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Research Article

Use of Gephi Applied Network Analysis for Selection Criteria of Refrigeration System Components

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Abstract

Connections between live or non-living node points and these node points are referred to as networks. The objects are directly or indirectly connected to each other by means of networks. Network analysis methods, especially social network analysis, are used in many social sciences. The aim of this study is to investigate the usability of network applied analysis for selection criteria of refrigeration system elements. In this respect, the study is one of the first studies in the use of network analysis in the energy field of engineering. It is perhaps the first study. Data sets were analyzed using Gephi package program. As a result of this study, selection criteria of refrigeration system elements are visualized by Gephi network analysis.

Keywords: Refrigeration System, Gephi, Network Analysis, Selection Criteria.

Soğutma Sistemi Elemanlarının Seçim Kriterleri İçin Gephi Uygulamalı Ağ Analizi Kullanımı

Öz

Canlı ya da cansız düğüm noktaları ile bu düğüm noktaları arasındaki bağlantılar ağ olarak ifade edilmektedir. Nesneler doğrudan ya da dolaylı olarak birbirleri ile ağlar vasıtasıyla bağlıdırlar. Ağ analiz metotları özellikle de sosyal ağ analizi birçok sosyal bilim alanında kullanılmaktadır. Bu çalışmanın amacı, soğutma sistemi elemanlarının seçim kriterleri için Gephi uygulamalı ağ analizinin kullanılabilirliğinin incelenmesidir. Bu açıdan yapılan çalışma, ağ analizinin mühendisliğin enerji alanında kullanımında ilk çalışmalardan olmaktadır. Veri setleri Gephi paket programı kullanılarak analiz edilmiştir. Çalışma sonucunda, soğutma sistemi elemanlarının seçim kriterleri Gephi uygulamalı ağ analizi ile görselleştirilmiştir.

Anahtar Kelimeler: Soğutma Sistemi, Gephi, Ağ analizi, Seçim Kriteri.

1. Introduction

Today, the most widely used cooling system is vapor compression refrigeration systems. A refrigeration system consists of four basic elements (evaporator, condenser, compressor, expansion valve) and the refrigerant flowing through the system. In a refrigeration system, the evaporator is component in which the liquid refrigerant evaporates and receives heat from the environment. The component in which the pressure and temperature of the refrigerant in vapor form is increased and turned into superheated vapor is called a compressor. In condenser, the superheated refrigerant is condensed by removing its heat. The refrigeration system component

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in which the pressure of the saturated fluid is reduced is the expansion valve. The selection of refrigeration system components according to specific selection criteria is crucial for the efficiency and economy of the refrigeration system.

Çelik has examined conflicts around the world using social network analysis. As a result of the study, he has determined that the two biggest actors in the world conflicts are USA and Russia respectively [1]. Gençer investigated the features and contributions of the network analysis approach. It was determined that the network analysis approach for the examination of social systems is complementary [2]. Ağcasulu used social network analysis as a method. In study, it was examined that the research topic, the boundaries and the determination of the target audience in the network researches, respectively [3]. Al et al. were examined the publications of Hacettepe University between 1968 and 2009 in terms of bibliometric properties by social network analysis method [4]. Gülpınar estimated the loss of customers in the Turkish telecommunications market with Artificial Neural Networks (ANN) and analyzed the customer communication network with the help of Social Network Analysis and examined the position and impact of customers at risk of loss [5]. Ataman and Çelik searched the WoS citation database and collected publication data from Yüzüncü Yıl University and Van between 2000-2015 and formed the social network analysis of these data. Furthermore, they have visually demonstrated scientific data [6].

In recent years, social network analysis has started to be used in the field of social sciences. It is possible to come across studies related to social network analysis in the literature [7-12]. The difference of this study from other studies is that network analysis is used for the first time for a refrigeration system. In addition, it is thought to be the first field of mechanical engineering using Gephi network analysis.

