive advantage and protect the organization’s innovations and creations (Bagdadli et al, 2021:446).Relational capital, on the other hand, encompasses the external relationships and networks that an organization maintains. This includes connections, which are the professional and personal relationships that facilitate collaboration, information exchange, and business opportunities. Social networks refer to the web of relationships among individuals and organizations that can be leveraged for support, advice, and resources (Choong,2008:621). Brand image is the perception of the organization held by external stakeholders, including customers, partners, and the general public, which can significantly impact reputation, trust, and market position (Marr, 2008:36).In the context of the interconnection between digital transformation and intellectual capital, it becomes evident that digital transformation is an imperative necessity for enterprises seeking to sustain their competitive edge. The contemporary economic landscape is characterized by the widespread integration of modern digital technology into various aspects of social business activity. The growth of information and communication technologies, digital technologies, and big data technologies contributes to the emergence of a new and distinct informative milieu (Pirogova et al., 2020:219). The phenomenon commonly referred to as the "process of digitalization" exerts a profound influence on economic activities and social processes.

The introduction of digital technology has substantially impacted multiple sectors of the economy, often leading to significant changes within industries and the formation of new types of economic activity (Zhang et al., 2022:41). Data, especially in digital form, has undergone a considerable evolution and now holds

strategic importance. The utilization of artificial intelligence relies on these fundamental elements, leading to the advancement of digital automation and empowering technology to augment various operations (Cole, 2021:83). The basic component of digital automation lies in its ability to minimize human participation in production processes, leveraging the powers of networks and data to enhance the significance of machines. This enables the facilitation of transitioning towards more automated processes, resulting in a reduction in human labor (Zhang et al., 2022:43).

The creation and use of digitalization tools are heavily dependent on technical progress (Cole, 2021:84). The advancement of digital technology concentrates on two primary areas. First, it focuses on enhancing and reorganizing the institutional landscape, which includes updating the regulatory framework for digital markets, digital manufacturing, and digital retail. Second, it aims to establish technical infrastructure, such as e-data transmission networks, data centers, and software services, all of which demand substantial labor and resources.The influence of digital technology on intellectual capital is evident through two distinct manifestations. Firstly, certain occupational classifications may face obsolescence due to the substitution of human industrial laborers by robots. Secondly, digital technologies have the capacity to transform the nature of employment by modifying necessary skill sets (Fleming, 2019:25). To comprehensively explore the impact of digital technologies on employment, it is vital to conduct a thorough investigation of job classifications and the specific proficiencies necessary for these positions.

Nevertheless, the specific abilities that might potentially become obsolete as a result of the advancement of digital technology are still unknown. Available information suggests that employment regular in nature and heavily reliant on technology are more susceptible to becoming obsolete. Governments are urged to adopt proactive measures to address the anticipated disruptions in employment caused by digital technologies, minimizing negative consequences that might further widen existing digital divisions throughout society (Faith et al., 2022:204). The significance of digital transformation and the relevance of criteria supporting it have become more important in recent years, particularly in relation to the components of intellectual capital. In light of the circumstances, many approaches are used by organizations undertaking digital transformation initiatives to strategically plan their trajectory(Ferreira and Franco, 2017:131).At present, one of the desired outcomes is to classify the nature of the interaction between criteria for digital transformation and intellectual capital from an organizational standpoint. This is largely driven by the significant impact exerted by digital transformation. The topic under consideration relates to the extent to which individual nodes, graphs, and subsystems contribute to the overall integrity of the system (Turnbull et al., 2018:116). A substantial level of integration indicates that the unit fulfills a crucial function in maintaining the integrity of the system and has the ability to form linkages with other units. The driving effect of a node and graph pertains to their capability to initiate the activation of other nodes and graphs within the system, hence indicating their potential to influence the network. According to Faith et al. (2022:204), nodes and graphs that possess this capacity demonstrate active communication values that exceed passive communication values. In this particular context, a substantial numerical number signifies a significant degree of efficacy in the activation of supplementary nodes and graphs. In some contexts, there is a preference for using units that possess a high value of this metric in order to facilitate extensive distribution across the system (Ferreira and Franco, 2017:133).

The measure in question quantifies the degree to which the impact of one node and its associated graph may affect another node and its corresponding graph. Nodes and graphs with this property have very elevated passive communication values. Comprehending these ideals is vital for elucidating the roots of achievements attained via implemented methodologies. The feature of driving is an intrinsic characteristic that emerges as a result of the passive influences exerted by nodes and graphs. The nodes and graphs in question exhibit a heightened vulnerability to the indirect connections inside the system (Emmerik et al, 2016:6). The aforementioned entities represent the primary component of the system that experiences modification, and as a result, they are the first in demonstrating the oscillatory behavior of the system.

The concept of system stability, within the framework of dynamic systems, pertains to the extent to which the behavior of the system remains within predetermined ranges and magnitudes, according to specified patterns. Stable systems have a propensity to generate results that are consistent and predictable. Nevertheless, the attainment of an exceedingly high level of stability beyond a certain threshold might result in the establishment being inflexible. The concept of institutional rigidity suggests that when confronted with

change, the ability of an institution to adapt and respond appropriately diminishes, leading to a gradual erosion of its overall integrity. In contrast, when the level of stability decreases to a certain threshold, it indicates a state of dynamism. Emmerik et al. (2016:8) assert that dynamic structures possess the inherent quality of adaptability, enabling them to effectively respond to changes.The significance of nodes or graphs inside a system is indicative of their crucial role in the overall operation and survival of the system. The concept of criticality is closely linked to the degree of sensitivity that a system exhibits towards changes. The unit exhibiting the greatest degree of criticality has the most substantial impact on the dynamics of the system. According to Hütt et al. (2016:613), every modification made to this unit has a significant influence on the whole of the system, leading to comprehensive alterations across the system. Forecasting the conduct of individuals who have high degrees of instability may provide a considerable challenge. It is crucial to acknowledge that, in many instances, the instability is mostly impacted by the internal composition of the entities rather than external environmental influences. According to Jong and Chung (2010:351), a limited level of instability indicates that the actors maintain a strong connection with the interactions occurring inside the system and exhibit less willingness to engage with external forces. Moreover, this situation suggests that these players exhibit a lack of inclination towards engaging in external cooperation and instead may have a preference for operating alone. Nevertheless, actors that exhibit a significant level of reluctance might possibly play a crucial role in instigating change within the system, provided that they are honest, forthcoming with information, and willing to explain their behavioral modifications.Following a comprehensive analysis of the value contributed by digital transformation criteria within the airport sector to the intellectual capital components using network analysis algorithms, the study identifies the most critical, proximate, and influential nodes within the entire network through graph schematization. In the context of the research methodology, Esenboğa TAV Holding, and its subsidiaries undergo an evaluation based on the indicators outlined. It is advisable to provide a concise examination of each indicator to determine its applicability in addressing the research question. This study differs from existing literature by specifically focusing on the impact of digital transformation on intellectual capital within the aviation sector, particularly in airport terminal management. It uses a detailed network analysis to explore the intricate relationships between digital transformation criteria and intellectual capital components, offering a unique perspective that transcends traditional boundaries and emphasizes the role of open innovation in transforming challenges into opportunities.

