Network Size and Diversity for ICT Standard Consortium Success: A Configurational Perspective

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Thesis report

by

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"Until you spread your wings, you'll have no idea how far you can fly." – Napolean Bonaparte

-Leela Meghana Kotha
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Executive Summary

While many researchers have researched the factors affecting standard consortium success, the size and diversity of a consortium were given the most importance. Past research includes statistical tests and case study analyses through which researchers tried to understand the significance levels of these variables.

However, the theoretical background shows that investigating the combined impact of these multiple factors on standard consortium success using specific indicators was limited. Past research required action on using a new approach to determine the extent to which these variables work together toward the success of standard consortia. It was also important to investigate the network configurations of consortia given the multiple factors that come into play in the process of standardization over the years leading to standard consortia success. This required a configurational approach with a lot of consortium-level data to test.

The objective of this research is to find the configurations of size and diversity that lead to the standard consortium success in the ICT and telecommunications industry, success being represented by specific indicators. The data of 35 consortia was collected from the websites 'consortiuminfo.org' and LinkedIn using Python packages and analyzed using Crisp-set Qualitative Comparative Analysis (csQCA). This analysis was done considering indicators of success the 'number of standards' produced by consortia, and the 'survival years of consortia until 2023' individually as outcomes of consortia, and combined, summing up to three ways of analysis.

The analyses revealed that the size and diversity of consortia are necessary conditions but only diversity is sufficient for standard consortium success to occur, in this dataset of ICT consortia. The findings explain that consortia and its member organizations can have a better perspective on their network characteristics by looking at the network characteristics in a configurational perspective, rather than a variance-based approach. Configurational perspective helps consortia improve their network characteristics concerning the specific factors of the network where they need to improve to achieve success.

The findings suggest that researchers should continue to explore the involvement of other factors along with the size and diversity as combinations instead of only analyzing the variables' effects individually. Research into organizational and network structures is better done using methods like Qualitative Comparative Analysis, rather than regression tests, based on past research. Furthermore, by doing this the scope of the research broadens by breadth and depth as more data and more insights about factors of standard consortium success can be studied.

Contents

1 Introduction

A standard can be defined as a set of rules or specifications established by a consensus of industry experts or organizations to ensure uniformity, compatibility, and quality across various products, services, or processes. Standards achieve interoperability and efficiency in industries by minimizing discrepancies and inconsistencies betIen firms that want to facilitate cooperation and collaboration for innovations in technological advancements (de Vries, 1999).

The standards we encounter today are often established by industry-driven groups known as 'standards consortia', which aim for widespread market acceptance (Pohlmann, 2014). These standards, known as consortia standards, are developed more rapidly and flexibly in response to technological advancements. In contrast, the formal processes used in the early days of ICT standardization, managed by official standards organizations, were lengthier (Bunduchi et al., 2008; Farrell et al., 2009)

The process in which organizations produce standards, resulting in successful outputs through increased adoption is termed as standardization (Brunsson et al., 2012). Setting successful standards is important for organizations to achieve market dominance in an industry. To succeed in standardization, organizations collaborate to pool knowledge and resources, creating an ecosystem that promotes innovation through standards development (Wiegmann et al., 2022). By forming consortia, organizations combine their efforts to develop the technical details and specifications needed to meet market needs and achieve their goals (Kamps et al., 2017)). In this research, I will examine consortia established over the years for standardization and investigate the factors contributing to their success in achieving standard consortia success.

In the process of achieving standard consortia success, consortia often engage in competition with other consortia to attain technology dominance, leading to standards battles between them (van den Ende et al., 2012). These battles are won when standard consortia maintain market success over time or continuously create multiple standards as technology changes with time, they achieve standard consortia success. To achieve efficiency in standard development, consortia invites organizations that enhance learning effects and increase knowledge spillovers, driving innovation (Schilling & Shankar, 2019). However, as the number of organizations in a consortium grows, reaching consensus and maintaining productive relationships can become challenging (van den Ende et al., 2012). Consortia must carefully manage their network characteristics to ensure efficiency and productivity, which are crucial for achieving success.

An interesting industry to look at is the ICT industry, based on its history of standardization. Consortia aimed to create a well-coordinated market segment within the ICT industry. Their goal is to use technology to form business communities and ensure that various products and systems can connect and work together while fighting standard battles. This helps in reducing barriers to connectivity and promotes a more integrated and functional technological environment (Weiss & Cargill, 1992). Over time, these consortia improved coordination and began to play a crucial role in ensuring the creation of effective standards especially, in the ICT and telecommunications industry (Hawkins, 1999). Once the standards are created, consortia promote and commercialize the standards and tests products to gain more users (Weiss & Cargill, 1992). This process of standardization supported by well-developed network structures has been happening since the beginning of technologies in one form or the other, and it will continue to happen as technologies are created and standard battles are fought. As mentioned above, in the recent history of consortia the ICT industry has tried to find a balance in their network structure while organizations keep leaving and joining consortia creating imbalances in their organizational structure for standard development. These network structures are necessary in any consortium for standard development. For consortia to identify their optimal network structure, it is essential to understand which characteristics are crucial. Past research has demonstrated that size and diversity are key characteristics of successful consortia. However, consortia might need additional support through their networks for balancing these characteristics in the long term to achieve success (Hill, 1997).

Standards formed by consortia can succeed by achieving dominance in the market based on its network effects like installed base, availability, and variety of complementary goods and market mechanisms (Ehrhardt, 2004; Suarez, 2004; van de Kaa et al., 2015). Researchers in the past have concluded that a strong inter-organizational network of industry consortia, in terms of size and diversity is essential for increasing network effects and achieving standard dominance in the market further leading it to succeed in the market (van de Kaa et al., 2015; van den Ende et al., 2012; Weiss & Cargill, 1992). This positions size and diversity as key characteristics of standard consortia.

Researchers have done multiple studies on the factors of network size, diversity, and the network effects (installed base and complementary goods) to understand their influence on standard consortia success (Suarez, 2005; van de Kaa & de Vries, 2015; van den Ende et al., 2012). The size of a consortium is defined as the number of member organizations in a consortium that contribute to standard development (Suarez, 2004). The diversity of a consortium refers to the combination of organizations from various industries participating in the standardization process to achieve their own goals, ultimately contributing to standard development (Sakakibara, 2001). Qualitative research and statistical tests in the past have identified that 'size' and 'diversity' of a consortium are key characteristics of consortia that can affect market dominance, for developing the standard (Den Hartigh et al., 2016; Kamps et al., 2017; Lee & Sohn, 2018; van de Kaa et al., 2015; van den Ende et al., 2012). These characteristics are explored further in this research.

Each consortium has a unique network structure configuration, defined by its size and diversity, that facilitates communication, directs power, fosters consensus, ensures resource availability, and motivates member organizations (Afuah, 2013; Raab et al., 2015; van den Ende et al., 2012). The quicker a consortium finds its best network configuration, the more efficiently it can standardize processes, ultimately developing successful standards that lead to long-term success for the consortium (Pohlmann, 2014).

However, in the real world, a large consortium consisting of organizations from various industries, each with different working styles, goals, and paths to success, likely involves many more factors in organizational management beyond just size and diversity. With this perspective, it is difficult to say that, in the real world, consortia that focus only on maintaining their network size and diversity will achieve standard consortia success based on research. It is easy to say from research that size and diversity are important factors, but proving their importance by testing them with real-world data is challenging. It is highly possible that size and diversity are not the only factors that consortia should focus on to achieve standard consortia success.

In organizational studies, it was said that network structures and practices need to be studied with a configurational analysis rather than a variance-based analysis (Fiss, 2007; Raab et al., 2015). Additionally, to reflect on past research mentioned above, it was difficult to understand what kind of network structures are needed for consortia success. Therefore, it seems to be necessary to move away from variance-based approaches. In this research, I took up the task of using a configurational approach, to better understand the real-world possibilities of network configurations of standard consortia success. To understand organizational dynamics within interconnected structures and explore the complex interplay of network factors, researchers recommend using Qualitative Comparative Analysis (QCA) as the configurational method. This method helps determine whether key factors, such as size and diversity, are necessary or sufficient for achieving desired outcomes in organizations (Fiss, 2007; Raab et al., 2015).

Past research has explored the effects of the size and diversity of consortia on standard success using regression tests and case study analysis (Jun-guangI et al., 2007; Kamps et al., 2017; Schott & Schaefer, 2023; van de Kaa et al., 2015; van den Ende et al., 2012). Obtaining regression coefficients and comparing cases was insufficient to help consortia understand the necessary network changes that could lead to successful outcomes when size and diversity were examined. These studies also struggled to attribute the statistical results to the specific consortia studied, making it difficult to support the impact of these factors on standard success from a variance-based perspective (Christensen et al., 1998; Ehrhardt, 2004). This research is aimed to fill this gap by using a configurational approach. Using the configurational approach, it is possible to see variations between consortia networks and characteristics within the sample data using QCA. The analysis of the sample consortia can reveal insights into unobserved heterogeneity within ICT consortia networks, helping to identify the configurations that contribute to standard consortia success by examining the structural and functional aspects of these consortia (Fiss, 2007). Like the phrase, 'all roads lead to Rome', multiple configurations of size and diversity can result in consortia success, which needs to be examined. This can help us understand the importance of network configurations and variables that can lead to consortia success, rather than exploring variables' effects alone (variance-based approach) Therefore, considering the configurational perspective I aim to determine if the size and diversity of a consortium are sufficient factors for standard consortium success in the ICT industry.

To adopt a configurational approach in assessing whether size and diversity alone are sufficient factors contributing to standard consortia success, comprehensive data on both successful and unsuccessful consortia must be gathered. The configurations of network structures derived from the collected data will enable us to evaluate the impact of size and diversity on consortia success. Such research necessitates extensive data collection, including detailed information about consortia, their member organizations, and the industries represented within each consortium. This process can be challenging, restrictive, and tedious. However, I took up the challenge of collecting this kind of data aiming for consistency despite potential obstacles, such as restricted access to consortia data, lack of availability or updates in the sample, and other barriers. In this research, configurations between size and diversity of ICT consortia are explored with a configurational approach using Qualitative Comparative analysis. This leads to the following problem statement, research objective, and research question:

Problem Statement: Standard consortia in ICT and telecommunications are affected by factors like size and diversity in achieving standardization. Past research suggests using a configurational approach to better understand these success factors. This study aims to identify the configurations of size and diversity of consortia that lead to successful standardization

Research Objective: To find the configurations of size and diversity of a consortium that can bring standard consortium success in the ICT and telecommunications industry.

Research Question: What are the configurations of size and diversity that can help consortia achieve standard consortia success, in the ICT and telecommunications industry?

