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Exploring the Factors Promoting Team Effectiveness in the Process of Creating International Technology Standards

A Case Study of ISO/SAE-joint Standard (21434) for Road Vehicle Cybersecurity

By

Hengwei Zhang

Claremont Graduate University

2020

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Approval of the Dissertation Committee

This dissertation has been duly read, reviewed, and critique by the Committee listed below, which hereby approves the manuscript Hengwei Zhang as fulfilling the scope and quality requirements for meriting the degree of Doctor of Philosophy.

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Abstract

Exploring the factors promoting Team Effectiveness in the process of Creating International Technology Standards

A Case Study of ISO/SAE-joint Standard (21434) for Road Vehicle Cybersecurity

By

Hengwei Zhang

Claremont Graduate University: 2020

International Technology Standards play an essential role in supporting technology adoption and implementation. Emerging technologies are reshaping global commerce. New technologies have been shown to be an essential factor in boosting the economy as they offer great prospects for growth. It is a complicated journey from promising emerging technology to full industrialization and commercialization. However, the process of creating International Technology Standards itself is dynamic and complicated, consists of many underlying dimensions, and is influenced by political, economic, socio-demographic, and technological changes during the development process. Few theoretical frameworks exist to help in understanding the process of creating technology standards as well as to provide practical guidelines.

This dissertation bridges this gap by conducting an in-depth case study analysis that aims to extend our knowledge and gain a deeper understanding of the process of creating International Technology Standards. The case I selected is the first ever joint International Technology Standard by the International Organization for Standardization (ISO, a Europe-based standards development organization), and SAE International (SAE, a U.S.-based standards development organization). The purpose of the standard in question is to setup global policies and guidelines for automotive

cybersecurity, in the era during which cars will become fully connected and will soon be autonomous. In this case study, data were collected through documents, observations, interviews, and questionnaires. A total of 18 semi-structured individual and group interviews, including 24 participants, were conducted within four months, and 25 completed questionnaires were collected.

Coding was adopted as the data analysis method. The results reveal a set of Input-Process-Outcome (IPO) factors and components that impact team effectiveness in the process of creating International Technology Standards. To be specific, team structure is the most critical IPO factor that influences the team effectiveness. Additionally, an Input-Choice-Outcome (ICO) conceptual framework and several lessons-learned are offered for future International Technology Standards creation projects. The study contributes to literature and practice by providing theoretical and practitioner insights into the process of International Technology Standards creation.

Dedication

This dissertation is dedicated to my mother, Yi Zhu. Without your love and support, I would never consider pursuing a Ph.D. Her sacrifices and faithful dedication empower me to strive for my dreams.

Acknowledgements

Throughout my journey of this dissertation and degree, I have received a great deal of support and kindness from many people.

I am deeply grateful to my dissertation chair **Dr. Tamir Bechor** for accompanying me on this journey, all your time, and commitment to my success. Tamir took a tremendous amount of time to discuss my dissertation topic, research questions, and methodology with me. He read all my drafts, and provide insightful feedback and valuable suggestions, which pushed me to sharpen my thinking and enrich my work. Thank you as well for guiding me, empowering me, and pushing me outside of my comfort zone during the whole journey (dissertation and degree).

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I want to express my sincere gratitude to **Dr. Yan Li** for her valuable guidance and ongoing support throughout my studies, my degree, internship, and job search. Job searching would have been much more difficult without you.

I would like to thank the two organizations, ISO and SAE International, that granted me this unique research opportunity. In specific, I want to acknowledge two key informants from these two organizations, **Dr. Gido Scharfenberger-Fabian** (ISO) and **Tim Weisenberger** (SAE). They shared with me their experiences and insights of this case study. I also want to acknowledge all participants in this study for their time and honestly sharing opinions and comments.

To many friends and my colleagues, thanks for being here with me along the journey.

Finally, a special thank to my parents for installing a love of learning and appreciation for higher education from a very young age. Thanks for your love, understanding, encouragement, and support along the way, though you always distract me from my writing during the final phases.

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Chapter 1 — Introduction

This chapter explains the rationale for understanding the factors affecting the process of creating International Technology Standards, from a team perspective. It includes a brief introduction to the need for understanding the International Technology Standards development process, the significance of this research, the research goals and questions, and a guide to the dissertation.

It is generally agreed that International Standards are a vital mechanism to facilitate the international exchange of goods and services and to disseminate technological advances and management practices (Balzarova & Castka, 2012). Standards help to address the innovation gap by building a connection between research and the global market through the establishment of customer trust and confidence in innovation solutions. Specifically, the early creation of International Technology Standards facilitates faster mass-market adoption of new technologies, products, and services. Further, consistently implementing International Technology Standards offers economic benefits to all kinds of companies, regardless of size, business sector, or home country. Research has identified a series of quantified benefits in the use of International Technology Standards. These benefits include the following (ISO, 2014):

1) Optimizing internal company processes

2) Reducing internal costs and risk

3) Increasing the efficiency of research and development (R&D)

4) Innovating business processes

5) Creating new products and market development.

At the beginning of 2018, the International Organization for Standardization (ISO) had published more than 21,990 International Standards and related documents, covering all aspects of daily life and a wide variety of sectors (ISO, 2017). Information Technology (IT) -related topics account for more than

20% of all published standards and papers. In 2018, SAE International (formerly the Society of Automotive Engineers) published more than 1,100 new standards, ranging from Aerospace Standards to Global Ground Vehicle Standards (SAE, 2018).

International Technology Standards address a broad spectrum of issues, including highly technical issues, socio-technical problems, and environmental concerns. The voluminous International Technology Standards are used by both private sector companies looking for workable technical solutions and by public sector (e.g., government) organizations seeking input regarding technical regulations and support in terms of certain public policy objectives. Thus, there is an increasing interest in advancing the understanding of various aspects of International Technology Standards.

1.1 The significance of the study

The motivation for this study is a response to the need for an "accelerated, simplified, and modernized" standardization process. The need has been recognized by the European Commission (European Commission, 2011) and has been discussed in technology communities for many years (Hoel & Pawlowki, 2012). Emerging technologies are reshaping global commerce, and new technologies have been proven to be an essential factor in boosting the economy as they offer great prospects for growth. International Technology Standards play an essential role in supporting technology adoption and implementation. Generations of technological advancement have been rapidly becoming shorter as each cycle passes. If standards are not released at an earlier stage, these standards run the risk of being obsolete by the time they come out.

This study is also motived by a significant gap that limited theoretical frameworks exist to help in understanding the process of creating technology standards as well as to provide practical guidelines. Given the importance of new technologies in modern life, technology standards have emerged as a

focus in a substantial body of literature. This literature can be roughly divided into three categories: the creation, diffusion, and the impact of standards.

The majority of the technology standards literature has centered on the diffusion and adoption of standards (Lyytinen & King, 2006). The research on standards diffusion seeks to explain the diffusion process and the adoption of different standards (e.g., Belleflamme, 2002; Markus et al., 2006; Weitzel et al., 2006), and network effects have been the most widely studied diffusion mechanism (e.g., West & Dedrick, 2000; Hovav et al., 2004; Bonaccorsi et al., 2006; Lin & Kulatilake, 2006; Zhu et al., 2006; Lee & Mendelson, 2007; Zhao et al., 2007; Liu et al., 2011; Li & Chen et al., 2012; Venkatesh & Bala, 2012; Zhao & Xia, 2014).

The literature on the impact of IT/Information Systems (IS) standards has broadly addressed the significance of IT/IS standards for companies that develop these standards and/or implement them. Researchers have studied the various impacts of standards on both the creation and adoption of technology, including the monopoly position and competitive advantages gained by both creators and adopters (West & Dedrick, 2000; Chellappa & Shivendu, 2003; Lyytinen & King, 2006); the decrease in market risk while creating standards in a group (Aggarwal et al., 2011); the impact of standards adoption choices (e.g., Belleflamme, 2002); the complex structured effects of standards implementation (Wigand et al., 2005; Hanseth et al., 2006); and the benefits, mainly compatibility and interoperability, gained from standards adoption (Steinfield et al., 2011; Liu et al., 2012; Venkatesh & Bala, 2012; Zhao & Xia, 2014).

However, relatively little research effort has been expended on understanding the processes of standards creation, especially examining what factors may impact those processes (Lyytinen & King, 2006). The few previous studies in this field have often been descriptive and have focused primarily on a limited number of processual issues, such as participation in standards committees (Zhao et al., 2011),

the role of power and politics (Backhouse et al., 2006), leadership quality (Spring et al., 2016), and consensus (Reed et al., 2015). Also, a few studies have focused on conceptualizing the process of standards creation (e.g., Fomin et al., 2003; Hoel & Pawlowki, 2013; Reed et al., 2015), rather than providing practical guidance (Cargill, 2011). Cargill (2011) critically reported that people could not understand the process of standards development in practice because most of the excellent studies on standards creation are "*ex post facto* and written from a dispassionate academic view". This hardly offers help and guidance to practitioners who are standards creators. Therefore, additional research that extends the understanding of the process of creating International Technology Standards is critical.

International Technology Standards are typically developed through a virtual-team-based structure. The effectiveness of working teams directly impacts the process, which leads to successes or failures in the standards' diffusion. However, virtual working teams in a standardization project are unique, with new types of working patterns, decision-making styles, and relationship of participants. Traditional factors affecting virtual team effectiveness may not apply or may be less relevant for creating International Technology Standards. This study, adapting theories from organization science, extends the current understanding of the process of creating International Technology Standards from a team perspective and focuses on team effectiveness.

1.2 Research goal and question

To fill this lacuna, this study will explore, from a team perspective, the key factors affecting the team effectiveness of an ongoing International Technology Standards development project to obtain a deeper understanding of the process and to improve the full process cycle of standards productions prior to market introduction, often referred to as "anticipatory standards" (Lyytinen & King, 2006). The case is the first-ever joint International Technology Standard by the ISO (a Europe-based standard development organization [SDO]), and SAE (a U.S.-based SDO). The standard's purpose is to set up

global policies and guidelines for automotive cybersecurity in an era in which cars are becoming fully connected and soon will be autonomous.

The ISO is an international organization with its headquarters, the ISO Central Secretariat (ISO/CS), based in Geneva, Switzerland. It is a membership network of 163 national standards bodies (NSBs) as of June 2016, comprising both public and private entities. It is generally considered to be a "quasi-governmental organization" (Christopher, 2017, p. 80). The ISO develops voluntary, consensus-based, market-relevant international standards that support innovation and provide solutions to global challenges.

SAE is a U.S.-based global professional association and SDO. It is the association of engineers and related technical experts in the aerospace, automotive, and commercial vehicle industries. SAE develops voluntary, consensus-based technical standards.

Previous research has proposed some theoretical frameworks for understanding the key activities within the standards creation process. This dissertation develops an explanatory model of factors affecting team effectiveness in the process of creating International Technology Standards by adapting an Input-Process-Outcome (IPO) framework.

This dissertation intends to fill the practice and knowledge gaps by addressing the following research questions:

1). ***What factors impact team effectiveness in the process of creating International Technology Standards?***

2). ***What particular lessons learned from the case of ISO/SAE 21434 should lead future work in creating International Technology Standards***

1.3 Guide to this dissertation

This section describes the following chapters in this dissertation. Chapter 2 is an overview of the relevant literature providing the foundation for this research. It reviews the existing literature on the process of creating International Technology standards, virtual team effectiveness, and the automotive cybersecurity standard as a case study. The objective of this review is to find existing research on these topics that could be used as a starting point for this study. Chapter 3 describes the conceptual framework. Chapter 4 presents the methodology used to conduct this research. Chapter 5 presents the individual case findings from four standard creation teams. Chapter 6 presents the cross-team findings and discusses them in order to answer the first research question. Chapter 7 further discusses the implications of the findings from Chapter 6, proposes a new conceptual framework, and highlights the lessons learned from the case with the intend to address the second research question. Chapter 8 presents the conclusions from this research, implications for practice and research, and directions for future research.

Chapter 2 — Literature Review

2.1 IT/IS standards

Standards are important to the technology industry because they make up the basic building blocks of product development through the laying down of consistent protocols that can be adopted and understood by all, thereby boosting interoperability and compatibility while streamlining the development of products and accelerating time-to-market. Standards are also used in the technology sector for the verification of the credibility of new markets and new products. In short, International Technology Standards enable the development and application of technologies that greatly impact how people communicate, work, and live (IEEE, 2011).

2.1.1 Standards development organizations (SDOs) and the development process

The development of International Technology Standards, interestingly, does not require standards according to Biddle (2016). This is because there are various ways to create, maintain, and distribute technology standards. However, there are predecessors that can set the stage upon which newer standards can build. Some of the SDOs that set IT standards include the ISO, the International Telecommunication Union (ITU), the International Electrotechnical Commission (IEC), the European Committee for Standardization (CEN), the Pacific Area Standards Congress (PASC), the Deutsches Institut für Normung (DIN), the Institute of Electrical and Electronics Engineers (IEEE), SAE, and ASTM International (Biddle, 2016).

SDOs vary widely in terms of size, geographic location, number of standards produced, profile of membership, and technologies and industries covered. However, nearly all SDOs share two important features (Lehr, 1992). First, they develop standards based on the principle of consensus. A simple majority vote among participants in a standard development project is insufficient to establish a standard. However, voluntary consensus standards are effective in the context of the standards

developer's mission, and they foster communication and coordination to overcome the limitations of the uncoordinated marketplace and achieve industry-wide standardization.

The second feature common to the majority of SDOs is administrative due process. These SDOs have formal policies governing facets of standards development such as establishing technical committee, setting the scope of proposed standards, drafting and revising standards, voting within committees, reviewing draft standards by a higher authority within the SDO, and balloting and approval by the membership at large (Lehr, 1992). Due process in SDOs bears many resemblances to regulations governing public administrative procedures. Laws governing public agency decision-making processes have aims such as the objectivity and fairness of procedures, the representation of multiple interests, public access to information about agency actions, and the accountability of the agency through a formal appeals process. Analogous features—public notice and comment, appeals, multiple interest group representation, and democratic procedures—are all to be found in the policies of most formal SDOs as well (Cheit, 1990). These procedures increase the possibility that a technical committee will reach a broad-based consensus, and thus enhance the value of the resulting standard.

The standards development process itself is variable in terms of the names of stages/steps, depending on the SDO. For instance, the ISO's development process (Figure 1) involves six stages, including proposal, preparatory, committee, enquiry, approval and publication (ISO, n.d.). For SAE, the process (Figure 2) contains four major steps of identifying a need, draft development, approval process, and publication, which is more flexible compared to the ISO's process.

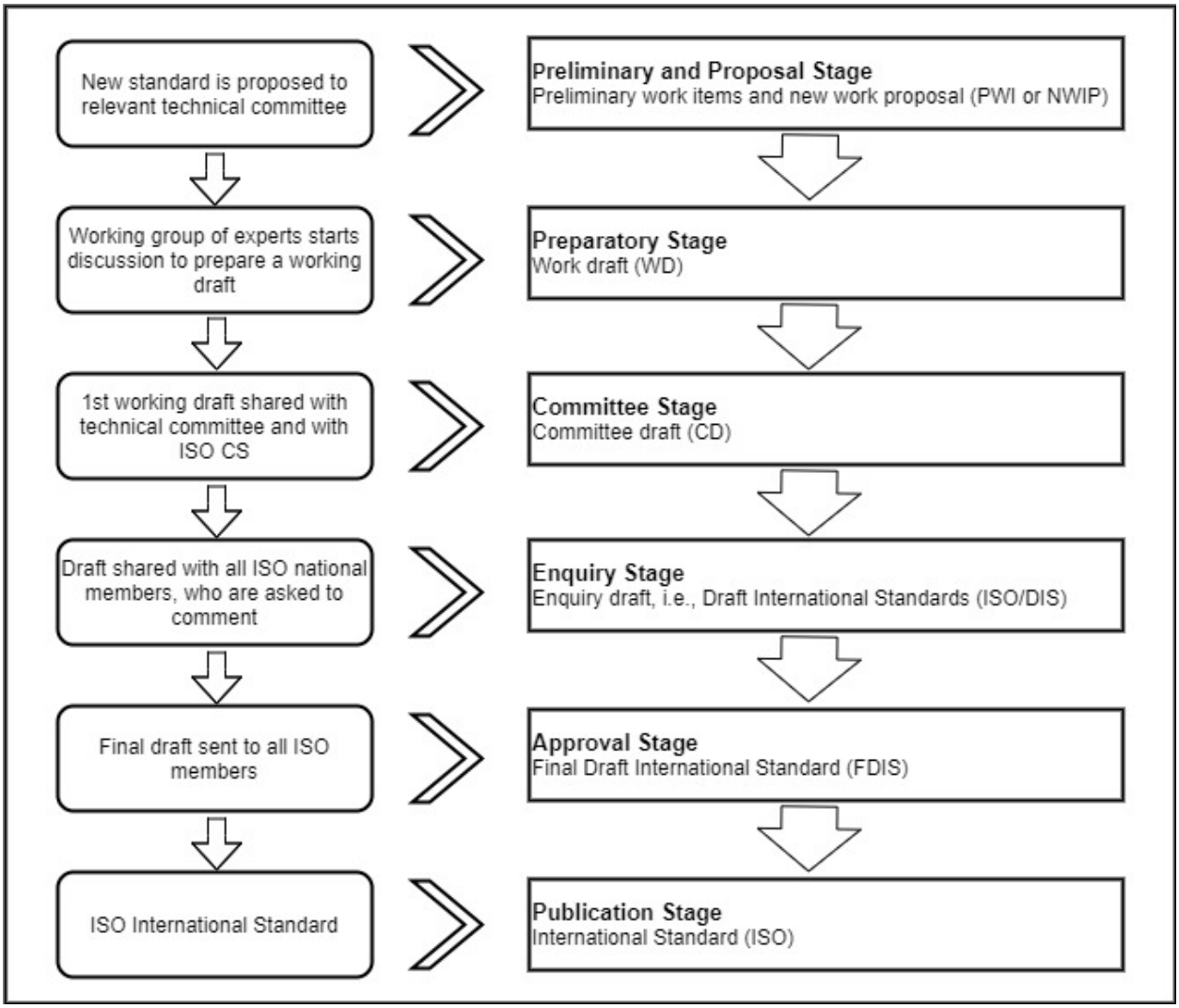

Figure 1: A schematic diagram of the ISO's standards development process (adapted from the ISO)

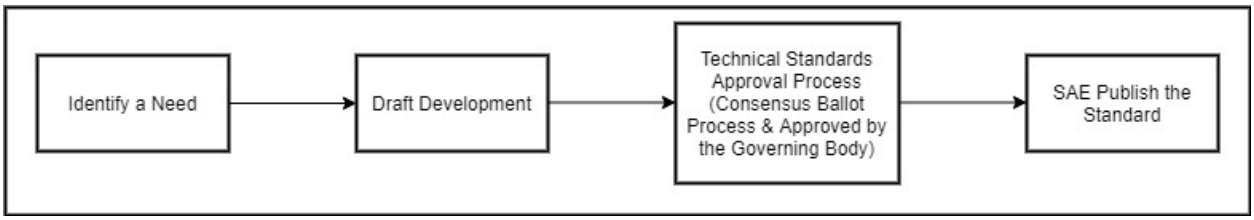

Figure 2: A schematic diagram of SAE's standards development process

According to SAE (n.d.), a new standard is commonly triggered for development in response to a formal request. An individual, organization, or any managing body makes the request to an SDO, which then reviews and evaluates the request. The SDO is tasked with mandating, supervising, and facilitating the standards development process. Upon approval of the request for a project by the SDO, the sponsor

then proceeds with the recruitment and assembly of a "working group" or "working team" following the pertinent rules and processes that have been set by the SDO. This collaborative team is composed of any individuals or organizations - representing manufacturers, vendors, buyers, consumers, or regulators - that volunteer to participate in the standards development process.