3. Method

In this study conducted with TAV Holding and its subsidiaries, a detailed network analysis is performed, and the results were carefully recorded. The NetworkX library is used for the network analysis. NetworkX is a Python package designed for the creation, manipulation, and study of complex networks and graphs. It allows for detailed analysis and visualization of network structures and the relationships between different nodes.The data collected from TAV Holding and its subsidiaries were processed and analyzed using NetworkX to identify patterns, connections, and influential nodes within the network. Various centrality measures, such as in-degree centrality, out-degree centrality, closeness centrality, and betweenness centrality, were calculated to understand the roles and significance of different nodes. Additionally, the modularity and community detection features of NetworkX were utilized to identify distinct communities within the network and understand the modular structure.Visualizations, including heatmaps and centrality diagrams, were generated to illustrate the network's structure and the interactions between nodes. The Vote-Rank algorithm is also employed to dynamically rank nodes and select seeds for community detection, demonstrating the network's adaptability and the changing effectiveness of nodes over time. Overall, NetworkX provided a robust framework for the comprehensive network analysis conducted in this study.

Participants, all senior managers in their respective organizations, provided insights reflective of their unique corporate perspectives. This study has been conducted with the approval of the ethics committee.This approach ensured independent evaluations of each entity.

Table 1: Demographic Information About Participants

Company and Subsidiaries	Position	Experience	Education	Gender	Age Range	Participants
TAV Esenboğa Head Office	TAV ESB Deputy General Manager	More than 10 years	Master	Male	40-45	**Interview 3**
TAV Esenboğa Logistics Department	TAV ESB Logistics Manager	More than 10 years	Bachelor	Male	40-45	**Interview 2**
TAV Esenboğa Head Office Finance Department	TAV ESB Finance Manager	More than 10 years	Bachelor	Male	40-45	**Interview 4**
TAV Technologies	TAV Technologies IT Assistant Manager	More than 8 years	Master	Male	30-35	**Interview 1**
PRIME CLASS	Prime class Manager	More than 10 years	Bachelor	Female	40-45	**Interview 5**
TAV Securities	TAV Securities Manager	More than 10 years	Bachelor	Male	40-45	**Interview 6**
HAVAŞ	HAVAŞ Manager	More than 10 years	Bachelor	Male	40-45	**Interview 7**

The data collected from each company was then reanalyzed, leading to insights about the performance of TAV Holding's Esenboga Airport Terminal Management. The findings, informed by discussions with senior management and methodological rigor in interviews and survey analysis, are summarized. Table 1 above provides demographic information about the participants for context.

4. Findings

Heatmaps visually display data intensity using color gradients, highlighting patterns and relationships within a dataset. Darker colors indicate stronger connections, while lighter or absent colors show weaker or non-existent links. Figure 2 illustrates the heatmap generated from the analysis of all collected data. This heatmap, based on survey scores, clearly displays the complete responses of all participants to the survey questions. However, as mentioned earlier, participants refrained from answering questions that fell outside their area of expertise. Consequently, any lack of relevance between the digital transformation requirements and intellectual capital components was assigned a score of 0, as the black areas were considered "outside the scope of responsibility and duty" for the participants. Therefore, participants did not provide a score of 0 as a weight in this study. In the NetworkX algorithm, the value 0 is employed to signify nodes that lack connections to one another. It is evident that the nodes labeled "23#Efficient Flight Profile (EFF)" and "25#Liberalization/Privatization Trends," which pertain to digital transformation criteria, are not associated with any of the intellectual capital nodes. This was attributed to them being deemed beyond the scope of TAV Holding's duties and responsibilities.

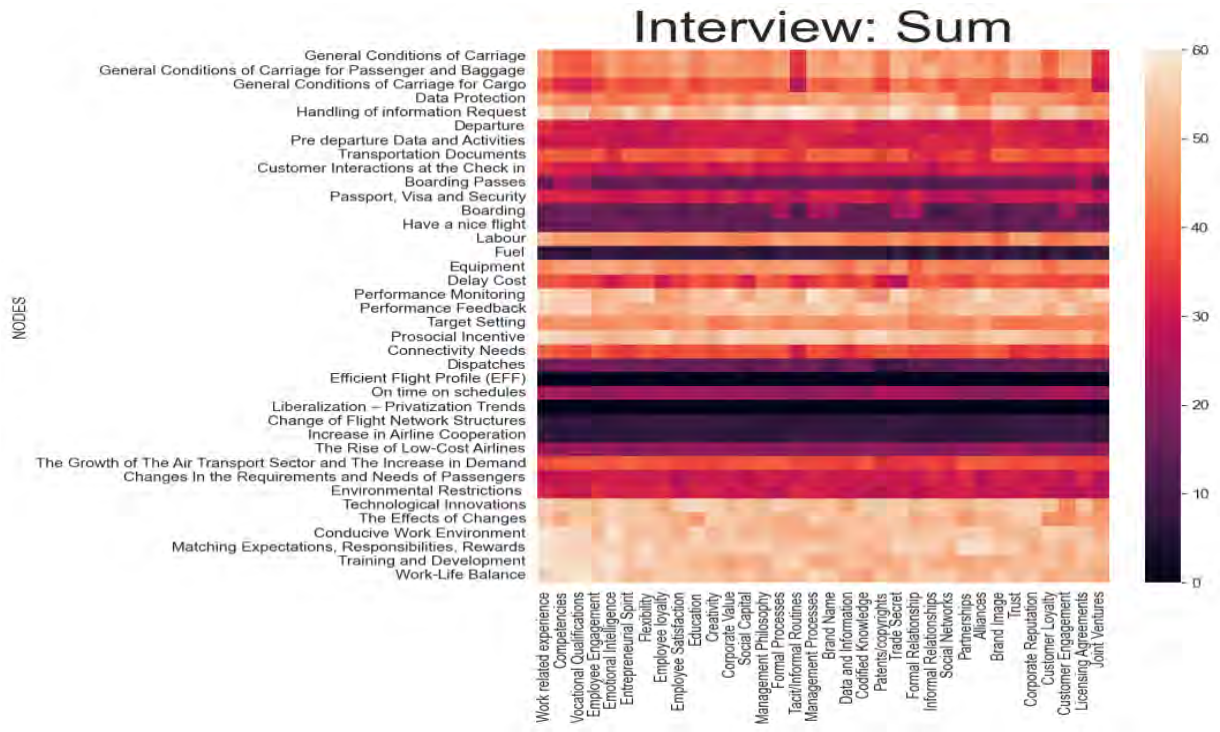


Figure 2: Esenboğa SUM -Raw Data Heatmap

In terms of degree centrality, when considering all the data collected from the firms, the nodes that emerge as the most prominent in terms of in-degree centrality are "59#Trade Secret," and the most significant node in terms of out-degree centrality is "3# Data Protection." These rankings for in-degree and out-degree centrality can be observed in Diagram 1.

