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Extra-curricular support for entrepreneurship among engineering students: development of entrepreneurial self-efficacy and intentions

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This study seeks to understand the impact of extra-curricular entrepreneurship support within a University Based Entrepreneurial Ecosystem (UBEE) on the entrepreneurial self-efficacy and entrepreneurial intentions of engineering students in India. A UBEE can directly affect the likelihood that students identify and exploit entrepreneurial opportunities, which, affects their entrepreneurial intentions. However, there is a dearth of research investigating the impact of university entrepreneurial support initiatives on engineering students' entrepreneurial intentions and entrepreneurial self-efficacy. This is especially true in the Indian context despite its start-up friendly policies. This study aims to address this gap and contribute to advance knowledge in the area of UBEE research. Grounded in Social Cognitive Theory, this study takes an ecosystem approach that considers the interactions and interdependencies among different elements of UBEE, such as entrepreneurial support initiatives and students' beliefs and intentions to start up. This study adopts a quantitative research design. Survey data was collected from 314 undergraduate engineering students from five engineering colleges in South India and data was analysed using structural equation modelling. Results suggest that the extracurricular support programs within a UBEE significantly influences beliefs of entrepreneurial self-efficacy in students, which in turn predicts the intentions of students to startup new ventures. This study found that entrepreneurial self-efficacy has a mediating effect between the extracurricular support programs and entrepreneurial intentions of engineering students. Findings of this study have several practical and policy implications for government, university management and entrepreneurship educators. This study contributes to the emerging literature on engineering entrepreneurship education.

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Introduction

In addition to technical knowledge, to stand out in a crowded job market and to support their ideas through to implementation, engineering graduates need capabilities relating to identifying opportunities, creating innovative products, leadership and communication

(Bosman and Fernhaber, 2018;Taks et al., 2014; Duval-Couetil et al., 2012; Dabbagh and Menasce, 2006). Organizations demand engineering graduates to have entrepreneurial mindset to innovate through R&D (Bosman and Fernhaber, 2018). Many universities have significantly expanded their offerings and support in entrepreneurship for engineering students to equip them to become the "entrepreneurial engineer" (as coined by Creed et al., 2002) and develop entrepreneurial mindset, intentions and skills (Duval-Couetil et al., 2012; Gilmartin et al., 2019). Founders of highly coveted technology-based ventures often include such entrepreneurial engineers in their founding teams.

The majority of the engineering entrepreneurship education literature has focussed on pedagogical approaches, entrepreneurship courses, curricular support and content (Taks et al., 2014; Girotto and Oliveira, 2022; Beagon et al., 2023). Cunningham and Menter (2021) calls for further research on extra-curricular support programs for the development of high-technology entrepreneurship. While extra-curricular support enables students to gain knowledge, skills, experience and develop entrepreneurial capabilities, there has remained little research on the effect of these support initiatives on Entrepreneurial Self-Efficacy (ESE), or the beliefs about entrepreneurial capabilities of students. Previous research strongly suggests that ESE can be a significant predictor of entrepreneurial intention (EI) and likelihood of intentions resulting in new venture creation (Zhao et al., 2005; Boyd and Vozikis, 1994; Saeed et al., 2015). Therefore, it is imperative to understand if extra-curricular support programs impact the underlying ESE beliefs of engineering students and provide a pathway to developing their EI.

The purpose of this study is to shed insights on the perceptions of engineering students on their university-based entrepreneurship support programs and the impact of these programs on their ESE and EI. This study contributes to addressing the paucity of research on the impact of extracurricular support programs on ESE and EI on engineering students in the rarely studied context of technical universities in India.

Out of the 1.5 million Indian engineers graduating every year, only 3% land in high paying engineering jobs, and they mostly come from Tier 1 engineering institutes (Chakrabarty, 2016). This inequity in employment opportunities across institutions cause around 1.25 million students to pursue non-technical job opportunities to overcome unemployment and risk commodifying a pure engineering education without other 'future of work' capabilities, leading to missed opportunities in innovation (*ibid.*). Meanwhile, to address this employment gap and lag in innovation, the Indian Government introduced their "National Innovation and Start up policy for students and faculty" in 2019, which aims at creating a robust university ecosystem by engaging students through various entrepreneurship related activities. The policy also points out to assess the impact of the support programs within the university ecosystem in order to devise new strategies and programs.

