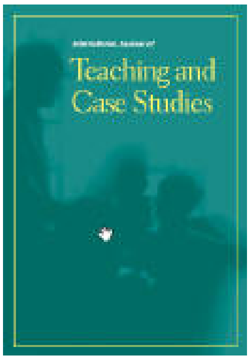

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Critical success factors for reskilling and upskilling engineer leaders in customised executive education programs: multiple case study

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Critical success factors for reskilling and upskilling engineer leaders in customised executive education programs: multiple case study

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Abstract: Sparse research on customised executive education programs leaves a gap in the extant literature on the critical success factors needed for reskilling and upskilling engineers in leadership development. This multiple case study addressed executive education program experts' views on the critical success factors (CSFs) needed in customised executive education programs for reskilling and upskilling engineers in leadership development. Semi-structured interviews with 11 participants, archival data, and reflective field notes constituted the multiple data sources. Through thematic analysis and cross-case synthesis and analysis, 20 themes were identified from the five coding categories. Recommendations are made for future research directions and social change initiatives on the critical success factors for reskilling and upskilling engineers in leadership development to support their midcareer transitions and ensure livelihoods amidst disruptive global events.

Keywords: critical success factors; CSFs; customised executive education programs; engineering leadership; joint training; professional development response; reskilling; upskilling.

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Biographical notes: Sarah Haverland received her Bachelor's in Psychology from Arizona State University, Master's in Education from the University of Phoenix, and second Master's in Philosophy Management from Walden University, and PhD in Business Management from Walden University. She has interests in transforming others through personal coaching and has taught all grade levels first through twelfth grade. She in an advocate for at-risk youth and empowering others to heal themselves.

1 Introduction

The global pandemic put pressure on organisational leaders to address the challenges of interdisciplinarity in training engineers in leadership development to meet the needs of the technology-driven Fourth Industrial Revolution (Rovida and Zafferri, 2022; Roy and Roy, 2021). The Reskilling Revolution program launched by the World Economic Forum in January 2020 estimated that 1 billion people need to be provided with better education, new skills, and better work by 2030 (Diaz and Halkias, 2021a; World Economic Forum, 2022), with engineers needing to engage in regular reskilling throughout their careers (O'Heir, 2021).

Executive education (EE) customised by business schools for engineer's plays a pivotal role in leadership development by reskilling and upskilling abilities such as collaboration, conflict management, and personal and organisational transformation (ASME, 2022; Siegelman et al., 2021). Despite the relevance of customised EE programs for leadership development, scholars still ignore the essential criteria that make these collaborations successful (Diaz et al., 2022; Roos, 2022). The lack of empirical research on customised EE programs leaves a gap in the extant literature on the critical success factors (CSFs) needed for effective reskilling and upskilling of engineers in leadership development and highlights the need for further empirical research from strategy-as-practice scholars (Rottmann and Kendall, 2022; Tiberius et al., 2021). The specific management problem is that organisational leaders have sparse information on the CSFs needed in customised EE programs for reskilling and upskilling engineers in leadership development (Retana and Rodriguez-Lluesma, 2022; Richardson and McCain, 2022; Rottmann and Kendall, 2022).

The objective of this qualitative, multiple case studies was to describe EE program experts' views on the CSFs needed in customised EE programs for reskilling and upskilling engineers in leadership development. The findings confirm that customised EE programs do offer a codesigned solution but lack a theoretical framework that ensures success. Customised EE can prepare engineers for leadership roles by reskilling and upskilling abilities such as soft skills, communication skills, leading through change, and conflict management (Roos, 2022; Rottmann and Kendall, 2022).

This study was framed by three key conceptual models that aligned with the purpose to describe EE program experts' views on the CSFs needed in customised EE programs for reskilling and upskilling engineers in leadership development:

a Rottmann et al.'s (2015) concept of engineering leadership

b Fung's (2020) concept of reskilling and upskilling the workforce

c Retana and Rodriguez-Lluesma's (2022) concept of customised executive programs.

This study's findings can drive positive social change by providing organisational leaders insight on the CSFs of customised EE programs to prepare engineers for leadership roles required within their profession to support their midcareer transitions and ensure livelihoods amidst disruptive global events (Retana and Rodriguez-Lluesma, 2022; Rottmann and Kendall, 2022).

2 Literature review

2.1 The evolution of engineering leadership and industry engineers' leadership practices

Since the turn of the century, rapid technological changes have merged the roles, and research has focused on engineering leaders' and managers' skills, traits, behaviours, and styles (Rottmann et al., 2018; Sydorenko, 2020) changing how management and leadership were distinguished (Ebert and Duarte, 2018). Three broad bodies of literature surround the development of effective engineering leadership:

1 engineer's career paths and transitions

2 professional identities

3 industry engineers' perspectives on effective engineering leadership (Rottmann et al., 2018).

Rottmann et al. (2015) defined and conceptualised 'engineering leadership' in an analytically clear manner through the works of Farr, Mallette and Robledo, which was grounded in the seminal research of Farr and Brazil (2009), Farr et al. (1997), Mallette (2005), and Robledo et al. (2012). In 2004, the National Academy of Engineering (NAE), in a publication titled The Engineer of 2020, reported a national call for all engineers to develop leadership skills, and several scholars claimed that this launched the beginning of engineering leadership education (Graham et al., 2009; NAE, 2013). Bernie Gordon established several multimilliondollar endowments to implement programs and institutes in engineering universities across the USA (Klassen et al., 2020).

The body of engineering leadership literature expanded as researchers examined several aspects of the engineer. Engineering leadership is rooted in engineering education with a focus on academic inquiry. The five streams of engineering leadership trending in the field are:

1 the demand for engineers to embody a leadership role

2 engineering leadership programs

3 competency-based representations of influential engineering leaders

4 industry-based empirical studies of engineering leadership

5 conceptual investigations of leadership from the perspective of engineers.