According to the ISO (n.d.), the working group is composed of a project leader, or convener, and various experts. This working team prepares the working draft, which is circulated until the experts are happy with the contents. In this case, the draft is submitted to the working team parent committee for evaluation and approval to move on to the next stage. The committee/enquiry stage, company review stages, and parts of the technical standards approval process are undertaken for the attainment of a consensus regarding the technical content of the draft. Finally, the approval stage and publication stage - which are identical in both the ISO and SAE - are reached sequentially, completing the entire standards development process (ISO, n.d.; SAE, n.d.). Unlike the ISO, SAE combines the consensus ballot process and governing body approval process into the technical standards approval process.

The ISO's standards are developed within a decentralized technical committee structure, drawing on volunteer technical experts from various member countries. Administrative support for technical committees is provided by a secretariat from one of the participating countries. Standards are drafted through consensus. Voting within committees and in the organization is by national delegation; as a result, a large country, such as the United States, has the same vote as a small country. The final approval requires that two-thirds of the member countries of the committee vote in favor, and that not more than one-quarter of the total number of votes cast are against.

Alternatively, SAE International remains a professional society whose membership spans the industry, including both manufacturers and suppliers, and is independent of any one organization or set of interests. The voting is by a panel of experts, with one vote each.

2.1.2 IT/IS standards – Standards diffusion

Given the importance of IT/IS standards in boosting economic growth and facilitating innovation, a substantial body of literature on IT/IS standards has emerged. The most relevant contributions to this research since 2000 are summarized in Appendix 1. A total of 38 studies are included. Based on the stage of the IT/IS standards lifecycle, the literature can be roughly divided into the following three themes: the creation, the diffusion, and the impact of IT/IS standards.

Standards have consistently played a vital role in technology adoption and diffusion (Shapiro & Varian, 1999). Understanding standards diffusion stands out as an important research topic at the company level (Lyytinen & Rose, 2003). Many studies focus on investigating theoretical mechanisms in seeking to explain the diffusion process and to identify influential factors. For instance, Hovav et al. (2004) propose a model to understand the adoption of Internet-based standards. They argue that adoption depends on the usefulness of the features to the potential adopters and the environment's conduciveness to the adoption of the standards. Weitzel et al. (2006) focus on understanding specific standards diffusion patterns using equilibrium analysis and simulation modeling. Venkatesh and Bala (2012) propose a model to understand the effects on IT-enabled inter-organizational business process standards (IBPS) adoption. The proposed model identifies a set of technological, organizational, and environmental factors that may have joint effects (i.e., interactions between a focal firm's and its partner's factors) on IBPS adoption. Furthermore, many researchers draw their attention to specific standards, such as inter-organizational systems (IOS) standards. Zhu et al. (2006) examine influential factors in the migration to open-standard IOS. The study concludes that network effects and expected benefits are important factors that drive the adoption of a new IOS standard. Steinfield et al. (2011) propose IOS characteristics that affect information transparency in supply chains. The author claims that in order to solve information transparency problems, a combination of standards, including information technology architectures, should be shared by organizations in an industrial field, not just in one

manufacture's supply chain. Zhao and Xia (2014) argue that IOS standards adoption facilitates organizations in developing interoperability. Specifically, interoperability is developed through two paths – internal capability building and community readiness across organizational boundaries.

2.1.3 IT/IS standards – Impact of standards

The literature on the impact of IT/IS standards has broadly addressed the significance of IT/IS standards for companies that develop these standards and/or implement them. Researchers have studied the various impacts of the standards on both creation and adoption. It has been widely argued that standards creators and adopters would gain substantial economic benefits; such benefits include competitive advantages and a possible monopoly position. For instance, West and Dedrick (2000) find that companies that won the standards competition could leverage long-term economic advantages. Chen and Forman (2006) point out that even open standards can provide significant competitive benefits to their creators. Weitzel et al. (2006) analyze conditions in which the standard diffusion processes can result in monopolies (winner takes all). Chellappa and Shivendu (2003) conclude that maintaining multiple technology standards may be critical for reducing global piracy losses. Lee and Mendelson (2007) study the adoption dynamics in a multi-segment market. They find that the technology advantages to users depend on vendor strategies driven by the existence of standards. Upfront de jure standards could provide maximum total social welfare, but the distribution of these benefits between users and vendors depends on market structure. However, the poor quality of a standard can hamper the potential benefits of standardization as Backhouse et al. (2006) demonstrate by using the case of international information systems security standard ISO/IEC 17799. Aggarwal et al. (2011) expand the standards impact research to the capital market and examine the relationship between firms' collaboration on creating IT standards and the individual risk faced by each firm based on 299 IT standards-creation events between 1996 and 2005. The study shows that creating standards in groups does not decrease the total risk faced by an individual firm's stakeholders, as one might expect.

However, the market risk faced by each firm declines, and the idiosyncratic risk goes up. This study also suggests that participating in a large standardization group can decrease the abnormal returns on stocks. Another set of standards impact research focuses on standardization choices. For instance, Wigand et al. (2005) argue that technical implementation choices by small and large organizations could lead to a significantly different outcome. More accessible IT/IS standards (e.g., XML-based) implementation can result in complex structural changes, such as disintegration, disintermediation, and the emergence of new entrants. Instead of focusing only on standards adoption choices, Zhao et al. (2007) examine the double-sided interactions between standards creation and standards diffusion. They explore the firms' choice of becoming a developer, a passive adopter, or a nonadopter and the resulting endogenous formation of the developer network and the adopter network. They find that firms' payoffs from standard adoption increase with their intrinsic value, but that developers' benefits increase faster than passive adopters' benefits. Therefore, they further suggest that firms should engage in standard consortia and thus enhance the social welfare created by the standard.

2.1.4 IT/IS standards – Standards creation

Compared to the impact and diffusion of IT/IS standards, studies on standards creation, mainly focusing on the process, are rare (Lyytinen & King, 2006; Zhao et al., 2011; Zhu et al., 2006). Although 20 out of the 38 most relevant studies in Appendix 1 are related to standards creation, only seven studies focus on the process of standards creation. Considering the scope and the purpose of this study, the major area of focus is IT/IS standards creation, in particular the *process* of IT/IS standards creation.

Some of the limited research attempts to understand the process of standards creation and provide some descriptive analysis. For instance, Backhouse et al. (2006) and Hanseth et al. (2006) present the development process of candidate standards in the context of de jure standards. Markus et al. (2006), in contrast, describe the creation process of a consortium-based standard. It is important to note that Fomin et al. (2003) propose an integrated framework to address the dynamics of creating

International Technology Standards and provide multi-theoretical lenses. They suggest that the process of standards creation could be viewed as three interplay activities of design (D), sensemaking (S), and negotiation (N). Each activity in the model is derived from a different theoretical viewpoint. Design activities aim to determine the technical specifications and physical characteristics of a product or service through rational analysis. The purpose of sensemaking activities is defining the potential uses of the product or service. Negotiation activities are where the players – such as creators, sellers and adopters – develop standards according to their visions and interests. Hoel and Pawlowki (2012) also propose a model integrating elements of innovation, global knowledge management, and standards development. The proposal is envisioned to provide a heuristic model that elucidates technology standards management and includes identifying potential breakdowns.

The other stream of studies has developed more in-depth insight into factors that may have influenced the process of standards creation. Jakobs (2017) emphasizes the importance of the human factor during the standards creation process. According to this author, the individual working team members' attitudes, skills, and behaviors are crucial factors for organizations planning to complete standards creation projects. Jakobs (2017) also reports that social capital accumulation is a central driver of the ideal distribution of power and participation among working team members. It could also take years to complete a technology standard, which means core members of the working team tend to create a tightly knit community. Zhao et al. (2011) explore the drivers of standards creation within consortia. The study highlights the critical role of consortia in IT/IS standards creation and suggests that those consortia's success depends on the contributions of the various participants. Similar, Spring et al. (2016) claims that the success of any standards creation project depends on the leadership quality of those in charge of the team, mainly the elected chair of the committee. For most of the members of the working team, competence is the most important quality. However, for the chairperson, diplomacy, leadership, and negotiating skills are the traits that are most needed. For the working team to be

effective, the chairperson must be able to resolve conflicts that could be political, personal, or technical since it is expected that members could have different interpretations of various policies and regulations relevant to the standards being created. When leadership in the working team cannot address and resolve conflicts, it will bog down the progress of the standards creation. Updegrove (2007), alternatively, points out that involving all stakeholders in the process might harm the standards creation. Every type of stakeholder brings unique input and expertise to the table that is highly useful in creating standards. However, such activities are not appealing to some stakeholders, such as government personnel, consumers, or advocates. Therefore, the standards creation working teams tend to be ill-suited to solving intricate problems and be vulnerable to manipulation by firms with time and resources to promote their own interests. Reed et al. (2015) note that consensus is the secret and key factor to successful standards creation projects since it is associated with an effective process and better standards. The process of technology standards creation can be viewed as a consensus-based decision-making process. Such a process attempts to reach a mutually acceptable agreement among members in the working teams who have unique experience and interests. Consensus or general agreement is arrived at by trying to resolve opposition by concerned parties until the consent of all participants is obtained. Such the consensus is essential for reaching solutions and better standards but can make the creation of a new standard time-consuming.

2.2 Virtual team

In recent years, virtual teams have become the norm for organizations looking to facilitate work among their members who are located in different geographical regions, especially for International Technology Standards development projects.

The effectiveness of virtual teams is an important issue for modern organizational performance, and it has been a topic of interest for researchers because of the growing number of businesses

adopting this work practice (Carlson et al., 2013). This literature review covers the background of and current research on virtual team effectiveness and the IPO model.

2.2.1 Virtual team effectiveness

Virtual team effectiveness is defined as "perceptions that the team worked effectively together in accomplishing a task" (Carlson et al., 2013). Lin et al. (2008), however, define effectiveness as a combination of the performance of the virtual team and the satisfaction of the team members, adding that the interplay of social factors and task-related factors determines virtual team effectiveness. Social factors, according to the authors, include relationship building and team cohesion, while task-related factors involve coordination and communication.

Brokaw (2009) recommends four habits that can make virtual teams successful. The first habit is emphasizing teamwork skills, such as the social skills that are crucial when communicating and collaborating through electronic means. The second habit is promoting self-leadership, which means having leaders on the team constantly ensuring that the team is functioning effectively. The third habit is facilitating face-to-face meetings, which are effective in fostering and preserving essential social processes. The fourth and final habit is nurturing a global culture, which is helpful in providing a productive environment for dispersed teams.

According to Bhat et al. (2017), virtual teams have the potential to magnify the benefits of teamwork and to foster greater innovation compared to conventional face-to-face teams. To achieve this, virtual teams have to develop a climate of trust within the team and amongst members, which means developing cultural intelligence, flexibility, awareness of surroundings, interpersonal skills, and communication skills in the members of the team.

Serrat (2009) echoes the concept that trust is a fundamental requirement for the effectiveness of a virtual team, adding that when teams are effective trust, purpose, clear roles, open communication,

and full participation become evident. In addition, effective teams also demonstrate a clear understanding of the appropriate mix of skills and talent, risk taking, quality control, provision of services, and products, resource and sponsorship, and work-life balance. The author recommends providing conditions to build trust, such as having values, social context, physical proximity, communication, time, and a shared culture.

Thomas (2014) also places an importance on trust for developing effective virtual teams, stating that people who believe they are members of a trustworthy organization tend to invest talent and time, have better interpersonal insight, have a higher sense of self responsibility, and engage in increased participation in attaining common objectives. The author notes, however, that aside from having trust, virtual team members must also be willing to share knowledge in order for virtual teams to be effective. This is because virtual teams arose in the knowledge economy, and knowledge is at the center of any organization's competitive advantage.

Knowledge sharing needs to be coupled with shared understanding to make virtual teams effective, according to Hinds and Weisband (2003). This is because shared understanding allows virtual teams to anticipate and predict the behavior of the group by first anticipating and predicting the behavior of team members. Predictable behavior enables the determination of what is being completed and what needs to be completed, eliminating the need for monitoring. Shared understanding also promotes effort and resource use efficiency as well as error and problem reduction, while increasing member motivation and satisfaction and mitigating member conflicts and frustrations.

Enabling factors in successful or effective virtual teams, according to Earnhardt (2009), include clarifying objectives, technology, and team forming. Clarifying objectives is seen as the major contributing factor to virtual team effectiveness because it is an integral component of communication, and communication reduces obstacles during the operation of virtual teams. Technology, such as audio,

video, and written tools, is likewise important because it provides the medium for communication and assists in the completion of a project. Meanwhile, team forming ensures the attainment of project objectives through the maintenance of team chemistry.

2.2.2 Input-Process-Outcome (IPO) Model

One popular paradigm of team effectiveness is the IPO model. The specifics of each IPO model may vary, but they share many common traits (see Figure 3). For example, group-level factors or environment-level factors (organizational factors) lead to an "outcome" in the form of group effectiveness or performance on the other side. Therefore, the influence of the input factor on the outcome factor is transported or mediated via the "process." This implies that the resources of a group are transformed into a product via several processes. Important input factors are, for example, team leadership and group structure. Processes are observable team behaviors that can be influenced by various factors and impact the outcome. The outcome or output is the team process's result and is viewed in a dynamic manner (Herre, 2010).

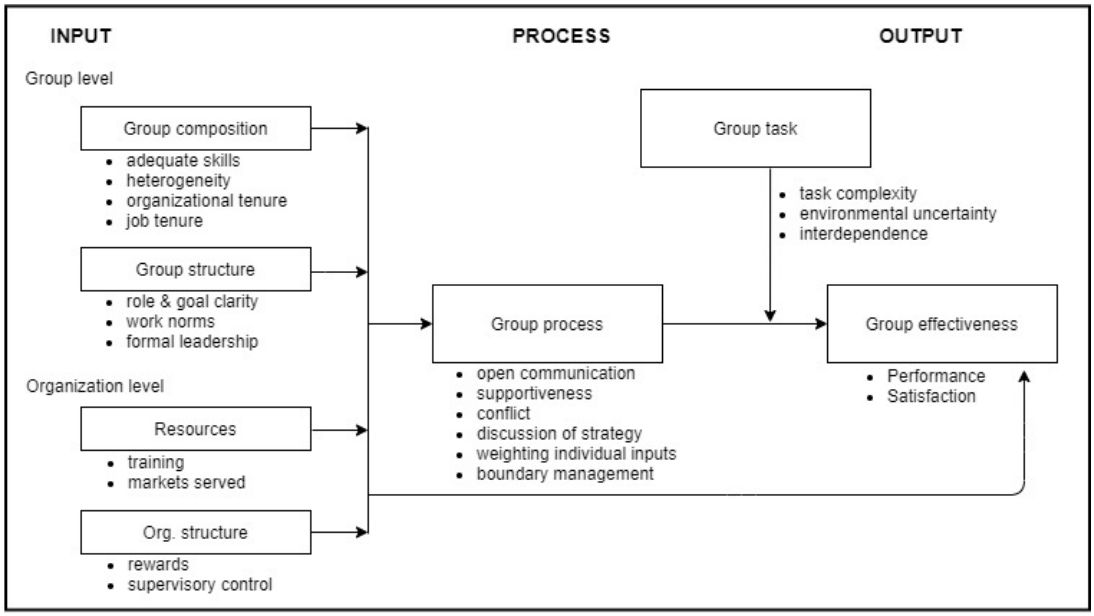

Figure 3: Input- Process - Outcome model (Gladstein, 1984)

Several studies have used IPO to examine virtual team effectiveness. Gibson and Cohen (2003) investigate the effect of moderators on design aspects as well as outcomes under human and business categories following the IPO model. Andriessen and Verburg (2004) use IPO to analyze the impact of inputs such as persons, tools, and culture on organizational and group vitality outcomes using communication as the key process. Espinosa et al. (2006) use the IPO model to determine the impact on project success of coping process factors and global team boundaries. Meanwhile, Staples and Cameron (2005) investigate the effectiveness of virtual teams using the IPO model. Using IPO, Liu et al. (2010) find that there is an insignificant correlation between communication and team performance.

2.3 Automotive cybersecurity standard as a case study

Cybersecurity is a set of technologies, practices, and processes designed to protect a computer system against intrusion or unauthorized access by hackers. Cybersecurity has become a topic of great significance in recent years. A study (Miller & Valasek, 2015) on automotive cybersecurity captured public attention given the expanded knowledge by car owners of the dangers posed by cyber-attacks on their cars. Miller and Valasek (2015) state that remote attacks can easily happen against any vehicle located in the United States. For this to happen, the attacker does not require any modifications to be done to the vehicle, nor do they require to physically access the car. Schmittner and Macher (2019) point out that electronic components constitute over 50 % of the total cost of manufacturing a car, which contains approximately 100 million lines of code, and that the automotive industry has shown an annual increase of approximately 30% in software-implemented functions. These systems make up approximately 80% of product innovation. The research shows that, currently, there are approximately 112 million vehicles that are connected worldwide. This increases the risk of vehicles being subjected to many forms of cyber threat. The study further shows that the market for automotive cybersecurity is projected to grow exponentially to US$ 759 million in the next three years.

Cybersecurity is a vital subject in any industry (Pentland et al., 2018). In the reviewed pieces of literature, it can be stated that there is a need to create policies that govern automotive cybersecurity. With the high demand for automotive technologies by consumers, there is a great push for more computerization each day (Enev et al., 2016). Almost all new cars have incorporated wireless technologies. These technologies are vulnerable to a lack of privacy policies and intrusion (Markey, 2015). It can also be stated that connected vehicles contain confidential data in their networks and the devices connected to them. The incorporation of technology in an automobile should be vetted. The ability to integrate technology with important automotive systems necessitates the need for the policies and standards governing cybersecurity features in automobiles to be formulated (Schmittner et al., 2018). It is necessary for all parties involved in the supply chain of vehicle production to be provided with a set of guidelines that support the global automotive industry.

The automotive industry decided to invest in the formulation of standards that would tackle the issues related to automotive cybersecurity and offer protection to their assets. Standardization organizations (the ISO and SAE) have worked jointly recently to establish a draft standard, tilted ISO-SAE AWI 21434 Road Vehicles – Cybersecurity Engineering. This standard focuses on security engineering in automotive systems. Additional standards and recommendations have been published before (Schmitter & Macher, 2019). The purpose of ISO/SAE 21434 was to outline a structured procedure to ensure cybersecurity in the production of internal vehicle systems. Schmittner et al. (2018) posit that this would reduce the chances of experiencing a potential attack. The ISO/SAE 21434 standard would also facilitate a reliable means of reacting to cybersecurity threats globally. It is meant to define an engineering framework for the automotive industry and to describe the future for automotive cybersecurity engineering (Much, 2016).

Automotive cybersecurity standards, specifically ISO/SAE 21434, are a unique case that deserves studying for the following reasons:

(1) ISO/SAE 21434 is the first-ever joint standard by two International SDOs (the ISO and SAE) with equal voting weights. Each SDO has its own pre-determined organizational culture and structure as well as its own development stages. This standards creation requires participants from both organizations to work together seamlessly and with good synergy. This collaboration adds more complexities to the process of standards creation. For instance, voting within the ISO's technical committee is by national delegations, while voting within SAE's technical committee is by experts. How to strike a balance and resolve different opinions and conflicts in the joint working team could be a good case study for future standards creation projects done in collaboration between two SDOs.