The current study is one of the first to establish a link between extra-curricular support programs, and ESE of engineering students, specifically in the context of a developing country. Most studies of ESE have focussed on business students in western economies. It may well be, that their entrepreneurial aspirations, engagement with extra-curricular entrepreneurial support and intentions are affected by the general environment and popular culture and in which they exist. On the one hand, in India, perceptions of opportunities, ease of starting a business, and the high-status of successful entrepreneurship are similar to western economies (Bosma et al. 2021). However, there are marked differences when it comes to entrepreneurial activity by employees, in that Indian entrepreneurship is the reserved domain of entrepreneurs and hardly done by employees, and Indian founders have lower job growth expectations, much lower intentions to access globalise markets, and entrepreneurship is vastly much more linked to continuing a family tradition (*ibid.*).

While it is beyond the scope of this project to include direct country comparisons, questions remain about the impact of education on entrepreneurship in India, including extra-curricular support. To get a better sense of the experience of an average engineering graduate, we also need to look beyond the Tier 1 engineering colleges. Consequently, it is significant to examine the entrepreneurial extracurricular support in Tier 2 and Tier 3 engineering colleges.

This study surveys students at Tier 2 and Tier 3 engineering colleges in South India to address the following research questions:

1. To what extent do extra-curricular entrepreneurial support programs affect ESE among engineering students?
2. How does ESE among engineering students contribute to their Entrepreneurial Intentions, including starting up technology-based ventures?
3. Are there specific extra-curricular entrepreneurial support programs that engineering students perceive to be important in enhancing ESE and EI?

This study accomplishes two outcomes. First, it quantitatively confirms the relationship between extra-curricular support, ESE and EI, allowing for better understanding of how generalisable these relationships may be across countries and across populations within those countries. Secondly, this study contributes qualitatively to the literature on entrepreneurship engineering education by shedding light on the perceptions of different types of extra-curricular entrepreneurial support initiatives students desire, particularly in the context of emerging economies such as India. Finally, the study has implications for educators, researchers and practitioners in understanding and designing entrepreneurial support programs, enhancing ESE and EI, and in turn generating new technology-based ventures. These more granular pragmatic contributions describe the mechanisms by which support, ESE and EI are related, which enables future research on why some mechanisms have direct or indirect effects.

Literature review

This literature review starts with an overview of the dependent variable (EI) and then reviews ESE and its antecedents. The intentional pursuit of opportunity has been suggested as the critical factor that distinguishes between an entrepreneur and a non-entrepreneur (Krueger and Brazeal, 1994). In her seminal article on entrepreneurial intentions, Bird (1988) argues that EI helps distinguish between entrepreneurial activity and strategic management. Thompson (2009, p. 676) defines EI as 'self-acknowledged convictions by individuals that they intend to set up new business ventures and consciously plan to do so at some point in the future.' Previous research underlines that EI is the single best predictor of entrepreneurial behaviour (Krueger et al., 2000; Sesen, 2013; Krueger and Brazeal, 1994). The literature shows that personal and situational variables have an indirect influence on entrepreneurship through influencing key attitudes and beliefs (Krueger et al., 2000) and this led to the emergence of intention models.

Intention models provide a robust theoretical framework for understanding and predicting new venture creation (Moriano, Gorgievski, Laguna, Stephen and Zarafshani, 2012; Krueger et al., 2000; Autio, Keeley, Klofsten and Ulfstedt, 1997). Among those models, the Theory of Planned Behaviour (TPB) (Ajzen, 1991) and the Entrepreneurial Event Model (EEM) (Shapero and Sokol, 1982) are the two most extensively used intention models. Krueger et al. (2000) compared the EEM and the TPB models and found that they are related in that they both have an element conceptually associated with perceived self-efficacy (perceived behavioural control in the TPB model and perceived feasibility in EEM model). Therefore, PBC and perceived feasibility are related to the concept of entrepreneurial self-efficacy, which can be defined as the degree to which individuals perceive themselves as having the ability to successfully perform the various roles and tasks of an entrepreneur (Hmieleski and Baron, 2008).