Theses streams are intertwined throughout undergraduate education with competency-based representations of influential engineering leaders and research studies of engineering leadership in the industry (Rottmann et al., 2016, 2018).

2.2 Reskilling and upskilling engineer leaders for the fourth industrial revolution

Today's postpandemic world requires 4IR leaders to support their workforce and deliver new business models by providing access to ever evolving reskill and upskill training and education programs (Agrawal et al., 2020; Halkias et al., 2020). Fung (2020) grounded his conceptual work on reskilling and upskilling on definitions gleaned from previous labour market literature. Reskilling (learning new skills to do a different job) can help corporations improve job security and create a more productive and stable work environment (Gagnidze, 2020). Incorporating upskilling (teaching and learning additional skills for one's present job) and EE allows organisations and employees to stay relevant (Gratton, 2019).

Scholars report limited consistent information in scholarly or practitioner-based literature and guide business schools to develop an EE model that reskills/upskills leaders to successfully manage the future's changing workforce (Diaz and Halkias, 2021b; Fung, 2020). Fung (2020) concluded his study future work projections stating the shelf life of skills is anticipated to be approximately five years, with individuals expected to update and refresh their skills six times throughout a 30-year career to remain relevant in their workplace. Engineers must continuously engage in reskilling throughout their careers (ASME, 2022; O'Heir, 2021). The emphasis on engineering leaders having technical and non-technical skills to meet organisational goals shows the importance of considering the reskilling and upskilling of engineering leaders to adjust to the Fourth Revolution market demands (O'Heir, 2021). It is evident that the engineering and technology fields are at the face of digital transformation, and their skill sets need to demonstrate strategic and innovative approaches that will add value (Flores et al., 2020).

2.3 Customised EE programs and industry partnerships

Retana and Rodriguez-Lluesma (2022) defined customised EE programs as a joint response by which firms and training providers craft specific solutions to 'unique problems'. In these programs, firms and training providers codesign a learning experience through the choice of topics, methods, instructors, and locations (Büchel and Antunes, 2007). As discussed by seminal and contemporary scholars in the psychology of work and management education, customised executive programs play a pivotal role in leadership development (e.g., Crossan et al., 2013; Kets De Vries and Korotov, 2007; Retana and Rodriguez-Lluesma, 2022). Customised EE programs offer a collaborative solution to prepare engineers for leadership roles required within their profession by reskilling and upskilling abilities such as soft skills, communication skills, leading through change, and conflict management (ASME, 2022; Retana and Rodriguez-Lluesma, 2022).

2.4 Identifying the gaps in engineering leadership and customised EE programs to support academic-industry partnerships

The lack of empirical research on customised EE programs leaves a gap in the extant literature on the CSFs needed for effective reskilling and upskilling of engineers in leadership development and highlights the need for further empirical research from strategy-aspractice scholars (Rottmann and Kendall, 2022; Tiberius et al., 2021). Organisational leaders report having little on what makes EE programs for engineers in leadership development effective and successful (Richardson and McCain, 2022; Rottmann and Kendall, 2022). Without practitioner-based empirical research on CSFs of EE programs, organisational leaders cannot identify effective leadership development programs customised for engineers (Retana and Rodriguez-Lluesma, 2022; Skibniewski and Kim, 2022). Despite the relevance of customised EE programs for leadership development between organisations and business schools, there remains a literature gap on the criteria that make these collaborations successful (Diaz et al., 2022; Roos, 2022).

In response to national calls for educational change in engineering (Rottmann et al., 2016; Kendall and Rottmann, 2022), organisational leaders throughout all specialisation sectors employing engineers must adjust quickly to changing market conditions driving the need for professional training customised for engineer leaders (Fung, 2020; Retana and Rodriguez-Lluesma, 2022). Ongoing debates in the literature argue about the importance of specific skills over others and whether they are necessary for leadership roles (Tiberius et al., 2021). Researchers focused on engineering leaders, and managers found that engineers who transitioned into leadership roles lacked the necessary leadership skills to succeed (Capretz and Ahmed, 2018; Kappelman et al., 2017; Perry et al., 2017; Racine, 2015). Although engineering leadership has evolved, limited perspectives remain on how engineers can develop technical, interpersonal, and conceptual skills for their careers (Farler and Haan, 2021; Hickman and Akdere, 2018). Understanding the dynamic skills of innovation leaders has not received sufficient evidence to define engineering leadership (Rottmann and Kendall, 2022). There is a distinct knowledge gap in engineering and management literature surrounding effective leadership and its development, resulting in limited resources relevant to the engineering profession (Retana and Rodriguez-Lluesma, 2022; Rottmann and Kendall, 2022; Skibniewski and Kim, 2022).

3 Research design and methodology

The purpose of this integrative literature review is to propose suggestions for further study on describing EE program experts' views on the CSFs needed in customised EE programs for reskilling and upskilling engineers in leadership development. CSFs can be identified from the perspective of strategy-as-practice scholars (Aminy et al., 2019) and are widely adopted as a concept in information management systems studies (e.g., Bele, 2019; Yeoh and Koronios, 2010). Consistent with the purpose of this study, the CRQ was as follows: how do EE program experts describe the CSFs needed in customised EE programs for reskilling and upskilling engineers in leadership development? After investigating a contemporary research problem in a real-life context (Yin, 2017), techniques such as prolonged engagement, observation, triangulation, transcript review, audit trail, reflexivity, and rich, thick descriptions were used to ensure alignment between the research components and to answer the research question.