2
Theoretical Background

Research in the past (Blind & Gauch, 2008; Hawkins, 1999; Papachristos & Van De Kaa, 2021; Pohlmann, 2014; Sakakibara, 2001; Schilling & Shankar, 2019; van de Kaa et al., 2015; Weiss & Cargill, 1992), indicates that several factors influence ICT consortia during the standard development process. Factors such as size, and diversity, contribute to the success of standard consortia (Pohlmann, 2014; van de Kaa et al., 2015; van den Ende et al., 2012). This section delves into notable standard battles to demonstrate the importance of size and diversity for consortia and explores why these factors need to be analyzed using a configurational approach in this research.

2.1. Standard Consortia Success

Standards winning battles against competing products, such as Blu-ray vs. HD-DVD, HomeRF vs. WiFi, and Firewire vs. USB, have provided valuable insights for researchers into how the network effects of a consortium can influence standard dominance (Schilling, 1998; Suarez, 2004; van de Kaa & de Vries, 2015; van den Ende et al., 2012). Based on the research done in the past (Baron & Pohlmann, 2013; Den Hartigh et al., 2016; Ehrhardt, 2004; van de Kaa et al., 2015; Weiss & Cargill, 1992), it was explored and found that as more users adopt a standard, the availability and variety of complementary goods that support that standard also increases. This led to two key network effects. The first is the 'installed base,' which refers to the growing number of users adopting the standard. The second is the 'complementary goods,' which are products that enhance the standard's compatibility and functionality. Standard's compatibility with other products leads the technology towards market lock-in which supports the technology's existence even after new efficient technologies are introduced in the market, for example in the case of QWERTY vs DVORAK, though DVORAK was an efficient layout of the keyboard, it was too late for users to switch from QWERTY keyboard layout (Greenstein, 1990). Both these network effects, 'installed base' and 'complementary goods' are crucial for the winning of standard battles to succeed in competitive markets (Christensen et al., 1998; Ehrhardt, 2004; van de Kaa et al., 2015). These two network effects also interact with each other and go hand in hand to achieve standard dominance.

It was observed by researchers (Afuah, 2013; de Vries, 1999; Kamps et al., 2017; Katz & Shapiro, 1985; Sakakibara, 2001; Suarez, 2005), that the crucial factors affecting these network effects were the consortia's size and diversity. Improvement in these two factors would help ICT consortia in promoting their products, increasing the 'install base' and creation of 'complementary goods' (Pohlmann, 2014; Shin et al., 2015), which in turn would help establish standard dominance (van de Kaa et al., 2015).

Considering another case of a standard battle, Ethernet vs Token Ring, the story of why Ethernet emerged as the dominant standard over its IBM-sponsored rival can be attributed to the "importance of communities and sponsor strategies" as stated by Jakobs (2017). Ethernet was developed and supported by a coalition of companies including DEC, Intel, Xerox (referred to as DIX), and a few others. This community not only collaborated effectively but also produced the necessary hardware which helped the consortia innovate continuously and achieve market dominance faster than Token Ring (Soh, 2010).

Expanding on the battle between WiFi vs HomeRF, the IEEE 802.11b standard (WiFi) had issues supporting certain services like telephony, which led to the development of the HomeRF standard. However, only one company from the HomeRF working group (WG) produced its technology in silicon, making it essentially proprietary. This was seen as undesirable by other members. In contrast, several vendors supported WiFi, leading to lower prices for its chipsets. Furthermore, it turned out that voice services were not in high demand, rendering the main purpose of HomeRF obsolete, and WiFi winning the battle (Jakobs, 2017; van den Ende et al., 2012).

Similarly, in the battle between VHS and BetaMax, Sony was the first to release an affordable video cassette recorder called BetaMax in the early 1970s. However, by the mid-1980s, JVC's VHS format emerged as the dominant competitor, despite being technically inferior. After falling behind VHS for 10 years, in 1978, Sony conceded and started producing VHS equipment, making BetaMax obsolete (Cusumano et al., 1991; Jakobs, 2017).

As highlighted in various cases of standard battles, technologies led by multiple member organizations often result in products becoming successful standards and achieving market dominance (Ethernet vs Token Ring). Once the standard becomes obsolete (case of VHS vs BetaMax, HomeRF vs WiFi), it no longer gives profits to its developers. Achieving market dominance at one point in time does not ensure success for consortia in the long run. The success of standards needs to be continuous either by modifying the standard over time or by continuing to innovate with new standards. Standards need to continue being used despite the new technologies entering the market. For this reason, compatibility of standards is essential for consortia to have consistent market dominance (Den Hartigh et al., 2016).

Studying the cases of QWERTY vs. DVORAK, VHS vs. BetaMax, HomeRF vs. WiFi, and Ethernet vs. Token Ring reveals that size and diversity have influenced standards through network effects in various ways. However, none of these cases explicitly attribute their success solely to larger membership or greater diversity. Each case had unique circumstances with multiple factors, beyond just size and diversity, playing roles at different times throughout the duration of standard battles. Additionally, researchers have struggled to trace their results and conclusions back to the specific network configurations of consortia. Instead, they often examined the impacts of size and diversity in isolation and explored their interrelations (Afuah, 2013; Pohlmann, 2014; van de Kaa et al., 2015; van den Ende et al., 2012). As a result, there is a lack of research that definitively establishes whether size and diversity are the sole factors influencing success or clarifies their importance and the extent of their relationship to success.

Given the existing literature on network effects and the insights from these case studies, it becomes evident that size and diversity are influential, but not the sole determinants of standard success. Therefore, it is crucial to adopt an approach that identifies which factors are necessary for success and which are sufficient (Berg-Schlosser et al., 2008; Ragin & Sonnett, n.d.). This will provide a deeper and clearer understanding of the dynamics at play in standard consortia, guiding us toward the configurational approach of Qualitative Comparative Analysis (QCA).

A configurational approach leads the research to consider whether some factors (size and diversity) are only effective in the presence of others, for the desired outcome to occur (success).

QCA applies the configurational approach by making conditions which are configurations of variables, to examine the impact of variables combined for the outcome to occur (Ragin, 2006). For example, achieving a larger network and more market power might require a larger consortium size. However, increasing the size within a single industry alone will not facilitate standard penetration into other industries, diversity must also be achieved to help gather knowledge from other industries. Similarly, if success is operationalized with indicators, QCA can help analyze configurations of factors that have historically helped consortia survive longer and achieve success. If current and future consortia understand how to achieve the optimal configuration of success factors, standard development can become faster and more efficient.

Hence, the conceptual model of our research aims to determine the extent to which the variables of size and diversity within a consortium in the ICT industry contribute to standard consortia success, utilizing a configurational approach as illustrated in Figure 2.1.

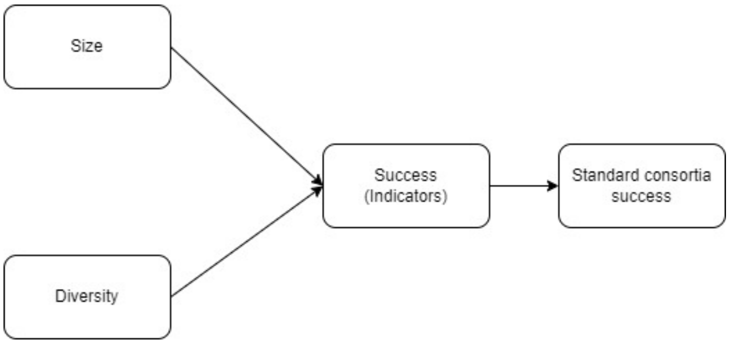

Figure 2.1: Flow chart of all the variables involved in the research

2.2. Size of a Consortium

Different researchers have defined network size in ways that align with their specific research requirements. For instance, Pohlmann (2014) defines size as the number of members in a consortium, focusing on the collective strength and resources available within the group. Katz and Shapiro (1985), on the other hand, provide a broader definition of network size. They explained in three different ways among which one explains that the network size can be defined as a coalition of firms using a common standard, such as computer manufacturers using the same operating system. Suarez (2005) builds on Katz and Shapiro (1985) definition, describing network size as "the total number of consumers owning units of hardware that are compatible with the individual's unit…", emphasizing the importance of user compatibility and the widespread adoption of a particular technology. Den Hartigh et al. (2016) also highlights the significance of network size, particularly the number of partners supporting a platform, indicating that a larger network of partners can enhance the platform's success. Soh (2010) suggests that the size of a technological community can reveal the performance effects of alliance networks, implying that a larger community may lead to better performance outcomes.

Our focus is on the size of the network consisting of a group of companies, or in other words, a consortium. Considering all these definitions by researchers, it seems that network size can be defined as the reach of the standard to the users based on the number of organizations adopting the standard as a part of the consortium. Hence, in this research, I define size by the number of organizations that are members of the consortium, contributing to the development or adoption of a standard created by the consortium, irrespective of their domain and technical areas.

Having more connections in the industry allows firms to contribute better to standardization. Research indicates that larger social networks of consortia contribute significantly to standard success by increasing the customer installed base of the standard (van den Ende et al., 2012) and by meeting the goals of more organizations. Two firms, pooling their knowledge, resources, and consumer insights, can develop a superior product that caters to a broader audience (Katz & Shapiro, 1985). This collaborative effort surpasses the capabilities of a single firm constrained by limited knowledge, resources, and a finite number of regular users. Organizations with larger network connections have appeared to benefit more from their connections compared to smaller networks in the past (Leiponen, 2008) with more resources and improved efficiency over time.

Large firms often excel in complementary activities like marketing and financial planning, enhancing their innovation capabilities (Schilling & Shankar, 2019). Similarly, consortia with a larger number of organizations might tend to succeed in developing a product that could win standard battles. New members joining consortia also can cause an increase in knowledge scope, leading to more innovation, research and development, and better applications of standards (Baron et al., 2014; Kamps et al., 2017).

Research also indicates that in response to market trends, consortia experiencing a decrease in size may opt not to terminate but instead merge with other consortia to sustain their presence in the network (Pohlmann, 2014). If a consortium is of a smaller size, consortia may not hold a dominant position in competition law, enabling them to engage in various activities (Kamps et al., 2017). Additionally, being involved in consortia related to institutional activities proves more beneficial than being in unrelated ones (Leiponen, 2008). As a result, consortia tend to gather like-minded organizations with shared interests or significant stakes in particular technologies (Pohlmann, 2014). These researchers have shown that size of the consortium is essential to be large enough to maintain resources, and technical knowledge and lead development as technology and time progress.