2. Material and Method

Network analysis gives us the opportunity to perceive the world as networks. In fact, we can see any system as networks in a relationship dimension. Relationships that we cannot see but become apparent when visualized by network analysis allow us to look at systems from different angles. The concept of network can generally be defined as the components that make up a network and the connections between these components. Graphs are used to visualize networks. Graphs are drawings that make invisible networks visible. A simple graph includes nodes and edges.

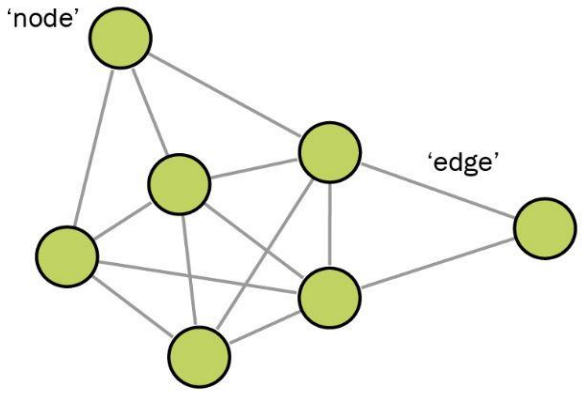

Figure 1. Relationship between nodes and edges in network analysis [13]

One of the most important stages of network analysis is visualization. Visualization is to make complex structures understandable. Numerous algorithms are used for visualization in network analysis. Different algorithms can be used depending on the structure of the analysis and the complexity of the data. Numerous software is available to implement network analysis techniques. Gephi is the most well-known of them.

3. Results and Discussion

The use of network analysis to the selection criteria of the cooling system elements was first applied to the evaporator. The network analysis of the evaporator selection was visualized and shown in Figure 2. Seven criteria were selected for the selection of the evaporator. These criteria are the evaporator material, the refrigerant, the cooling capacity, the type of place (air, fluid), refrigerant state condition, evaporator's type and evaporator's size. Secondly, the network analysis of the compressor selection was visualized and shown in Figure 3. Seven criteria were selected for the selection of the compressor. These criteria are the long life, vibration, energy consumption, safety, efficiency, noise and cost.