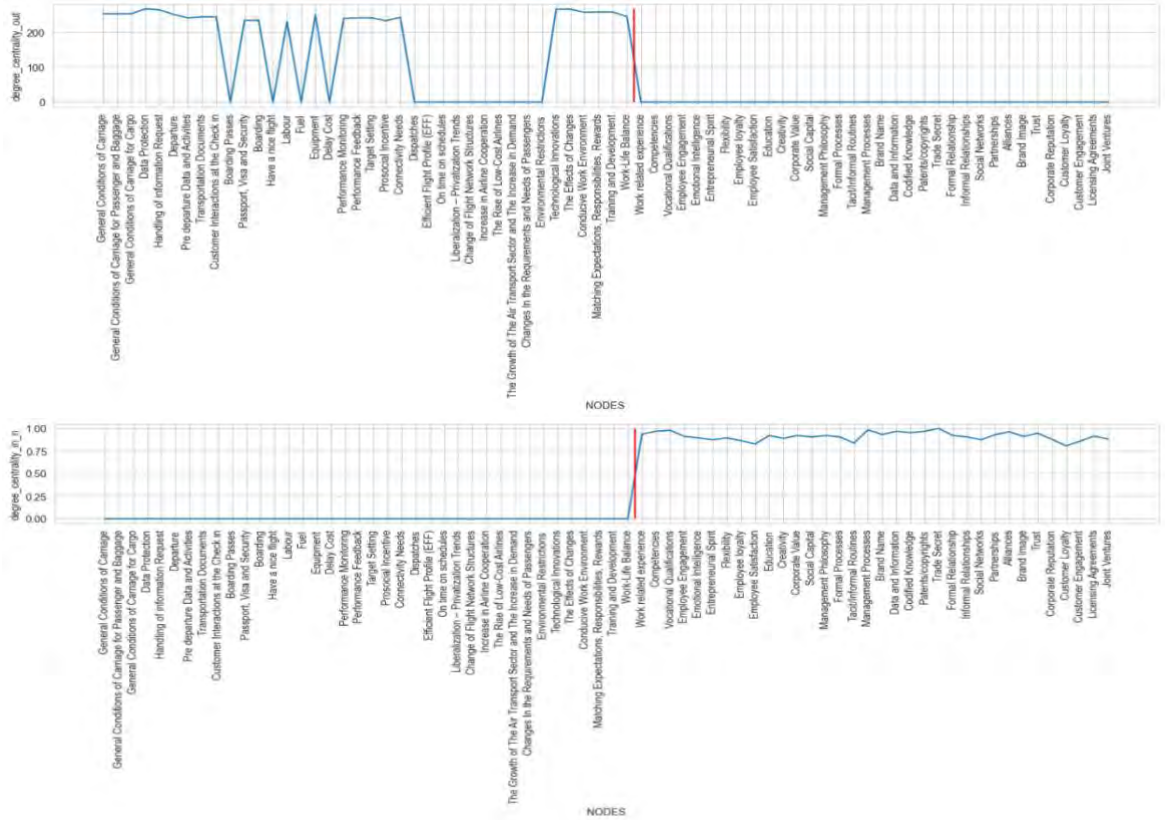


Diagram 1: Esenboğa SUM-In&Out Link Normalized Degree Centrality

In the realm of centrality analysis, it becomes apparent that specific nodes play pivotal roles within the network, thereby exerting varying degrees of influence. Notably, when considering all the data accumulated from the participating firms, two nodes stand out prominently in terms of in-degree and out-degree centrality. These nodes are identified as "59#Trade Secret" and "3# Data Protection," respectively, as reflected in the rankings for in-degree and out-degree centrality, as depicted in Diagram 1.

The importance of these nodes extends beyond mere centrality; they assume distinct roles within the network structure. "Data Protection," characterized as an influencer node, is intrinsically linked to the "Customer Service" digital transformation criterion. In contrast, "Trade Secret" operates as a supported node and constitutes an integral element of structural capital. This delineation underscores their respective positions within the network and the nature of their interactions.

For Esenboğa TAV Holding Terminal Management, the "Customer Service" component emerges as the most influential aspect, a finding corroborated by the centrality analysis. In contrast, the "Structural Capital" component is identified as the most supported within the network, affirming its significance within the organization's intellectual capital framework.

Delving further into network analysis, the examination of closeness centrality statistics reveals additional insights. Closeness centrality, which considers the distances between nodes in a network, elucidates the nodes that assume central positions in terms of both in-link and out-link. Within the comprehensive dataset gathered from the companies, two key nodes come to the forefront.

Firstly, in terms of in-link centrality, the node "Trust" emerges as the pivotal hub within the network. It signifies the integral role of trust in fostering interconnections and relationships among various components. This finding underscores the critical importance of trust in shaping the network dynamics and overall functioning.

Secondly, in the context of out-link centrality, the node "Matching Expectations, Responsibilities, Rewards Technological Innovations" takes centre stage as the central hub. This node's prominence underscores its role in facilitating outward connections and disseminating information or influence throughout the network. It reflects the node's position as a linchpin in enabling the flow of information and collaborative efforts within the organization.

In summation, centrality analysis within the network context not only highlights nodes of significance but also elucidates their distinct roles and impacts on the network's overall structure. These findings shed light on the intricate interplay between intellectual capital components and digital transformation criteria within Esenboğa TAV Holding Terminal Management, providing valuable insights for strategic decision-making and organizational development.

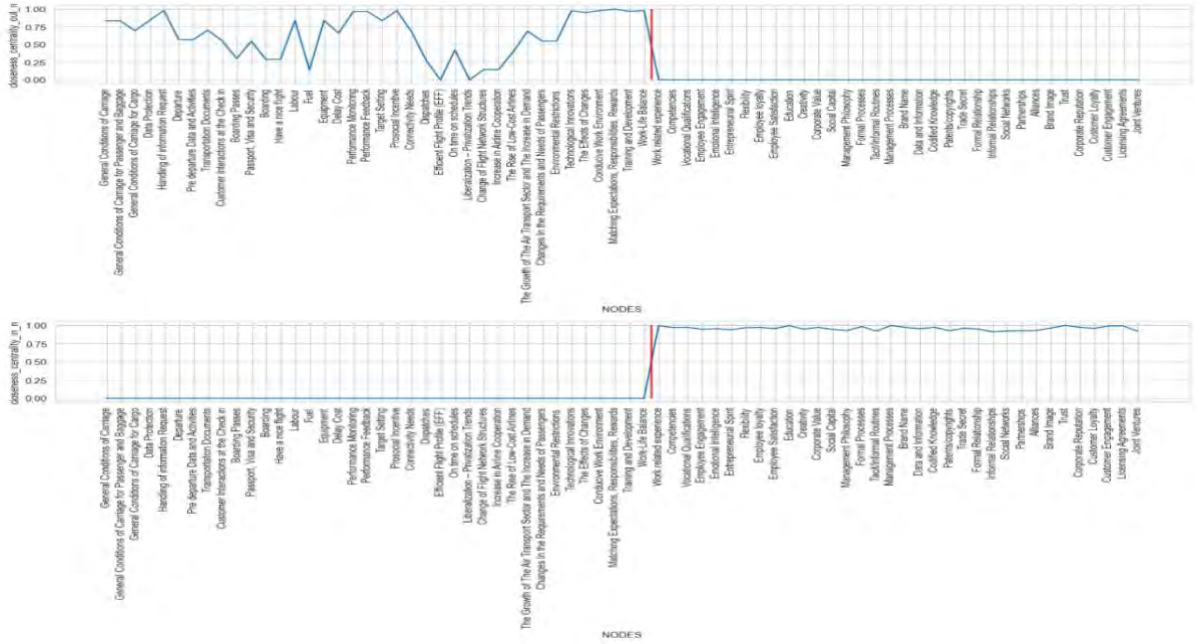


Diagram 2: Esenboğa TAV Holding Terminal Management -In&Out Link Normalized Closeness Centrality

In essence, the impact of digital transformation criteria on intellectual capital can be elucidated as follows: Within this network, "Trust" plays a central influential role, while "Matching Expectations, Responsibilities, Rewards" provides support to other nodes. To put it differently, nodes with high centrality have the capacity to transmit information more rapidly than nodes with lower centrality, as they possess shorter pathways to knowledge. Consequently, highly central nodes enjoy the advantage of efficiently disseminating information throughout the network.

Examining the network's centrality further reveals that the most central node in terms of out-link connections is the "Increase Employee Retention" criterion. This signifies its pivotal role in facilitating external connections and the dissemination of information within the network. Conversely, in-link centrality designates the "Relational Capital" component as the most central node, highlighting its significance in fostering internal connections and relationships within the network.