Multiple case studies are focused on exploring a phenomenon within real-world settings (Eisenhardt and Graebner, 2007), and expert interviews are a standard qualitative research method (Bogner et al., 2018). Compared to other research designs, multiple case studies differ from surveys and experiments for exploring management behaviours across different contexts in a global economy (Halkias and Neubert, 2020). This research was an extension study that provides replication evidence and expands previous studies' findings in other theoretical areas (Bonett, 2012). To gain an in-depth understanding of the phenomena under study, a multiple-case study design was selected with the goal of theory extension (Eisenhardt and Graebner, 2007; Halkias and Neubert, 2020). The unit of analysis in this study was the EE program expert.

The purposeful sample of ten participants was screened based on meeting the inclusion criteria:

a adult over the age of 18

b EE program educator with a minimum of five years of experience delivering reskilling and upskilling programs for engineers in leadership development

c had published at least two articles in a peer-reviewed or practitioner-based journal on EE ecosystems

d had a terminal degree from an accredited institution e possessed in-depth expert knowledge regarding the central topic of study (see Merriam and Tisdell, 2015).

3.1 Data collection

The data collection strategy of the multiple case study involves collecting evidence from multiple sources (Yin, 2017) and three sources used were a semi-structured interview protocol with items designed and standardised by previous researcher, archival data in the form of industryrelated reports, media articles on EE programs for reskilling and upskilling engineers in leadership development (see Yin, 2017), and journaling/reflective notes (see Merriam and Tisdell, 2015). The careful selection of a qualitative, open-ended, unstructured interview guide allows for enhanced trustworthiness of the data (Merriam and Tisdell, 2015). This study's interview guide consisted of (5) open-ended questions, grounded in the conceptual framework and literature applied to customised EE programs, reskilling and upskilling, and engineering leadership (Fung, 2020; Retana and Rodriguez-Lluesma's, 2022; Rottmann et al., 2015). The aim of exploring EE program experts' views was to extend theory and academic knowledge on customised EE programs that prepare engineers for leadership roles.

In each interview, participants were asked to describe their views on the CSFs needed in customised EE programs for reskilling and upskilling engineers in leadership development. Definitions of customised EE programs were defined prior to interviews. The virtual Zoom meeting platform was offered to all interviewees given candidates' locations spanned the time zones from Greece to Spain, Jordan, Italy, Switzerland, Canada, Saudi Arabia, and the USA. Eleven participants were provided formal invites, and four chose to respond in writing. I used deep engagement, which translated into devoting the time needed to review the literature till reaching data saturation to develop the study's interview protocol. Participants agreed to be recorded via Zoom videoconference and each interview conducted lasted approximately 30 minutes. A digital audio recorder was used to record a copy of each interview, and a reflexive journal was kept to track self-reflection practices were also used (Stake, 2013). A professional transcription application was employed to transcribe the interviews and were sent via email to clarify responses, avoid misconceptions, or prevent misinterpretation of the collected data (MeroJaffe, 2011). Data collection stopped when no new themes emerged, and data saturation was reached.

3.2 Data analysis

The data analysis process for the interview transcripts, journaling notes, and archival data developed was compiled and data was collected into categories and themes through content analysis (Merriam and Tisdell, 2015). Data was transcribed, analysed, coded, and categorised using Microsoft Excel software to ensure accuracy (Yin, 2017). The data analysis process consisted of analysing the participants' responses by looking for patterns while reviewing and integrating the differences across multiple data sources for triangulation purposes (Merriam and Grenier, 2019).

The thematic analysis approach used was translated into manually coding the data through a systematic process mapped out in the descriptive coding method (Saldaña, 2016) and the ground-up strategy was applied to identify codes from the raw data and allow critical concepts to emerge. A hierarchical coding frame was used to organise codes and themes based on how they relate to one another (see Table 1).

Table 1 Coding categories and aligned themes

Coding category		*Aligned theme*
Customized executive education in the post pandemic era	1	Central focus on managing change and complex problem-solving skills
	2	Skill-based executive education
	3	Cross-cultural competency focus
	4	Lifelong, industry-based learning versus traditional degree-based learning
Cocreation of academic-corporate partnership for customized executive education programs	1	Partners recognize engineering as a heterogeneous profession across workplace/disciplinary contexts
	2	Business schools evolving to meet industry needs
	3	Managing resource allocation and constraints
	4	Continuous formal and informal communication between partners
Academic-corporate partnership goals for engineer leadership education	1	Leadership training in interpersonal skills
	2	Engineering leaders as employee coaches and team players
	3	Multimodal leadership skills: face-to-face, hybrid, virtual
	4	Entrepreneurial/commercial mindset
Critical success factors for customized executive education program for engineers	1	Agile EE program leadership team
	2	Flexible programs with synchronous and asynchronous delivery options
	3	Constantly updated STEM curriculum as markets and industries evolve
	4	Deeply understanding the skill gaps/needs of the customer/learner
Critical success factors for academic-corporate collaborations for reskilling and upskilling engineer leaders	1	Focus on engineering leadership education that initiates/leads change
	2	Focus on the deeper meaning behind program performance metrics
	3	Emphasize leadership skills for AI-driven projects
	4	Continuous program experimentation and upgrading

The two data analysis involved two stages: a within-case analysis for each case and a cross-case analysis looking at similarities and differences within the themes and categories (Yin, 2017). The benefit of using the same consistent coding method to analyse both the within and across data is to permit the replication of the cases, which will help compare and contrast the results (Yin, 2017). The data analysis process discovered patterns from the interview transcripts and integrated and examined the dissimilarities within the data sources for the triangulation purpose (Merriam and Grenier, 2019). The hand-coding method enabled the researcher to dive deep into the data to ensure a better understanding of the research problem and collected data (Halkias et al., 2022). Categories and themes were repeated during the iterative process of coding and indicated no further need to continue the coding process (Fusch and Ness, 2015). After coding the data emerging from the interview questions, the objective was to link themes to classifications grounded in the conceptual framework and the reviewed scholarly literature.