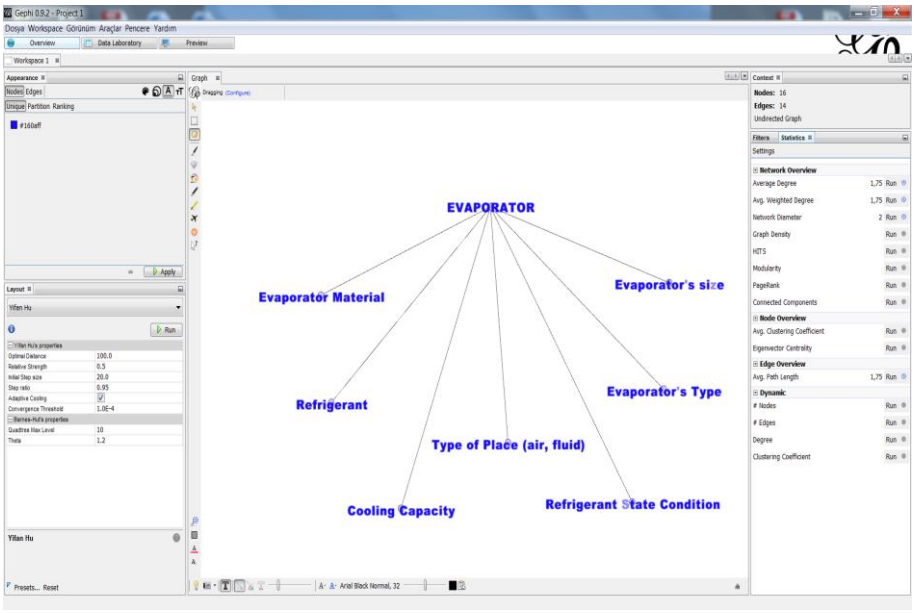

Figure 2. Network analysis of evaporator selection

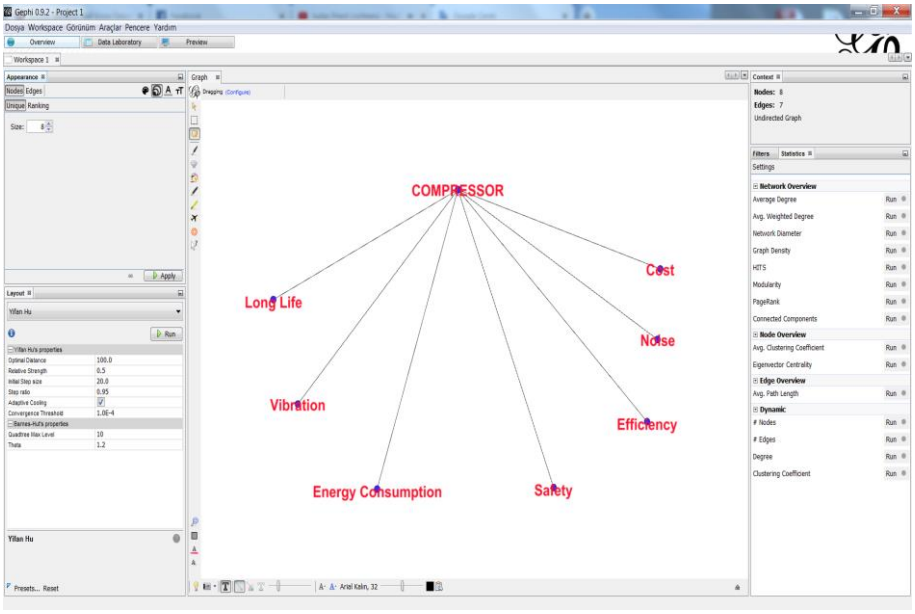

Figure 3. Network analysis of compressor selection

Eight selection criteria were considered for condenser that another component of the refrigeration system. These criteria are condenser capacity, cost, environmental temperature, type's place (air, fluid), condenser material, vibration, noise and condenser's size. The network analysis of the condenser selection was visualized and shown in Figure 4.

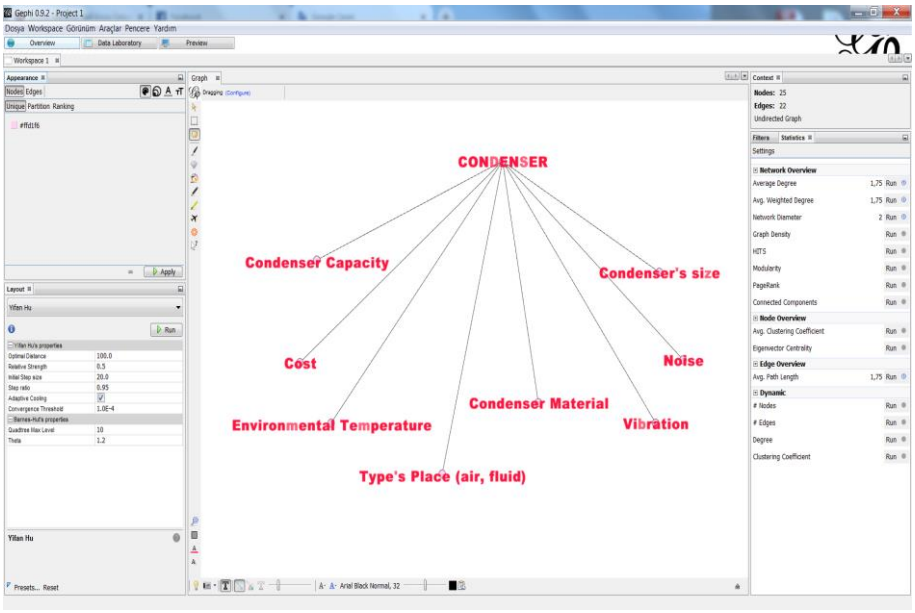

Figure 4. Network analysis of condenser selection

Four selection criteria were considered for the expansion valve, which is constant enthalpy pressure reducing component of the refrigeration system. These criteria are operating temperature, refrigerant type, cooling capacity and type (capillary tube, TEX). The network analysis of the expansion valve selection was visualized and shown in Figure 5.