It is crucial to note that an individual node's contribution to the network's eigenvector centrality is more substantial when it possesses fewer but higher-quality connections, as opposed to having numerous but lower-quality connections. This underscores the importance of nodes with influential neighbors, as their eigenvector centrality is determined not only by the number of connections but also by the influence these connections exert. As a result, nodes with influential neighbors are considered prestigious within the network, signifying their integral role in shaping network dynamics and information flow.

In summary, centrality analysis provides valuable insights into the structure of the network and the interactions between digital transformation criteria and intellectual capital components. This analysis underscores the critical roles played by specific nodes, including "Trust," "Matching Expectations, Responsibilities, Rewards," "Increase Employee Retention," and "Relational Capital," in influencing and supporting network dynamics. These findings enhance the understanding of knowledge-sharing mechanisms within the organization and the nodes that drive effective information dissemination and connectivity.

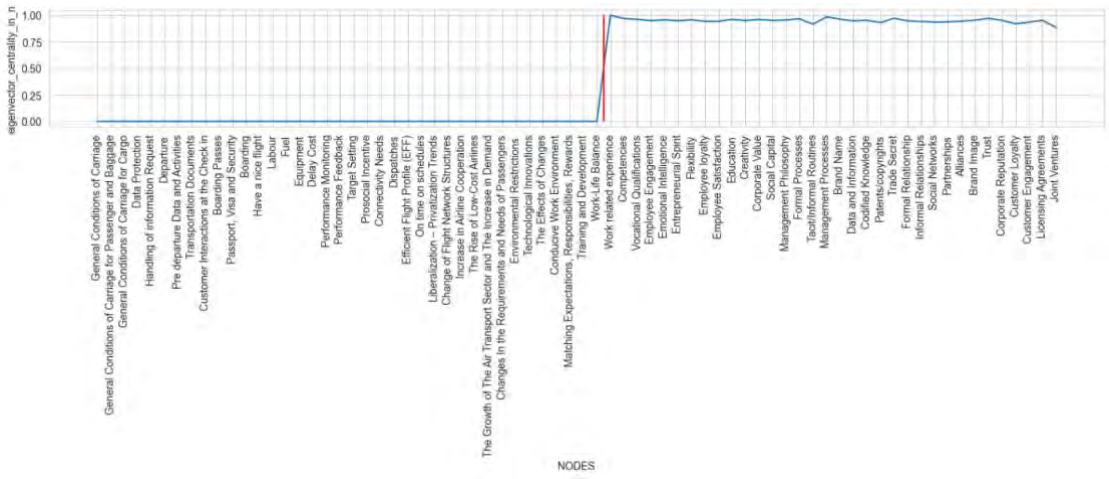


Diagram 3: Esenboğa TAV Holding Terminal Management - In&Out Link Eigenvector Centrality

The determination of node prestige within Esenboğa TAV Holding Terminal Management, based solely on in-link connections, yields "Work Related Experience" as the most prestigious node, as depicted in Diagram 3. This outcome is a result of considering the edges directed towards the node, which highlights the significant influence and centrality of "Work Related Experience" in the network.

In this context, "Work Related Experience" stands out as a pivotal component within the organization's intellectual capital framework, showcasing its prominence in shaping internal connections and knowledge-sharing dynamics. Its high eigenvalue underscores its importance as a node that receives substantial input and plays a critical role in the dissemination of expertise and experience throughout the network.

This finding further emphasizes the significance of "Work Related Experience" in enhancing the organization's intellectual capital and knowledge-sharing processes. Understanding its central role in the network provides valuable insights into the organization's operations and the factors contributing to its success in leveraging work-related experience as a key asset.

In summary, the in-link analysis highlights "Work Related Experience" as the most prestigious node within Esenboğa TAV Holding Terminal Management, signifying its pivotal role in influencing and shaping the organization's intellectual capital and knowledge-sharing dynamics.

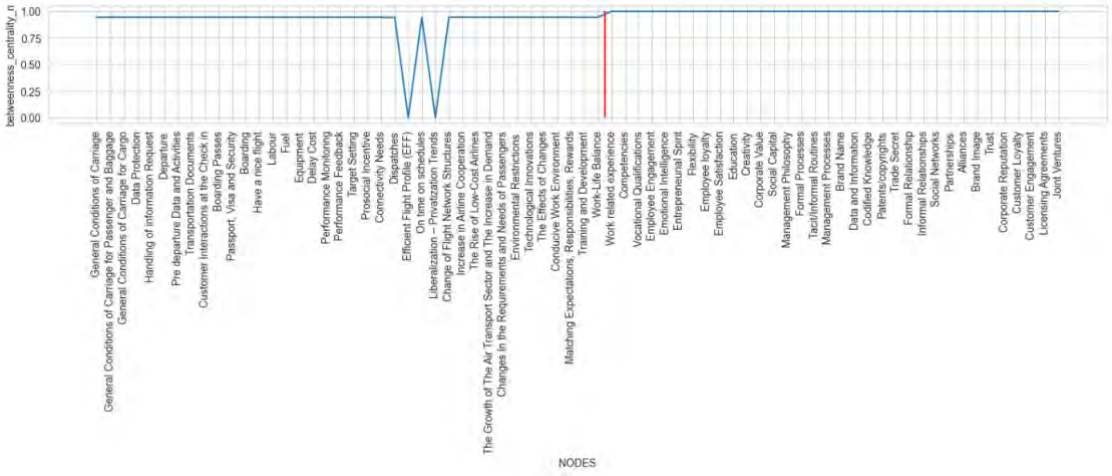
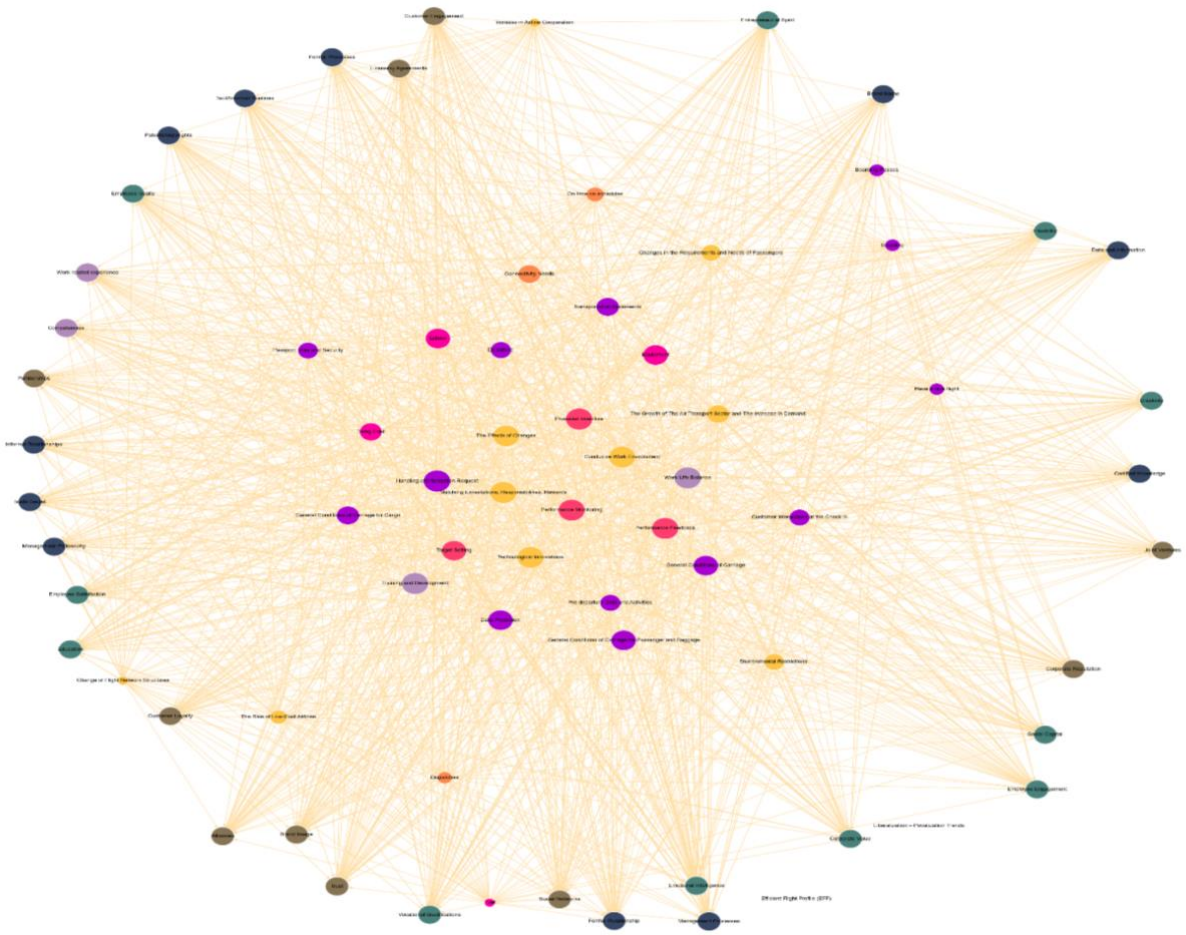