3.3 Ethical procedures

The experts were identified through the professional network sampling on LinkedIn and EE program experts were contacted immediately following IRB approval. Participants received information regarding anonymity and confidentiality, potential risks and benefits, and the relevant contact information. Participants agreed to the informed consent that ensured they understood the voluntary nature of their participation, the do no-harm principle, and privacy and data protection. All participants that agreed to the Zoom interview received the invitation email following the informed consent agreement.

3.4 Limitations

The first limitation of this and any qualitative study involves the participants' truthfulness and the trustworthiness of the study results. A second limitation of this study was the overall targeted population was limited to only the participants that met the inclusion criteria. The third and final limitation regarding the interview process was that the interviewees may not have engaged truthfully with me, and their responses may have been influenced by bias, nervousness, or concerns (Merriam and Tisdell, 2015).

4 Results

4.1 Characteristics of the sample

The study's sample consisted of male (9/10) and female (1/10) participants ranging between the ages of 43 and 63 years old (average = 52.4). The PhD earned candidates had written between three to over 100 published articles, up to three books and had between 5 and 25+ years of EE experience in leadership development delivering reskilling and upskilling programs for engineers. Two participants were citizens of Canada, two were from the USA, one was from Jordan, one was from Spain, one was from Greece, one was from Italy, one was from Saudi Arabia, and one was from Switzerland. All candidates had developed leadership programs with engineers.

4.2 Study results

Data analysis involved two stages: a within-case analysis of each of the selected cases and a cross-case analysis of the data to seek similarities and differences across the categories and themes (Yin, 2017). Table 2 presents this multiple case study that has finalised coding categories and themes, and representative participant quotations aligning with each of those categories and themes.

Table 2 Coding and theme examples

Participant	*Interview excerpt*	*Coding category*	*Theme*
Participant 3	"Both blue collar and white collar workers, and middle management and executives, have many more options when it comes to on-the-job education, both skill-based and leadership-focused, than just attending a bespoke executive education."	Customised executive education in the postpandemic era	1 Central focus on managing change and complex problem-solving skills 2 Skill-based executive education 3 Cross-cultural competency focus 4 Lifelong, industry-based learning versus traditional degree-based learning
Participant 1	"The main advantage is that these programs are designed collaboratively between both parties. Instead of the off-the-shelf training programs that don't go really beyond the basic level, a more in-depth tailored solutions are designed to solve the problems businesses face."	Cocreation of academic – corporate partnership for customised executive education programs	1 Partners recognise engineering as a heterogeneous profession across workplace/disciplinary contexts 2 Business schools evolving to meet industry needs 3 Managing resource allocation and constraints 4 Continuous formal and informal communication between partners
Participant 5	"The organization and the school need define exactly what they want and the communication and partnership should be ongoing."	Academic–corporate partnership goals for engineer leadership education	1 Leadership training in interpersonal skills 2 Engineering leaders as employee coaches and team players 3 Multimodal leadership skills: face-to-face, hybrid, virtual 4 Entrepreneurial/commercial mindset
Participant 9	"Our purpose as helping engineers lead change to build a better world – this may be partly about innovative technology, but is also always about building self-awareness paired with constant reflection about the social impact/consequences of our work."	Critical success factors for a customised executive education program for engineers	1 Agile EE program leadership team 2 Flexible programs with synchronous and asynchronous delivery options 3 Constantly updated STEM curriculum as markets and industries evolve 4 Deeply understanding the skill gaps/needs of the customer/learner

Table 2 Coding and theme examples (continued)

Participant	*Interview excerpt*	*Coding category*	*Theme*
Participant 2	"We have a team of people that have all the practical experience they need. It would benefit them to be exposed to some theory to see how the variables and concepts of their practice relate to each other."	Critical success factors for academic – corporate collaborations for reskilling and upskilling engineer leaders	1 Focus on engineering leadership education that initiates/leads change 2 Focus on the deeper meaning behind program performance metrics 3 Emphasise leadership skills for AI-driven projects 4 Continuous program experimentation and upgrading

4.3 First phase: thematic analysis of the textual data

The analysed themes that emerged from the data collected and understanding of education program experts' views on the CSFs needed in customised EE programs for reskilling and upskilling engineers in leadership development.

4.3.1 Central focus on managing change and complex problem-solving skills

This theme refers to the central focus on managing change and complex problem-solving skills. Participant 7 stated:

> "The 4.0 digital transformation has accelerated the innovation, innovation meaning more tools, more simplification, more devices that help do all kinds of things from simple stuff, online video conferencing, to more complex stuff like using big data algorithms, applications, machine learning, AI, blockchain, whatever, platforms."

Participant 7 highlighted:

> "The need to develop these skills that will help you to track, retain, accelerate, develop your talent becomes even more critical because you're going to lose it, and you are losing talent, so it's becoming an imperative to build these leadership skills."

4.3.2 Skill-based EE

This theme refers to the focus on skill-based EE. Participant 7 said: "The need to develop these skills that will help you to track, retain, accelerate, develop your talent becomes even more critical because you're going to lose it, and you are losing talent, so it's becoming an imperative to build these leadership skills". Participant 6 highlighted:

> "Figure out goals and expectations. What is the specific activity you want to deliver to improve leadership skills? And what leadership skills in particular you're trying to develop, broad or narrow type of leadership improvement? And once you identify that, I would say you should always start with self-assessment test in the beginning to understand the characteristics of participants in terms of leadership."