However, as consortia expand, they may struggle to sustain R&D efficiency due to managerial control loss (Schilling & Shankar, 2019). Bureaucratic inertia in larger groups can slow agility and responsiveness, hindering innovation. While large consortia benefit from resource availability and scale, organizational complexity and bureaucracy can impede innovation (Schilling & Shankar, 2019) showing the need for organizational management and hierarchical coordination within consortia. In such cases, conflicting opinions, or a lack of decision-making control among consortium members can negatively impact the standard's progress and adoption in the market (van den Ende et al., 2012). Research by Kamps et al. (2017) using regression also shows that being open to expanding network size is beneficial for the survival of the consortia, especially in uncertain markets, but this might not be the case in every industry every time. However, this research also said that it could not be concluded if increasing the number of memberships of the consortium helped the consortium's survival. These instances explain that though size is an important characteristic of consortia, the size of the consortium alone might not guarantee standard success (Afuah, 2013; van den Ende et al., 2012).

Since research so far has only considered the impacts of size in isolation, they have examined the quantitative increase in consortia size and its impact but have largely overlooked other factors such as changes in diversity, member participation, and market power. Information regarding standard battles also suggests that size alone is not sufficient for success. The various impacts of increasing size, both positive and negative, may result from the cumulative effects of growth combined with changes in these overlooked factors. This highlights the need to investigate additional factors influencing consortia success. As previously established, diversity is the other major factor contributing to standard success and therefore will be explored alongside size to determine of these variables together contribute to consortia success, as will be discussed further.

Hence, this explains that the size of the consortium alone might not guarantee standard success. It is possible that lack of other factors, like diversity, power of hierarchy, and commitment of organizations within the consortia are causing problems like bureaucracy inertia, R&D efficiency, participation, and commitment of organizations is present. To understand the necessity of maintaining the size of a consortium in the ICT and telecommunications industry, it is important to test the following hypothesis:

H1: The size of a consortium is necessary but not a sufficient condition for standard consortium success in the ICT industry.

2.3. Diversity of a Consortium

I define diversity based on the information and new knowledge and resources brought by members of a consortium with diverse backgrounds and industries in standard development (van den Ende et al., 2012). Diversity brings in more compatibility of the standards created increasing complementary products for the standard (Den Hartigh et al., 2016; van de Kaa et al., 2015). Diversity is also considered one of the network characteristics that affect market dominance, along with size. There were also cases in the past that indicated that diversity supports innovation when organizations do not rely on in-house R&D and cooperate with external organizations that are unrelated to the core fields to improve innovation and standard success. The extent to which technological diversity can be maintained might vary according to industries based on the cooperation in the consortium (Beck & Schenker-Wicki, 2013).

The diversity observed among consortia underscores the varied roles these organizations can play, reflecting a wide range of objectives and organizational structures. This diversity helps consortia in achieving transparency, accessibility, and exclusiveness (Teubner et al., 2021). Diversity also contributes to consortia's innovativeness as there will be more resources to come up with unique ways of using them for new technologies promoting research and development (Garcia-Vega, 2006; Sakakibara, 2001). The article explains that the diversity of consortia results in an increase in diverse technological knowledge leading to learning opportunities and increasing technology spillovers (Sakakibara, 2001; Schilling & Shankar, 2019). Literature on the 'Resource-based view' explains that heterogeneity in the distribution of knowledge and absorptive capacity gives an advantage to consortia and firms (Schilling, 2002). Schumpeter also explained that diverse technological expertise supports technological progress and destroys competition within the market (Ziemnowicz, 2013). Therefore, to achieve diversity in a consortium, diversity in knowledge and resources is essential, which ultimately drives advancements in applied knowledge.

Within a diverse consortium, the involvement of member organizations in the development process of a particular standard is likely to be unequal, which can make reaching a consensus challenging. This is possible due to factors like membership rules, technical expertise, reputation, hierarchical structure, etc. However, this still presents an opportunity to improve the knowledge base of the organizations not involved and explore further standardization opportunities within their technical domain, contributing to the consortium's future success. If the organizations of the consortium are committed to standardization, they can also learn from their mistakes which can eventually lead them to success (Caviggioli et al., 2015). Therefore, the strength of diversity depends on how a consortium leverages its potential.

In history, there have been cases where technological diversity has caused the growth of the standard among the users faster, for example, in the case of IBM PC, PC manufacturers, and software creators were able to join the platform comfortably as the information on creating the products was made openly available (Den Hartigh et al., 2016). In this case, organizations being more open to spreading awareness and letting new organizations join in led to improving publicity of the standard creating more market. potentially increasing switching costs and leading to user lock-in to specific standards (Papachristos & Van De Kaa, 2021; van de Kaa et al., 2015). Hence, diversity presents an opportunity for knowledge spillovers and learning effects leading to standard consortium success. However, other researchers also highlighted a potential drawback of diversity: some actors within the network may not be fully committed to the standard or technology being promoted.

Similarly, in the case of WiFi vs HomeRF, both standards were promoted by a large group of diverse members. However, Intel, one of the leading supporters of HomeRF was also investing in WiFi which made the community conclude that Intel is not fully committed to its product. This created equal negative publicity for HomeRF leading to its faster downfall (Jakobs, 2017; van de Kaa & de Vries, 2015). This case demonstrates that factors such as participation and commitment must be effectively managed within a consortium to positively leverage its diversity.

The case above elevates that diversity alone does not guarantee success for a consortium. The participation and commitment of the consortium's member organizations are also important in some cases. Furthermore, other factors may influence the relationship between diversity and consortia success. For example, high diversity in a consortium with a small number of member organizations (size) might not result in standard success. Diversity may become a significant factor only when the consortium exceeds a certain threshold number of organizations. For this exact reason, it seems to be necessary to test if diversity alone is sufficient for standard consortia success, or if it is only a necessary factor showing its significance when other factors like size or commitment of member organizations are present.

Hence, with the presence of other factors in the process of standardization, the diversity of the consortium has played a significant role. Past research to find diversity's influence on the success of the organizations, using regression has also not clearly concluded if diversity in the ICT industry can support standard consortium success, whereas diversity is significant according to some past research (Garcia-Vega, 2006; Sakakibara, 2001; Teubner et al., 2021; van de Kaa et al., 2015). Hence, it is important to study multiple cases and determine the necessity of diversity in various contexts of the standardization process, with or without the participation of other variables. As mentioned in the cases above, diversity is an important factor, but it might only be more effective with a few other factors of the network structure supporting it. This gives rise to the following hypothesis:

H2: Diversity within a consortium is necessary but not a sufficient condition for standard consortium success in the ICT industry.

3
Data and methods

This study employs collecting data on ICT consortia from large sources such as 'consortiuminfo.org' and LinkedIn. This data was then analyzed using Qualitative Comparative Analysis (QCA) to explore the individual and combined effects of the size and diversity of a consortium on standard consortium success, making this a mixed-method research.

3.1. Empirical Setting

To test our hypotheses, the data source chosen is the website called 'consortiuminfo.org'. This website is utilized for its list of consortia across various industries, providing essential details such as member information, technical areas of participation, links to consortium websites, and the date of the consortium's last activity. It has been used as a data source by researchers in the past specifically for data collection on ICT consortia (Baron & Pohlmann, 2013; Baron et al., 2014; Chiao et al., 2005), the site is also hosted by Gesmer Updegrove LLP, an internationally known law firm for representing consortia that creates and promotes standards. 'consortiuminfo.org' contains overviews of 1120 organizations. It has details of the consortia irrespective of their geographical location and are categorized according to the industry. Information regarding 35 consortia was collected according to the consortium websites mentioned in 'consortiuminfo.org'. The member organizations' industries were gathered from LinkedIn, and the number of standards of every consortium was collected from the respective consortium websites. This data was considered as the sample for further analysis. Unlike other websites related to consortia, the website 'www.consortiuminfo.org' simplifies the search process by containing accessible data without needing to specify technologies or regions. Moreover, relying on alternative sources may result in a smaller sample size or limit the generalizability of the findings and prolong the data collection process.

3.2. Data collection and Operationalization

3.2.1. Standard success of a consortium

Standard success is determined by the standards winning battles and achieving standard dominance in the industry. However, 'success' is an abstract variable and is difficult to objectively quantify for research, as there are multiple perspectives and contexts in which it can be defined. Hence in the context of this research, it needs to be operationalized to be able to measure. Research in the past shows survival of a consortium indicates that the consortium might have a bigger market share and a probability of succeeding in the long term (Suarez & Utterback, 1995). Van De Kaa (2012) analyzed 137 consortia from 1990 to 2009, finding significant correlations between network diversity, standard flexibility, and network size, using consortium survival as a measure of success in establishing dominant standards. Similarly, Kamps et al. (2017) used consortium survival as a success metric, acknowledging the complexity of market dynamics. Multiple other researchers in the past also have indicated that consortium survival can be used as a measure of success in the process of standardization (Den Hartigh et al., 2016; Pohlmann, 2014; Suarez, 2004; Suarez & Utterback, 1995; van de Kaa et al., 2015). However, consortium survival alone might not be very accurate to represent the success of a consortium.

Standards are the outcomes of consortia. As mentioned in the previous section, winning standard battles leads to the success of both the standard and the consortium to survive longer (Christensen et al., 1998; Suarez & Utterback, 1995). Investing into creating more standards also can lead to wins in standard battles eventually as learning continues with every standard's development (Schilling, 2002). Hence, efficiency in creating more standards is crucial. This efficiency in creating standards continuously can be achieved only when the participation and commitment of member organizations lead to the continuous production of high-quality standards over time (Baron et al., 2014; Kamps et al., 2017). As a consortium's efficiency improves, the pace of standard development improves for winning longer standard battles and achieving sustainable success (for example, the case of VHS vs BetaMax). Therefore, the production of more standards improves learning and eventually leads to more successful standards, resulting in a longer consortium's reign of success (survival of the consortium). Therefore, the number of standards produced by a consortium can be considered as another indicator of the consortium's success (Biddle et al., 2012; Lucash, 1995).

As the indicators of success were chosen, a number of standards were released by every consortium, and the survival year of the consortium was extracted manually after looking into the consortia's website specifications. Consortia which did not openly discuss their standardization process or standards released, were removed from the sample, further reducing the sample size.

3.2.2. Size of the consortium

Every consortium has its own way of representing the consortium's structure of member organizations. Some consortia designate certain organizations as members who have memberships, while other consortia have separations to identify technological partners, training providers, and business partners among their affiliations. Additionally, some consortia portray their members as sponsors, emphasizing their support for standard development initiatives. For example, the Distributed Management Task Force (DMTF) operates with a central Board of Directors who hold the most decision-making power, supported by a Leadership group that manages other member organizations and sets specific standard objectives (Appendix A.1). Such hierarchical arrangements help maintain focus on long-term strategic and industry-wide issues (Lucash, 1995). In contrast, the International Telecommunication Union (ITU) comprises 193 member countries, reflecting its extensive international network, with members participating in the standard development process within a global framework (Appendix A.1). Both consortia involve members in standard development but differ in their organizational structures and the scope of their membership. These diverse approaches to representing member organizations reflect the varied roles and relationships within consortia, highlighting the nature of collaborative efforts in standardization processes.