Boyd and Vozikis (1994) extends Bird's aforementioned model of intentionality (1988) through the addition of self-efficacy as an antecedent of EI. To understand selfefficacy, we need to consider Social Cognitive Theory (SCT) pioneered by Bandura (1989), of which selfefficacy is the central component. SCT examines the role of selfefficacy and how it affects the dynamic interaction between individual behaviour and environment. According to Bandura (1989), self-efficacy affects behaviour by first affecting people's motivational levels, as in how much effort they will exert and the amount of perseverance they might display while facing challenging situations. Individuals with high levels of self-efficacy tend to set challenging goals, persist towards achieving the goals, display persistence even under difficult and challenging situations, and resilience (ibid.). In summary, SCT provides a theoretical framework and mechanisms that explain how self-efficacy drives motivation and amplifies intentions to act in a given environment.

SCT and its mechanisms have been contextualised to entrepreneurship via Entrepreneurial Self-Efficacy (ESE) (e.g., Drnovšek et al., 2010). ESE can be defined as the degree to which individuals perceive themselves as having the ability to successfully perform the various roles and tasks of an entrepreneur (Hmieleski and Baron, 2008). Significant studies in the broader entrepreneurship literature reinforce that ESE is an important predictor of EI (Krueger and Brazeal, 1994; Boyd and Vozikis, 1994; Aggarwal and Shrivastava, 2021; Memon et al., 2019; Zhao et al., 2005; Maheshwari, 2021; McGee et al., 2009; Drnovšek et al., 2010). While most of the above are studies of business school students, we test whether this relationship still holds among engineering students, who may have wildly different career opportunities and paths to the participants in the above studies:

H1. The higher the perceived entrepreneurial self-efficacy of engineering students, the stronger their entrepreneurial intentions.

In line with SCT, ESE affects the dynamic interaction between entrepreneurial behaviour and the entrepreneurial environment. ESE not only affects behaviour in a context, but is also shaped by the engagement with the context. So, to understand the role of ESE and how it is generated, we need to investigate the context or environment and the degree to which it supports the development of ESE. Recent reviews of the literature on supportive environments find that there is a relationship between the university environment and intended entrepreneurial action exhibited by students (Saeed et al., 2015; Trivedi, 2016; Liñán et al., 2011; Kraaijenbrink et al., 2010; Shirokova et al., 2016).

A supportive University-Based Entrepreneurial Ecosystem (UBEE) can influence the entrepreneurial behaviour of students by helping them to create new ventures (Shirokova et al., 2017). Particularly, student entrepreneurs can access resources provided by universities, such as networking support, financial aid, and entrepreneurial curricular and co-curricular activities that enhance their knowledge and skills (Shirokova et al., 2017). Some studies have investigated the impact of key elements of university ecosystems, such as university entrepreneurial support on the student start-up activities (Morris et al., 2017; Kraaijenbrink et al., 2010). These studies examined if entrepreneurial support within the university ecosystem helped students to start new ventures. Kraaijenbrink et al. (2010) found that students who had started their own ventures desired more educational (curricular) support and concept development (motivating students, creating awareness, idea generation, etc.) support from their universities. Kraaijenbrink et al. (2010) suggest those student entrepreneurs might have faced difficulties while launching their ventures with regards to knowledge and concept development from their universities. Recently, Morris et al. (2017) analysed the impact of three components of university ecosystems on the start-up behaviour of students: curricular programming, cocurricular support activities, and financial resources for student entrepreneurs. They found that entrepreneurship courses could help students recognise opportunities and generate viable business ideas. Co-curricular activities such as business plan competitions, internships, student incubators, entrepreneurial mentorships, coaching programs and entrepreneurship clubs organised by the university also had a significant effect on the scope of student start-up activities.

Previous studies have primarily focussed on examining the direct relationship between entrepreneurial support within universities and EI (Shirokova et al., 2017) with exceptions such as Saeed et al., (2015) who investigated the influence of university support programs on EI through ESE, notably in the context of a developing country. Within the engineering entrepreneurship education literature, only a few studies such as Shekhar and Bodnar (2020) examined the influence of university ecosystems on ESE, across two institutions on business and engineering undergraduates. Their study of formal and extra-curricular programs found that having a diverse set of support activities had a strong influence on the ESE of students.