Diagram 4: Esenboğa TAV Holding Terminal Management Betweenness centrality

In the context of betweenness centrality analysis, encompassing all the data collected from the participating companies, a comprehensive list of network nodes emerges as the most influential intermediaries in facilitating information flow within the network. These nodes play a pivotal role in connecting various parts of the network and enabling the transfer of knowledge and insights. The nodes with the highest betweenness measurements are as follows:38#Work related experience, 39#Competencies, 40#Vocational Qualifications, 41#Employee Engagement, 42#Emotional Intelligence, 43#Entrepreneurial Spirit, 44#Flexibility, 45#Employee loyalty, 46#Employee Satisfaction, 47#Education, 48#Creativity, 49#Corporate Value, 50#Social Capital, 51#Management Philosophy, 52#Formal Processes, 53#Tacit/Informal Routines, 54#Management Processes, 55#Brand Name, 56#Data and Information, 57#Codified Knowledge, 58#Patents/copyrights, 59#Trade Secret, 60#Formal Relationship, 61#Informal Relationships, 62#Social Networks, 63#Partnerships, 64#Alliances, 65#Brand Image, 66#Trust, 67#Corporate Reputation, 68#Customer Loyalty, 69#Customer Engagement, 70#Licensing Agreements, 71#Joint Ventures. These nodes collectively serve as the most crucial and instrumental players in the network's information flow dynamics. Their prominent betweenness centrality positions signify their significant contributions to bridging various parts of the network and facilitating the exchange of knowledge and insights. This extensive list underscores the diversity of factors and components that influence the flow of information within the organization, highlighting the multifaceted nature of intellectual capital and its impact on organizational dynamics.



Graph 1: Vote-Rank Network of Esenboğa TAV Holding Terminal Management

An examination of the network analysis conducted on Esenboğa TAV Holding Terminal Management reveals a directed network structure, as depicted in graph 1. In this directed network, distinct patterns emerge regarding the positioning of nodes.

Source Nodes: Source nodes occupy central positions within the network. These nodes play a prominent role in initiating or influencing information flow within the system.

Destination Nodes: Conversely, destination nodes are located at the periphery of the network. They tend to receive or be on the receiving end of information and knowledge flow.

Influencer and Support Nodes: Within this weighted network, nodes that hold significant influence or provide crucial support are relatively larger in size. These nodes play pivotal roles in shaping the network's dynamics.

Flaneur Nodes: Nodes with no relationships or minimal connections are positioned on the network's periphery and appear minuscule in size.

The network's visualization highlights several noteworthy features:

One-directional Interaction: A substantial portion of nodes exhibit one-directional, dense, and tightly coupled interactions with each other. This suggests that information and knowledge flow within the network is characterized by a consistent directional pattern.

Network Resilience: The prevalence of dense interactions implies that the network is highly resilient. It can adapt to changes and disruptions while maintaining its connectivity and information exchange.

Overall, the network's directed structure reflects the distinct roles and relationships among nodes within Esenboğa TAV Holding Terminal Management. Source nodes serve as initiators, influencers, or hubs of information dissemination, while destination nodes receive and potentially act upon this information. The

presence of influencer and support nodes underscores their significance in shaping the network's dynamics and facilitating the flow of intellectual capital.

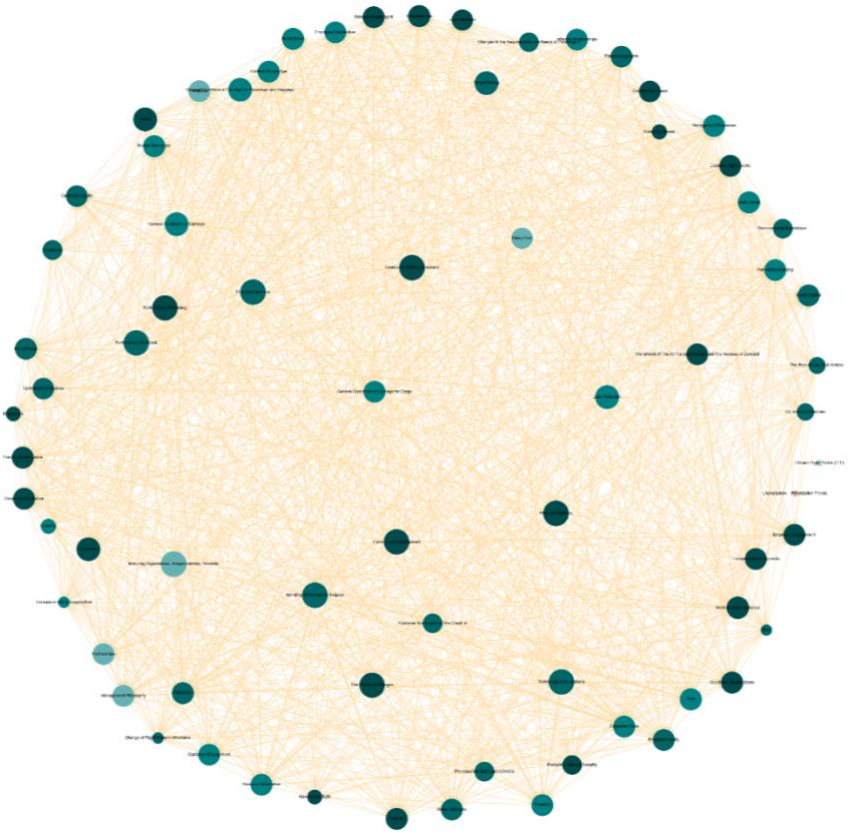
Table 2: Esenboğa TAV Holding Terminal Management 's Modularity, Community Detection, and Vote Rank Distribution