After visiting every consortium's website links from 'consortiuminfo.org', the lists of the consortium members were collected (i.e., if disclosed by the consortium) either by scraping data from the webpage or were manually written depending upon the web page's structure. For the analysis, only member organizations that contributed to the standard development process were considered, based on the specific category designations within each consortium. The filtered lists of every consortium provided the number of members (or partners or sponsors) of the consortium, giving the size variable of every consortium, and were used further for estimating diversity.

Every active consortium's website was visited to extract the list of member organizations and the number of standards released by every consortium. When members' lists could be extracted manually, they were copied into an Excel sheet, the rest were scraped by using web scraping codes in Python. A few consortia did not specify their members, those consortia were removed from the sample consortia list, reducing the sample size to N = 35 consortia (Appendix A.2).

3.2.3. Diversity of the consortium

The diversity of the consortium can be broadly understood based on technical areas mentioned for each consortium on the 'consortiuminfo.org' webpage. Every consortium is a part of multiple technical areas in the ICT industry or sometimes other industries. As mentioned in the previous section, consortia involved in more technical areas should represent more diverse innovations that lead them to success (Ziemnowicz, 2013). Finding the technical areas that a single consortium is involved in, should be able to represent the diversity of the consortium on a broader scale. To be more accurate with this measurement, every organization in a consortium was searched on the LinkedIn website, and the industry of every organization was extracted (Appendix A.3).

LinkedIn was chosen as the source for this as the website is used by approximately 79% of the organizations for recruiting, advertising etc (Bonsón & Bednárová, 2013). It is a large pool with information on organizations' establishment industry and areas of focus through posts. LinkedIn follows the North American Industry Classification System (NAICS) for its industry classifications. NAICS is a standard used by Federal statistical agencies to classify business establishments for collecting, analyzing, and publishing U.S. business economy data, based on production processes for high comparability (United States Census Bureau, 2022). After the list of the member organizations in a consortium was extracted, this list was run through a code that could extract information about every company from LinkedIn. A 252-line code was built in Python using the Selenium package and was based on human mimicking behavior (Appendix A.4). This code extracted the industry types of members in consortia, with each consortium having between 100 to 350 members, in a single execution cycle by searching the members' names on LinkedIn. In multiple cycles, industry types of 1050 members could also be extracted. This code has collected industries of 35 consortia's member organizations and provided the industries of every organization involved in each consortium. This industry extraction was done for every member organization in every consortium for all the 35 consortia.

Overall, for 35 consortia data was collected adding up to 5800 member organizations. For further analysis, it was observed that member organizations are across various industries (more than 100), making it difficult to accurately measure diversity on a broader scale. Hence, these industries of member organizations were again categorized based on industry sectors. For example, IT Services and IT Consulting, Software Development, and Computer Networking were categorized under IT (Information Technology) and CS (Computer Science). Similarly, category sectors such as Manufacturing, Business Consulting, Services, Energy, etc., were created based on the sample being used for analysis and NAICS code for category sectors (United States Census Bureau, 2022) (Appendix A.2). This gave rise to 20 category sectors with industry names under each category sector. A 'Miscellaneous' category was also introduced for all member organizations that did not specifically belong to any category sector in the NAICS code.

When multiple consortia with different sizes and different industries are being considered together, the data from every consortium needs to be on a common scale to ensure efficiency and numerical stability (Hunt et al., 2015). For this reason, the Herfindahl–Hirschman index was used to calculate diversity for every consortium.

The Herfindahl-Hirschman Index (HHI) is a measure used by economists and government agencies to assess the degree of concentration in an industry. It provides a quantitative basis for evaluating market concentration and is often used in antitrust analysis and competition policy (Michael Bromberg, 2024; Rhoades, 1995). Estimating the market share of an industry can be considered as assessing the diversity of revenue within that industry, which essentially reflects the distribution of revenue among various organizations (Rhoades, 1995). Similarly, the HHI index can be used to estimate the diversity of an industry within the consortium, to understand how diverse the industry is with regards to their standard development (Garcia-Vega, 2006). Hence, the concept of the HHI index is used to calculate the diversity of the consortium considering the industries of every member company. The formula for the HHI index and normalized HHI Index (HHI*) (Hunt et al., 2015) is shown below :

$$HHI = \sum_{i=0}^{n} x_i^2 \tag{3.1}$$

$$HHI^* = \frac{HHI - \frac{1}{n}}{1 - \frac{1}{n}} \quad \text{for } N > 1 \tag{3.2}$$

Normalized HHI Index ranges from 0 to 1 (Boydstun et al., 2014; Hunt et al., 2015). Therefore, diversity for all consortia is calculated using the formula above, yielding results between 0 and 1. Consortia with lower values (closer to 0) for the normalized HHI index indicate higher diversity, while higher values (closer to 1) indicate lower diversity (Rhoades, 1993). After all the data regarding the member organizations (members) of every consortium were collected, the HHI index was calculated for the consortia to determine the diversity of every consortium.

After collecting all the data required for analysis, i.e., the size and diversity of every consortium, their survival years, and the number of standards they developed, the data was summarized into a table (Table A.3).

All the data collection process is summarized in Figure A.5.

3.3. Data Analysis Method

A configuration refers to a specific combination of causal variables that interact synergistically to indicate an observed outcome (Berg-Schlosser et al., 2009; Raab et al., 2015). The objective of Qualitative Comparative Analysis (QCA) is to uncover causal relationships in complex real-world phenomena through the concept of "multiple conjunctural causation." QCA employs Boolean algebra and minimization algorithms to identify patterns of multiple conjunctural causation and to simplify complex data structures in a logical and comprehensive way (Massey & Ragin, n.d.). Since QCA relies on Boolean algebra, it requires binary data (0 or 1) as input and uses logical operations throughout the process, making it crucial to dichotomize variables in a meaningful and effective way. QCA examines whether multiple configurations of variables as conditions can lead to the same outcome, a principle known as equifinality. Conjunctural causation and equifinality come under the umbrella of complex causality, which is determined by QCA as an analytical tool (Thiem & Du¸sa, n.d.).

The QCA technique allows for the grouping of diverse individuals into relatively homogeneous subgroups to evaluate the relevance of these subgroups among each other (Prentice et al., 2023). QCA uses set theory and Boolean algebra with an intermediate number of cases (10-50) and compares them at a meso-level, with units of analysis such as organizations or households, for cross-case comparisons and analysis (Basurto & Speer, 2012). The contribution of independent variables is measured by forming configurations identified as "necessary" or "sufficient" conditions with the presence (or absence) of the outcome (dependent variable). This highlights that the methods used in QCA to analyze cases where multiple configurations of consortia variables lead to the same outcome make the analysis highly context-specific, and tailored to each consortium being examined.

QCA makes it simpler for the researcher to understand the significance of the variables individually and in combinations with the help of conditions. These conditions are evaluated in terms of necessity and sufficiency (Berg-Schlosser et al., 2009). This comes from the contextual understanding of cases that, a given path toward an outcome usually consists of a combination of conditions that is sufficient (a sufficient combination or “intersection” of conditions) to produce that outcome. However, this path is not always necessary, as some other alternative paths (with different conditions, at least partly) could very well produce the same outcome (Berg-Schlosser et al., 2009). Hence, a condition can be necessary for an outcome to occur, because it is always present when the outcome occurs. However, it might not always be sufficient for the outcome to occur in multiple contexts because the condition alone cannot bring the outcome unless it is combined with other conditions.

When several cases are examined to explain the same outcome (success) it is important to eliminate the individual effects of a few variables to have a clearer opinion on the significance of other variables, especially in cases that can be contradictory with the outcome (Berg-Schlosser et al., 2009). By automatically removing contradictory cases, the fsQCA software provides a parsimonious solution that identifies the conditions under which the outcome has occurred. This process allows researchers to trace the solution conditions back to specific cases, offering clarity in the analysis. With the help of this approach of determining the conditions of our variables as necessary or sufficient, it is understood more easily if factors like size and diversity in every consortium’s context (case) are important for every consortium (sufficient) or only in specific cases (necessary).

Studying consortia and their success by understanding the size and diversity of their member organizations raises questions about their impact of together on the success of the consortium. Examining these factors individually through regression does not account for their combined influence, which is highly possible given their nature.

3.3.1. Consistency and Coverage

Set-theoretic 'consistency' and 'coverage' are crucial metrics in Qualitative Comparative Analysis (QCA). Consistency measures how well cases that share a particular condition or combination of conditions display the expected outcome (Ragin, 2006). Consistency in crisp-set relations is the proportion of cases with a specific cause or combination of causes that also exhibit the outcome (Marx et al., 2013). If there are contradictions in the sample, i.e., if the same configuration has resulted in both the absence and presence of the outcome, these cases lower the consistency.

On the other hand, coverage evaluates how much a cause or combination of causes accounts for the instances of an outcome (Ragin, 2006). When multiple pathways lead to the same outcome, any single path's coverage might be small, so coverage helps gauge the empirical relevance or importance of a causal combination. These measures also assess necessary conditions, where consistency shows how well instances of an outcome display the necessary condition, and coverage indicates the relevance of the necessary condition by showing how often instances of the condition are paired with the outcome (Ragin, 2006).

It is crucial to understand that the theoretical data and context of the variables and unit of analysis are essential for considering the variables as 'necessary' conditions by default (Ragin, 2006). Consistency and coverage are only measures to quantify the necessity of these variables as 'necessary' or 'sufficiency' in specific contexts. Consistency only measures the degree to which the variables display a causal condition, considering them to be necessary for the outcome whereas, coverage assesses the relevance of the causal condition when the outcome occurs (Ragin, 2006). More types of consistency and coverage will be explained ahead in the following section along with results.

3.3.2. Data preparation for QCA

All the collected data was organized into Excel sheets, each dedicated to a different consortium. These sheets included the number of member organizations (size of a consortium) and the industries they belong to, as obtained from LinkedIn. The industries were then categorized to calculate the Herfindahl-Hirschman Index (HHI) for each consortium's diversity (diversity of a consortium). The data on size and diversity, along with the consortia's survival years and the number of standards collected, were compiled into a comprehensive table for analysis using QCA (Qualitative Comparative Analysis). This list contained all the necessary details for the analysis (Table A.3).

Two types of data can be analyzed using QCA: crisp-set data and fuzzy-set data. Crisp-set data is binary, indicating the presence or absence of a condition in a specific case. Fuzzy-set data determines the degree of the condition's effect on the outcome variable (Marx et al., 2013). In this research, I aim to examine the factors of Size and Diversity affecting the success of a consortium, to determine if the conditions of these variables impact success, regardless of the degree of impact. Hence, I converted the data into a crisp set. Furthermore, while there has been a noticeable and recent increase in the number of fsQCA articles in management and organization studies, articles using a crisp set approach remain significant and even dominant (Marx et al., 2013).