4.3.3 Cross-cultural competency focus

This theme refers to cross-cultural competency. Participant 6 stated: "I really think it's cultural sensitivity; you need to adjust your cultural sensitivity". Participant 1 highlighted:

> "What works in one culture may not work in another culture. For example, training program in the Arabian Gulf have to accommodate for differences between males and females."

4.3.4 Lifelong, industry-based learning versus traditional degree-based learning

This theme refers to lifelong, industry-based learning versus traditional degree-based learning. Participant 1 stated: "The Fourth Industrial Revolution was already a major change driver in EE. Firms were finding that many of their executives are somewhat too traditional and are not embracing the ways of work brought by the increasing interconnectivity at the workplace". Participant 3 highlighted:

> "I think more and more firms are developing their own 'universities' (Boeing, SABIC, Google, etc.), and the proliferation of online education has never been stronger (YouTube, Coursera, Khan Academy). Thus, both blue collar and white collar workers (and middle management and executives) have many more options when it comes to on-the-job education – both skill-based and leadership-focused – than just attending a bespoke executive education (EE) program in-person for a large amount of money."

4.3.5 Partners recognise engineering as a heterogeneous profession across workplace /disciplinary contexts

This theme refers to partners that recognise engineering as a heterogeneous profession across workplace /disciplinary contexts.

Participant 10 stated: "Taking time to understand the need of the engineer individually and the need of the industry they are targeting". Participant 9 highlighted:

> "Recognize that engineering is a heterogeneous profession and make sure to connect with industry partners across workplace/disciplinary contexts before developing your program unless you are gearing your program to a particular discipline or industry."

4.3.6 Business schools evolving to meet industry needs

This theme refers to business schools evolving to meet industry needs. Participant 11:

> "It is the ability to represent with more accuracy the problems that the corporate partners are facing and tapping into the knowledge or the knowledge creation or content creation of the business school to try to address this effectively through a variety of frameworks that are within the competence of the business school."

Participant 3 highlighted:

> "Business schools need to be more flexible in terms of what they deliver, they really must make sure it matches client needs, and spend more time on developing detailed content that is clientfocused. We should be working harder

> upfront to learn about the client, participant needs, and what success means to the client, not the university's executive education group."

4.3.7 Managing resource allocation and constraints

This theme refers to managing resource allocation and constraints. Participant 7 stated: "The main strength of partnership is relevance. A partnership ensures that there is relevance in the program design but also in the delivery of the program". Participant 3 highlighted:

> "They need to lower their prices to be more competitive. Only the largest, most profitable companies can afford a Harvard executive education program."

4.3.8 Continuous formal and informal communication between partners

This theme refers to continuous formal and informal communication between partners. Participant 9 stated: "Make sure to include more than one academic and more than one industry partner. There is a wide range of academic contexts/frameworks/paradigms, and an equally wide range of workplace contexts. Try to diversify each side of the partnership so that you can reach the full range of potential students". Participant 6 highlighted:

> "It is a mutual process in which the company gives a lot of ideas to the school, and the school receives a flow of ideas from multiple companies and their research teams, they can really add everything together and deliver a lot of value."

4.3.9 Leadership training in interpersonal skills

This theme refers to leadership training in interpersonal skills. Participant 4 stated: "It was surprising to me the level of interaction that they actually have with the public. So it's almost as if they're becoming more customer service oriented". Participant 7 highlighted:

> "Leadership skills are needed for engineers, potentially, I see a huge need for upskilling, reskilling, especially because now they need to lead. It's been always a lack in engineering background, the leadership skills, but now, it's even beyond. There are other things that are here to stay such as the future of work dimension, so you are going to be leading, communicating, negotiating, working in teams that are hybrid, most of the time online with different challenges."

4.3.10 Engineering leaders as employee coaches and team players

This theme refers to engineering leaders as employee coaches and team players. Participant 10 stated: "The leadership capability will have a gap without understanding". Participant 9 highlighted:

> "The idea of engineering leadership education is to drive/lead change, not prepare our students to fit into the world as it is. While it would be irresponsible for us to exclusively focus on students driving change, we should nevertheless help our graduates navigate organizations without assimilating into them."

4.3.11 Multimodal leadership skills: face-to-face, hybrid, virtual

This theme refers to multimodal leadership skills: face-to-face, hybrid, and virtual. Participant 3 stated: "Offer flexible programs over time and utilize in-person, virtual, and asynchronous channels of instruction easily". Participant 6 highlighted:

> "The demand and the dynamics of the market, and specifically for the executive education, in the sense that has been like a catalyst of acceleration for digitization, more digital delivery, more digital products."

4.3.12 Entrepreneurial/commercial mindset

This theme refers to an entrepreneurial/commercial mindset. Participant 2 stated: "Here you have people that have all the practical experience they need. It would benefit them to be exposed to some theory to see how the variables and concepts of their practice relate to each other". Participant 3 highlighted:

> "Universities are very slow improve/adapt/innovat and even YouTube videos are beating them out these days. The firms (and individuals) that have the best (tested) content, references, and adaptability to offer EE online, in-person, blended, etc. will win in the end."

4.3.13 Agile EE program leadership team

This theme refers to interactions with an agile EE program leadership team. Participant 1 stated: "These programs are designed collaboratively between both parties. Instead of the off-the-shelf training programs that don't go really beyond the basic level". Participant 11 highlighted:

> "It's about timing. Many of the corporate partners tend to have faster cycles of response than what academia has. Some of the schools that have been able to be very agile and responsive have created a higher chance of success in this partnership."

4.3.14 Flexible programs with synchronous and asynchronous delivery options

This theme refers to flexible programs with synchronous and asynchronous delivery options. Participant 6 stated: "After the COVID, people learned that was making most cost-effective or more efficient if you have to deliver a course to people in many different geographical areas". Participant 7 highlighted:

> "There is a lot of added value and innovation coming from the blend of digital and physical, the two things, digital and physical, and the ability to work with everybody simultaneously in different parts of the world, and even to engage in team activities or company-client relationship on real-time mobile devices and digital devices."