	Unnamed: 0	modularity	community_detection	vote_rank
0	General Conditions of Carriage	3	2	1
1	General Conditions of Carriage for Passenger and Baggage	3	2	1
2	General Conditions of Carriage for Cargo	3	2	1
3	Data Protection	3	2	1
4	Handling of information Request	2	5	1
5	Departure	2	5	1
6	Pre departure Data and Activities	2	5	1
7	Transportation Documents	1	7	1
8	Customer Interactions at the Check in	2	5	1
9	Boarding Passes	1	1	1
10	Passport, Visa and Security	1	1	1
11	Boarding	3	2	1
12	Have a nice flight	1	1	1
13	Labour	1	7	1
14	Fuel	2	5	1
15	Equipment	1	7	1
16	Delay Cost	4	6	1
17	Performance Monitoring	1	7	0
18	Performance Feedback	2	5	0
19	Target Setting	2	5	0
20	Prosocial Incentive	2	5	0
21	Connectivity Needs	1	6	0
22	Dispatches	1	1	0
23	Efficient Flight Profile (EFF)	5	3	0
24	On time on schedules	2	2	0
25	Liberalization – Privatization Trends	6	4	0
26	Change of Flight Network Structures	2	7	0
27	Increase in Airline Cooperation	3	2	0
28	The Rise of Low-Cost Airlines	2	5	0
29	The Growth of The Air Transport Sector and The Increase in Demand	1	6	0
30	Changes In the Requirements and Needs of Passengers	2	6	0
31	Environmental Restrictions	2	1	0
32	Technological Innovations	2	5	0
33	The Effects of Changes	1	7	0
34	Conducive Work Environment	1	1	0
35	Matching Expectations, Responsibilities, Rewards	4	6	0
36	Training and Development	1	1	0
37	Work-Life Balance	1	1	0
38	Work related experience	1	1	0

39	Competencies	1	1	0
40	Vocational Qualifications	1	1	0
41	Employee Engagement	1	1	0
42	Emotional Intelligence	1	1	0
43	Entrepreneurial Spirit	1	7	0
44	Flexibility	1	7	0
45	Employee loyalty	2	1	0
46	Employee Satisfaction	3	2	0
47	Education	2	5	0
48	Creativity	3	7	0
49	Corporate Value	3	7	0
50	Social Capital	2	5	0
51	Management Philosophy	4	6	0
52	Formal Processes	3	2	0
53	Tacit/Informal Routines	2	5	0
54	Management Processes	3	2	0
55	Brand Name	3	2	0
56	Data and Information	3	2	0
57	Codified Knowledge	3	2	0
58	Patents/copyrights	2	5	0
59	Trade Secret	3	2	0
60	Formal Relationship	3	2	0
61	Informal Relationships	3	2	0
62	Social Networks	2	5	0
63	Partnerships	4	6	0
64	Alliances	4	6	0
65	Brand Image	2	5	0
66	Trust	3	2	0
67	Corporate Reputation	1	7	0
68	Customer Loyalty	2	1	0
69	Customer Engagement	3	2	0
70	Licensing Agreements	1	1	0
71	Joint Ventures	1	7	0

Esenboğa TAV Holding Terminal Management's network analysis has revealed various aspects, including modularity, community detection, and vote rank, as outlined in Table 2. The network exhibits a complex and sophisticated topology, which the study will be delved into further in the subsequent sections. One notable observation is that as nodes within the network undergo micro dynamics, they tend to form tightly connected groups by increasing their relationships with one another. This phenomenon reflects the evolution of small systems over time, leading to increased specialization within these groups. In crowded systems, it becomes challenging for components to adapt and evolve compatibly with one another. Consequently, all systems tend to comprise highly specialized groups, each serving a specific function and maintaining positive business relationships. This pattern aligns with the concept of "small worlds" in network theory (Gençer, 2017).

In subsequent sections, it will explored and discussed the implications of Esenboğa TAV Holding Terminal Management's network topology, modularity, and community structures in greater detail. These insights will provide a deeper understanding of how the organization's intellectual capital components interact and influence each other within the network.

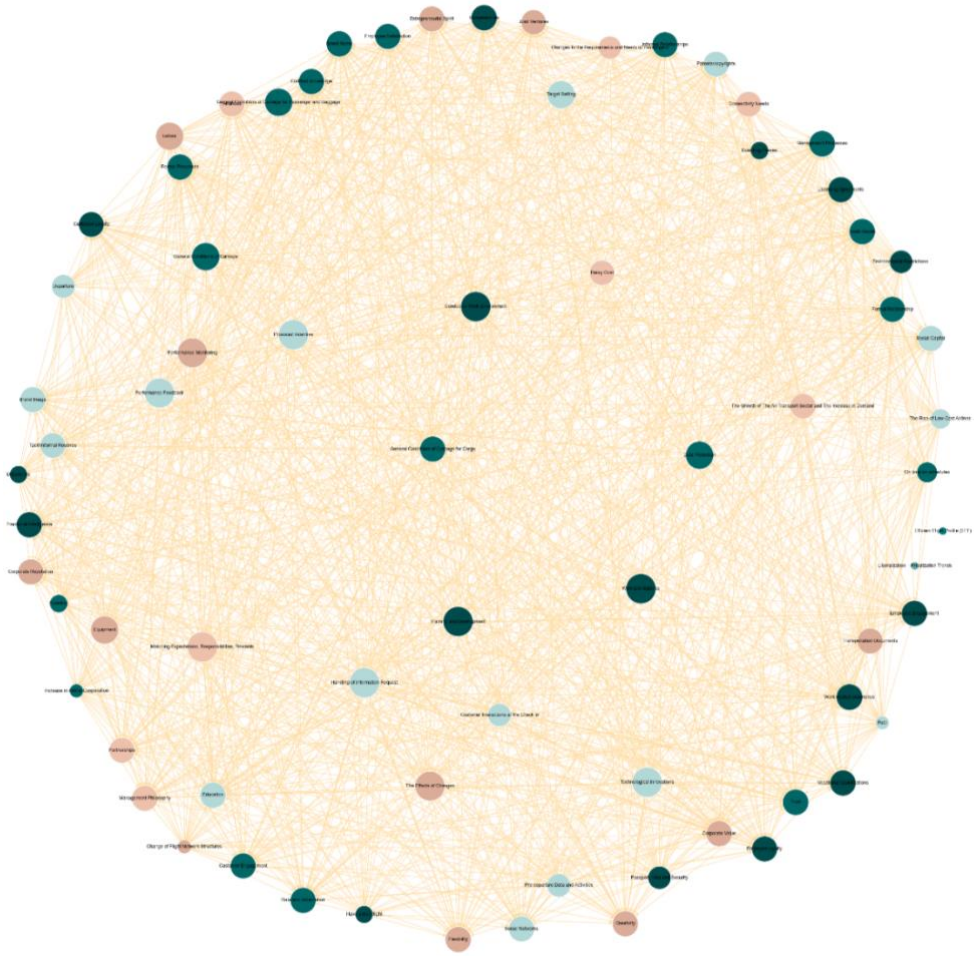


Graph 2: Modularity Network of Esenboğa TAV Headquarter,

The analysis of Esenboğa TAV Holding Terminal Management's network has revealed a distinct structure, which can be summarized under six categories of digital transformation criteria as source nodes and three main categories of intellectual capital components as target attributes. As depicted in Graph 2, all 72 nodes in the network were classified into six different modules based on these attributes, considering their weights and orientations. The modular structure of Esenboğa TAV Holding Terminal Management's network is characterized by the distribution of nodes across different modules. Module 1 is the most populated with 24 nodes, indicating a significant concentration of attributes related to digital transformation criteria and intellectual capital components. Module 2 contains 22 nodes, while Module 3 encompasses 19 nodes, both reflecting substantial clusters of attributes.