(2) Automotive cybersecurity is a rapidly evolving field; traditional automotive safety and security standards have not sufficiently and appropriately covered the topic of cybersecurity. Despite numerous efforts toward shedding light on the management of automotive cybersecurity, a great deal of issues remains unexplored and unsolved, and the knowledge regarding automotive cybersecurity is fragmented. Giving the example of ISO 26262, Schoitsch et al. (2015) state the standard fails to address the risk in security and therefore recommend a standard that will consider the risks and hazards in the analysis phase and associated measures to be implemented in all the other phases of automotive engineering, particular in security. The study (Schoitsch et al., 2015) also highlights that all systems are presumed to be functioning properly. According to Schmittner et al. (2018), the automotive industry has worked on producing secure and safe automated vehicles to curb the risk of cybersecurity, such as EVITA (E-Safety Vehicle Intrusion Protected Applications) and the EMC2 (Embedded Multi-Core). However, the particular characteristics of engineering procedures for automotive systems made it difficult to use the existing cybersecurity standards (e.g., IEC 62443) (Schmittner et al., 2018). As technological changes are accelerating today, and emerging technologies are advancing at a rapid pace, standards development teams are pressured to produce and deliver standards more quickly while facing the challenge that the knowledge regarding these technologies is fragmented and underdeveloped.

Thus, the ISO/SAE 21434 standard could provide a plethora of implications regarding how to deal with this situation.

(3) Automotive cybersecurity, especially connected car cybersecurity, is a complex ecosystem. Automotive cybersecurity is an inherently inter-disciplinary domain and cannot be viewed as purely an IT topic. This highlights the fact that automotive cybersecurity standards development requires a multidisciplinary approach and needs to include a variety of stakeholders. Therefore, OEM's, tier-one suppliers, tier-two suppliers, public authorities, and others need to work together to establish specific guidelines and standards for automotive cybersecurity, that address the growth, prevalence, and sophistication of cyberattacks. The ISO/SAE 21434 harmonizes industry and supply-chain efforts toward cybersecurity and serves as a state-of-the-art guideline to which regulators and governments can refer. It is not a purely IT/IS standard, but as a standard it approaches the entire ecosystem related to the connected vehicle and not merely the vehicle itself.

Chapter 3 — Conceptual Framework

In the following, an adaptation of the virtual team IPO framework is presented that includes general categories relevant to working teams of creating International Technology standards. The model provides a contingency approach to virtual team research, focusing especially on project/task team type. As a result, particular inputs, processes, and moderating factors may be more or less deterministic as to their effectiveness. In addition, the adapted IPO framework (Figure 4) presented below serves as a guided theoretical foundation in this study. It is important to note that leadership is an influential factor in International Technology Standards creation, which was identified from a previous study (Spring et al., 2016). The leadership factor is eliminated in this study because it is not stable and changes over time in this case.

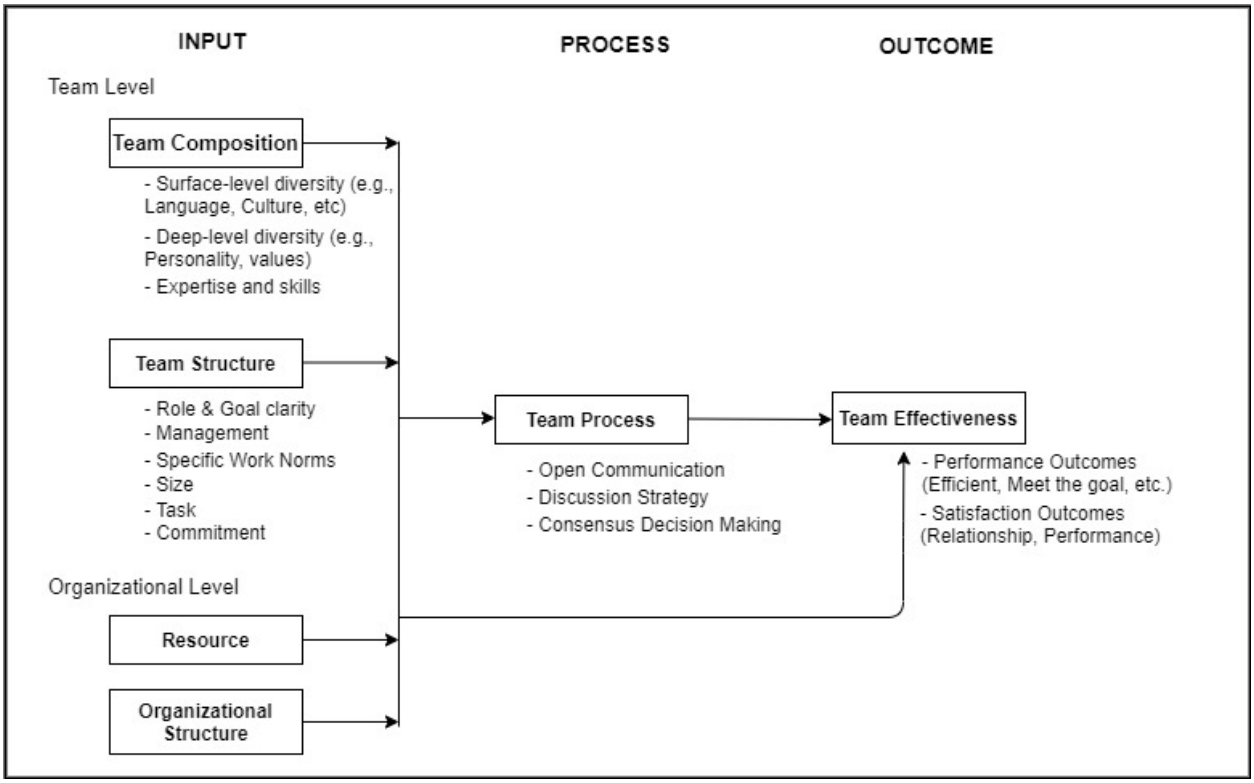

Figure 4: Proposed IPO model of standards creation teams

3.1 Input

Figure 4 presents an adaptation of the IPO to a standardization project team. Team inputs play a double role in the model; they influence team effectiveness both directly and indirectly. The indirect link to effectiveness is achieved through their influence on the team process.

There are four input categories that represent the key deterministic criteria for standardization project group teams. The first two components are team level factors, including team composition and team structure. Team composition and team structure are expected to impact team processes and outcomes.

Team composition represents both surface-level and deep-level diversity and individual differences, which are expected to impact team processes and outcomes (Hoch & Dulebohn, 2013). Surface-level diversity includes ethnicity, culture, and language, and deep-level diversity includes personality and values. Expertise and skills are needed to perform the task. Commitment refers to effort and the amount of time that team members can allocate and invest in the team.

Team structure includes the team's size, the clarity of its goals and member roles, specific norms about how to go about doing the work, management, and task complexity and interdependence. It is important to note that "task" is an aspect under team structure factors instead of a moderator that influences the team process because standardization project teams have clear pre-assigned and determined tasks when teams are established.

The two organizational-level factors are organizational structure and resources. Organizational structure and resource factors are organizational-level variables that support and lead to project team effectiveness.

3.2 Process

Team process is the mediator of the inputs and outcomes relationship. Team process refers to the interdependent acts of team members that transform inputs into outcomes. These are based on the characteristics of standardization project teams – open communication, discussion strategy, and consensus decision making.

3.3 Outcome

Figure 4 presents outcomes as the final components in the IPO model. Outcomes represent the effect of the process of transforming team inputs into outputs that are valued by the organization. Standardization project teams generally exist to complete certain tasks and reach certain goals, deliverables, performance outcomes, and so on. Team effectiveness is a good measure of performance outcome.

As mentioned in the literature review, Cohen and Bailey (1997) suggest that effectiveness can be measured by the following three dimensions:

- performance effectiveness (productivity, efficiency);
- attitudinal outcomes (satisfaction, commitment, and trust in the management); and
- behavioral outcomes (absenteeism, turnover, or safety).

Considering the unique characteristics of working teams in standardization projects, team effectiveness in this study is measured by two dimensions – performance effectiveness and attitudinal outcomes.

Chapter 4 — Methodology

A qualitative study is an inquiry process of understanding a social or human problem based on building a complex, holistic picture, formed with words, reporting detailed views of informants, and conducted in a natural setting (Creswell, 1998). For this reason, a qualitative research approach was the most reasonable for investigating the process of International Technology Standards development.

The overall study design follows the typical model of qualitative research with iterative data collection and data analysis cycle. Specifically, constant adjustments to the research design, the research sub-questions, and the sources and types of data were applied as the study evolved. Themes were identified using Strauss and Corbin's (1998) open and axial coding techniques. They are supported by the data gathered from the interviews, observations, and documents.

4.1 Case study research

As defined by Yin (1993), case study research is "an empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident" (Yin, 1993, p.13). A case study offers the opportunity to investigate the directions that the participants and their experiences may take and gain a deeper understanding of the real-life context. There are several types of case studies, such as descriptive, exploratory, and explanatory. The explanatory case study approach intends to explore and explain the purpose while focusing on answering "how" and "why" questions through empirical inquiry (Yin, 2003), and exploratory case studies answers "who" and "what" questions. Siggelknow (2007) and Thomas (2010) argue that case studies are valuable for inspiring new ideas and for new theory extension or generation.

This study is an exploratory case study as Yin (2009) notes that "many social scientists still deeply believe that case studies are only appropriate for the exploratory phase of an investigation." Specifically, this research consists of a single in-depth case study. There are two motivations for using a single case study instead of multiple case studies. First, there is no prior theoretical framework that could be reviewed regarding this practical problem. A single in-depth case study has the potential to generate new propositions and extend existing theories through the inductive process. Second, the case selected for analysis is unique as it is the first international joint working entity between the ISO and SAE.

An interpretivist case study design was chosen because it facilitates the overall purposes of this research to gain an in-depth understanding of the process of developing International Technology Standards. Case studies are designed to take the reader of the research into the world of the participants. They provide a much richer and more holistic picture of the phenomena under study (Yin, 2003). Technology standardizations are highly complex processes. They involve multiple steps and multiple-shareholders with different interests, and they need to reach a consensus-based decision. This makes the study of the process of standardization well suited for a case study design.

4.2 Overview of the research site

The ISO/SAE 21434 standard, which is currently under development, is the research site for this study. ISO/SAE 21434 is a domain-specific standard for the automotive industry, titled "Road Vehicle – Cybersecurity Engineering," and it will become the first global automotive cybersecurity standard. The aim of ISO/SAE 21434 involves "the necessity to coordinate and develop these disciplines [cybersecurity] and to exchange requirements on a system, software, and hardware level" (Schmittner et al., 2018).

The development of ISO/SAE 21434 started in October 2016 with four project groups (PGs), and the final standard is scheduled to be published by the end of 2020. The current draft form, as of May

2020, is the result of four years of drafting by experts representing 14 different countries and 82 different industry organizations, including OEMs, tier-one suppliers, semiconductor vendors, cybersecurity specialist companies, academic institutions, and others. The standard provides a standardized automotive cybersecurity framework; establishes cybersecurity as an integral element of engineering throughout the lifecycle of a vehicle from the conceptual phase all the way through decommissioning, ensures that cybersecurity is considered in post-production processes (software updates, service and maintenance, incident response, etc.); and calls for effective methods of lessons learned, training, and communication related to automotive cybersecurity. More specifically, the scope of the ISO/SAE 21434 standard includes specific requirements for cybersecurity risk management, a cybersecurity process framework, and a common language to help manufacturers and organizations to communicate their cybersecurity risks (Goldstein, 2020). It is important to highlight that ISO/SAE 21434 will not prescribe any specific technology, solutions, or tools related to cybersecurity.

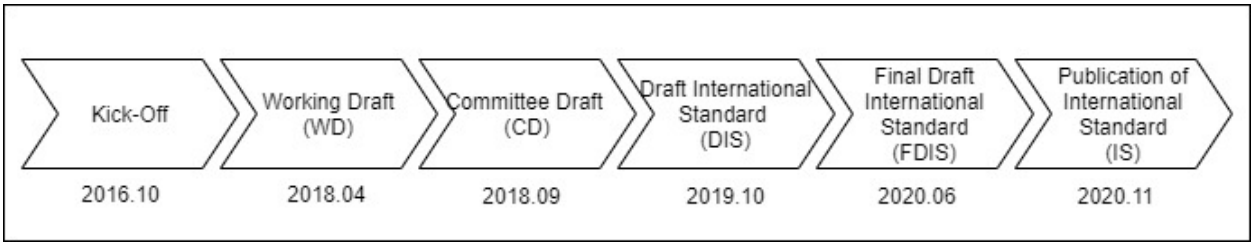

Figure 5: ISO/SAE 21434 timeline (ISO n.d.)

The unit of analysis in this study is the four PG working teams. The structure of the joint working group (JWG) and four working teams are shown in Figure 6. The JWG assigns topics to the PG teams, and the PG teams discuss the details and draft the associated contents. Each working team has a leadership team, including a chair, a co-chair, and a secretary. The chair and co-chair are from and represent the ISO and SAE or vice versa.

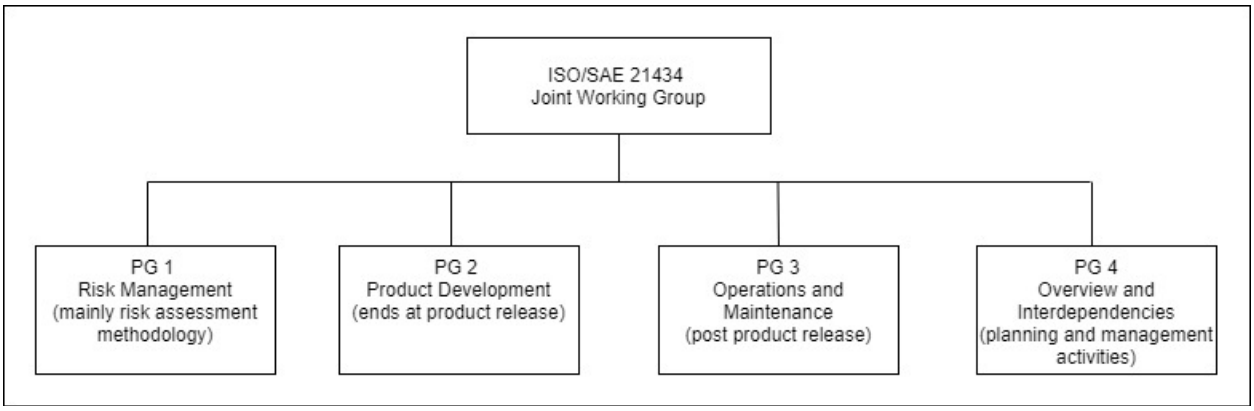

Figure 6: ISO/SAE 21434 JWG structure (Schmittner et al., 2018)

4.3 Data collection

This study incorporates several data collection methods, including interviews, questionnaires, and field notes (observations). The data collection strategy is shown in Figure 7. Interviews were the primary data source among multiple sources of evidence. The other sources were used to support the data collected from the in-depth interviews. Data were gathered from key individuals within each of the working teams being studied. The researcher interviewed each participant. Some interviews were conducted face to face during September's meeting, while others were conducted via Skype based on the availability of the respondent. Individual interviews as well as team interviews were conducted.

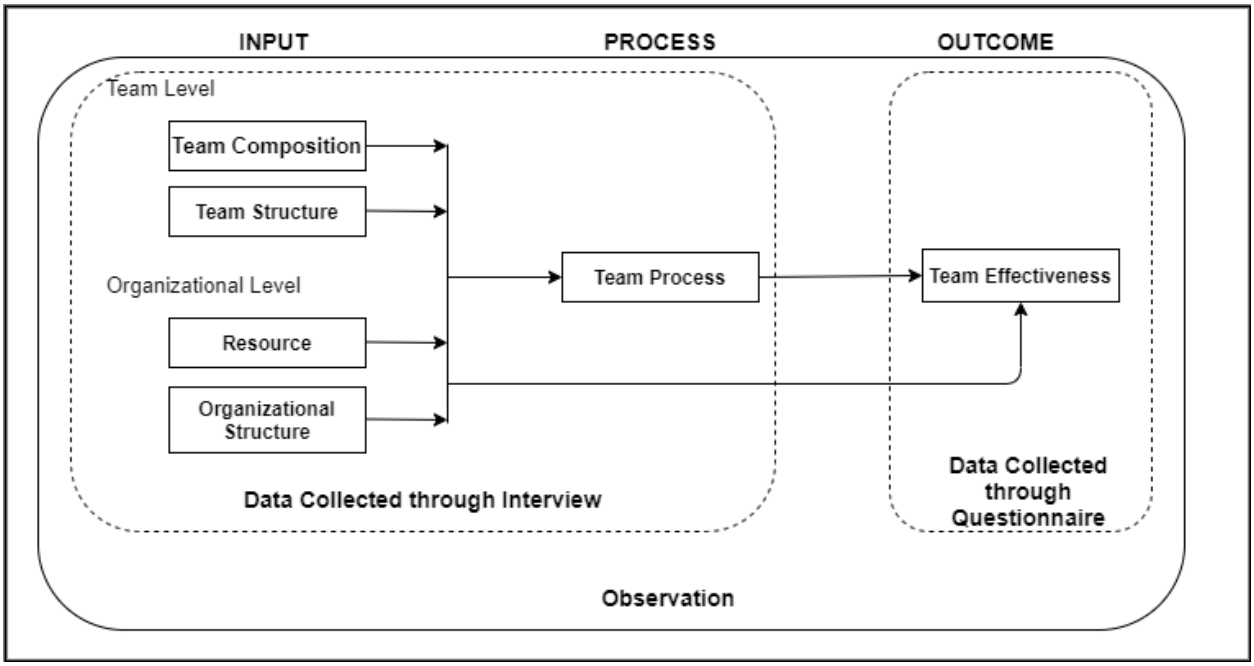

Figure 7: Data Collection Strategy

Quantitative data were collected from questionnaires, and qualitative data were obtained from interviews. Participants included individuals who participated in the ISO/SAE 21434. A priori constructs were defined based on the research questions, and these constructs were used as the basis for the interviews and questionnaire.

This triangulation of multiple data collection methods provided a stronger substantiation of the construct and hypotheses (Eisenhardt, 1989). All the sources of evidence were reviewed and analyzed together so that the findings were based on information from all sources used (Yin, 2003).

4.3.1 Field notes (observations)

Field notes were captured and documented after observations. Field notes are an ongoing stream-of-consciousness commentary about what is happening in the research, involving both observation and analysis (Van Maanen 1998). The researcher observed a five-day JWG meeting. Field notes were taken, as much as possible, at the end of each day during the JWG meetings. Payne and Payne (2004) suggest that a qualitative researcher should take field notes whenever possible since it is not possible to tell what will be relevant later. Also, as the data collection progressed, field notes were

taken to capture research ideas, observations, general thoughts, and self-reflections during the span of the study. Payne and Payne (2004) also state that "fieldwork is a reflexive experience, with researchers bringing themselves into contact with real-life situations (reflexivity). The researcher is part of the things being studied. The researcher's own reactions are an essential element of participation."