4.3.15 Constantly updated stem curriculum as markets and industries evolve

This theme refers to constantly updated STEM curricula as markets and industries evolve. Participant 5 stated: "STEM, as people in STEM, should be taught or should learn based on defined organizational strategies, organizational objectives". Participant 9 highlighted:

> "Engineering is not just one thing, it is an acknowledgement of the wide range of workplace contexts, disciplines, and industries in which engineers work. We characterize our purpose as helping engineers lead change to build a better world, this may be partly about innovative technology, but is also always about building self-awareness paired with constant reflection about the social impact/consequences of our work."

4.3.16 Deeply understanding the skill gaps/needs of the customer/learner

This theme refers to profoundly understanding the skill gaps/needs of the customer/learner. Participant 1 stated: "A major disadvantage is related to the show-off effect. Many firms will contract big names in EE and then assume that they have done enough". Participant 3 highlighted:

> "Firms also often hire their own internal 'university' team or create their own partnerships with educational providers (online and in-person) to maximize the creativity and customizability of their programs."

4.3.17 Focus on engineering leadership education to initiate/lead change

This theme focuses on engineering leadership education to initiate/lead change. Participant 10: "Social emotional awareness is number one, first, getting the time to understand the need of the engineers individually and the need of the industry they are targeting". Participant 7 highlighted:

> "For engineers, leadership skills is where I see huge need on upskilling, reskilling especially because now you need to lead. I see a huge need of upskilling, reskilling for the engineers that are potentially in managerial positions."

4.3.18 Focus on the deeper meaning behind program performance metrics

This theme refers to focus on the deeper meaning behind program performance metrics. Participant 8 stated: "Understanding flexibility and speed to respond to market needs. That is also very important that you have access to or understand the problems of practice and can respond to that". Participant 9 highlighted:

> "My recommendation is to look beyond skills and traits, include leadership identity and mindset as a starting point, encouraging students to reflect on the impact of the pandemic on their leadership opportunities over the last 3 years. Consider pairing it with industry-specific practical skill training since that will likely attract more students."

4.3.19 Emphasise leadership skills for AI-driven projects

This theme refers to emphasise leadership skills for AI-driven projects. Participant 1 stated: "The new era requires 24/7 agility and alertness". Participant 8 highlighted:

> "What you have a lot of now is data science, artificial intelligence and during the pandemic, there's rescaling concerning logistics, resilience of companies, and cost savings, which can be achieved through, data science, and AI."

4.3.20 Continuous program experimentation and upgrading

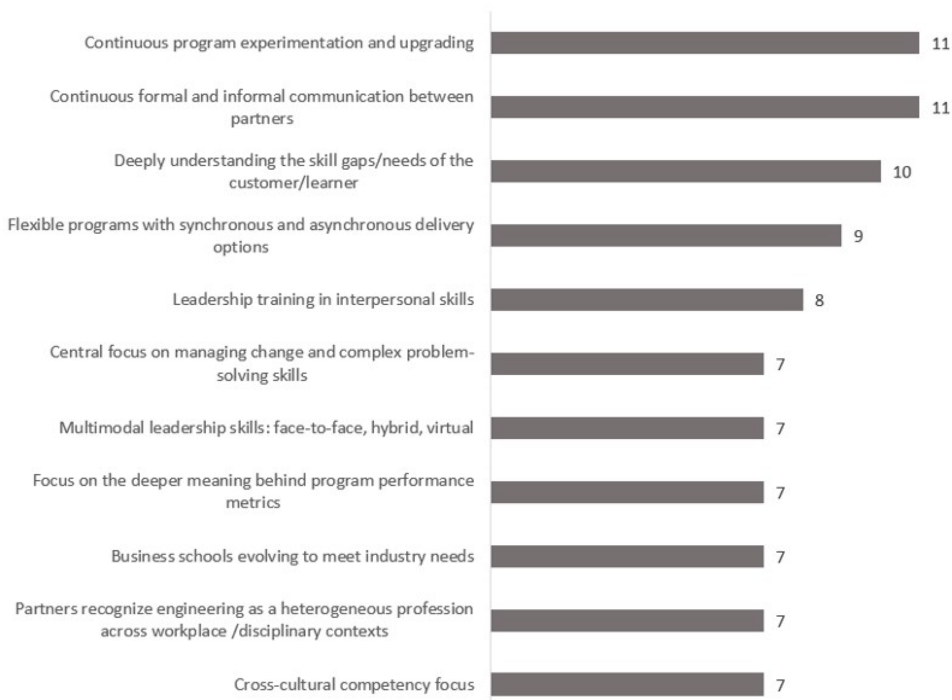
This theme refers to continuous program experimentation and upgrading. Participant 6 stated: "Every time you deal with multiple organizations, there's a lot of learning on both sides, so you can really bring to the table a lot of constant innovation and stimulus". Participant 5 highlighted:

> "Instead of the organization going to everybody, an organization going to just learn for learning's sake or learning in an openended environment. But in the setting of an executive education, in terms of partnering with an organization, it's customized to their needs, which is great."

4.4 Second phase: cross-case synthesis and analysis

The analytic process included both within-case and cross-case analyses to identify patterns within the data. A cross-case synthesis technique helps achieve an organised analysis of the reasoning connecting the collected data with the study's conceptual framework (Eisenhardt and Graebner, 2007; Yin, 2017) and to identify the divergence and convergence between cases (Halkias et al., 2022). The cross-case analysis method enabled me to identify the themes and patterns across expert participants' views. In Figure 1, each theme's cumulative frequency of occurrence shows the cross-case analysis of the convergent and divergent data across the seven cases.