Crisp sets are a set of dichotomous variables (binary form) of data representation where each unit of analysis's information is assigned a value of 0 or 1. Hence, the conversion of the data collected into binary format is necessary to perform the analysis further. For converting the sample data into binary data, a consistent cut-off threshold value needs to be decided for every variable, above which the values will be assigned 1 and below which values will be assigned 0. To identify the threshold descriptive statistics were used.

4 Analysis

4.1. Descriptives and Correlations

Descriptive and correlational statistics explain the data differently, they describe and summarise the data.

Variable	Mean	s.d.	Min	Median	Max	1	2	3
1. Number of Standards (2023)	169.9	354.4	0	10	1200	-		
2. Survival Years (2023)	27.69	26.40	4	24	158	.54**	-	
3. Size of a consortium	165.7	259.2	1	49	1028	.49**	.56**	-
4. Diversity of a consortium	0.35	0.23	0.138	0.315	1.0	-.34*	-.27	-.36*

Table 4.1: Descriptive Statistics and Correlations[1]

As mentioned in the previous section, the analysis will need a cut-off threshold to convert the data into binary values for performing crisp-set QCA.

Given that the sample data is positively skewed, and as the sample had outliers with higher values, using the medians of every variable as cutoff points will provide more accuracy when converting the data into binary format. Hence, values above the median are assigned 1, and those below the median are assigned 0. For the 'survival years' variable, cases having above or equal to 24 survival years were given the value '1'. For the 'Diversity' variable, as mentioned in the previous section, higher values in numbers indicate lower diversity. Therefore, cases with a diversity value less than 0.315 were assigned '1' indicating higher diversity, and the cases with diversity above 0.315 were assigned '0' indicating lower diversity.

The correlation analysis shows a moderate positive relationship between Survival Years and both the Number of Standards and the Size of the consortium. However, Diversity shows a weak correlation with the other three variables, in this sample. This also made it obvious that both the indicators of success need to be analyzed separately and together, to understand the data in depth.

[1] n = 35; **p < .01; *p < .05.

4.1.1. Dichotomous variables

After converting every data point collected from Table A.3 into dichotomous variables, the table looked like Table A.4 mentioned below. This table was used for further analysis to determine the necessary and sufficient conditions. The dichotomous values are then uploaded into the fsQCA software to analyze the individual and combined effects of the variables on the outcome using configurations of the variables. By using these binary values, fsQCA formed a truth table to observe data in a configurational perspective to further form a parsimonious (more logical and empirical) solution (Berg-Schlosser et al., 2009) and calculate the consistency and coverage of the variables. For instance, if a consortium has both size and diversity coded as 1, and the number of standards and survival years also coded as 1, this indicates that having higher size and diversity above the sample's cutoff (median), resulted in consortium success, according to the measured indicators on this sample. The consistency and coverage of that configuration with its super set is also given by fsQCA. If the consistency is higher in this specific sample, then that configuration is considered to be the parsimonious solution for the sample, making it a sufficient condition for success.

4.2. Results

In this section, the results of the fsQCA data analysis are discussed, which were conducted in three distinct ways. I examined two indicators of success, the 'Number of standards' and 'Survival Years' of consortia, separately and together as a combined variable for success. During the analysis in three different ways, parsimonious solutions were found that led to finding the sufficient condition for consortia success.

4.2.1. Logical Minimization

As mentioned above, QCA involves making truth tables of different configurations of independent variables, to find a solution condition, where the outcome is present and consistent. In the process of making the truth table, cases with contradictions, i.e., the same configurations in the truth table result in different outcomes. In fsQCA software, contradictions within the sample are utilized to reduce complexity, resulting in a more parsimonious solution. The software identifies and removes these contradictions, known as 'logical remainders' (Marx et al., 2013; Raab et al., 2015). Logical remainders represent cases that are not empirically observed, making their exclusion essential for empirical accuracy. Removing these remainders refines the data, allowing for a stronger and more reliable parsimonious solution (Marx et al., 2013). In fsQCA software this is done automatically with the conditions (Pappas & Woodside, 2021). The fsQCA software provides a complex solution and intermediate solution which are super sets of parsimonious solutions. They contain the conditions before removing complexity (Pappas & Woodside, 2021). These conditions are not explored in this research.

To remove the complexity of the solution conditions, and to reach a parsimonious solution, the truth table needs to be sorted based on its 'Raw consistency', which is the cutoff over which the conditions can be considered for the solution. In crisp set QCA, it is recommended to consider the cases with more than 0.75 raw consistency (Pappas & Woodside, 2021; Ragin & Sonnett, n.d.). This threshold indicates that the conditions meeting or exceeding it might be a parsimonious solution, as each condition results in the outcome in at least 75% of its cases. This makes the parsimonious solution to be more logical and accurate. Consequently, based on their consistency and coverage, these conditions are further analyzed to determine the parsimonious solution within the sample. This process aims to confirm whether the identified condition configurations are sufficient for achieving the outcome or not. This approach ensures that only logically and empirically relevant cases are included, leading to a parsimonious solution that strengthens the robustness and validity of the findings.

4.2.2. Size, Diversity, and Survival Years

Qualitative Comparative Analysis (QCA) was conducted with the consortia's size and diversity as independent variables and survival years as the dependent variable. The truth table below illustrates the various configurations of size and diversity, along with the survival years of the consortia as the outcome and the raw consistency of each condition. For instance, the first row in the truth table 4.2 indicates that there are six cases (consortia) having low size (0), high diversity(1), and more survival years (1). The raw consistency for this condition is 1, indicating that 100% of the cases (consortia) with this configuration have survived longer.

Only one condition demonstrated raw consistency above 0.75 (as mentioned in the previous section, raw consistency above 0.75 is recommended), with a raw consistency of 1, making it the only condition that satisfies the requirements for a parsimonious solution. The other conditions were excluded from the solution due to their raw consistency values falling below the 0.75 threshold. The condition is as follows:

Size	Diversity	Number of Cases (Consortia)	Survival Years	Raw Consistency
0	1	6	1	1
1	1	13	0	0.615385
1	0	4	0	0.5
0	0	12	0	0.166667

Table 4.2: Truth table when Survival Years (until 2023) is the outcome

~Size * Diversity -> Survival Years

The table 4.3 shows the parsimonious solution with only one condition explains that the consortia with lower size (members of the consortium) and higher diversity seem to have survived longer compared to other consortia, according to the solution consistency which is ‘1’. Solution consistency is defined by the overall consistency of the solution, indicating how well the combination of conditions consistently predicts the outcome. In this case, '1' indicates that all the cases under this condition predict the desired outcome. Hence, in other words, having less size and more diversity for a consortium supports the consortium’s survival years in this sample.

	Raw Coverage	Unique Coverage	Consistency
~Size * Diversity	0.333333	0.333333	1
Solution Coverage	0.333333		
Solution Consistency	1		
Consortia in this case	e@Class, GSA, IAAR, INCITS, MULTOS, TTC		

Table 4.3: Parsimonious solution table when Survival Years (until 2023) is the outcome

The table also shows that e@Class, GSA, IAAR, INCITS, MULTOS, and TTC are the consortia that exhibit this configuration and have achieved success. In addition to the consistency results, the table also presents the raw coverage and unique coverage of the condition within the sample. Raw coverage is defined as the proportion of cases in which a specific condition is present, while unique coverage is a refined measure that accounts for the unique combinations of conditions that lead to the outcome.

In this instance, the raw coverage and unique coverage are both 33.3%. This means that 33.3% of the cases in the overall sample meet this condition for success as an outcome, and these cases represent unique combinations when considering other variables within the sample.

4.2.3. Size, Diversity and the Number of Standards

Another QCA analysis was conducted with size and diversity as independent variables and the 'number of standards' of the consortia as the dependent variable. It was found that none of the conditions met the threshold for sufficiency, as all exhibited raw consistency below 0.75 (Table 4.4). This indicates that less than 75% of the cases with these conditions had a high number of standards. As a result, these conditions, could not be considered sufficient for the solution to proceed for a parsimonious solution, the software produced an error to proceed further.

Size	Diversity	Number of Cases (Consortia)	Number of Standards	Raw Consistency
0	1	6	0	0.666667
1	1	13	0	0.615385
0	0	12	0	0.333333
1	0	4	0	0.25

Table 4.4: Truth table when Number of Standards of a consortium is the outcome

4.2.4. Size, Diversity and Success

In this case, the indicators of success, the 'number of standards' produced, and 'survival years', were combined into a single condition for the success of the consortium as the outcome. For a consortium to be considered successful, it had to produce at least 20 standards or have survived for at least 20 years. The threshold of 20 years was selected to account for significant industry changes that can occur over two decades and the potential impact of 20 standards on an industry, regardless of their magnitude. This period provides a meaningful benchmark for evaluating long-term effects and changes within the industry. According to past research, it was also indicated that the probability of failure is higher between 5-15 years of organizations, making 20 an appropriate threshold (Carr et al., 2010; Durand et al., 2001). Additionally, sensitivity checks were conducted using different minimum thresholds[2] to provide more insights into different thresholds.

Size	Diversity	Number of Cases (Consortia)	Success	Raw consistency
0	1	6	1	1.000
1	1	13	1	0.769231
0	0	12	0	0.5
1	0	4	0	0.5

Table 4.5: Truth table when Success (combination of the indicators) of a consortium is the outcome

In the truth table 4.5, the following two conditions exceeded the sufficiency threshold of 0.75 raw consistency with '1' and '0.7629' raw consistency respectively:

Size * Diversity -> Success and Diversity -> Success

These conditions were further analyzed by fsQCA for the parsimonious solution. The parsimonious solution reveals that after logical minimization, only the second condition 'Diversity -> Success' seems to be considered as the sufficient condition with higher consistency.

The parsimonious solution (Table 4.6 revealed that diversity alone was a sufficient condition for success, indicating that consortia with higher diversity in the sample had achieved success. The solution consistency for the parsimonious solution is 84.21% explaining that that 84.21% of the cases with this condition show the outcome as success. The table also indicates that the consortia EICTA, DMTF, e@Class, GSA, BioIT, GESI, IAAR, ETSI, INCITS, ITU, IOTSF,

[2] Sensitivity checks were conducted to evaluate whether a threshold of a minimum of 20 standards or 20 years of survival was effective. When using a threshold of 15, three configurations exceeded a consistency of 0.75. The configuration with 'Diversity -> Success' had the highest raw consistency at 1.00. This was followed by 'Size*Diversity->Success' with a raw consistency of 0.923, and 'Size->Success' with a raw consistency of 0.75. The solution consistency for this threshold was 0.913, identifying Size (0.88 consistency) and Diversity (0.95 consistency) as conditions in the parsimonious solution. Conversely, with a threshold of 25, only one configuration exceeded a consistency of 0.75: 'Diversity->Success' with a raw consistency of 0.833. Other conditions fell below 0.6 raw consistency. The solution consistency at this threshold was 0.833, with Size*Diversity emerging as the sole condition in the parsimonious solution.