The field notes were very helpful in uncovering areas that could be probed further. They captured points meant not only to clarify thoughts on situations but also to help recall details of situations during the data analysis and when reporting the findings. In addition, the field notes could be viewed as a source of deep insight later, particularly if the researcher found that the understanding had changed over time (Myers, 2013). The field notes were invaluable in capturing the evolution of ideas and emerging themes throughout the study.

4.3.2 Interviews

In-depth semi-structured interviews were conducted with key participants. Participants from different working teams were interviewed to obtain different perspectives. An oral interview invitation as well as an email interview invitation were sent out to a potential participant attending a JWG meeting. The potential participants who accepted the invitation were then contacted directly to schedule an interview. The questions asked during the interview were a subset of the questions in the interview protocol. Each interview lasted approximately 45 minutes to one hour. The potential participants were selected using theoretical sampling (Strauss, 1991). Theoretical sampling enables the researcher to select interviewees based on the "working theories" relevant to the research question. The number of interviews depends on the theoretical saturation. A total number of 18 interviews were conducted, including 24 participants.

The interview protocol (see Appendix 2) was used to ensure consistency across interviews. However, all respondents were encouraged to elaborate on issues they felt were of importance to them,

so that additional dimensions and perspectives could be pursued. The interviews provided various perspectives, which collectively gave a holistic understanding of the process. When conducting interviews, since the interviewer is present with the subject, there is an opportunity to collect nonverbal data and to clarify the meaning of questions if the subject does not understand.

Interviewees were contacted by email or telephone to provide any required clarification once the interviews had been conducted. Interviews were taped with the permission of the subject. Each interview was transcribed into a Microsoft Word document. Initial questions were constructed based on the literature review to probe for an in-depth understanding of the key constructs in this study.

4.3.3 Questionnaire

A structured questionnaire was developed to collect additional background information and to assess the effectiveness of the working team in which the respondents were mostly involved. All respondents completed and submitted the questionnaire via the Internet. The questionnaire contained only closed questions (see Appendix 3). The questions were derived from previously published research. Measures for team effectiveness, in terms of team performance and team relationship satisfaction, were derived and selected from Lurey and Raisinghani (2001) and Cook (1981, pp. 248-250). The use of the four-level Likert scale leads respondents to give a certain tendency of their opinions and is consulted with experts in this field.

The use of the questionnaire in addition to the use of interviews increased the validity of the findings and was used to gather information from subjects who were not available for interviews. This secondary source was used primarily for the validation and triangulation of the data collected from the interviews. Another advantage of questionnaires is that subjects are more likely to feel that they can remain anonymous and thus are more likely to express controversial opinions (Neuman, 2003).

4.4 Data analysis

The qualitative case study contains a massive amount of raw data; therefore, it is crucial to collect and keep the data in a timely and organized manner (Myers, 2013). More importantly, it is better to conduct preliminary data analysis post-collection, or even concurrently with data collection, as Merriam (2002) states that "the right way to analyze data in a qualitative study is to do it simultaneously with data collection." For this reason, data analysis was started following the first interview to begin identifying themes and to facilitate subsequent data collection (Strauss & Corbin, 1998).

Qualitative analysis is a form of "intellectual craftsmanship" (Mills, 1959), which means there is no single way to complete qualitative research since data analysis is a process of making sense. It is a creative process, not a mechanical one (Denzin & Lincoln, 2000). Similarly, a qualitative study capitalizes on ordinary ways of making sense (Skake, 1995)

Methodologically, Esterberg (2002) suggests "getting intimate with data" (p. 157) and describes the main objective of immersing oneself in interview transcripts to "load up your memory" with the collected data. This study followed the data analysis and coding procedure suggested by Creswell (2009) and Esterberg (2002). Esterberg (2002) suggests that open coding is a process where "you work intensively with your data, line by line, identifying themes and categories that seems of interest" (p. 158). Creswell (2009) mandates that traditional approach in the social sciences allows the codes to emerge during the data analysis. Open coding helps to identify and uncover concepts and themes. Segments of text are also selected and flagged as a quotation. Once the data from this study were examined thoroughly through the open coding process, the codes were reviewed for emerging themes in the data.

This study followed Creswell's (2009) six steps during the data analysis process, and though these steps are described in linear order, Creswell describes "an interactive practice" in analysis. That is,

there is a recursive element to following these steps – the process is not simply a static, linear order of analysis.

Step 1: Organize and prepare the data for analysis (Creswell, 2009, p. 185). During this step, I reviewed audio tapes from interviews, transferred these into Word document transcripts, and created a data repository.

Step 2: Read through the data (Creswell, 2009, p. 185). This step also aligns with Esterberg's directive to "get to know your data." I reflected on the overall meaning to gain a general sense of the information and ideas that the participants conveyed.

Step 3: Begin detailed analysis with the coding process (Creswell, 2009, p. 186). I followed Creswell's procedure of organizing the material into segments by taking the text data and segmenting sentences into categories. I then labeled those categories with terms based on the actual language from the participants.

Step 4: Use the coding process to generate a description of the setting or people as well as categories for these for analysis(Creswell, 2009, p. 189). I used this process to generate codes for the descriptions, which then led to generalizing a small number of categories or themes. Then, I analyzed the themes that emerged and gathered the various cases into a general description for this bounded case.

Step 5: Advance how the description of the themes will be represented in the qualitative narrative (Creswell, 2009, p. 189). For this step, I wove the emergent themes into narrative passages so that the findings emerged logically from the participants' responses.

Step 6: Interpret the meaning of the data (Creswell, 2009, p. 189). Creswell recognizes that a researcher's own background plays just as important a part of the meaning making process as a

researcher's fidelity to a theoretical lens. To convey the participants' perceptions of their experiences accurately, I focused specifically on what they were saying, the conclusions they drew, and their recommendations for future practice. The themes that emerged from this study came directly from identifying the keys factors that affect the process of creating International Technology Standards between my own biases and the participants' own meaning-making processes.

4.5 Validity

Since qualitative research is based on subjective, interpretive, and contextual data, it is highly likely to have multiple, equally valid interpretations of the same situation. It is crucial to establish the highest possible levels of trustworthiness and ensure appropriate procedures and methods. The overall strategy to obtain trustworthiness is to make every movement in the research transparent and reflective. In this study, I adopted the following procedures/techniques (Table 1) to maintain validity.

Table 1: Procedures/techniques to maintain validity

Criterion	Procedures/Techniques
Validity	• Triangulation • Member checks • Peer debriefing • Note taking
Reliability	• Audit trail • Constant data comparison • Triangulation

To be specific, this dissertation triangulated the findings through the use of interviews, questionnaires, observations, and reflective notes to maintain trustworthiness and reliability. Member

checks were used throughout the data collection and analysis. During the data collection stage, the researcher kept contact with the participants to verify the interviewer's interpretations. During the data analysis, the researcher kept contact with key informants to verify the findings and themes resulting from the analysis of the data. Peer debriefing happened throughout the process of the study, helping to reduce any researcher bias. Multiple discussions were held with professors, stakeholders, and participants to collect valuable feedback, criticism and suggestions for improvement. It is important to note that the final findings of this dissertation will be presented to SAE. Last but not least, reflective notes were taken during the data collection and data analysis stages.

Meanwhile, all the research-related activities and data, including the raw interviews, audio-recordings, transcriptions, and the coding book, were kept for monitoring and auditing. Constant data comparison was applied in the data analysis stage, contributing to the reliability of this research.

Chapter 5 — Team-level Findings

The purpose of this study is to explore key factors that affect team effectiveness in the process of creating International Technology standards. This chapter presents a summary of the findings for each individual PG team. For reporting purposes, I gave each PG team a nickname. Team Apple, Team Banana, Team Citrus, and Team Date each represent one of the four PG groups shown in Figure 6. The findings presented are based on a conceptual framework that includes team-level input, organizational-level input, team process, and assessment of team effectiveness.

5.1 Team Apple

Team Apple is the biggest PG team and has the most challenging and controversial content assigned. The content is the backbone of this standard.

5.1.1 Input

5.1.1.1 Team composition

The respondents were asked to describe the team composition. Team composition factors influence the team process and team output. Respondents identified the following surface-level diversity (e.g., language, culture, etc.) which had an impact on the team process and may finally influence the output:

> *At the very beginning, it is very challenging for some non-native English speakers to follow the team process. Now [September JWG meeting], it is much better. Now, the dynamic of our team is much better.*
>
> *Even [though] we documented everything thoroughly, it still can be misinterpreted in the discussion. The misinterpretations, I think, are part of the language issue and part of the cultural issue. Some people, I think, are interpreting things differently.*

One of the other challenges for collaboration is time zone, especially online meetings. When we are trying to schedule our online meetings, it is usually about two hours in a day that works for everybody. There will be some people very late at night and very early in the morning. That is a problem that we can't find a perfect time that works for everyone.

The experts of Team Apple were from a diverse industry, holding different understandings, interests, and perceptions and with different personalities. Respondents indicated that deep-level diversity had a significant impact on team process and output. As some respondents explained:

Young people's characteristics sometimes cause a problem and [they can be] too aggressive. People still need good communication skills and cultural respect while working in a team.

We got people from OEM, tier-one suppliers, and cybersecurity, and this design causes some conflicts. We have diversity from different countries as well as industries. For example, we discuss [some specific item/clause in this standard]; we realize we don't have the same understanding of specific concepts. We need to have our understandings on the same table.

Knowledge discrepancy is another issue; If you exclude people from standardization, but again, the industry is new; a lot of principles have not [been] established. But not obvious, the different understanding of the topic also makes the process very challenging. Excluding experts from this topic also dilutes the efforts we are working on here. That is the dynamic we face in this project.

Each organization and each individual have their own perceptions of what's important or not, so that's why there will always be differences. Whereas one particular topic [discussed in] this group is fine [for some], others will argue over it. It depends on what's important [to each group member]; also the representative for that also causes discussions.

5.1.1.2 Team structure

The respondents were asked to describe the team structure and indicate whether they believed this structure was adequate and good for the general team process and output. The following comments provide various perspectives on the team structure in Team Apple.

In terms of scope, participants struggled to decide what content should be put into the standard. The initial scope and plan looked good before it started. The following comments were made:

> *The scope was decided at the beginning of the project, but it was broad in nature, so the interpretation of it was up to our group.*
>
> *I think the scope issue because we don't have an established international standard to begin with, and people don't realize this is a huge project until we did it already.*

Specifically, the scope issue was also attributed to the topic and content on which Team Apple worked.

> *The content is so controversial and not yet decided in the industry. Since we don't have an international standard to begin with, everybody brings the proportional part; either [his or her] personal knowledge or the knowledge coming from their organization. Everybody was naturally thinking that what they are doing is currently the best one, so you want to show the team and want to impact and contribute to the team. The other issue we have in Team Apple is that we have very diverse experts and need to consolidate and come to a consensus of a debating content; it is very challenging.*

Team Apple had a relative mix of participants from the ISO and SAE. According to one respondent:

> *I think there is a mix of [ISO and SAE], but I haven't looked at the numbers and there are representatives more for ISO than SAE.*

There were two major roles in Team Apple — clause leader and contributor. According to the team leader:

> *Yeah, I would think that most of the people are contributors. We have clause leaders. I'm going to give you a rough number — we have roughly 10 different leaders (clause leaders, sub-clause leader) that are responsible for developing their section about that clause.*

However, only a relatively small portion of participants were actively involved and committed to this project. One participant made the following comments:

> *In terms of very active members, I would say the clause leader and doing work on the comments, about 10 people. Another 20 people are consistently attending the meeting. Some national delegations are just observing.*

Team Apple had a weekly base online meeting, and every 10-12 weeks the team would have a large face-to-face meeting. According to the respondents, the majority of work and progress had been made through the weekly online meeting, but the face-to-face meetings were more productive than the online meetings. Following are participant comments on the face-to-face meetings:

> *During the face-to-face meeting, a lot of comments get closed. We are very productive during the face-to-face meeting.*

> *The face-to-face meeting is very beneficial and more efficient. One might [say] because you're less distracted. All of us are reading our emails as well at an online meeting; there's a distraction.*

Moreover, when talking about the management style and leadership, one respondent shared the following comment:

> *At this point, Team Apple was operating quite flexibly, not following any particular methodology, like agile or waterfall management.*

5.1.1.3 Resources

Respondents were asked to comment on the resources. They complained about the document sharing platform. According to one respondent:

> *The mechanism of sharing the documents, the platform doesn't really support the daily activity you need to share visions, or update comments. The functionality of the platform is not up to the level we need. For example, I have a document to edit. The current system has a very mechanical way to preserve it, check it out, and edit it. We have some industry standards; this function is missing, and I am surprised. I would expect ISO and SAE to have this. This function would definitely make document sharing easier.*

Additionally, several participants mentioned reference documents and standards. They thought that there was a lack of a documents and standards repository ready at the preparation stage. According to respondents:

> *This project might create a silo with respect to the rest of the world. One of the goals of this project is to have more commonality. There are some common intermediate things that cross domains, so we can cross domains and we can reuse some standards with the same approach and the same components.*

> *The standard contains a certain amount of duplication. The same topic and tasks have been done underneath the big umbrella of standardization. Actually, we should make sure the contents we developed in the standard are very different or merge with the existing standards. We should have a list of reference standards or documents that we can just refer to the original standards or documents.*

5.1.1.4 Organizational structure

Participants from Team Apple also shared their comments regarding the JWG team. People felt unclear about some of the basic rules that they needed to follow. For example, one respondent made the following comment:

It is unclear for me about some basic rules. When JWG-level voting is called, I don't know who is eligible to vote and how to make the final decision.

5.1.2 Process

When respondents were asked to describe the team process, most complained about it. As mentioned in the previous section, Team Apple did not employ any specific method to manage the team process. Basically, Team Apple broke up the topic into different parts and asked for volunteers (the clause leader) who would like to work on those parts. As participants explained:

We just break up what we first agreed on the overall outline of our section, and then we simply break it up by individuals who wanted to volunteer to work on a particular section. Those individuals who work on it as the clause leader would hold meetings to decide contents, and then this person would do most of the writing for that section to reflect that consensus decision.

They [the clause leader] would basically write that section, and then the team would review [and make] comments on it. The clause leader would make changes, then it would go out to the wider team, and then we would get comments. So typically, the clause leader is responsible for looking at the comments that we received as a section again, and they would recommend how to address the comments. Then the team would indicate whether they agreed with that or not.

In terms of decision making, the leadership team found voting was a crucial mechanism to keep records as well as to achieve "facial" consensus. The leadership team shared the following comments:

I think voting is the most important process to engage the group to make a consensus decision.

What makes consensus difficult is that sometimes some delegations were very vocal about their voice and their objections, and that would leave the perception that it was the majority opinion. I thought I had a problem with some delegations because they would be very vocal about the problem and because they were vocal and nobody else said anything about it, which left you with the impression that everybody agreed

with the interjection. Yeah, then we ended up finding out it's just the people who spoke with the problem; so I learned early on that even though it may be loud and very vocal, you have to bring it to a vote in the end, and that opinion may be in the minority. Sometimes people come up with some opinions, and you have to bring it to a vote because otherwise you're thinking everybody agrees with them- because they're not saying anything at all, and then when you bring it to a vote most people didn't agree.

Moreover, achieving consensus seemed to be inefficient, according to two participants:

Some PG groups we've had issues with, where our perception and their perception are different in terms of like one group. I don't think we are prepared for joint PG meetings. They want us to give them proposals on how to fix it. We prefer to have discussions during the meeting and verbally walk through it. Still, other groups want us to give them suggestions or pre-observation. This is how we recommend things to other groups, that is having discussions in verbally walking away with decisions for language whoever leads it.

No opportunity to reach a consensus in a short time. Not a participant. Several different proposals from experts. This causes a lot of delays. Open discussion is not easy. However, we spend a lot of time on how to achieve the consensus instead to achieving a consensus.

Regarding the discussion, one participant also shared a unique experience:

They should be more open discussions. Sometimes the discussion falls into, 'my way is right, and your way is wrong.' Rationale is very important. We all have these problems in the industry; this is not about whose solution is right. It is more about the rationale behind it. Time has been lost.

5.1.3 Output

Nine respondents from Team Apple answered the survey assessing the team's effectiveness. The respondents generally agreed that Team Apple had completed the team purpose as was intended. However, there were discrepancies regarding team performance, team relationship satisfaction, and

efficiency. Half of the respondents were unsatisfied with the team's performance, relationship, and efficiency, while others thought they were acceptable. The overall scores are presented in Figure 8.

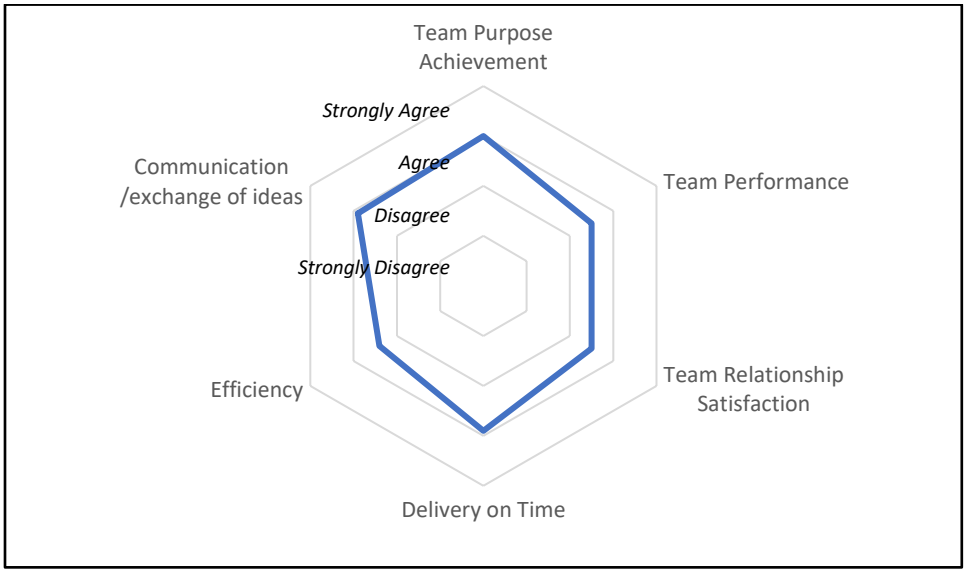

Figure 8: Team effectiveness assessment of Team Apple

5.1.4 Summary

A summary of Team Apple's findings is presented in Figure 9.