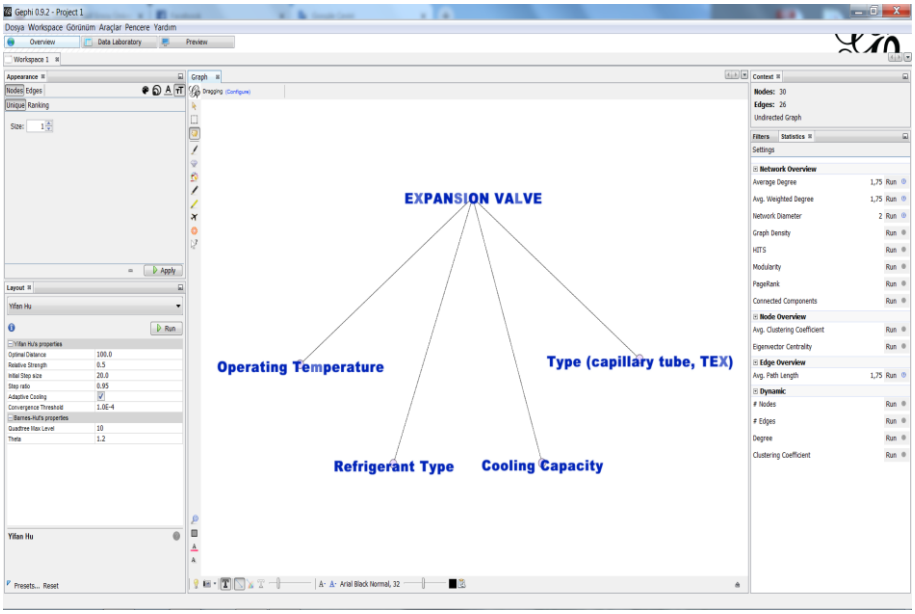

Figure 5. Network analysis of expansion valve selection

The choice of refrigerant for refrigeration systems is very important. Refrigerants are one of the most important parameters affecting refrigeration performance. In this study, the network analysis of the refrigerant selection was visualized for thirteen criteria and shown in Figure 6. These criteria are chemical stability, non-toxic, non-explosive, high critical temperature, non flammable, cheapness, easy availability, no corrosion effect, high critical pressure, low-ODP, low-GWP and low boilling temperature.