Figure 1 Cross-case synthesis results (theme frequency of occurrence by participants)



In formulating interpretation of the study findings, the frequency with which expert-generated themes occurred together in at least seven of the 11 cases (Rosenthal, 2018). A total of 11 cross-case themes emerged across the data collected from the 11 expert participants: continuous program experimentation and upgrading, continuous formal and informal communication between partners, deeply understanding the skill gaps/needs of the customer/learner, programs with synchronous and asynchronous delivery options, leadership training in interpersonal skills, central focus on managing change and complex problem-solving skills, multimodal leadership skills: face-to-face, hybrid, virtual, focus on the deeper meaning behind program performance metrics, business schools evolving to meet industry needs, partners recognise engineering as a heterogeneous profession across workplace/disciplinary contexts, cross-cultural competency focus. All participants agreed with continuous program experimentation and upgrading, continuous formal and informal communication between partners, and deeply understanding the skill gaps/needs of the customer/learner.

5 Discussion, recommendations, and conclusions

5.1 Interpretation of findings

The study's findings provide evidence from the 11 semi-structured interviews with subject matter experts to support how the study's findings confirm or disconfirm existing knowledge or extend it. Theory extension from case studies represents a vital research strategy that may contribute new and novel insights into theorised phenomena that remain unexplored in extant literature (Halkias and Neubert, 2020; Eisenhardt, 1991).

5.1.1 Customised EE in the postpandemic era

Customised EE can prepare engineers for leadership roles by reskilling and upskilling abilities such as soft skills, communication skills, leading through change, and conflict management, yet organisational leaders have little information on what makes these programs between business schools and employers successful (Diaz et al., 2022; Roos, 2022). This study aligns with Retana and Rodriguez-Lluesma's (2022) conclusions that a theoretical framework describes the behaviours needed to foster a successful codesigned EE program and further extended the emerging theory describing the four conceptually distinct but interrelated behaviours that foster successful customised EE programs.

5.1.2 Co-creation of academic-corporate partnerships for customised EE programs

This study confirmed that although several partnerships have successfully met context-specific problems through a codesign, several important factors that enable effective partnerships among business schools and EE providers have not yet been identified. This study aligned with Halkias et al.'s (2020) and Horn and Dunagan's (2018) conclusions that academic and industry leaders and researchers are working to redefine EE. Further knowledge extension regarding partnerships with corporate clients aim to work to develop relevant, digitally driven, and sustainable EE ecosystems (Caratozzolo et al., 2020; Diaz and Halkias, 2021b; Horn, 2020).

5.1.3 Academic-corporate partnership goals for engineer leadership education

Higher education institutions and online learning play a significant role in reskilling and upskilling the workforce and are essential in developing a robust pipeline of skilled engineers (Paullet et al., 2020; Skibniewski and Kim, 2022). This study aligned with Jamieson and Donald's (2020) and Rottmann et al.'s (2016) conclusions that engineering leadership skills continue to be improved through project management education. The results further extend knowledge based on the works of Rodriguez et al. (2018), Rottmann et al. (2018), and the research collected from this study that engineers must learn to embrace their roles as leaders understanding that engineering identity might change over time.

5.1.4 CSFs for a customised EE program for engineers

Valuable skills are being taught in engineering education training programs, but they lack the skill-based approaches needed to drive real world application (Harrison et al., 2017; Nix and Bigham, 2015). This study's results aligned with Ismail and Fathi's (2018) and Rottmann et al.'s (2016) conclusions that the engineer is expected to engage in lifelong learning to develop the engineering mindset and strengthening skills in communication, presentation, business writing, and cross-competence. This study extends knowledge from the works of Flores et al. (2020), Romero et al. (2020), Sakurada et al. (2020), that engineering leaders need strong skills that include intrinsic human skills as strategic and innovative approaches that add value to an organisation.

5.1.5 CSFs for academic-corporate collaborations for reskilling and upskilling engineer leaders

Business school industry partnerships enable opportunities to develop a partnership of technology, knowledge, and organisational transfer to support digital skill development critical for success (Diaz and Halkias, 2021b). Organisational leaders need engineering leaders across all specialisation sectors to reskill and upskill to adjust to rapidly changing market conditions (Fung, 2020; Retana and Rodriguez-Lluesma, 2022). This study's results confirmed that although there is a lack of preferred alternatives and success factors for engineers across the profession, it is essential to understand each engineer individually from their contextspecific sector. This study aligns with Diaz and Halkias's (2021a) conclusions that partnerships between education providers and industry leaders can codesign ecosystem models that offer the preparedness and agility needed to reskill and upskill 4IR leaders' changing workforce and extends knowledge from the works of Agrawal et al. (2020), Fung (2020), Halkias et al's (2020), and the research that requires 4IR leaders to deliver access to new models and ever-evolving reskill and upskill training and education programs as change is ongoing.

5.2 Recommendations

Increasing demand for high-level leadership skills in engineering, coupled with the global digitalisation trend and 24/7 connectivity, may be heralding a new period of disruption for EE programs servicing various industry sectors (Diaz et al., 2022). Practice-based knowledge and future research suggestions on where business schools' EE programs find themselves today and how to develop academic-industry partnerships for successful customised EE remain rare in the extant scholarly literature (Rottmann and Kendall, 2022; Tiberius et al., 2021).

More research will be required to understand better how employers can assess and recognise skills to operate in a skill-based context and how business schools can seek partnerships within the industry if they hope to continue a relevant role within the EE sector (Diaz et al., 2022). The future of work will generate new jobs and destroy many existing ones. Corporate leaders can support practitioners-based research first start by defining the skills that are relevant for any given job, then looking at their existing workforce and finally intentionally moving towards incorporating a more diverse labour force that places an emphasis on skills rather than credentials (Longmore et al., 2018).