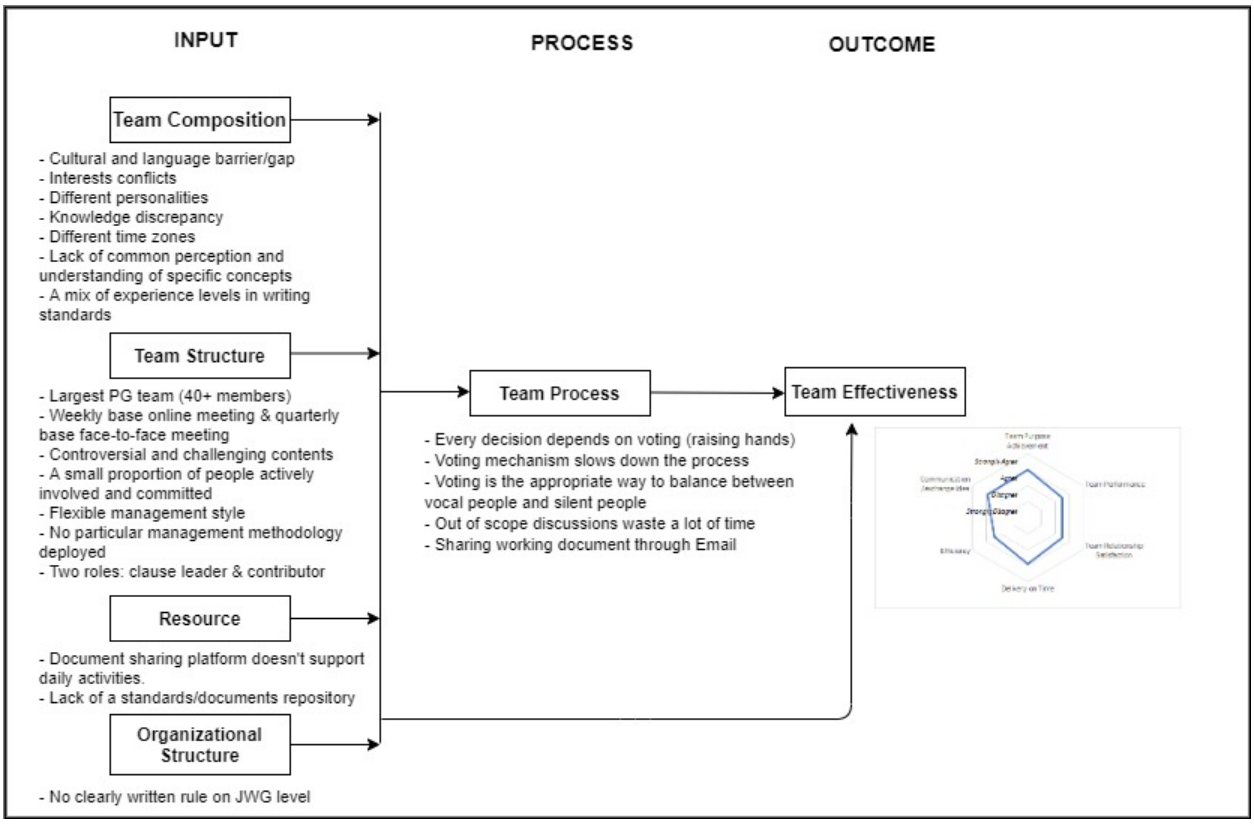

Figure 9: A summary of Team Apple findings

5.2 Team Banana

Team Banana is a comparatively small PG team, working with very technical and engineering-oriented contents — mid-layer.

5.2.1 Input

5.2.1.1 Team composition

A language and cultural gap also existed in Team Banana. According to respondents:

> *There are many national groups in Team Banana. Some national groups are very open and easy-going, but the problem is the cultural and language issue.*
>
> *Language is a barrier for the majority of the members. Because the majority of the participants are non-English speaking, that certainly brings some interesting issues. Because of non-English speakers, the quality of the contents s not written in a [good]*

way. However, we have to live with this. This is not something that can be easily addressed.

While Team Banana maintained a good mix of experts from the ISO and SAE, the team composition was more homogeneous in its field of expertise. Some respondents made the following comments:

[Team Banana] is a group of engineers. They are easy to come to a consensus with on the methodology level.

In [Team Banana], the experts are older and with [more] experience in writing standards compared to other PG groups.

The experts in [Team Banana] are very cybersecurity-focused.

5.2.1.2 Team structure

Team Banana was a comparatively small group. Even though it had volunteer-based membership, Team Banana still put some controls on the membership as well as on the experts' backgrounds to align with the topic assigned to the team. According to the leader of Team Banana:

Our Team has 12 to 15 active members participating in each meeting.

We intend to control our team member background and team size.

Since Team Banana's topic is more focused on technical content, being well established and discussed, the topic was less controversial. One expert made the following the comments:

Compared to [Team Apple], [Team Banana] doesn't have as many debates, and the subject and topic are less controversial.

Our team has a very good technical focus, and we are mainly responsible for the delivery of the technical content of the standard.

Though Team Banana did not follow any specific project management method, they did have a specific style. They followed some best practices from agile development, such as prioritization, as one participant mentioned:

> *The management style of [Team Banana] is similar to Japanese style.*
>
> *Before each meeting, the chair and co-chair will go through everything, such as the agenda, slides, and discussion. Before we start our task, we prioritize everything, as well as each clause.*

Team Banana had three roles for each clause — clause leader, clause editor, and contributor. This design was to help handle the language issue. The clause leader was responsible for a specific clause or sub-clause, and the contributor was to make comments on it. The editor's role was only seen in Team Banana and was used for better document management purposes and addressing language differences to maintain consistency. As one participant shared:

> *People in [Team Banana] have a clause leader, editor, and multiple contributors. At least two people are responsible for one clause (clause leader and clause editor). The editor is the only person who has the right to write on the document and comments resolution.*

5.2.1.3 Resources

Participants from Team Banana also commented on the document management platform. According to one respondent:

> *We are using the ISO DIN site. That site is useful, but it is hard to say it is super user-friendly. So, I agree that the document management is weak. It doesn't enable the teams to collaborate on the document because it is hard to find where documents are. Sometimes, [there are] multiple versions of the documents, we have to comment on. You need to convert it to Word, and track changes. It would be better if we had an, I don't know the technical terms, online version of the document, and everybody*

can work on it at the same time. Such tools definitely help to enable collaboration, more efficiency, and also version control. Because we have a lot of people working on the different documents, we don't know which document is the latest [-version], and we need to carefully control the version of the documents. As you know, at the end of the day, we merge different documents of the different parts together, assemble those, and make sure they are consistent. I expect this will help.

5.2.1.4 Organizational structure

Participants from Team Banana mentioned that the ISO was dominant in the standards creation process, consistent with the researcher's observation. According to one participant:

ISO and SAE work together to develop this standard. The ISO seems to be the dominant part of the process. There could be a set of reasons [for this]. One possible reason could be that they have more engagement from the ISO side; because there are more countries, and you know from the organization's standpoint. The policies and rules of ISO are more established and more understood by more people in the world. SAE, on the other hand, seems to have not as much of an influence in the world as ISO. The SAE only have 10+ people joining in the meeting, and thus our voice is comparatively weak compared to the three to four times as many people from the ISO side.

Another point brought forth by respondents was about the high-level ISO and SAE leadership and collaboration. One participant shared the following comments:

There are many meetings between ISO and SAE, but I don't think they always resolve the issues [between ISO and SAE collaboration]. As you know, sometimes, we discuss how SAE and ISO are jointly doing things. For example, the ISO can sell the DIS standard, but generally speaking; on the SAE side, we don't sell the draft. That's one different thing. Another thing is about the technical writers. SAE hire technical writers earlier, but ISO says they couldn't do that.

5.2.2 Process

Respondents from Team Banana were very satisfied with the team process. According to one participant:

> *Our team process is very efficient and very fast.*

Team Banana had a thorough group discussion regarding the team process and the expectations that had been set. The leadership team shared the following comments:

> *At the very beginning, we discuss and devote a lot of effort to designing what the internal process looks like. Beyond that, we set our expectations and task force for each face-to-face meeting.*

However, there were still some conflicts influencing the process of Team Banana. According to the respondents:

> *Compared to [Team Apple], we have fewer conflicts.*

> *Experts from America want to go deep, while the EU side wants to go fast. We need to have a balance.*

The internal team process was strictly followed, and participants made the following comments:

> *We have a more structured internal group process. We have designed a form to provide comments. Also, we reject any comments on emails unless you submit your comments form. People from other PG group may feel that our protocol is too strict and hard to follow, but we think our [process] is very efficient and make sense.*

> *[We] strictly follow the process defined by ISO and our internal processes, having trackback of everything.*

Team Banana made its decisions by consensus. The consensus decision came from dynamic discussion. To better prepare for the discussion and achieve consensus in each meeting, the leadership

team set up clear expectations and tasks for each meeting (for the online meetings as well as the face-to-face meetings) and sent the meeting slides two to three days before the meeting. Respondents made the following comments:

> *We have a very dynamic discussion in each meeting.*
>
> *After the discussion, we all agreed on the clauses or comments resolutions and made our consensus decision. Also, I feel our face-to-face meeting is more effective in terms of achieving the consensus.*

The way of sharing documents in Team Banana was very similar to that of Team Apple, being through email. The difference was that only editors had the right to modify the shared document in Team Banana.

5.2.3 Output

Five participants from Team Banana answered the questionnaire. Overall, respondents from Team Banana thought it was an effective PG team. The respondents strongly agreed upon three items — team purpose achievement, team performance, and efficiency. The respondents indicated that Team Banana could do better on other items, including team relationship satisfaction, delivery on time, and the communication/exchange of ideas. The summary is presented in Figure 10.

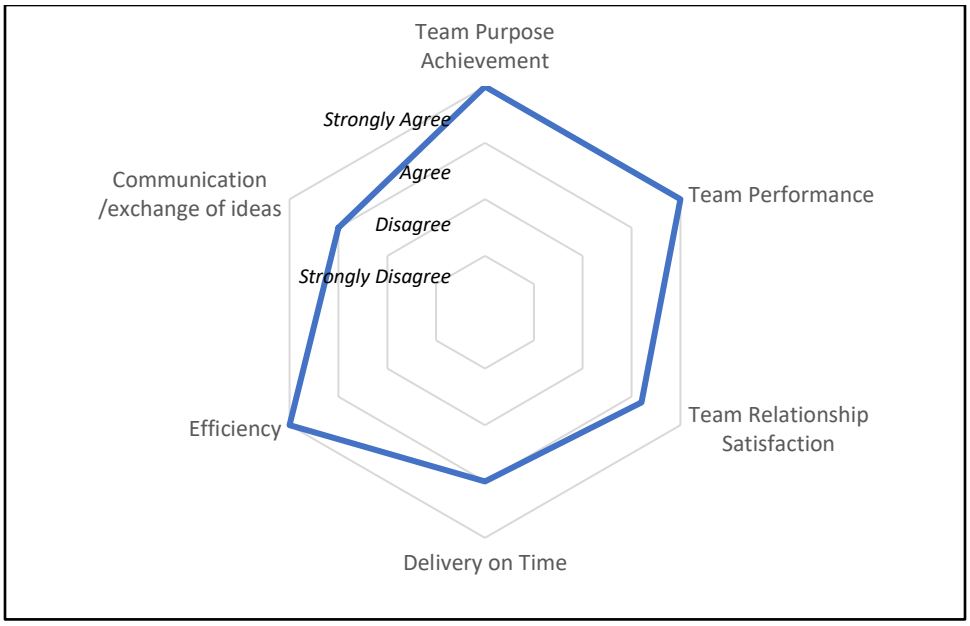

Figure 10: Team effectiveness assessment of Team Banana

5.2.4 Summary

The findings for Team Banana are summarized and presented in Figure 11.

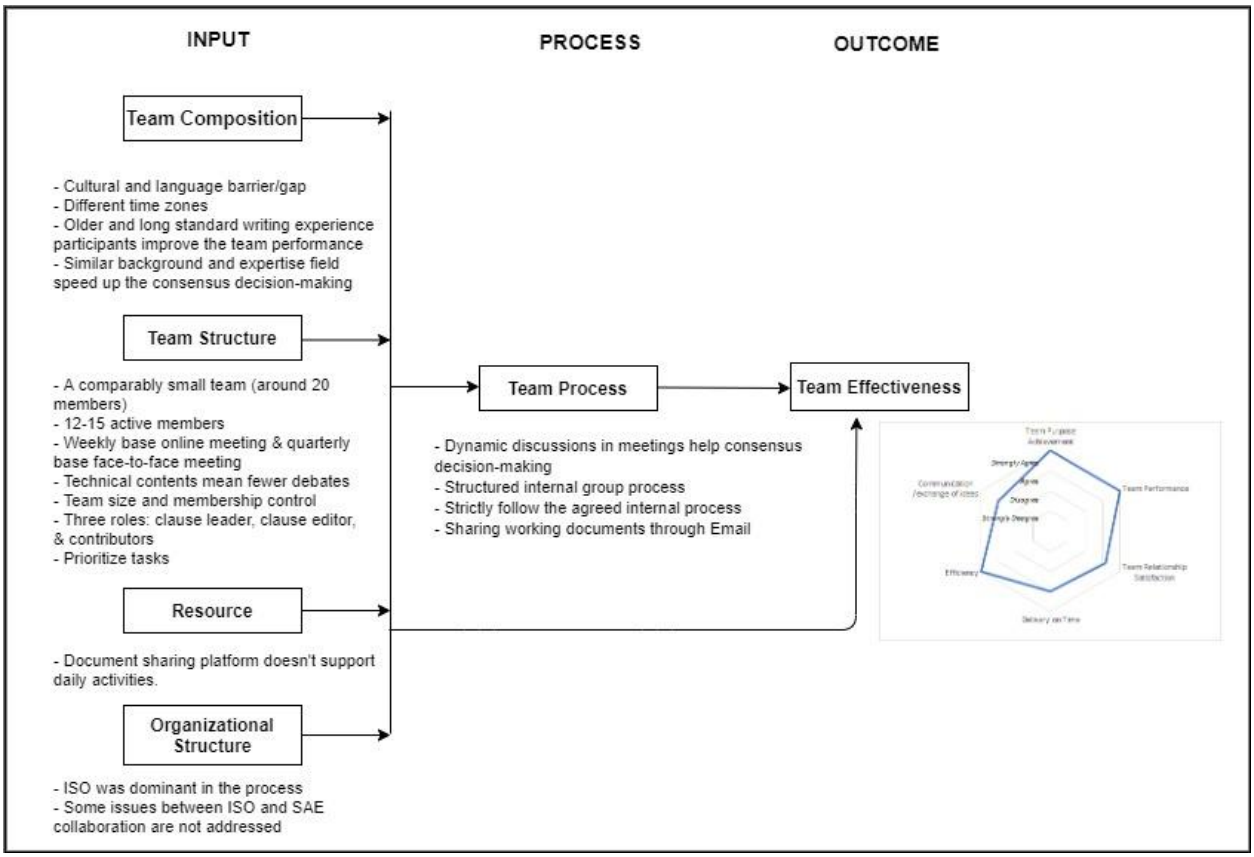

Figure 11: A summary of Team Banana findings

5.3 Team Citrus

5.3.1 Input

5.3.1.1 Team composition

The experts on Team Citrus tended to achieve a balance between industry and countries, as one expert described:

> *A mix of the experts and national delegations representing their nations.*

Like Team Apple and Team Banana, cultural and language gaps existed in Team Citrus. Beyond that, one participant explained in more detail and more explicitly about where a source of conflicts was:

> *People have a different mindset from different points of view. From my perspective, I want to be able to have to complete this cybersecurity standard as much as possible as a safe gate because it will help us to differentiate our product; for OEM, we don't*

have to be strictly regulated, they might spend more money. The reason is that people won't buy a car because one is more cyber secure than the other. People buy a car just expecting that it is secure. Selling security is a difficult thing to do. You can have a different level of insurance.

Another conflict came from the style of the organizational culture. As one respondent shared:

It is more about how they do things in ISO, and in SAE, this is very different. We do things quicker in SAE.

5.3.1.2 Team structure

Team Citrus did not follow any project management method and thus was more flexible. As one participant mentioned:

Team Citrus is very dynamic and the most informal group.

Another participant described it thusly:

Team Citrus is very American management style and very flexible.

The roles in Team Citrus were the same as in Team Apple. There were two roles: the contributor and the clause leader. For all topics assigned to Team Citrus, experts volunteer to be the clause leader.

People pick their part first and then assign them the rest of the tasks.

At the beginning, fewer people wanted to be the clause leader. We just had a discussion and picked the one who we thought was the best fit. Now, people are more likely to be the clause leader, and we seldom assign the clause leader. People are more committed to this project.

Team Citrus was responsible for limited and less controversial content compared to Team Apple. As one participant shared:

We have very limited items on the agenda.

5.3.1.3 Resources

Consistent with the research expectations, participants made comments on the software the project had adopted and used.

> *The alignment [with software] is not good. There are no ways to really manage emails. We couldn't auto send the emails to all members in Team Citrus. You need to copy and paste all member addresses manually. The system doesn't have team discussion support and therefore couldn't track what you have discussed through the emails. I think the system supports versioning, but we don't use that very well. We only have a list of N documents. We should have a track between the document number and the version number. Now, there is no way for you to go back to track changes somebody has made. The documents are not organized very well, and it is a big mess of the N document list.*

5.3.1.4 Organizational structure

Respondents also shared their opinions regarding ISO and SAE collaboration. In general, they thought that there had been a lack of agreements and rules before the project had started. According to one respondent:

> *They didn't appropriately write the agreement before they started it. They didn't go through the rule of engagement for it. They tried to force things to go along, but as the thing goes along, they had already made the position where they want to be. I don't see a great collaboration going on [with] the leadership. To be honest, I don't think people high up enough got involved with this. It should be somebody high up enough in ISO, and somebody high up enough in SAE.*

5.3.2 Process

Though Team Citrus was another small group in terms of size and task complexity, they spent a lot of time on the discussions, which they did not expect. As one respondent commented:

"We should have a better way to organize the meeting and make the contributions to some clause. Otherwise, people will keep talking as time runs out. You don't really move on."

Participants on Team Citrus complained about the procedure and process of this project. They thought things should have been planned out better and with sufficient documents, as is shown by this participant's opinion:

We should have some documents to record the process. There is no closure for some discussion points. There is no written conclusion. Therefore, the discussion just keeps going round and round. People need to move on.

Team Citrus made their decisions based on consensus in meetings. Compared to the other three teams, Team Citrus orally asked for consensus. However, since Team Citrus was more informal and did not have a strict protocol to follow, participants shared their concerns regarding the consensus decision making of PG and JWG levels:

This is a very unique project. We have two organizations involved and in equal weights: SAE and ISO. How to define the consensus? No one really brings this out.

In the meeting as well, one particular delegation is quite large, eight delegates. All delegates will vote, but it won't get the general consensus. They need the rule of getting a general consensus. One delegation is overwhelming the other delegates, they will persuade the meeting. This might not be a good thing. It is a game of consensus. The decision shouldn't take so long time. Again, there is no rule about that. For example, for some statements, we have an objector, we go through the same discussion again and again. Some delegation will keep raising the same points again and again.

In this ISO and SAE collaboration, the rule of voting keeps changing. There is no clear guidance on how long you have to give people to call a vote. Last year, there was a vote called in the last minute of the meeting.

Document sharing was another pain point for Team Citrus; the team shared opinions and documents through emails. First, it was tough to manage the different draft versions of the documents. Second, there was no document sharing between the various teams. Yet, there were a great deal of tasks interdependent upon each other. One respondent made the following comments:

> *We have multiple versions of one document. It is difficult to track changes. There are a lot of things which we are talking about in the JWG meeting, but no documents have been shared. The leadership should take care of them.*

5.3.3 Output

A total of seven participants on Team Citrus answered the team effectiveness assessment survey. Participants strongly agreed that Team Citrus had achieved the team's purpose and was able to deliver the result on time. Participants also agreed on three other statements — satisfactory team performance and efficiency, and the communication/exchange of ideas was good. However, the participants, to some extent, were unsatisfied with the team relationships among members. The overall scores are presented in Figure 12.