	Raw Coverage	Unique Coverage	Consistency
Diversity	0.666667	0.666667	0.842105
Solution Coverage		0.666667	
Solution Consistency	0.842105		
Consortia in this case	EICTA/Digital Europe, DMTF, e@Class, GSA, BioIT, GESI, IAAR, ETSI, INCITS, ITU, IOTSF, MULTOS, OMF, W3C, TIAQuestForum, TIP, TTC, TTA, OpenGroup		

Table 4.6: Parsimonious solution table when Success (combination of the indicators) of a consortium is the outcome

MULTOS, OMF, W3C, TIAQuestForum, TIP, TTC, TTA, and OpenGroup all exhibit this configuration and have achieved success.

4.2.5. Findings

As we can see above, the first analysis considered 'survival years' as the success indicator for consortia, with size and diversity as independent variables. The results from fsQCA software revealed that the configuration of consortia with lower size and higher diversity led to success in most cases within the sample, establishing it as a sufficient condition for consortia success.

Parsimonious solution and sufficient condition: ~Size * Diversity -> Survival Years

The second analysis focused on the 'number of standards' as the success indicator but did not yield effective results, as the configurations were inconsistent in producing the desired outcome, preventing further analysis.

The third analysis combined both success indicators, using a minimum threshold of 20 standards produced or 20 survival years for the consortia. This analysis revealed two configurations consistent with the outcome. One condition was the same as the result of the first analysis, while the other showed that diversity alone could lead to consortium success. Further analysis for a parsimonious solution identified one configuration as the sufficient condition for consortia success. The condition demonstrated that higher diversity alone led to consortia success, making diversity a sufficient condition with high consistency for standard consortia success.

Parsimonious solution: ~Size * Diversity -> Survival Years & Diversity -> Survival Years

Sufficient condition: Diversity -> Survival Years

After analyzing success through three different measures, I concluded that both Size and Diversity are necessary conditions for a consortium's success, but only Diversity is a sufficient condition. Additionally, the results also explain that having lower sizes with higher diversity is more consistent for consortia success.

These findings conclude the hypotheses as follows:

Hypothesis	Status
H1: The Size of a consortium is necessary but not a sufficient condition for standard consortium success in the ICT industry.	Confirmed
H2: Diversity of a consortium is necessary but not a sufficient condition for standard consortium success in the ICT industry.	Rejected

Table 4.7: Hypotheses and their confirmation status

5

Discussion and Conclusion

I initially argued, based on the literature, that the size and diversity of a consortium are crucial factors supporting its standard success. Further, after realizing that other factors could contribute to consortia success alongside these variables, I questioned the significance of size and diversity on standard success. It was understood that these factors might be important but not very significant for standard consortium success in the ICT industry, either individually or in combination.

In this research, I aimed to identify the configurations of size and diversity that lead consortia to achieve standard consortium success. Success was represented by two indicators: the 'survival years' of each consortium and the 'number of standards' produced in the ICT and telecommunications industry. Data for the analysis was collected from multiple consortia in the ICT industry, a process that was both challenging and time-consuming. The data represented size, defined as the number of member organizations in a consortium, and diversity, determined by identifying the industries of each member company within the consortium and calculating the consortium's diversity using the HHI Index (Table A.3).

To explore the causal relationship between the size and diversity of consortia and their standard success, I chose to analyze these variables using Crisp-set Qualitative Comparative Analysis (QCA). The collected data was then converted into binary format to perform Qualitative Comparative Analysis (QCA) in three different ways with success indicators (Table A.4). After understanding the QCA techniques, I performed QCA analysis with the indicators individually and in combination to test our hypotheses.

Hence, to answer our research question mentioned in chapter 1, the configuration of having a lower size and higher diversity within the consortium is consistent with achieving standard consortia success in the ICT and telecommunications industry. The findings explain that while both the size and diversity of consortia are necessary, only diversity is a sufficient condition for achieving standard consortium success in this sample dataset of ICT consortia. This explains that size is necessary, but having a larger size does not guarantee success. Instead, consortia with smaller sizes and higher diversity are more likely to achieve success, according to this sample dataset. Even if larger consortia exist, maintaining a high level of diversity remains crucial for achieving success within the consortium.

The results indicate that higher diversity among member organizations is driving success in ICT consortia. There could be several reasons for this. As mentioned in the introduction, diversity may enhance learning effects and promote innovation within the consortium, both of which are significant factors contributing to success. The findings confirm that diversity fosters positive outcomes within the consortium more significantly than the negative outcomes. This is not the case with size, as it has been identified as not being a sufficient condition for success. This finding supports the point made in chapter 2 that merely increasing the size of a consortium does not necessarily lead to success, showing a weaker causal relationship between size and success, compared to diversity.

According to the literature presented in chapters 1 & 2 above, this research supports the argument that size and diversity are important variables for ICT consortia while aiming for consortia success. Additionally, looking at this from a configurational perspective, consortia with lower size and higher diversity as their network configuration tend to be successful compared to consortia with other network configurations. This result is different from the research done by past researchers involving variance-based approaches (Jun-guangI et al., 2007; Kamps et al., 2017; Schott & Schaefer, 2023), making configurational perspective important for examining organizational structures and networks. Performing similar analysis with other factors like market power, timing of entry, and participation of members, might also provide deeper insights into the network configurations.

5.1. Theoretical Implications

Our study offers several notable contributions to the existing literature on ICT consortia, specifically by employing a configurational perspective rather than relying solely on traditional case study analysis or statistical methods.

Firstly, previous researchers have been unable to trace their results back to the specific consortia and firms involved in their analyses (Chiao et al., 2005; Kamps et al., 2017; Sakakibara, 2001; van den Ende et al., 2012). In contrast, our method allows for the explicit tracing of outcomes to the sample consortia data. Now that we understand which configurations of size and diversity lead to consortia success (along with the names of the consortia), consortia can trace these configurations back to their existing network structures to identify areas for improvement and work towards achieving success. Every consortium's structure is different. A configurational perspective will help multiple consortia understand what their current configuration can lead to (success or not success, or any other outcome). This would not have been possible with variance-based approaches, as each consortium develops its network characteristics in its own unique way. It's important to note that this finding may not apply to every industry, a different industry might have a different ideal configuration for success. This capability not only supports qualitative insights on the variables of size and diversity but also offers unique logical conclusions regarding their significance. This specificity can aid the consortia within the sample in understanding potential improvements for achieving an optimal network structure and configuration.

Secondly, as mentioned in the introduction, a configurational perspective is valuable in organizational studies while examining network structures (Fiss, 2007; Raab et al., 2015). However, in this area of research, few researchers have applied similar approaches in different contexts of variables and different industry fields. Notable research in this area has often explored consortia using case study analysis or statistical tests (regression, chi-square, t-tests) (Chiao et al., 2005). Variance based analysis was done in every context with different variables and were compared against each other to understand their significance which was still not clear. However, this approach often left the significance of these variables unclear. This study represents a preliminary attempt to apply a configurational perspective to the network factors of ICT consortia. By analysing the interplay between key factors such as size and diversity within ICT consortia, the research provides insights that go beyond traditional case studies or statistical tests. It lays the groundwork for future research with more extensive data and the use of more refined configurational techniques, as organizational studies are better justified with a configurational perspective. Hence, this research can help future researchers understand the variables in different contexts better than relying on variance-based analysis.

Lastly, while multiple researchers have highlighted the importance of these factors, their significance for ICT consortia has not been effectively demonstrated (Afuah, 2013; Soh, 2010; van de Kaa et al., 2015; van den Ende et al., 2012; Weiss & Cargill, 1992). Our use of a configurational perspective and consistency tests has explicitly demonstrated the importance of these factors, both individually and in combination, for the success of ICT consortia. Our findings suggest that while size and diversity are necessary conditions, they are not sufficient on their own. (our sample), this again lays the foundation to include additional variables, such as market power and timing of entry, to determine whether the presence of these other factors might yield different results when considered alongside size and diversity.

Additionally, this research was done by collecting data of every member organization under every consortium. Past research said that collecting data regarding the board of directors (Kamps et al., 2017) of every consortium can help understand the diversity, but I went a step ahead and wanted to be more accurate in analyzing the consortia which could be very uncertain. To address this challenge, I collected data by developing a code capable of extracting information for any organization registered on LinkedIn. Collecting data from every member organization was very challenging given the obstacles with every consortium's website, such as difficulties in accessing and verifying information. The process of collecting, filtering, and organizing the data was particularly time-consuming. The code proved to be a crucial tool for our research, significantly enhancing the accuracy and efficiency of data collection. Although our study focused only on a sample of 35 consortia, the ability to extract detailed information from LinkedIn ensured that the data on size and diversity was both comprehensive and reliable. Despite some challenges in locating very niche organizations, the code used for data collection can be further developed to enhance precision and address these limitations. Furthermore, this code's capability extends beyond our current research, making it a valuable asset for future studies. It can be employed to collect information on additional consortia across various research areas, facilitating more extensive and diverse analyses.

5.2. Practical Implications

I have done this research by operationalising success of ICT consortia using two indicators 'survival years' and 'number of standards'. Success is an abstract variable that can be defined in multiple ways depending on data collection methods, goals of the research, and industry type. The results will differ when other indicators are chosen giving more insights into the industry like I have seen in the past research (Kamps et al., 2017; Van De Kaa, 2012). Success for one consortium might mean improving financial returns, while for another, it could be increasing market power in the industry. In such cases, the outcome variable can be customized so that the success indicators align with the consortium's specific goals. The financial income of the consortium can be an indicator along with the market power of all the member organizations withing the consortium being another. This approach can help consortia avoid significant structural and functional problems. In practice, when new consortia are established, they can also leverage historical data on success indicators to design a network structure that aligns with their goals, thereby enhancing their chances of success in the industry.

The configurational approach used is crucial for industry consortia and organizational managers to identify the most effective strategies for network development. For example, understanding which configurations of size and diversity are necessary for success can inform decisions about consortium membership, resource allocation, and governance of structures. This perspective could also guide better structural choices about pursuing broader inclusivity within a consortium or focusing on a more streamlined, homogeneous group of organizations to achieve faster consensus and standard adoption (Baron & Pohlmann, 2013; Pohlmann, 2014). Network connections among consortia may also evolve due to this configurational perspective. Consortia can begin to focus on the types of member organizations they will need in the future to maintain healthy diversity within the consortium, ultimately increasing their chances of achieving success.