In contrast, Module 4 comprises only 5 nodes, suggesting a smaller but distinct group of attributes within the network. Additionally, two nodes are allocated to separate Modules 5 and 6, further highlighting the network's modular organization.

This modular structure provides valuable insights into how various attributes, such as digital transformation criteria and intellectual capital components, are interconnected and grouped within Esenboğa TAV Holding Terminal Management's network. Further analysis of these modules will contribute to a deeper understanding of the network dynamics and the relationships between different attributes.

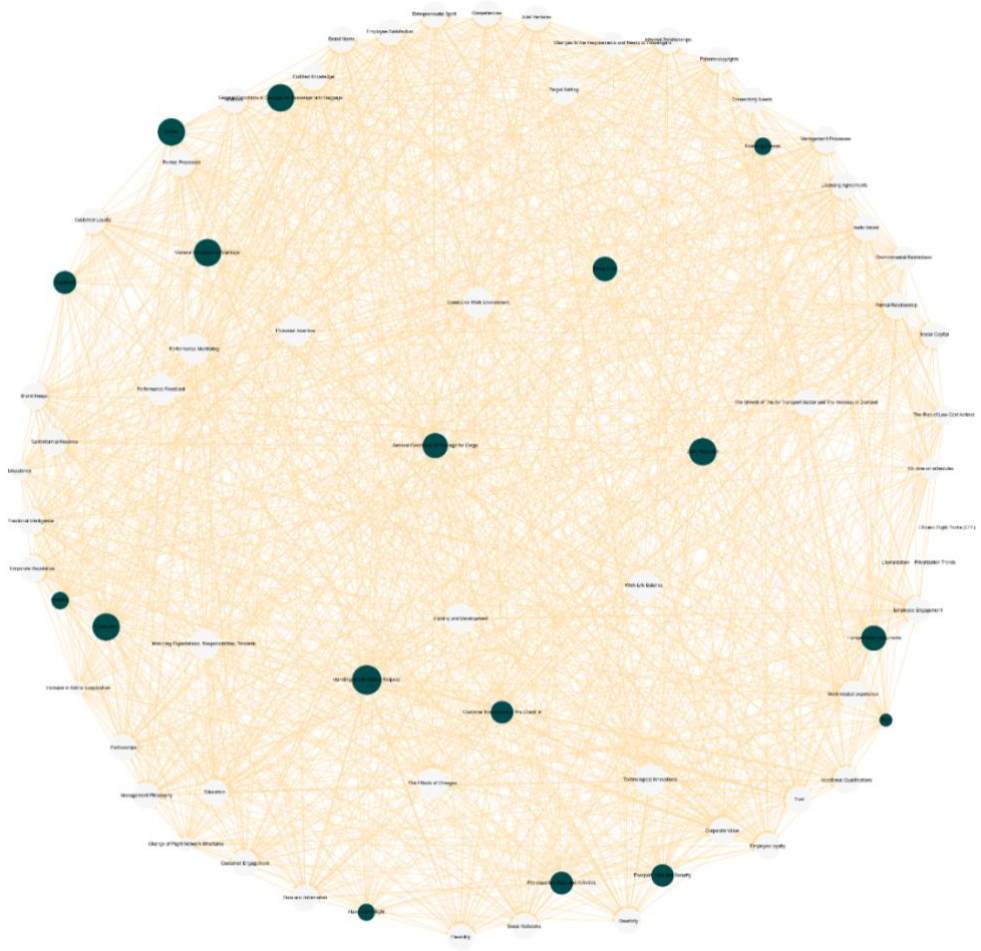


Graph 3: Community Detection Network of Esenboğa TAV Holding Terminal

In the analysis of Esenboğa TAV Holding Terminal Management, a total of 7 distinct communities were identified within the network, which comprises 72 nodes and 1272 edges, as depicted in Graph 3. Community detection in a network is a valuable technique because it allows for the identification of subsets within the larger network that exhibit similar properties and interactions.

Nodes within the same community are densely interconnected, meaning that they have more frequent and substantial connections with one another compared to nodes in different communities. This dense interconnection often arises from shared characteristics, mutual acquaintances, or similar qualities among individuals or nodes within the same community.

One of the primary objectives of this analysis is to investigate the impact of seed selection when using sequential seeding, particularly in conjunction with dynamic rankings generated through the Vote-Rank algorithm. This approach aims to explore how different seed nodes can influence the formation and development of communities within the network, shedding light on the network's underlying dynamics and structural patterns.



Graph 4: Vote-Rank Network of Esenboğa TAV Holding Terminal Management

In the analysis of TAV Holding Terminal Management, seeds for community detection were initially selected based on their rank within the network. These seeds included nodes with the following labels: General Conditions of Carriage, General Conditions of Carriage for Passenger and Baggage, General Conditions of Carriage for Cargo, Data Protection, Handling of information Request, Departure, Pre departure Data and Activities, Transportation Documents, Customer Interactions at the Check-in, Boarding Passes, Passport, Visa and Security, Boarding, Have a nice flight, Labour, Fuel, Equipment, Delay Cost.

As depicted in Graph 4, nodes in the network were ranked during the initial stage of the process, and seeds were chosen based on their rank. However, as the spreading processes continued within the network, nodes that were initially considered highly effective for seeding may have lost their effectiveness over time. It's important to note that only active nodes are eligible to cast a vote in this process.

The results of this approach highlighted the performance of the proposed method, particularly in scenarios where further seeding occurs after the initial process has evolved. This dynamic approach allows for adjustments and refinements in seed selection, ensuring that the community detection process remains effective even as the network undergoes changes and adaptations.

5.Discussion

In the aviation sector, particularly in airport terminal management, the relationships between subsidiaries and stakeholders are typically formalized within well-defined hierarchical structures. These structures provide clear guidelines on how different entities should interact with each other, along with established procedures and communication channels. Each partner within these relationships has a specific role and purpose, and they generally adhere to these roles, deviating only in exceptional circumstances (López-Fernández, 2006:33). At all levels, from the micro to the macro, all participants, including partners, stakeholders, and subsidiaries, collaborate to secure the future of the company. The primary objective within this extensive network is to ensure interoperability and efficient utilization of all available capabilities within the framework of open innovation (Little,2020:124). While there may be a linear or even super-linear flow of information in innovative projects within these networks, the roles, responsibilities, opportunities, and rights of network participants are typically non-linear and multifaceted. This complexity reflects the dynamic nature of collaboration and innovation in the aviation industry.

The aviation sector is currently undergoing a significant transformation, transitioning from Industry 4.0 to Industry 5.0, with a focus on adaptability and innovation. The rapid changes in the industry, particularly accelerated by the COVID-19 pandemic, have captured the attention of organizations like Eurocontrol. Eurocontrol has conducted an analysis of developments in the European aviation sector for the years 2022-2028, considering various factors such as air traffic trends, macroeconomics, ticket prices, fuel costs, and geopolitical tensions (Eurocontrol, 2022:21). Notably, air traffic density and ticket prices have seen fluctuations, and jet fuel prices have increased significantly, affecting the industry's economics.In this volatile and complex environment, the aviation sector often operates in what is known as a VUCA (Volatility, Uncertainty, Complexity, and Ambiguity) setting. This means that relationships with stakeholders are crucial at all times and across all areas within the sector. During unexpected and crisis situations, quick, impactful solutions are essential, and these are often facilitated through a network of stakeholders. Such agility and resilience contribute to the sector's sustainability and, in turn, increase its intellectual capital. While the concept of digital transformation may not be explicitly categorized as a component of intellectual capital in existing literature, its substantial value is undeniable. Digital transformation significantly enhances not only the overall intellectual capital of organizations in the aviation industry but also its human, structural, and relational components.