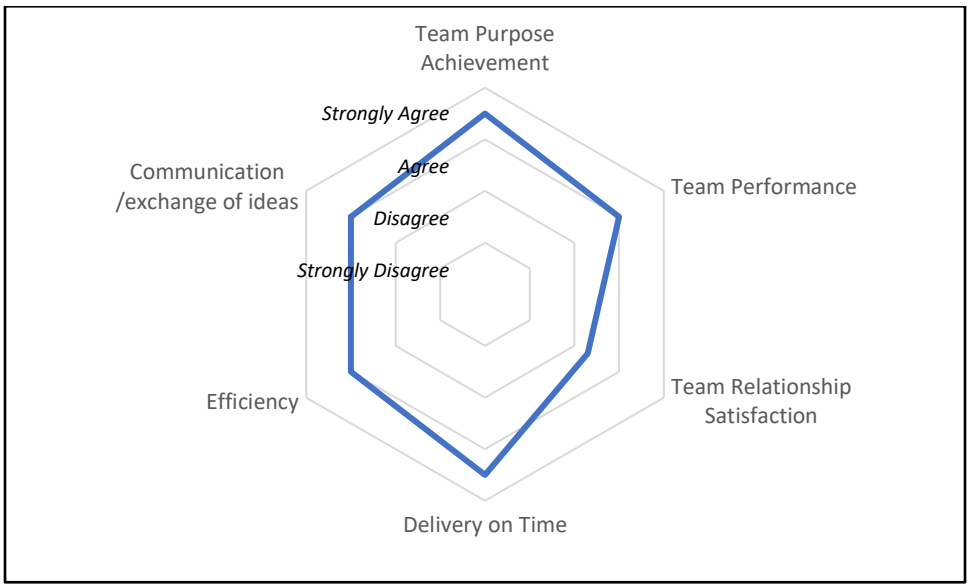

Figure 12: Team effectiveness assessment of Team Citrus

5.3.4 Summary

The findings for Team Citrus are summarized and presented in Figure 13.

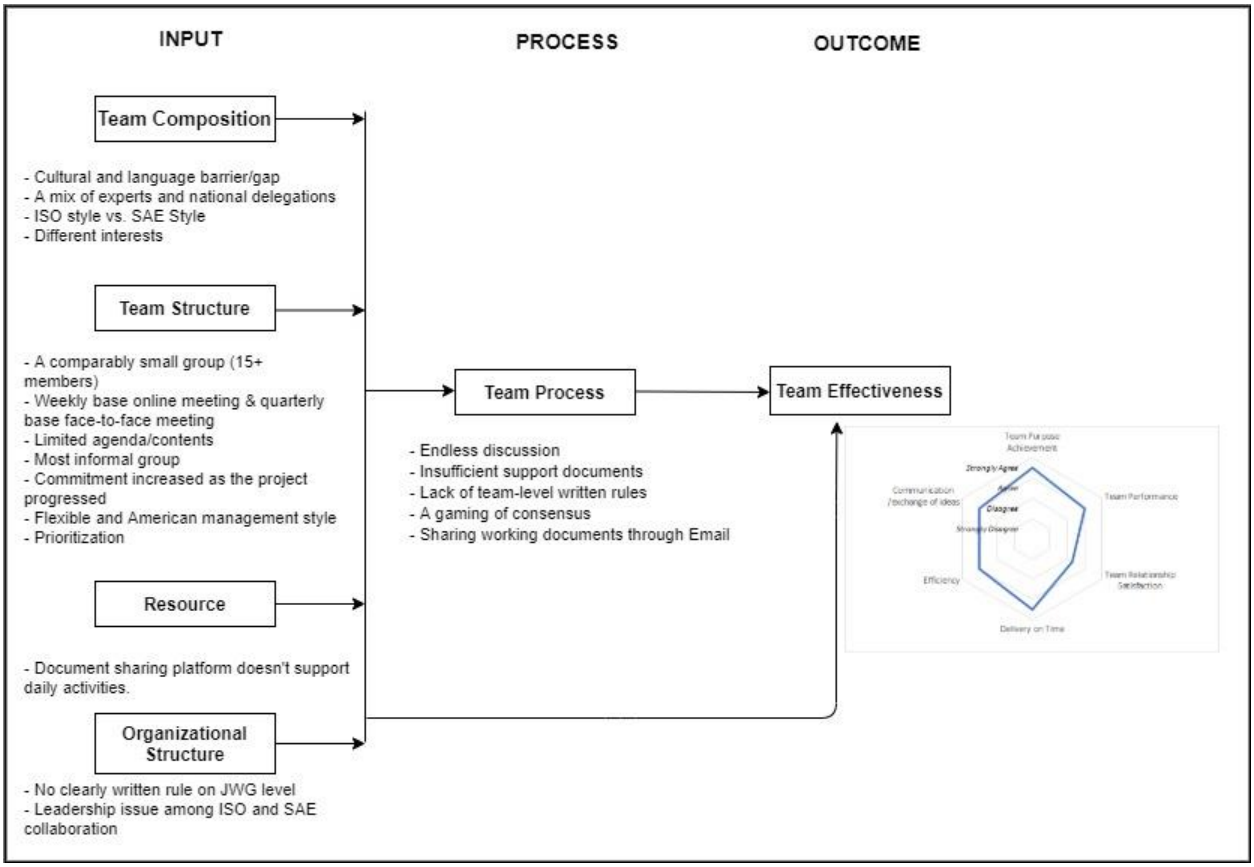

Figure 13: A summary of Team Citrus findings

5.4 Team Date

5.4.1 Input

5.4.1.1 Team composition

Team Date was a unique team in this project. Team Date's role was mainly for handling dependencies and processes, and it was not responsible for specific clauses. Unlike the other three teams, Team Date did not have to balance members from both the ISO and SAE organizations. Two members had the following to say:

> *Most of the participants are from the ISO side, and I am the only person from the SAE side.*

We have some strong personalities. Overall, I think we are working well.

5.4.1.2 Team structure

Most of Team Date's meetings were face to face. Therefore, attending the meetings could be another issue as pointed out by one of the participants:

> *Since our meetings are around the world, we need to get approval for our travel, for the PG meeting as well as the JWG, from our companies.*

Since Team Date was only responsible for managing the process and not for a specific clause, Team Date had only the contributor role — that is, all members of Team Date are contributors. Experts from Team Date shared their opinions regarding the commitment.

> *Commitment is the issues. [For some], their full job is working on standards development, but for some other their real job is not; they are voluntary on this project. A lot of companies don't realize the time they need to commit to this project. Because the organization changes, in the beginning, [we] have a balance. Everyone provides the effort they can.*

Team Date also did not follow any strict protocol, as the leadership team shared:

> *We don't have any written down rule. Everyone can put their comments. We let our members make their comments.*

5.4.2 Process

Participants were generally satisfied with the internal process of Team Date. As one respondent commented:

> *Team Date has a good and balanced process.*

Participants also shared their opinion regarding the discussion:

We have a very dynamic discussion. However, sometimes we have the issue that we don't stop the discussion.

Team Date used voting to make a consensus decision. However, they had an exceptional design for this voting. Every member was given three colors of cards — green, red, and yellow. When the group was called to vote, the participants only needed to show the card representing his/her opinion instead of just raising hands. Green represents the participant agrees with the proposal, yellow represents that the participant has some concerns, and red indicates that the participant disagrees with the proposal. One participant shared the following comments:

This voting method makes us [vote] quicker. You can just look around and know people's opinions. However, it takes more work for people. You have to prepare and read the comments ahead of time. During the group meeting, you should already have the idea. Instead of either [simply] agreeing or disagreeing, you should understand what they are asking for; this makes our process much faster and more efficient.

5.4.3 Output

A total of four participants from Team Date answered the team effectiveness assessment survey. Overall, the participants were neutral with respect to most of the statements — achieving the team purpose, team performance, team relationship satisfaction, and efficiency — while participants held a positive opinion to the other two statements regarding delivering on time and the communication/exchange of ideas. Average scores are presented in Figure 14.

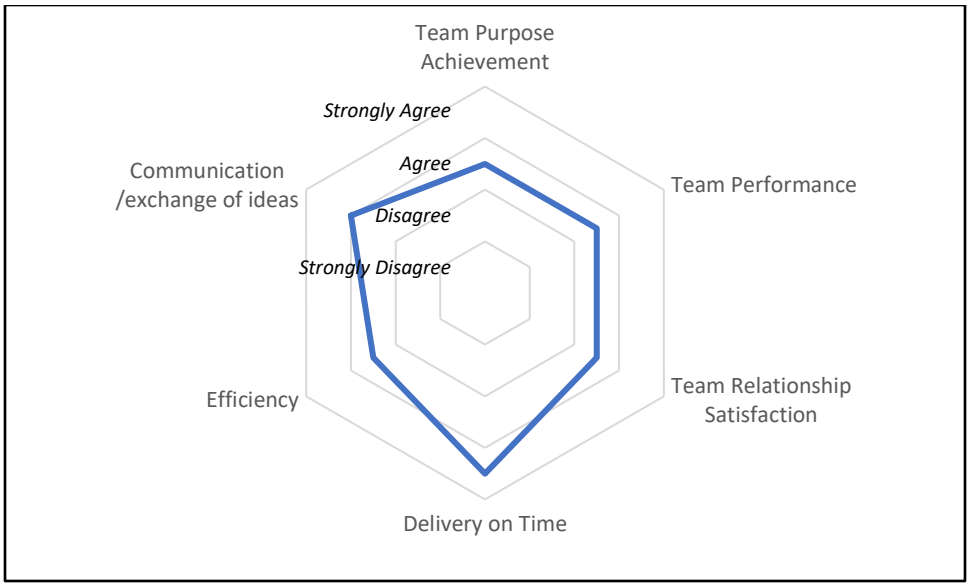

Figure 14: Team effectiveness assessment of Team Date

5.4.4 Summary

A summary of Team Date's findings is presented in Figure 15.

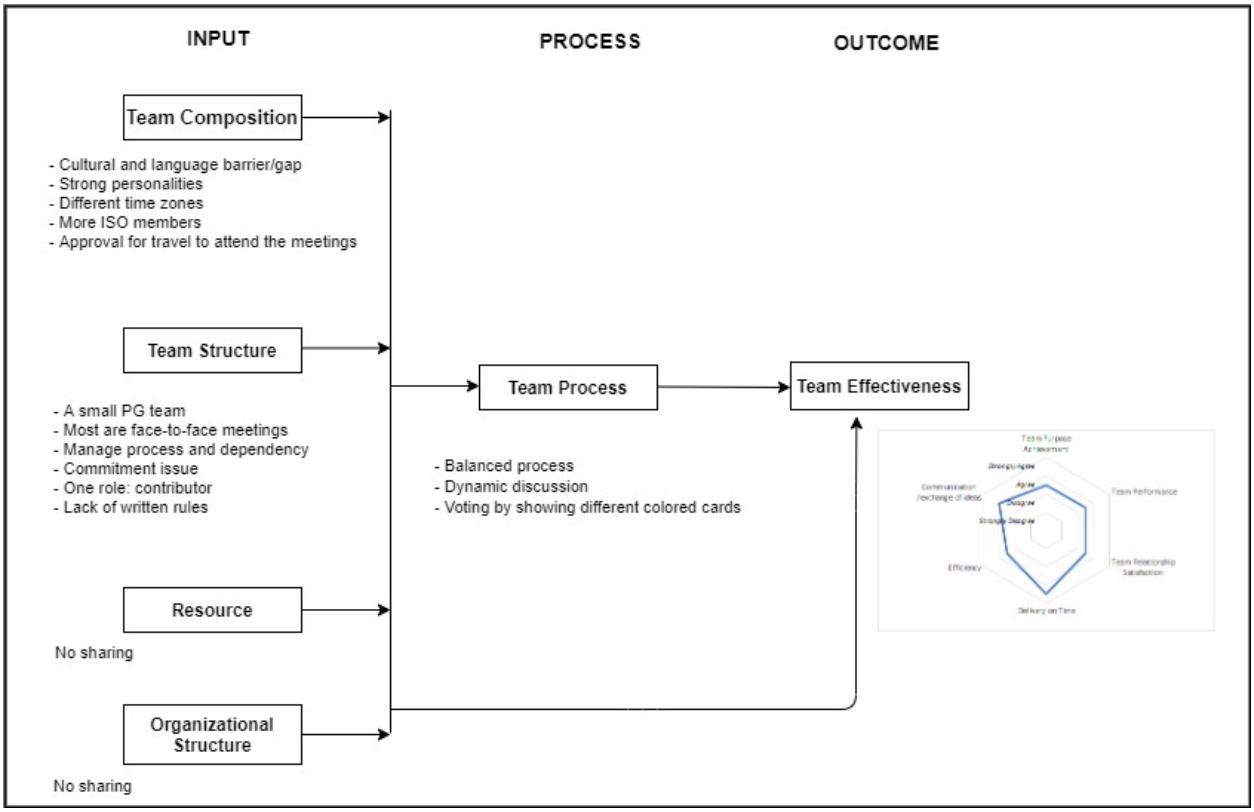

Figure 15: A summary of Team Date findings

Chapter 6 — Cross-team Findings and Discussion

This chapter discusses the findings from the four teams using cross-case perspectives. It intends to address the first research question by consolidating the three aspects of the previous analysis — the six facets of team effectiveness, the IPO factors, and the relationship between IPO factors and team effectiveness. The similarities and differences across the team are discussed. This is done by comparing the similarities and differences between team input and processes linked to a different team effectiveness level across the four teams, as the conceptual framework hypothesizes that the team input and process may be more or less deterministic with respect to team effectiveness.

6.1 Six aspects of team effectiveness and IPO factors

A summary of the four teams' effectiveness assessment is shown in Figure 16. The team effectiveness data were collected through a survey. Twenty-five questionnaires were received. None of the survey respondents in any of the PG working teams expressed complete satisfaction with different aspects of team effectiveness. Note that the four teams have very similar opinions on communication/the exchange of ideas, and the feedback is quite positive. There is a convergence on on-time delivery but a big divergence on the other four items of team relationship satisfaction, team performance, efficiency, and team purpose achievement.

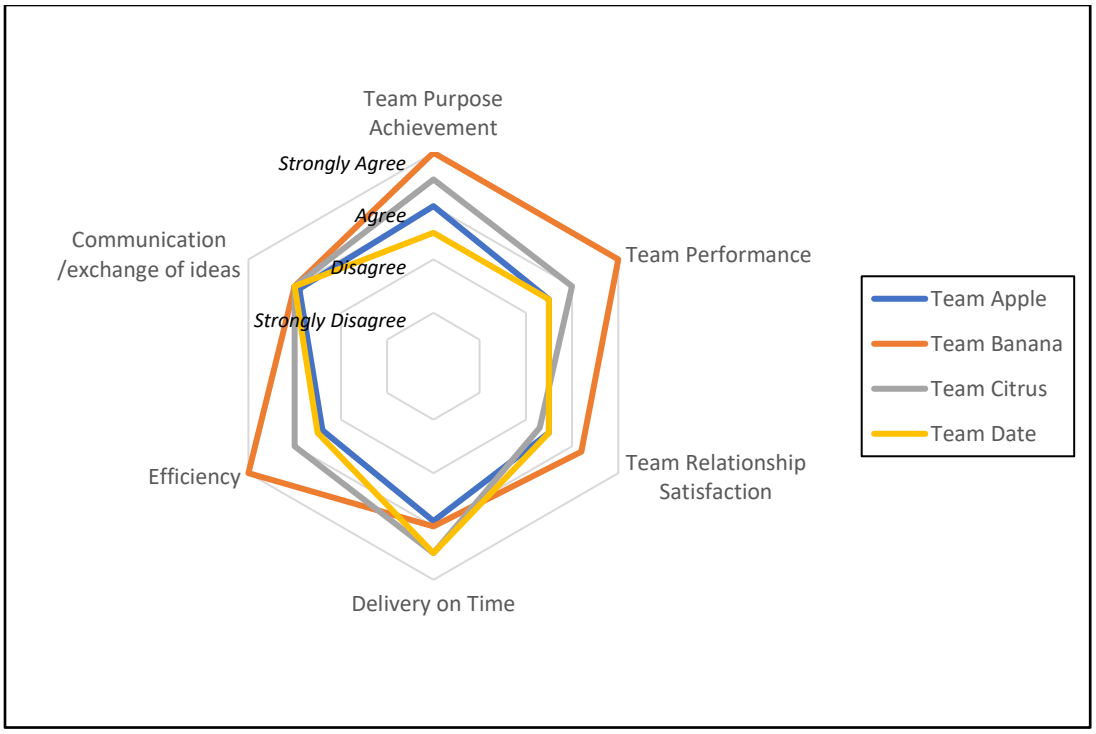

Figure 16: The summary of the four teams' effectiveness assessments

A comparison of the team input and process factors across the four teams is shown in Table 2. The information provided in this table was collected via interviews and observations. The IPO factors presented in the table are guided by the conceptual framework and constant comparison across the four teams. If a factor was mentioned in the conceptual framework and could be differentiated across the four teams, this factor is presented and compared in the table. Also, if any additional factor is obtained through the comparison, the factor was added to the table. It is important to note that the absence of any factor in the table does not indicate a lack of impact on team effectiveness, but that the factor did not contribute to the different team effectiveness levels.

Table 2: A comparison of the main IPO factors in four teams

	Team Apple	Team Banana	Team Citrus	Team Date
1. Team Composition				
1a. Deep-level diversity	High	Medium — low	Medium	Medium
1b. Expertise	High variety	Engineers only	High variety	Medium variety
1c. Member experience in writing standards	Medium	Medium—high	High	High
2. Team Structure				
2a. Team size	40+ members	Less than 20	Less than 20	Less than 20
2b. Membership control	Not applied	Applied	Not applied	Not applied
2c. Task complexity	High	Low—medium	Low—medium	Medium—high
2d. Goal clarity	Low—medium	High	High	Medium
2e. Role	Two roles: clause leader and contributor	Three roles: clause leader, clause editor, and contributor	Two roles: clause leader and contributor	One role: contributor
2f. Management methodology	Semi-flexible	Formal	Flexible	Flexible
2g. Commitment	A small proportion	High	High in the later stage	Medium
3. Team Process				
3a. Communication	Emails, online meetings (weekly), face-to-face meetings (quarterly)	Emails, online meetings (weekly), face-to-face meetings (quarterly)	Emails, online meetings (weekly), face-to-face meetings (quarterly)	Emails, some online meetings but mostly face-to-face meetings (quarterly)
3b. Decision making	Voting for everything	Asking for objections	Asking for consensus	Voting only for final decision
3c. Internal team process	Semi-formal	Very formal	Informal	Informal

Detailed discussions regarding IPO factors linked to each aspect of team effectiveness are provided below. The logic of factors selection is based on the following two criteria: the relevance in this study and the similarities and differences across the four teams.

6.1.1 Team purpose achievement

Table 3: Relationship between team purpose achievement and IPO factors

	Team Apple	Team Banana	Team Citrus	Team Date
Team Purpose Achievement	**LOW**	**HIGH**	**HIGH**	**LOW**
1. Team Composition				
1a. Deep-level diversity	High	Medium — low	Medium	Medium
1b. Expertise	High variety	Engineers only	High variety	Medium variety
1c. Member experience in writing standards	Medium	Medium—high	High	High
2. Team Structure				
2a. Team size	40+ members	Less than 20	Less than 20	Less than 20
2b. Membership control	Not applied	Applied	Not applied	Not applied
2c. Task complexity	High	Low—medium	Low—medium	Medium—high
2d. Goal clarity	Low—medium	High	High	Medium
2e. Role	Two roles: clause leader and contributor	Three roles: clause leader, clause editor, and contributor	Two roles: clause leader and contributor	One role: contributor
2f. Management methodology	Semi-flexible	Formal	Flexible	Flexible
2g. Commitment	A small proportion	High	High in the later stage	Medium
3. Team Process				
3a. Communication	Emails, online meetings (weekly), face-to-face meetings (quarterly)	Emails, online meetings (weekly), face-to-face meetings (quarterly)	Emails, online meetings (weekly), face-to-face meetings (quarterly)	Emails, some online meetings but mostly face-to-face meetings (quarterly)
3b. Decision making	Voting for everything	Asking for objections	Asking for consensus	Voting only for final decision
3c. Internal team process	Semi-formal	Very formal	Informal	Informal

The purpose of each PG team is to either develop the pre-assigned content or manage the process. Team Banana and Team Citrus have a comparatively higher average score than Team Apple and Team Date. This difference may be attributed to task complexity (2c), goal clarity (2d), and commitment (2g).