Business schools can launch more practice-based research on proactively incorporating external stakeholders to serve the reskilling and upskilling learning experience. Postpandemic EE programs will force institutions to research best practice strategies, prepare their faculty for technology-based hybrid programs, identify, and train them to engage in online academic experiences, and adapt the renewed economic model for future workplace training needs. A higher upfront investment will be required and serve a market in which the attraction of digital-first future EE students will reinvent how business schools connect with their customer candidates. The benefit of upskilling is an investment in building relevant and competitive organisations that reduce turnover and increases employee satisfaction and engagement.

5.3 Significance of the study

Social change is a fundamental approach to providing opportunities for communities to receive support in their development, such as in engineering education (Rottmann et al., 2016). By recruiting engineers with leadership qualities within a professional project, a project's stakeholders are more likely to feel the positive impact of a successful project. Projects can also progress more smoothly and efficiently, achieving positive results in less time with competent engineers educated in leadership (Bakht, 2018). Engineering leadership education has become increasingly popular over the past decade in response to national calls for another type of social change: educational change (Rottmann et al., 2016; Kendall and Rottmann, 2022). As the pandemic has brought new homeostasis to world labour markets, industry and professional bodies have re-asserted the importance of 'non-technical' skills, which has created openings for a leadership resurgence in engineering (Klassen et al., 2020). Workers across industries must figure out how to adapt to rapidly changing conditions and leaders must learn how to match those workers to new roles and activities (Fung, 2020).

Reskilling and upskilling engineers in leadership development are more than leading corporate initiatives for innovative technology and artificial intelligence. Today's professional leaders must access ever evolving reskill and upskill training and education programs to support their workforce and deliver new business models in the postpandemic era (Halkias et al., 2020). This study may be significant to practice in that it may inform organisational leaders on the CSFs of customised EE programs to prepare engineers for leadership roles required within their profession to support their midcareer transitions and ensure livelihoods amidst disruptive global events (Retana and Rodriguez-Lluesma, 2022; Rottmann and Kendall, 2022). This study adds empirical research from scholar-practitioners perspectives that may be significant to practice by offering solutions that support midcareer transitions of individual engineers and their families' livelihoods (Rottmann and Kendall, 2022). Lifelong learning is essential for the engineering workforce and impacts their ability to develop versatile, agile, creative, and positive learning mindsets needed to solve complex problems (Diaz and Halkias, 2021b; Fung, 2020).

This study provides insight for organisations needing to reskill and upskill leaders in the hybrid era that may provide insight into the various synchronous and non-synchronous programs that have revolutionised frameworks to connect the sensemaking, experimentation, and self-discovery components of leadership development (Birkinshaw et al., 2022). The experts from this study may offer scholars and industry leaders a deeper understanding of the strengths and weaknesses of customised EE programs from their experiences.

The findings from this study may have potential implications that support the expansion of several engineering leadership theories (Kalliamvakou et al., 2017; Rottmann et al., 2016) and add insight into the application of Katz's (1955) model of effective leadership to various levels of leadership. This study may be significant to theory by contributing original qualitative data to the foundational theories supporting my conceptual framework (Fung, 2020; Retana and Rodriguez-Lluesma, 2022; Rottmann et al., 2015). Such empirical results describing EE program experts' views on the CSFs needed in customised EE programs for reskilling and upskilling engineers in leadership development may extend theory to other related areas within the management, leadership, and EE, and reskilling/upskilling literature.

5.4 Conclusions

Professionals searching for upskilling and reskilling together with academic and non-academic players can create a skill-up economy at the intersection of education and career paths through customised EE programs (Richardson and McCain, 2022; Retana and Rodriguez-Lluesma, 2022). As people pursue high-tech jobs, knowledge and skillbuilding must occur intentionally and continuously. Universities and companies have tried to bridge the gap to smooth the transitions between learning and career opportunities (Diaz et al., 2022; Lamine et al., 2021). Customised EE programs present a collaborative response by which firms and training providers develop specific solutions to unique problems of reskilling and upskilling within a given professional context to ensure livelihoods in the turbulent future of labour markets (Diaz and Halkias, 2022; Retana and Rodriguez-Lluesma, 2022).

Despite the relevance of customised EE programs for leadership development between organisations and business schools, there remains a literature gap on the criteria that make these collaborations successful (Diaz et al., 2022; Roos, 2022). This study's results align with Ismail and Fathi's (2018), Rottmann et al.'s (2016), and Rottmann and Kendall's (2022) conclusions that customised EE for the engineers is expected to engage in lifelong learning to ensure the engineering mindset continues to develop alongside strengthening skills in communication, presentation, business writing, and cross-competence.

This study extends knowledge from the works of Flores et al. (2020), Romero et al. (2020) and Sakurada et al. (2020), and the research from this study that engineering leaders need strong skills that include intrinsic human skills to ensure practical application and optimal usability of digital technologies and that demonstrate strategic and innovative approaches that add value to an organisation. More research is needed in this new educational ecosystem with different players, interests, and potentially different outcomes for students and companies across industry sectors, including engineering (Diaz et al., 2022; Rottmann and Kendall, 2022).

Customised EE can prepare engineers for leadership roles by reskilling and upskilling abilities such as soft skills, communication skills, leading through change, and conflict management (Roos, 2022; Rottmann and Kendall, 2022). Further empirical research that includes scholar-practitioners views is needed to drive social change by identifying the CSFs of EE programs for reskilling and upskilling engineers in leadership development required during the Fourth Industrial revolution (Rottmann and Kendall, 2022).

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