It is essential for consortia to actively experiment with new approaches to standard development. In our sample, this could be the reason why some consortia, despite producing fewer standards, manage to survive and thrive over longer periods. By providing the industry with the freedom to challenge and tackle existing standards, consortia can drive innovation and develop new standards that better address evolving needs and opportunities. Sticking rigidly to established standards may limit growth and adaptability, whereas giving flexibility and freedom to standard development can significantly improve the potential for long-term success (Christensen et al., 1998; Suarez & Utterback, 1995).

5.3. Limitations and suggestions for further research

It is important to acknowledge that the hypotheses tested in this study are based on a limited number of consortia. While the findings suggest that lower diversity might contribute to the success of ICT consortia, it is possible that in some cases, higher diversity could potentially lead to breakthroughs by exploring various survival strategies (Christensen et al., 1998; Kamps et al., 2017; Suarez & Utterback, 1995). Future research should consider these variations and the potential impact of different sample data to acknowledge that the hypotheses tested in this study are based on a limited number of consortia. Future research should build on these findings by incorporating larger and more diverse datasets, enabling the examination of a broader range of consortia across different industries and specific regions. For example, industries such as automotive, healthcare, and finance, in different countries and regions might benefit if a similar configurational analysis is done in their contexts. Valuable insights into how various industries' consortium configurations can be understood and analyzed to improve standard consortium success in every industry.

Additionally, other factors such as market power, timing of entry, and complementary goods should be considered in future research. Including these factors can change the results of other variables as a configurational approach check for combinations of variables that can work together in the presence of the outcome. For example, when market power and timing of entry are also a part of the configurational approach of QCA, their combinations with size or diversity might become sufficient conditions for the outcome. This can help in understanding the optimal network configuration in ICT industry better than what I have done.

The data collection process, which was done using 'consortiuminfo.org' and LinkedIn, presented several challenges. While I analysed data from 5,800 organizations, there are many more consortia listed on consortiuminfo.org and other sources within the ICT industry that were not included in our sample. This exclusion was due to difficulties in data collection and the need for consistency. Additionally, some niche organizations were not registered on LinkedIn, which limited our dataset. Future research could improve the code and data collection methods to obtain more accurate and comprehensive information, especially for organizations that are not on LinkedIn.

During the analysis phase, consortia that did not meet the criteria of having a minimum of 20 survival years or 20 standards were assigned a score of zero. This does not imply that these consortia were unsuccessful; rather, it indicates that they have not yet achieved success. More refined conditions and scientific support could improve the accuracy of results, rather than relying solely on sensitivity checks.

Moreover, this research did not account for the dynamics of member organizations entering and leaving consortia, nor the overlap of organizations involved in multiple consortia. For example, companies like Huawei, Hewlett Packard, and Lenovo participate in several consortia, indicating their market power. Future research should consider these organizational overlaps and their potential impact on consortium success. Considering the market power of organizations like IBM, and Huawei, the power of consortia might vary largely in practise than what we see statistically.

In summary, future research should aim to use more accurate data and broaden the scope to generalize findings across the extensive pool of ICT consortia. The configurational approach could strengthen the views of researchers on the impacts of factors in networks in organizational studies. This approach could strengthen the connection between research and real-world applications, enhancing the efficiency of creating and developing standards by understanding the network dynamics within the ICT and telecommunications industry.

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A
Appendix

Link to GitHub repository for the code developed for data collection:
https://github.com/

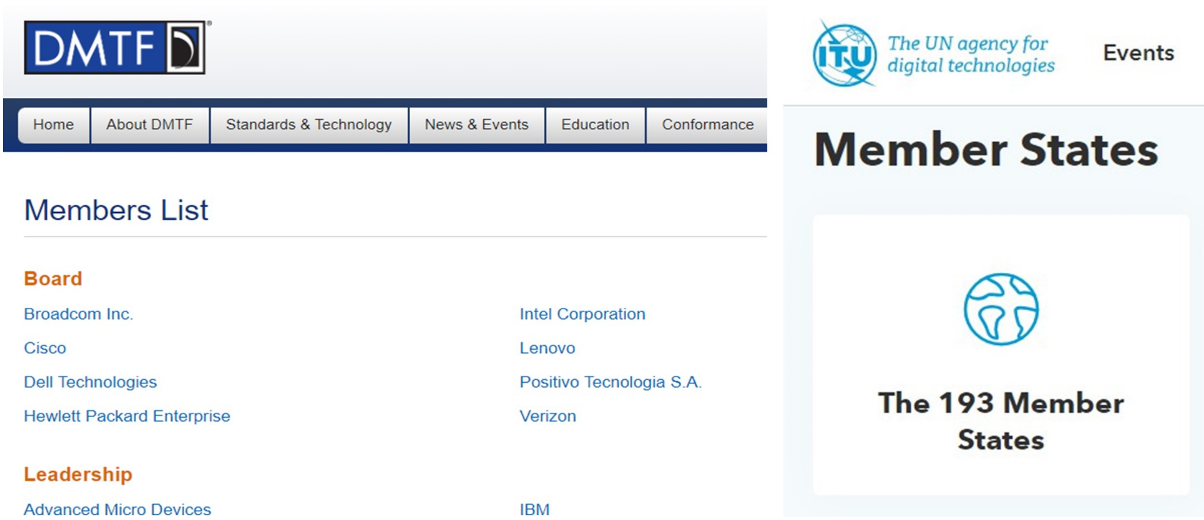

Figure A.1: Standards list of DMTF and ITU consortia.

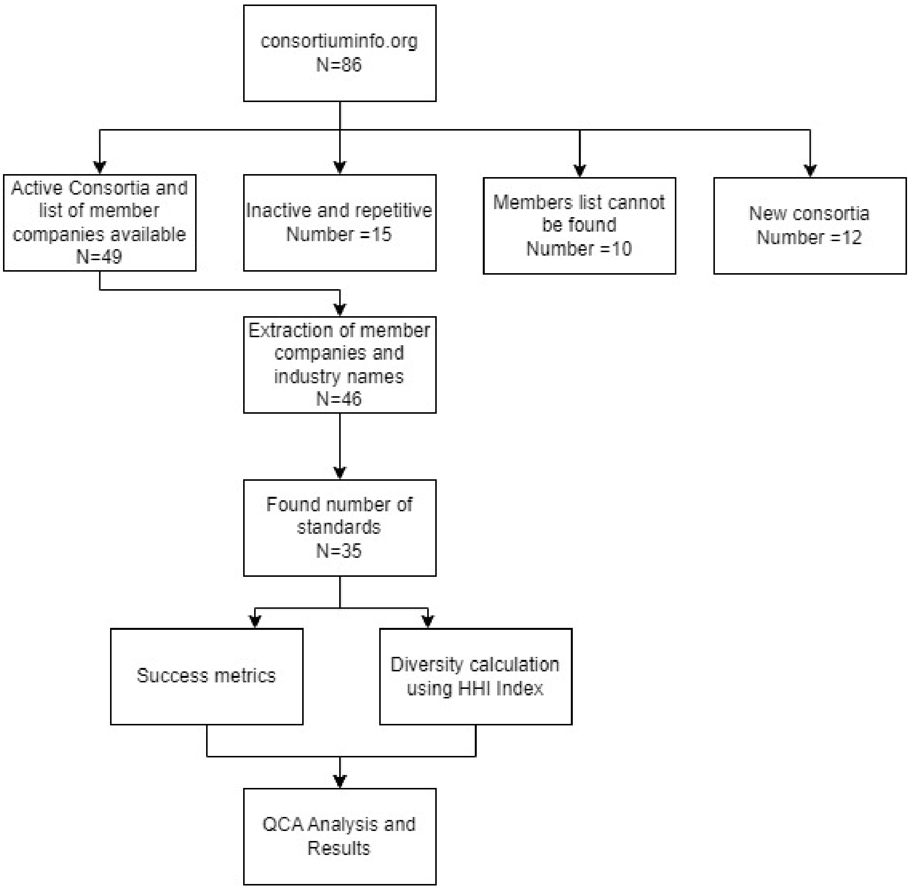

Figure A.2: Flow chart of the sample dataset during collection

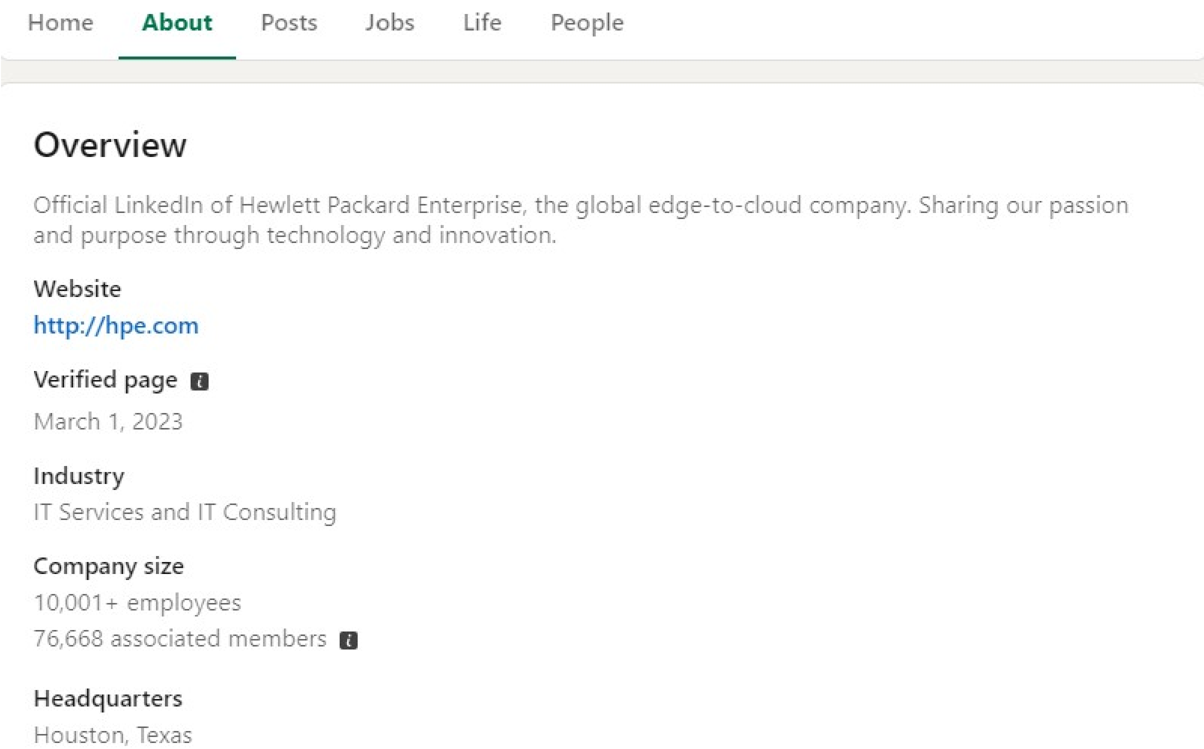

Figure A.3: LinkedIn webpage for Hewlett Packard

```python
for Company_name in mydf3['Company_name']:

    search_company(driver, Company_name)
    current_url = driver.current_url
    if "companies" in current_url:
        print(f"URL contains 'companies': {current_url}")
    else:
        print(f"URL does not contain 'companies': {current_url}")
        click_companies(driver)
    match_result = match_with_LI(driver, Company_name, mydf3)
    if match_result:
        about(driver, Company_name, mydf3)
    else:
        print(f"Attempting to search for next company in the loop.")
        time.sleep(5)
        search_name.send_keys(Keys.CONTROL + "a")
        search_name.send_keys(Keys.DELETE)
        continue  # Proceed to the next iteration of the loop
```