The study aims to understand the value added by digitalization to intellectual capital in airport terminal management. It utilizes network analysis to explore the close relationships between TAV Holding, the operator of Ankara Esenboga Airport, and its subsidiaries. These relationships transcend geographical and temporal constraints and transform crises into opportunities through open and innovative approaches, even in uncertain and ambiguous circumstances. The network structure analysis of TAV Holding and its subsidiaries reveals that the organization's original structure was a mix of formal, decentralized, horizontal, and hierarchical components. In network analysis, structural equivalence emerges when actors within networks share the same relationships. However, a network with power and influence is more valuable than two structurally equivalent networks. The strength and quality of relationships between nodes depend on factors such as contact frequency and proximity. The relationships in this network are categorized into three groups: functional, source, and geography. Functional relations are built on functions related to the organization's founding purpose. In this case, the relationships revolve around digital transformation criteria related to customer services, operational cost reduction, employee productivity, efficiency, and employee retention. The digital transformation criteria emphasize creating resource-oriented relationships among human, structural, and relational components of intellectual capital.Data and information are critical resources in the aviation sector. The flow of data within relationships is particularly significant in organizations like TAV Holding that foster open innovation relationships. The study findings highlight the positive contribution of digital transformation criteria to intellectual capital components, particularly through data flow. Geographical relationships are also relevant in the aviation sector, encompassing local, national, and global dimensions. However, this study primarily focuses on the Ankara location. The network analysis demonstrates the power dynamics between TAV Holding and its subsidiaries, emphasizing functionality and influence in formal and contract-based relationships. The network's dynamics emerge from the interactions within this socio-technical system, capturing both official and bureaucratic aspects of relationships.

Finally, the study uses graph theory to map the network's interaction dynamics, applying six criteria: Integration, Driving, Driven, Stability, Criticality, and Precariousness (Baskici and Ercil, 2018). These criteria help in comprehending the overall network structure and its complex interplay of nodes and edges. In conclusion, this study sheds light on the significant value digital transformation criteria bring to intellectual capital components within the aviation sector, particularly in airport terminal management. The network analysis reveals the intricate relationships between TAV Holding and its subsidiaries, highlighting the importance of functionality, influence, resources, and data flow. These findings provide insights into the evolving dynamics of the aviation industry and its readiness to embrace change and innovation in a VUCA environment.

6. Conclusion

The aviation industry, renowned for its technological innovation and adaptability, has undergone accelerated evolution in the context of Industry 4.0 and the emergent Industry 5.0. The exigencies of staying competitive and resilient in a dynamic landscape, exacerbated by the COVID-19 pandemic, have propelled the industry towards the swift adoption of advanced technologies and innovative practices. Eurocontrol's exhaustive analysis has delineated a roadmap for the future, emphasizing critical factors such as air traffic trends, macroeconomics, ticket prices, and geopolitical tensions. The VUCA framework aptly characterizes the aviation sector, encapsulating its essence in an environment marked by constant change and unpredictability. It underscores the pivotal role of stakeholder relationships, serving as vital lifelines during crisis moments. The agility demonstrated by these stakeholder networks in implementing impactful solutions not only ensures organizational resilience but also contributes to long-term sustainability. Additionally, it elevates the intellectual capital of the industry, enabling active participation in transformation journeys. While traditional literature may not explicitly categorize digital transformation as an element of intellectual capital, this study illuminates its pivotal role, showcasing how digitalization significantly contributes to the intellectual capital of aviation organizations, enriching human, structural, and relational aspects and enhancing the industry's capacity to thrive amidst uncertainties. The focus of the research centred on discerning the tangible value derived from digital transformation, particularly within the domain of airport terminal management. Utilizing network analysis as a tool, it is unravelled the intricate web of relationships defining TAV Holding and its subsidiaries. Results emphasized the transcending of traditional boundaries through open, innovative approaches, transforming challenges into opportunities, even amid ambiguity.

The network structure divulged insights into TAV Holding's organizational design, featuring a unique blend of formal, decentralized, horizontal, and hierarchical elements. This intricate network design facilitated the necessary flexibility for TAV Holding to adapt, innovate, and succeed in the dynamic aviation landscape. Structural equivalence emerged as a significant concept within network analysis, highlighting relationships conferring power and influence as having paramount value. The quality and strength of these relationships, influenced by factors such as contact frequency and proximity, further enriched the intellectual capital of the organization. The study identified three fundamental categories of relationships within the network: functional, source, and geographical. Functional relationships, rooted in the core functions of the organization, exemplified by digital transformation criteria, facilitated resource-oriented relationships across human, structural, and relational components of intellectual capital, serving as catalysts for innovation and growth. In an industry where data is pivotal, the study emphasized the crucial role of information flow in fostering relationships and driving intellectual capital growth. Digital transformation criteria, by design, facilitated the efficient flow of data, further enhancing intellectual capital components. While geographical relationships were considered, the study primarily focused on the Ankara location, providing insights applicable on a global scale.

Moreover, while this study highlights the intellectual capital-enriching role of digital transformation, a deeper dive into the nuanced challenges and barriers faced by organizations in implementing these transformative initiatives is warranted. Understanding the specific contextual constraints and obstacles faced by different entities within the aviation sector can provide valuable insights for practitioners and policymakers.The study's focus on airport terminal management offers valuable insights into the tangible benefits derived from digital transformation. However, a more granular examination of other facets within the aviation industry, such as aircraft manufacturing or air traffic control, could reveal additional dimensions of the impact of digitalization on intellectual capital. Structural equivalence emerges as a significant concept within network analysis,

highlighting relationships conferring power and influence as having paramount value. The quality and strength of these relationships, influenced by factors such as contact frequency and proximity, further enrich the intellectual capital of the organization. Despite the thorough analysis, future studies may delve deeper into the specific mechanisms through which these relationships influence decision-making processes and strategic outcomes.

The study concludes with a discussion on the significant value of digital transformation criteria in enriching the intellectual capital of the aviation sector, particularly within airport terminal management. The insights gained from the intricate relationships between TAV Holding and its subsidiaries emphasize the importance of functionality, influence, resources, and data flow. However, future studies could explore the long-term sustainability of these digital transformation initiatives and their enduring impact on intellectual capital. In future studies, researchers could explore the long-term impacts of digital transformation on various components of intellectual capital across different industries. Additionally, comparative studies between sectors could provide insights into how digitalization uniquely influences intellectual capital in diverse contexts. Another area for future research could be the development of frameworks or models that organizations can use to effectively integrate digital transformation strategies with intellectual capital management, ensuring sustained competitive advantage. Furthermore, examining the role of emerging technologies, such as artificial intelligence and blockchain, in shaping and enhancing intellectual capital would be valuable for both academic research and practical applications.

In conclusion, the study employed graph theory to illuminate power and influence dynamics within the network, utilizing criteria to comprehend network functioning and evolution. Overall, the research underscores the significant value of digital transformation criteria in enriching the intellectual capital of the aviation sector, particularly within airport terminal management. It unveils the intricate relationships between TAV Holding and its subsidiaries, emphasizing the importance of functionality, influence, resources, and data flow. These insights offer a profound understanding of how the aviation industry navigates change and innovation in an environment characterized by volatility, uncertainty, complexity, and ambiguity, serving as a guide toward a future defined by resilience, adaptability, and intellectual capital growth.

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