According to the literature, team members perform better if the goals are clear and specific (Latham et al., 2008; Latham & Locke, 2013; Rainey & Jung, 2015), which is consistent with the finding that Team Banana and Team Citrus have a more straightforward and clearer goal, leading to better team purpose achievement, while Team Apple and Team Date were assigned far more sophisticated tasks; less specified goals make the evaluation of purpose achievement harder.

In addition, team purpose is achieved through team members' individual contributions, which are pooled or constructed in a fixed serial sequence. More commitment to the pre-assigned task leads to higher-level team purpose achievement. Members on Team Banana and Team Citrus are more committed to their tasks according to the interviews, while Team Apple and Team Date participants expressed some commitment issues.

Based on the comparison, the team structure component affects the team purpose achievement of team effectiveness.

6.1.2 Communication/exchange of ideas

Table 4: Relationship between communication aspect and IPO factors

	Team Apple	Team Banana	Team Citrus	Team Date
Communication/ exchange of ideas	**MEDIUM**	**MEDIUM**	**MEDIUM**	**MEDIUM**
1. Team Composition				
1a. Deep-level diversity	High	Medium — low	Medium	Medium
1b. Expertise	High variety	Engineers only	High variety	Medium variety
1c. Member experience in writing standards	Medium	Medium—high	High	High
2. Team Structure				
2a. Team size	40+ members	Less than 20	Less than 20	Less than 20
2b. Membership control	Not applied	Applied	Not applied	Not applied
2c. Task complexity	High	Low—medium	Low—medium	Medium—high
2d. Goal clarity	Low—medium	High	High	Medium
2e. Role	Two roles: clause leader and contributor	Three roles: clause leader, clause editor, and contributor	Two roles: clause leader and contributor	One role: contributor
2f. Management methodology	Semi-flexible	Formal	Flexible	Flexible
2g. Commitment	A small proportion	High	High in the later stage	Medium
3. Team Process				
3a. Communication	Emails, online meetings (weekly), face-to-face meetings (quarterly)	Emails, online meetings (weekly), face-to-face meetings (quarterly)	Emails, online meetings (weekly), face-to-face meetings (quarterly)	Emails, some online meetings but mostly face-to-face meetings (quarterly)
3b. Decision making	Voting for everything	Asking for objections	Asking for consensus	Voting only for final decision
3c. Internal team process	Semi-formal	Very formal	Informal	Informal

The survey respondents tend to have very similar opinions toward communication/exchange of ideas since the frequency and communication channels (3a) are similar across all four teams. According to the interviewees, all participants frequently change their ideas through circulating emails and weekly

online meetings. Three out of four teams in the drafting and revision stages met virtually almost weekly and held a face-to-face meeting quarterly.

However, the researcher continuously heard complaints regarding the online document management system. Although the system is user-friendly, it lacks functions such as managing emails, commenting on the document directly, and tracking the changes of different versions. The lack of system support could be considered a barrier to engaging participants in communication and frequently exchanging their ideas.

Based on the comparison, the team process component impacts and contributes to the team effectiveness in communication.

6.1.3 Efficiency

Table 5: Relationship between efficiency and IPO factors

	Team Apple	Team Banana	Team Citrus	Team Date
EFFICIENCY	**MEDIUM**	**HIGH**	**MEDIUM**	**MEDIUM**
1. Team Composition				
1a. Deep-level diversity	High	Medium — low	Medium	Medium
1b. Expertise	High variety	Engineers only	High variety	Medium variety
1c. Member experience in writing standards	Medium	Medium—high	High	High
2. Team Structure				
2a. Team size	40+ members	Less than 20	Less than 20	Less than 20
2b. Membership control	Not applied	Applied	Not applied	Not applied
2c. Task complexity	High	Low—medium	Low—medium	Medium—high
2d. Goal clarity	Low—medium	High	High	Medium
2e. Role	Two roles: clause leader and contributor	Three roles: clause leader, clause editor, and contributor	Two roles: clause leader and contributor	One role: contributor
2f. Management methodology	Semi-flexible	Formal	Flexible	Flexible
2g. Commitment	A small proportion	High	High in the later stage	Medium
3. Team Process				
3a. Communication	Emails, online meetings (weekly), face-to-face meetings (quarterly)	Emails, online meetings (weekly), face-to-face meetings (quarterly)	Emails, online meetings (weekly), face-to-face meetings (quarterly)	Emails, some online meetings but mostly face-to-face meetings (quarterly)
3b. Decision making	Voting for everything	Asking for objections	Asking for consensus	Voting only for final decision
3c. Internal team process	Semi-formal	Very formal	Informal	Informal

In terms of efficiency, Team Banana is the most efficient team, while Team Apple is the least efficient. Team Apple and Team Banana have some critical differences in input and process. Several potential reasons, such as deep-level diversity (1a), expertise (1b), team size (2a), member control (2b),

role (2e), decision making (3b), and internal team process (3c), can be drawn from the comparison and explain the variance in team efficiency.

First, as discussed by many respondents from Team Apple, participants hardly agree on the fundamental concepts. This issue is partly attributed to the assigned content itself since most of the content is very controversial and undecided in the industry; it can also be partly attributed to participants from diverse industries and fields in which people follow a variety of methodologies and understand concepts differently. According to the interviews, some communication problems in Team Apple occur because of the use of technical or domain-specific language that is unique to their area of expertise and, therefore, unfamiliar or different to other team members. The domain's unique language reflects deeper differences in underlying assumptions and methodology, consistent with the previous literature (Eigenbrode et al., 2007). Those deep-level differences lead to collaboration and communication problems and negative impacts team efficiency.

The team size is significant in the study of the teams and groups. Though large team size provides the chance to address large-scale and more complex problems effectively (Gallupe et al., 1992), large team size is also identified with process losses (Liden et al., 2004). Team size, consistent with many studies (Wuchty et al., 2007), has been widely discussed and influences team efficiency. The size of Team Apple, the largest among the four teams, adds numerous complexities to managing the team processes and communications, as well as to building team cohesion. As a comparison, Team Banana realized that the team size might be causing the process issues, so the leadership team of Team Banana installed some rules to control the team size. It is clear to see that Team Banana has a higher average of team efficiency. Therefore, a practical implication can be drawn from this. Basic team size control and membership control may be necessary to manage team complexity effectively.

Regarding team roles, Team Banana is the only team that had three roles. All four teams suffered to some extent from language and cultural barriers. Team Apple and Team Citrus did not take active actions to mitigate this issue because the participants in the teams got to know each other and understand each other's writing as the project progressed. However, Team Banana designed a role called clause editor to help the clause leader to manage and to keep the quality and consistency of the writing, so that the participants do not waste time discussing the writing and the specific words. One participant from Team Apple shared the following comments:

> *We start talking and finding out what their objection was in the ballot that didn't pass and then found out it was just little word changes. In my opinion, some people were getting too focused on the word.*

The process of decision making is another factor that decreases efficiency in Team Apple. Compared to the other three teams, Team Apple is the only team that requires voting on every tiny decision. The leadership team shared the reason for bringing everything to vote:

> *In the beginning, there is a requirement from [one national delegation] that they want to vote on everything because language challenges and somethings goes too fast.*
>
> *A ballot of vote will force you [team member] to look at the proposal and encourage them to go over it. Also, as long as we vote, we have official records… If we don't vote on everything, I'm concerned about people later disagreeing with something that was published because there weren't a vote and people don't go over it.*

One member from Team Apple comments on the method of decision making:

> *The decision making is not efficient.*

Last but not least, a detailed and structured internal process is essential. Many respondents from Team Apple complained about the internal team process, such as when to call a vote, how to call a

vote, and the rules for voting. Respondents were confused over some general team rules and policies. These unclear rules led to redundant and repeated team processes. For instance, some controversial topics were called to a vote repeatedly because of a lack of clear rules to guide members about what can and cannot be called to a vote. Members tried hard to put their interests into the agenda.

Based on the above analysis, the team structure component affects the efficiency aspect of team effectiveness.

6.1.4 Delivery on time

Table 6: Relationship between delivery on time and IPO factors

	Team Apple	Team Banana	Team Citrus	Team Date
DELIVERY ON TIME	**MEDIUM**	**MEDIUM**	**MEDIUM**	**MEDIUM**
1. Team Composition				
1a. Deep-level diversity	High	Medium — low	Medium	Medium
1b. Expertise	High variety	Engineers only	High variety	Medium variety
1c. Member experience in writing standards	Medium	Medium—high	High	High
2. Team Structure				
2a. Team size	40+ members	Less than 20	Less than 20	Less than 20
2b. Membership control	Not applied	Applied	Not applied	Not applied
2c. Task complexity	High	Low—medium	Low—medium	Medium—high
2d. Goal clarity	Low—medium	High	High	Medium
2e. Role	Two roles: clause leader and contributor	Three roles: clause leader, clause editor, and contributor	Two roles: clause leader and contributor	One role: contributor
2f. Management methodology	Semi-flexible	Formal	Flexible	Flexible
2g. Commitment	A small proportion	High	High in the later stage	Medium
3. Team Process				
3a. Communication	Emails, online meetings (weekly), face-to-face meetings (quarterly)	Emails, online meetings (weekly), face-to-face meetings (quarterly)	Emails, online meetings (weekly), face-to-face meetings (quarterly)	Emails, some online meetings but mostly face-to-face meetings (quarterly)
3b. Decision making	Voting for everything	Asking for objections	Asking for consensus	Voting only for final decision
3c. Internal team process	Semi-formal	Very formal	Informal	Informal

It deserves to be noted that people have significant variance in their opinions toward team efficiency, but people across all four teams still have a similar opinion regarding delivery on time. It is difficult to find the IPO factors that can explain this convergence. A possible reason could be that each

team works on their tasks, but the deadline for each team is the same, and there are many dependencies among teams' tasks. Therefore, the view on delivery on time tends to converge.

However, the convergence on delivery time with a large variance in terms of efficiency indicates the possibility that the low-efficiency team has lowered the whole project efficiency and is a bottleneck regarding efficiency improvement.

Therefore, this aspect will be eliminated from my conclusion because the difference in IPO factors hardly explains the convergent trend of delivery on time.

6.1.5 Team performance

Table 7: Relationship between team performance and IPO factors

	Team Apple	Team Banana	Team Citrus	Team Date
TEAM PERFORMANCE	**MEDIUM**	**HIGH**	**MEDIUM-HIGH**	**MEDIUM**
1. Team Composition				
1a. Deep-level diversity	High	Medium — low	Medium	Medium
1b. Expertise	High variety	Engineers only	High variety	Medium variety
1c. Member experience in writing standards	Medium	Medium—high	High	High
2. Team Structure				
2a. Team size	40+ members	Less than 20	Less than 20	Less than 20
2b. Membership control	Not applied	Applied	Not applied	Not applied
2c. Task complexity	High	Low—medium	Low—medium	Medium—high
2d. Goal clarity	Low—medium	High	High	Medium
2e. Role	Two roles: clause leader and contributor	Three roles: clause leader, clause editor, and contributor	Two roles: clause leader and contributor	One role: contributor
2f. Management methodology	Semi-flexible	Formal	Flexible	Flexible
2g. Commitment	A small proportion	High	High in the later stage	Medium
3. Team Process				
3a. Communication	Emails, online meetings (weekly), face-to-face meetings (quarterly)	Emails, online meetings (weekly), face-to-face meetings (quarterly)	Emails, online meetings (weekly), face-to-face meetings (quarterly)	Emails, some online meetings but mostly face-to-face meetings (quarterly)
3b. Decision making	Voting for everything	Asking for objections	Asking for consensus	Voting only for final decision
3c. Internal team process	Semi-formal	Very formal	Informal	Informal

Through the analysis and comparison, the possible reasons that contribute to team performance across the four teams are deep-level diversity (1a), team size (2a), task complexity (2c), management (2f), commitment (2g), and communication (3a).

De Dreu and Weingart (2003) suggest that conflicts have a strong negative impact on team performance in highly complex tasks, consistent with this study. According to De Drue and Weingart (2003), conflicts may refer to relationship conflicts, such as personal taste, values, motivation, interests, cultural factors, interpersonal styles, or task conflicts, such as the distribution of resources, procedures, and judgments and the interpretation of facts. Those conflicts rooted in deep-level diversity impact on team performance. Yet, more complex tasks require more team members to be involved and from multiple domains. When a team must complete such tasks, knowledge integration can be challenging since knowledge integration requires combining and deeply integrating a broad set of stakeholder perspectives. When a team fails to identify, discuss, and clarify the knowledge discrepancy among its members, confusion and conflict can arise.

The questionnaire responses and observations showed that Team Apple was assigned the most complex tasks covering a great deal of controversial content. Therefore, Team Apple involved the largest number of experts with diverse expertise. As a result, many recurrent debates happened repeatedly. According to the researcher's observation, the experts did not reach agreement on some core concepts even when the final standard draft was ready. It took time for people to achieve a deep level of knowledge integration. The highest-level of task complexity and deep-level diversity of Team Apple may be the reason for lower team performance. When the participants were asked what could be improved the next time, one shared the following comment:

> *We should have more processes done at the beginning, such as sharing knowledge. We should have some introductory presentations from different perspectives and bring what we know to the table.*

Meanwhile, there is a considerable body of literature on the effect of team size on team performance. While a large number of participants can bring many benefits, Stokols et al. (2008) found that a multi-institutional team requires a lot of preparation and trust among members to achieve a

comparatively high performance. In terms of the four teams, participants from Team Apple made comments regarding the large team size while participants from the other teams seemed okay with their team sizes, as one participant from Team Apple mentioned:

> *It is very challenging and hard to make progress: one is the [team] size, and the other is the topics itself.*

Though no participants mentioned there were management issues in their teams, Team Banana and Team Citrus members stated that both groups adopted several principles and methods from agile management, such as the prioritization and estimation of tasks, while Team Apple and Team Date were just using flexible management styles without explicitly specifying any management principle or practice. The findings of the cross-team analysis indicate that the adoption of agile management principles and practices can enhance team performance as well as team effectiveness.

Besides team composition and structure issues, communication is another factor that has been identified as an influential in regard to team performance (Salas et al., 2008). In a multidisciplinary team, members trained in different disciplines combine their expertise in an additive way. Complex structures incorporate the integration of knowledge and tasks through collaboration and feedback links, making the quality of team member interaction more important to team performance and ultimately to team effectiveness. Less frequent team-based meetings might contribute to Team Date's lower-than-average team performance score.

Based on the analysis, team structure significantly influences the team performance aspect of team effectiveness.

6.1.6 Team relationship satisfaction

Table 8: Relationship between team relationship satisfaction and IPO factors

	Team Apple	Team Banana	Team Citrus	Team Date
RELATIONSHIP SATISFACTION	**MEDIUM**	**HIGH**	**MEDIUM**	**MEDIUM**
1. Team Composition				
1a. Deep level diversity	High	Medium-low	Medium	Medium
1b. Expertise	High variety	Engineers only	High variety	Medium- high variety
1c. Member experience in writing standards	Medium	Medium-high	High	High
2. Team Structure				
2a. Team size	40+ members	Less than 20	Less than 20	Less than 20
2b. Membership Control	Not applied	Applied	Not applied	Not applied
2c. Task complexity	High	Low - Medium	Low - Medium	Medium -high
2d. Goal clarity	Low - Medium	High	High	Medium
2e. Role	Two roles: clause leader and contributor	Three roles: clause leader, clause editor, and contributor	Two roles: clause leader and contributor	One role: contributor
2f. Management methodology	Semi-flexible	Formal	Flexible	Flexible
2g. Commitment	A small proportion	High	High in the later stage	Medium
3. Team Process				
3a. Communication	Emails, online meetings (weekly), face-to-face meetings (quarterly)	Emails, online meetings (weekly), face-to-face meetings (quarterly)	Emails, online meetings (weekly), face-to-face meetings (quarterly)	Emails, some online meetings, but mostly face-to-face meetings (quarterly)
3b. Decision making	Voting for everything	Asking for objections	Asking for consensus	Voting only for final decision
3c. Internal team process	Semi - formal	Very formal	Informal	Informal

The average scores of team performance and team relationship satisfaction are very similar between the four teams. It seems that a team with a lower performance rate tends to have a lower relationship satisfaction rate and vice versa. Through the comparison, the possible reasons that contribute to the team relationship satisfaction across the four teams are deep-level diversity (1a) and expertise (1b).

Therefore, the team composition component influences the team relationship satisfaction aspect of team effectiveness.

6.2 Conclusion

Based on the discussion so far, conclusions are drawn based on the analysis of the data collected from the observations, interviews, and questionnaires in order to answer the first research question: "*What factors impact team effectiveness in the process of creating International Technology Standards?*"

Generally, team structure is the most important IPO factors influencing team effectiveness under the standards creation context. A set of conclusions can be drawn from the cross-team comparison and analysis regarding how IPO factors contribute to team effectiveness:

1) Team structure (i.e., task complexity, goal clarity, and commitment) is the major component in the IPO model that impacts team purpose achievement.
2) Team structure (i.e., member control, task complexity, management, and commitment) is the major component in the IPO model that impacts team performance.
3) Team structure (i.e., team size, member control, and goal clarity) and team process (i.e., decision making and internal team process) are the major components in the IPO model that impacts team efficiency.
4) Team composition (i.e., deep-level diversity and expertise) is the major component in the IPO model that impacts team relationship satisfaction.
5) Team process (i.e., communication) is the major component in the IPO model that impacts communication/the exchange of ideas.

Chapter 7 — Discussion

The cross-team analysis addresses the first research question by highlighting the IPO factors and components that impact team effectiveness. This chapter further discuss the findings in light of the second research question, "*What particular lessons learned from the case of ISO/SAE 21434 should lead future work in creating International Technology Standards?*"

The previous chapter concludes that team composition, team structure, and team process have different impacts on team effectiveness. However, the nature of team composition in a standard creation team is hard to change. A standards creation team is slightly different from other project teams as team members are voluntary based. Team composition results from the mutual selection process of assembling a combination of team members with the expertise, knowledge, interests, and skills necessary for accomplishing team tasks. This diverse nature enables the success of a standards creation project yet brings many challenges to the team process and ultimately impacts team effectiveness.

However, it is clear that Team Banana outperforms the other teams in most aspects of team effectiveness. It is not surprising that Team Banana implemented many special team designs in regard to team structure and team process. Also, it is found that teams with similar team composition and nature of task, performed so differently. Therefore, the conclusion also indicates that team design choices, such as team structure and team process, are the two key factors that deserve more attention and could be manipulated for better team outcome. In other words, team structure and team process could be viewed as contingent factors that are flexible in choosing to suit the team composition and nature of task to deliver better team outcome. Instead of investing efforts on re-specifying inputs, devoting efforts on team design choice is a better approach.