Figure A.4: Glimpse of the code for extraction of industry types from LinkedIn

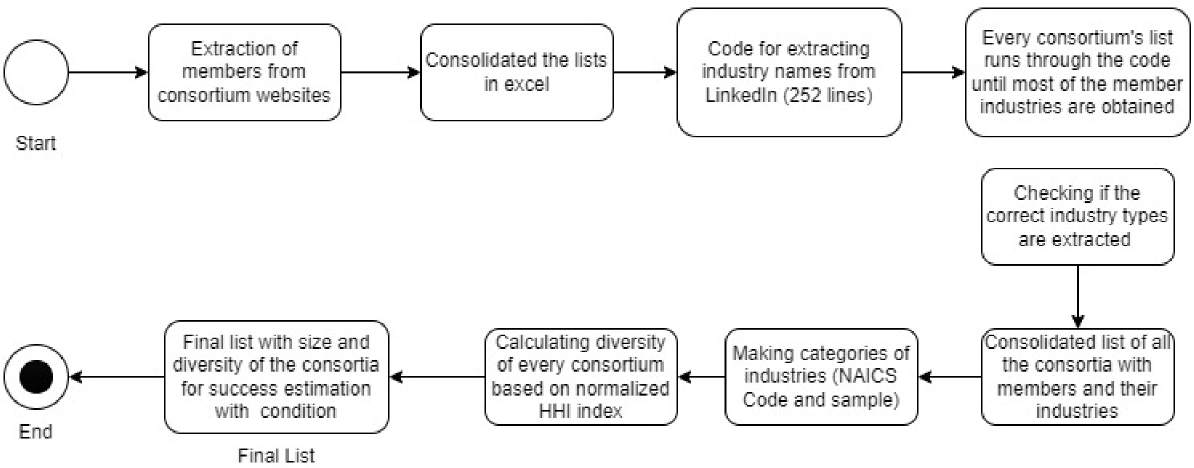

Figure A.5: Flow of operations for data collection

The list of the industry sectors under which the industry names of member organizations were classified, based on the NAICS code (United States Census Bureau, 2022) and the sample data collected:

Industry Sector	**Sub-categories**
Industrial Engineering	Mechanical Or Industrial Engineering, Industrial Automation, Industrial Engineering, Commercial and Industrial Machinery Maintenance
Group/Association/Consortium	Group/Association/Consortium
Business Consulting and Services	Business Consulting and Services, Market Research, Holding Companies
Services	Food and Beverage Services, Public Relations and Communications Services, Environmental Services, Facilities Services, Information Services, Professional Services, Engineering Services, Wireless Services, Advertising Services, Marketing Services, Design Services, Legal Services, Consumer Services, Human Resources Services, Wellness and Fitness Services, Individual and Family Services, Strategic Management Services, Security Systems Services, Outsourcing/Offshoring, Veterinary Services, Philanthropic Fundraising Services, Health and Human Services, Internet Marketplace Platforms
Govt	Government Administration, International Affairs, Public Safety, Public Policy Offices, Law Enforcement, Administration of Justice, Government Relations Services, Government Relations, Armed Forces, Public Policy
Health Care	Medical Device, Hospitals and Health Care, Medical Practices
Research and Education	Research Services, Higher Education, Education Administration Programs, Research, Education Management, Libraries, Education, Biotechnology Research, Primary and Secondary Education, Nanotechnology Research, Biotechnology
Travel and Transportation	Travel Arrangements, Transportation, Logistics, Supply Chain and Storage, Rail Transportation, Truck Transportation, Maritime Transportation, Urban Transit Services, Transportation/Trucking/Railroad, Transportation Programs
IT/CS	IT Services and IT Consulting, Information & Technology Services, Software Development, Technology, Information and Internet, Computer and Network Security, Data Security Software Products, Computer Networking Products, Computer Networking, IT System Training and Support, IT System Custom Software Development, Embedded Software Products, Computer Hardware, Data Infrastructure and Analytics, Mobile Computing Software Products
Wholesale/Retail	Wholesale, Retail, Retail Apparel and Fashion, Retail Groceries, International Trade and Development, Industrial Automation, Retail Health and Personal Care Products, Consumer Goods, Retail Office Equipment, Wholesale Import and Export, Wholesale Building Materials, Import & Export, Retail Motor Vehicles

Table A.1: Industry Sectors and Their Sub-categories Table 1

Industry Sector	Sub-categories
Manufacturing	Appliances, Electrical, and Electronics Manufacturing, Manufacturing, Computers and Electronics Manufacturing, Aviation and Aerospace Component Manufacturing, Defense and Space Manufacturing, Machinery Manufacturing, Personal Care Product Manufacturing, Computer Hardware Manufacturing, Electrical Equipment Manufacturing, Packaging and Containers Manufacturing, Motor Vehicle Manufacturing, Semiconductor Manufacturing, Pharmaceutical Manufacturing, Automation Machinery Manufacturing, Medical Equipment Manufacturing, Industrial Machinery Manufacturing, Communications Equipment Manufacturing, Measuring and Control Instrument Manufacturing, Motor Vehicle Parts Manufacturing, Chemical Manufacturing, Textile Manufacturing, Food and Beverage Manufacturing, Audio and Video Equipment Manufacturing, Renewable Energy Semiconductor Manufacturing
Construction	Construction, Civic and Social Organizations, Civil Engineering, Real Estate, Architecture and Planning, Building Materials
Finance	Insurance, Financial Services, Venture Capital and Private Equity Principals, Banking, Accounting, Investment Management, Venture Capital and Private Equity Principals
Professional Coaching/Recruiting and E-learning	Human Resources, Staffing and Recruiting, E-Learning Providers, Professional Training and Coaching, E-learning
Aviation/Space Aerospace	Airlines and Aviation, Defense & Space, Space Research and Technology, Aviation
Telecommunications	Telecommunications, Consumer Electronics, Broadcast Media Production and Distribution, Satellite Telecommunications, Radio and Television Broadcasting
Energy Environment	Renewable Energy Power Generation, Services for Renewable Energy, Renewables
Media	Photography, Newspaper Publishing, Media Production, Book and Periodical Publishing, Internet Publishing, Writing and Editing, Online Audio and Video Media, Media and Telecommunications, Entertainment Providers, Movies, Videos, and Sound, Online Media, Technology, Information and Media, Computer Games, Entertainment, Graphic Design
Miscellaneous	Non-profit Organizations, Think Tanks, Utilities, Security and Investigations, Industry Associations, Law Practice, Oil and Gas, Executive Offices, Mining, Semiconductors, Industrial Automation, Civic and Social Organizations, Non-profit Organization Management, Farming, Arts & Crafts, Political Organizations, Warehousing and Storage, Spectator Sports, Farming, Ranching, Forestry, Fisheries, Translation and Localization, Furniture, Packaging & Containers, Museums, Historical Sites, and Zoos, Retail Luxury Goods and Jewelry, Apparel & Fashion, Recreational Facilities, Gambling Facilities and Casinos
Not available	Not available

Table A.2: Industry Sectors and their Sub-categories Table 2

Consortium	Number of Standards	Survival Years	Size	Diversity
EHR	63	19	29	0.413793
EICTA/Digital Europe	16	25	109	0.250255
DMTF	241	32	112	0.219273
e@Class	1	24	48	0.185284
ECMA	423	63	78	0.335331
GSA	28	26	49	0.314626
BioIT Alliance	5	17	80	0.314557
CESI	11	21	33	0.422348
GESI	10	22	81	0.137654
IAAR	36	32	25	0.152174
5G Americas	17	21	15	0.638095
CISQ	4	13	9	0.444444
IFX	1	26	418	0.328514
ETSI	1200	35	895	0.145884
INCITS	1200	62	19	0.216374
GreenTouch	1	13	41	0.491463
ITU	736	158	1028	0.208971
IQ Link	4	17	458	0.350043
IOTSF	0	8	89	0.232891
Medbiquitous	13	18	38	0.347084
MULTOS	10	26	35	0.247059
NETSECOPEN	1	6	11	0.527273
OMF	2	19	72	0.174491
W3C	311	29	354	0.199549
TIA Quest Forum	8	35	290	0.141916
STAR	1	22	34	0.333333
TIP	23	7	196	0.195133
TTC	104	38	1	0.145504
TTA	1200	35	234	0.151755
5G-MAG	7	4	59	0.40678
Open Group	259	27	791	0.165091
VoiceXML	1	24	10	1
Zero Outage	1	7	15	0.866667
ISF	7	34	16	0.758333
IDSA	0	4	28	0.859788

Table A.3: Consortium Data until (2023)

Consortium	Number of Standards	Survival Years	Size	Diversity
EHR	1	0	0	1
EICTA/Digital Europe	1	1	1	1
DMTF	1	1	1	1
e@Class	0	0	0	1
ECMA	1	1	1	0
GSA	1	1	0	1
BioIT Alliance	0	0	1	0
CESI	1	0	0	1
GESI	0	0	1	1
IAAR	1	1	0	1
5G Americas	1	0	0	1
CISQ	0	0	0	0
IFX	0	1	1	1
ETSI	1	1	1	1
INCITS	1	1	0	1
GreenTouch	0	0	0	0
ITU	1	1	1	1
IQ Link	0	0	1	0
IOTSF	0	0	1	0
Medbiquitous	1	0	0	0
MULTOS	0	1	0	1
NETSECOPEN	0	0	0	0
OMF	0	0	1	0
W3C	1	1	1	1
TIA Quest Forum	0	1	1	1
STAR	0	0	0	1
TIP	1	0	1	1
TTC	1	1	0	1
TTA	1	1	1	1
5G-MAG	0	0	1	0
Open Group	1	1	1	1
VoiceXML	0	0	0	1
Zero Outage	0	0	0	0
ISF	0	1	0	1
IDSA	0	0	0	0

Table A.4: Consortium Data in binary format