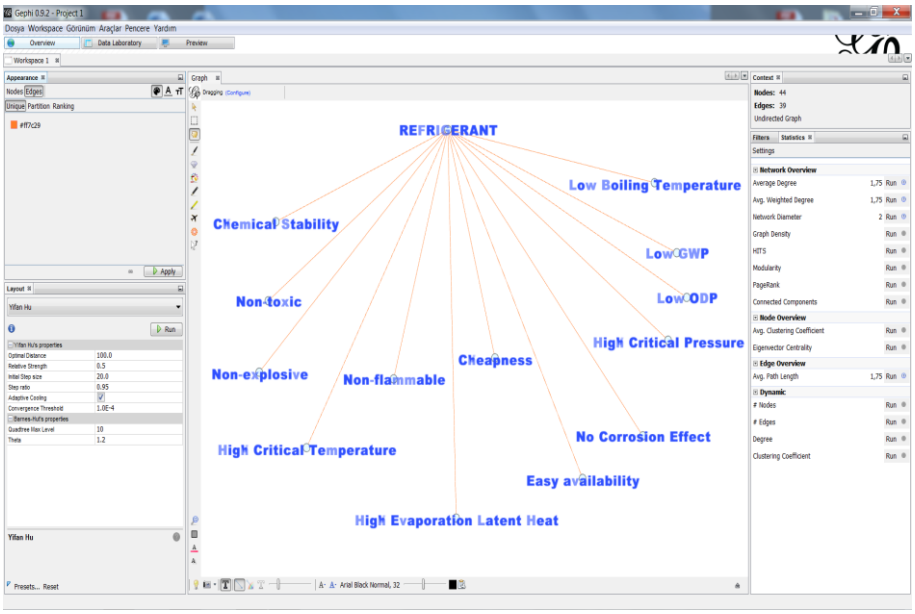

Figure 6. Network analysis of refrigerant selection

45 nodes were used in the application of this study. Nodes and properties of nodes used in Gephi network analysis application are given in Figure 7. In addition, the edges and edges properties of the application are given in Figure 8.