Therefore, an Input-Choice-Outcome (ICO) framework is proposed and shown in Figure 17. Comparing to IPO model, the proposed ICO framework is specialized for standards creation teams and

focuses on contingent variable: team design choice (i.e., team structure and team process) that could mitigate the risk from input and derive a better team outcome. The ICO framework includes three parts — input, team design choice, and outcome.

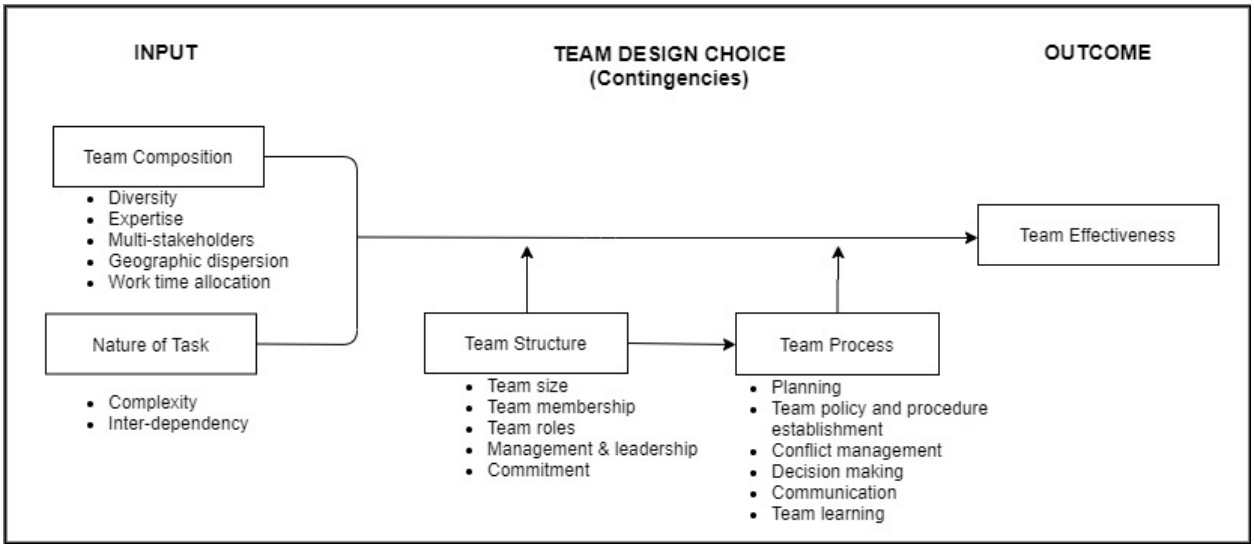

Figure 17: Proposed ICO framework

The input includes the team composition and the nature of the tasks in a standards creation team. These two inputs are pre-determined and hard to change since the team composition results from a mutual selection process and the tasks are aligned with the scope and the objective of a standard. The relationship between team input and team outcome is moderated by team design choice or – in other words – contingencies. The team design choice includes the design choices for team structure and design choices for team process. The choices for team structure and team process listed in Figure 17 are either from interviewees' comments or researcher's observations and thoughts. As shown in Figure 17, the design choice is influenced by inputs. Note that team process is also influenced by team structure. As given team composition and nature of task, team leader is flexible in choosing and adapting different team structure and team process to address any paradox and issue introduced by inputs and to improve team effectiveness. Such paradox and issue, for example, could result from diversity, as diversity is known to bring a lot of advantages to a team but to be very challenging to manage. Consequently, a

highly diverse standards creation team with a very complex task, the team probably requires a lot of special designs to mitigate the risk from diversity and complexity. Outcomes represent the effect of the process of transforming team inputs into outputs through design.

The ICO framework intends to serve as a conceptual framework for standards creation teams regarding how to design the team structure and team process for a better team outcome.

Also, based on the comparative analysis of the four teams and the proposed ICO framework, several lessons learned from this interpretative case study are highlighted in the following.

1. An appropriate team structure design can mitigate the challenges from diversity.

The diverse nature of the team brings benefits as well as many challenges to the team process. The researcher observed several practices adopted by Team Banana to mitigate these challenges. For instance, as mentioned by the leadership team, Team Banana intentionally controlled the team size and membership such that the team had a more stabilized membership according to their assigned tasks. This means that Team Banana could potentially mitigate the communication challenges resulting from the surface-level diversity and deep-level diversity and facilitate the formation of shared understanding and knowledge. Similarly, Cook and Hilton (2015, p. 94) suggest avoiding unnecessary challenges of size and diversity by analyzing the tasks and requirements of team members of various disciplines. Additionally, instead of two roles, Team Banana created an additional role of clause editor, with the intention to address language issues and transform ideas into high-quality written documents, which actually increased the efficiency and team performance.

2. Team learning is an important team design choice in the team process.

Standards creation teams face many of the same process challenges as traditional working teams do, such as a high diversity of membership, geographic distribution, and deep knowledge discrepancy

and integration. The literature on team effectiveness shows that learning is an intervention to facilitate positive team processes as well as ultimately improve team effectiveness (Shuffler et al., 2011; Delise et al., 2010).

However, based on the researcher's observations and interviews, the team learning activities are insufficient and to some extent are missing. According to the literature, there are three categories of learning outcomes, as follows (Cannon-Bowers et al., 1995; Salas et al., 2008; Klein et al., 2009; Delise et al., 2010; Shuffler et al., 2011):

- team knowledge (e.g., task understanding, shared mental models, role knowledge);
- team skills (e.g., communication, assertiveness, situation assessment); and
- team attitudes (e.g., team orientation, trust, cohesion).

Team Banana, because of similar expertise levels and backgrounds of the experts, could integrate their knowledge through their work without additional learning activities, but this is not the case for the other high diversity teams. Therefore, considering the nature and reality of standards creation teams, team learning should be installed at an early stage of the project and cultivate at least the team knowledge and team attitudes learning outcomes. First, standards creation teams are composed of participants with distinct sets of knowledge and expertise, which requires integration to facilitate effective collaborative performance and avoid unnecessary debates in the latter stages. Rentsch et al. (2010) showed that team learning on knowledge building can improve knowledge transfer (i.e., the exchange of knowledge from one team member to another), knowledge interoperability (i.e., shared knowledge that multiple team members can recall and use), and higher performance on the task. In a follow-up study, Rentsch et al. (2014) found that, compared to untrained teams, the team trained to build knowledge shared more unique information, transferred more knowledge, and produced higher-quality solutions to a realistic problem-solving task than other teams.

3. Team policy and procedure are critical.

Studies have shown the influence of best management practice on team effectiveness. Essentially, standards creation teams are very similar to other project teams, which need management to develop a concrete plan for carrying out work. The researcher observed that Team Banana adopted several principles and methods from agile management, such as the prioritization and estimation of tasks. Unfortunately, some management practices are missing in some of the four teams, which can lead to bad consequences such as delays and inefficient team processes.

According to the interviewees' opinions, prioritization increases the efficiency of the internal team process, which is consistent with the questionnaire results. The prioritization of tasks helps teams to streamline the process as well as manage task interdependency. Besides prioritization, estimation is another key concept in agile management and is adoptable by standards creation teams. Estimation helps to produce a better "game plan," allocate resources and contribute time to each assigned task, and monitor the progress.

Overall, these management principles and practices mean that teams spend more time on planning, experimenting, executing, and learning and less time on speculation and debating. The cycle time for each task delivery is reduced, enabling teams to incorporate other stakeholders' feedback and other learning into the next version.

Chapter 8 — Conclusion

This study investigated the team effectiveness of four standards creation teams in the process of creating ISO/SAE 21434 International Technology Standards. The goals were to understand the key features that impact team effectiveness, to learn from the case, and to provide practical recommendations for future standards creation projects.

The results presented in this study are based on a detailed and rigorous investigation of four standards creation teams. The study offers theoretical and practitioner insights into the process of International Technology Standards creation. A set of conclusions are drawn from the cross-team comparison, an ICO framework is proposed, and three lessons learned are provided.

The findings indicate that team design choices are critical factors impacting team effectiveness and can mitigate the challenges from team level input, such as team composition and the nature of task. Specifically, the findings suggest that as the team is more diverse and the task is more complex, the design of the team structure and the team process needs more consideration.

8.1 Implications for research

This research contributes to the existing research on the processes of international standards creation in the following ways. First, this investigation focused on the standards creation team's effectiveness, while most of the prior research has focused on the standard creation project itself. Second, this research adds to the existing body of research regarding the process of International Technology Standards creation. Last but not least, this research proposes an ICO framework that can direct future standards creation teams.

8.2 Implications for practice

As technology advances at a high speed, more and more International Technology Standards need to be created to foster adoption. Chapter 6 identifies the factors that affect the six aspects of team effectiveness, and Chapter 7 proposes a conceptual framework that can be used to mitigate the challenges that existed in this case. In addition to the lessons learned, the results of this research will provide valuable insights for practitioners in the following ways.

First, the research provides insights that will help standards creation teams to improve team effectiveness during the creation process. It identifies a set of lessons learned from the case of ISO/SAE 21434.

Second, it seeks to understand and describe the team-level input that shapes the team process and ultimately impacts team effectiveness. This provides a better understanding of the factors that shape the team process as well as ultimately influence team effectiveness in the process of standards creation.

Third, it provides practitioners with insights into how to mitigate the challenges caused by team-level input. This enables practitioners to be proactive in establishing a more detailed game plan and adopting management principles and practices at an early stage.

8.3 Limitations

There are some limitations of this study in the areas of trustworthiness and generalizing to theory. As a qualitative case study, the research findings are highly context- and case-dependent. There are possibilities of selection bias because the method used to select respondents was purpose sampling. The researcher tried to include as many participants as possible from each team to acquire greater knowledge of the team. However, this was mitigated by having key informants review the narrative drafts, using multiple sources of evidence, and engaging with participants. Also, there is the possibility

that there are other team-level factors that shape the team process and influence team effectiveness. This was mitigated by conducting cross-case comparison and analysis and an iterative analysis process.

With regard to generalizing to theory, as demonstrated, this case is unique; the process of ISO/SAE 21434 standard creation may not be a representative sample of most international standards creation projects. The limitation may be mitigated through a follow-up study where practitioners can apply the findings in this study to other standards creation projects.

8.4 Future research

While this research focuses on a few factors that influence team effectiveness through a qualitative approach, future research could be conducted to explore team-level factors that influence team effectiveness quantitatively.

Additionally, as the cross-team analysis and lessons learned presented in Chapter 6 and Chapter 7 show, high diversity in participants and larger team size make it more challenging to manage the team process and ultimately negatively impact team effectiveness. For common working teams, managers can minimize the diversity of team members and team size. However, there is a dilemma for teams in the standards creation world since incorporating all types of stakeholders can put unique input and expertise onto the table (Updegrove, 2007). Future research could explore the optimal size and mix of standards creation working teams.

These are only a few suggestions for further study; however, as mentioned earlier, there is much more that practitioners and researchers can learn about improving team effectiveness that ultimately contributes to successful standards creation.

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Appendix 1: Summary of Relevant Literature on IS/IT Standards

Study	Context	Impact of Standards	Standard Diffusion	Standard Creation	Analyzing the creation process
West & Dedrick (2000)	A case study of the Japanese PC market on standards competition in the 1980s and 1990s	√	√		
Garud et al. (2002)	A case study of Sun Microsystems's sponsorship of JAVA technology as a common standard		√	√	
Belleflamme (2002)	An analytical model of users' choice between formal and de facto ICT standards that compete with each other	√	√		
Chellappa & Shivendu (2003)	An analytical model of the effects of multiple incompatible technology DVD standards on piracy and pricing	√			
Fomin et al. (2003)	A dynamic process model of understanding and analyzing the process of ICT standards creation and diffusion		√	√	√
Hovav et al.(2004)	A conceptual model of the Internet-based standards adoptions, illustrated through a case study of IPv6 standard		√		
Wigand et al. (2005)	A case study of vertical information systems (IS) standards and industry structure effects in the U.S. home mortgage industry	√			
Yoo et al. (2005)	A case study of the role of standards in the evolution of mobile infrastructure in South Korea over a 10-year period		√	√	
Backhouse et al. (2006)	A qualitative case study of the role of power and politics in standards creation, the first standard in information security management (BS 7799, later ISO 17799)			√	√
Bonaccorsi et al. (2006)	A survey of 146 Italian software firms' strategies on entering the open source (OS) field	√	√		
Hanseth et al. (2006)	A case study of the standards creation process of an electronic patient record (EPR) in a Norwegian hospital	√		√	

Lee & Oh (2006)	A case study of standard setting and actor-network theory, demonstrating by the case of China's attempts to set its own WAPI national wireless standard		√	√	
Lyytinen & King (2006)	An introduction to a special issue of MIS Quarterly with a brief review of standard-making literature			√	
Markus et al. (2006)	A case study of vertical information systems standards creation and standards diffusion in the U.S. residential mortgage industry		√	√	
Nickerson & Muehlen (2006)	A case study of the patterns of movement of standardization ideas on Internet Standards			√	
Weitzel et al. (2006)	A formal analysis of the diffusion of a communication standard using equilibrium analysis and simulation modeling		√		
Zhu et al. (2006)	A conceptual model of the impacts of network effects on open-standard interorganizational system (IOS) adoption based on the data from 1,394 firms in multiple countries and industries		√		
Bala & Venkatesh (2007)	A multiple case study of the assimilation of interorganizational business process standards (IBPS) in organizations based on the data from 11 firms in the high-tech industry		√		
Lee & Mendelson (2007)	An analytical model of adoption dynamics in different market structures characterized by network effects		√		
Zhao et al. (2007)	A formal model of firms' choices among a leading developer, a passive adopter, and a nonadopter at the standards development stage and the adoption stage		√	√	
Updegrove (2007)	A review and discussion of whether traditional standard-setting infrastructure is inadequate to the task of supplying the ICT standards of the future			√	
Leiponen (2008)	A panel data analysis of the competition among firms in the cooperative standard-setting in the			√	

	empirical context of the third-generation partnership project (3GPP)				
Rysman & Simcoe (2008)	An empirical analysis of the economic and technological significance of standard-setting organizations (SSOs) by analyzing patent citations		√	√	
Smith et al. (2010)	An action research study of the power relationships during an information systems security standards (ISS) adoption and accreditation process in compliance with a national de jure ISS standard		√		
Aggarwal et al. (2011)	An empirical study of the relationship between establishing standards in a group and total risk faced by an individual firm's shareholders based on the data from 299 IT standard-setting events between 1996 and 2005	√			
Cargill (2011)	An experiential analysis of whether the participants achieved their goals from their participation in the standardization process		√	√	√
Liu et al. (2011)	An analytical model of the impact of conversion technologies on market equilibrium in the context of sequential duopoly competition and proprietary technology standards		√		
Steinfield et al. (2011)	A conceptual paper of interoperability and information transparency of interorganizational systems (IOS) in supply chains illustrated through a case study in the automotive industry	√	√		
Zhao et al. (2011)	A research model to investigate the drivers of standard development within consortia based on a data set of 232 firms from 7 consortia			√	
Li & Chen (2012)	A formal model of the choice between standardizing on one product or allowing the users to make their own choices when companies purchase information technology (IT) products for their employees, departments, or divisions		√		
Liu et al. (2012)	An empirical analysis of the effects of network externalities on the pricing of flash memory cards with standards	√	√		

	competition over 44 months (2003 — 2006)				
Venkatesh & Bala (2012)	A survey on the adoption of interorganizational business process standards (IBPS) illustrated by 248 firms (124 firm-client dyads) in the high-tech industry implementing RosettaNet-based IBPS	√	√		
Hoel & Pawlowki (2013)	A conceptual model of identifying and evaluating critical stages within anticipatory standardization projects to improve the process of ICT standardization			√	√
Zhao & Xia (2014)	An empirical study of interoperability and interorganizational systems (IOS) standards illustrated by the data from 194 organizations in the geospatial industry	√	√		
Reed et al. (2015)	A review of the early development of the consensus process in the Open Geospatial Consortium (OCG)			√	√
Spring et al. (2016)	An exploratory study of a traditional standards development process and insights into several mechanisms that might be used to improve the process			√	√
Jakobs (2017)	A literature review of how to increase a firm's chances for success in ICT standardization using four cases.	√	√	√	√
Uotila et al. (2017)	A simulation study of supply-side network effects on the development of IT standards by various technology suppliers	√	√	√	

Appendix 2: Interview protocol

For all members:

1. What motivate you to join ISO/SAE 21434, and specific project group?

2. What is your profession, which industry are you in (i.e., OEM, Tier One Supplier, Cybersecurity companies, etc.), and are you from ISO or SAE? (*Team Composition*)

3. How much experience do you have in writing standards? (*Team Composition*)

4. How is your commitment and involvement in your project group? (*Team Composition*)

5. Could you describe your feeling and experience in your project group? (*All Factors*)

6. What challenges do you face working in your project group? (*All Factors*)

7. What do you think about your team process, any improvement or Good example? (*Team Process*)

8. How do you view your project group leadership team? (*Team Structure*)

9. What are your thoughts about the JWG? (*Organizational Structure & Resource*)

10. Anything else you would like to mention ? (*All Factors*)

Additional questions for team leaders (chair, co-chair, and secretary):

1. Could you generally describe your project group in terms of structure, such as how many roles in the group, how many active members, any specific work norm? (*Team Structure*)

2. Do the leadership team employ any management method and practice in your project group? (*Team Structure*)

3. How are decision made within the project group? (*Team Process*)

Appendix 3: Team Effectiveness Assessment Questionnaire

Instructions: *This questionnaire contains questions about your team and the team performance outcomes. Indicate whether you feel each statement is true or not true of your team. Use the following scale:*

Key: 1= Disagree 2= More disagree than agree 3= More agree than disagree 4 = Agree

1. So far, our group has achieved the purpose it is intended to serve

1 □ 2□ 3□ 4□

2. I am satisfied with our performance

1 □ 2□ 3□ 4□

3. I am satisfied with the relationships among group

1 □ 2□ 3□ 4□

4. Our group provides deliverables on time

1 □ 2□ 3□ 4□

5. Our group is efficient

1 □ 2□ 3□ 4□

6. Group members frequently exchange their opinions and ideas

1 □ 2□ 3□ 4□

Appendix 4: Email Invitation to Participate in the Research Project

Greetings,

I am a Ph.D. student from Center of Information Systems and Technology (CISAT) at Claremont Graduate University. I am conducting interviews as part of a research study to extend our knowledge and gain a deeper understanding of the process of creating International Technology Standards. You are in an ideal position to give me valuable information and insights as you are involving in the development process of ISO/SAE 21434.

The interview takes approximately half an hour to an hour. I am simply trying to capture your thoughts and perspectives regarding the development process of ISO/SAE 21434. Your responses to the questions will be kept confidential. Each interview will be assigned a number code to help ensure that personal identifiers are revealed during the analysis and write up of findings.

Participation in this research is voluntary and with no compensation. However, your participation will be a valuable addition to my research and findings that could lead to a better understanding of creating International Technology Standards and providing guidelines for the future project.

If you are willing to participate, please suggest a day and time that suits you, and I will do my best to be available. If you have any questions regarding the study or would like additional information to assist you in reaching a decision, please do not hesitate to contact Hengwei (Rachel) Zhang at hengwei.zhang@cgu.edu.

I very much look forward to speaking with you and thank you in advance for your assistance in this study.

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