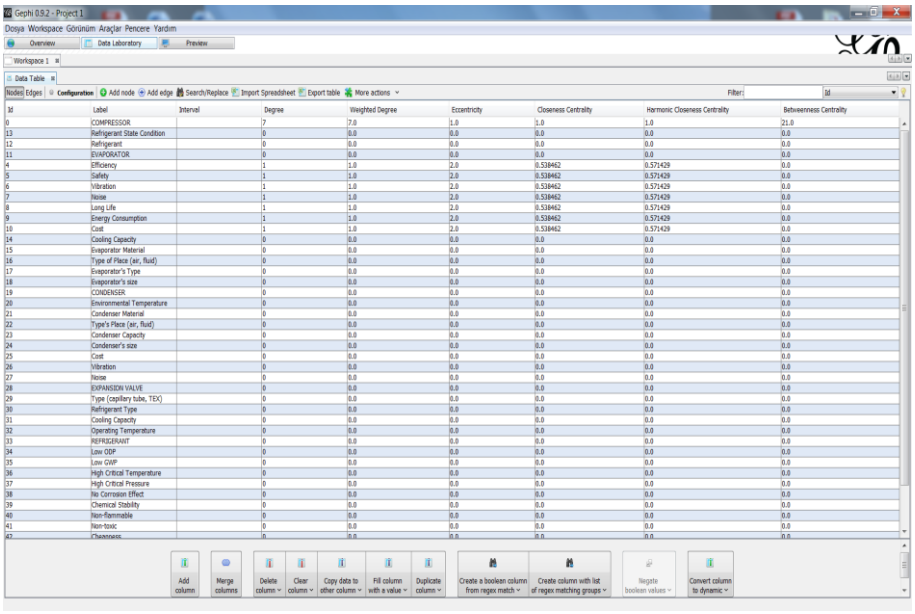

Figure 7. Nodes specifications of Gephi network analysis

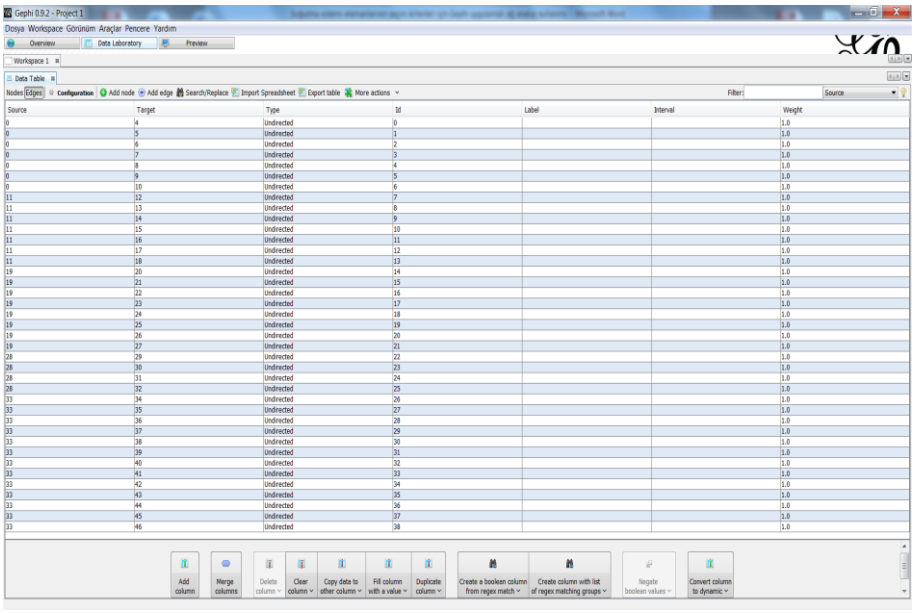

Figure 8. Edges specifications of Gephi network analysis

Optimizing the selection of the five basic componets that make up a refrigeration system is extremely important for energy efficiency. The selection criteria of the refrigeration system basic components are made by Gephi network analysis and are given in Figure 9. Visualization of selection criteria using network analysis has made these criteria more understandable.

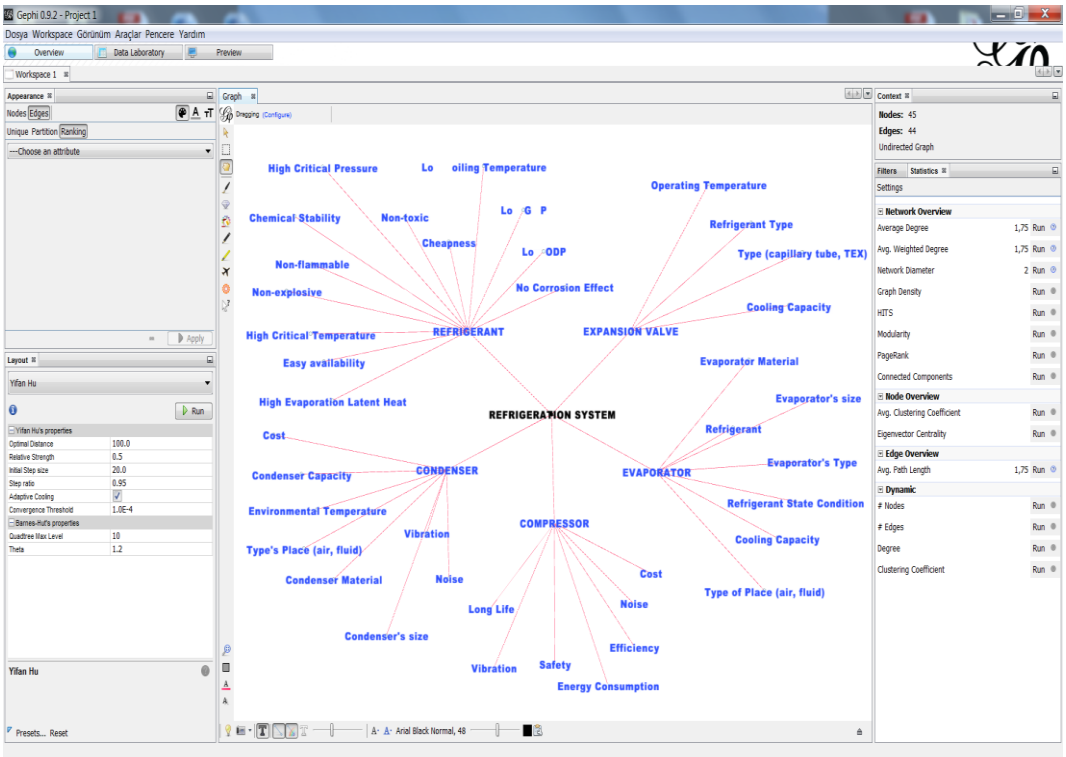

Figure 9. Network analysis for selection criteria of refrigeration system components

4. Conclusions

In this study, Gephi network analysis is used for the selection criteria of the five basic components of the vapor compression refrigeration cycle. Gephi network analysis was used for visualization and easy perception of these criteria. It is thought that a researcher from any field examining this study may make more sense of the selection criteria of the refrigeration system components

with the visual analysis of the network. In addition, since this study is the first network analysis study for the refrigeration system, it will serve as an example for future studies. Moreover, this study is important in terms of showing that analysis programs used in both social and engineering sciences can be used within each other.

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