Extra-curricular programs may also affect students' entrepreneurial mindset, attitudes, decision-making process, entrepreneurial behaviour (Shirokova et al., 2017; Preedy et al., 2020; Middleton et al., 2020), contribute to formation of venture creation competencies and develop selfconfidence in students to pursue entrepreneurship (Pocek et al., 2022; Arranz et al., 2017). Although curricular support programs are more prevalent, they are also criticised for being overly theoretical and structured with higher consequences of failing, whereas extra-curricular support programs are practical and open for experimentation (Preedy et al., 2020). However, extracurricular support within university ecosystem remain under researched in the context of developing countries.

There is potential for extra-curricular support to have a similar impact to curricular support, either complementing it or even substituting it. For instance, Preedy et al. (2020) found that students felt the knowledge, skills and experience provided by the extra-curricular support initiatives enhanced their abilities to pursue an entrepreneurial career, and that engaging in extra-curricular initiatives could help student entrepreneurs gain access to resources and support.

The Extra-curricular support in this study includes initiatives with direct cognitive support such as mentoring, career advice, and entrepreneurial guest talks, (Fig. 1) has direct links to SCT. According to Wood and Bandura (1989), individuals develop and strengthen their self efficacy beliefs in the following ways: (1) Enactive mastery (Mastery experiences); (2) Observational learning (3) Social persuasion (Boyd and Vozikis, 1994). Mastery experiences or repeated performance accomplishments are

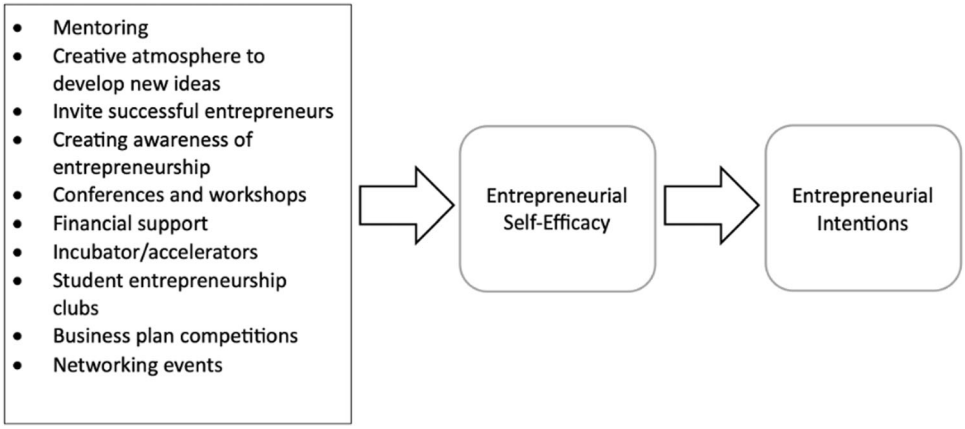

Fig. 1 Conceptual model.

considered effective ways to elevate the ESE levels of an individual (Wood and Bandura 1989) as they increase an individual's capabilities and perceptions of capabilities (Erikson, 2003). Observational learning can be operationalised via guest talks (Zozimo et al., 2017), mentors (Boyd and Vozikis, 1994; St-Jean and Mathieu, 2015) and other forms of role-models (BarNir et al., 2011). Social persuasion encourages people to believe that they possess the required capabilities to achieve or fulfil the task (Erikson, 2003). Wood and Bandura (1989, p.67) state that "if people receive positive encouragement, they will be more likely to exert greater effort" (Erikson, 2003). Such encouragement may come from aforementioned role-models as well as from educators and peers (Wang, 2014).

While many of the above initiatives have become embedded within business school curriculum, they are virtually entirely absent in engineering curriculum, which is often set by professional engineering societies. For engineering students fortunate to have access to curricular support, Duval-Couetil et al. (2012) found that such entrepreneurship programs raised the venture self-efficacy of engineering students, and widened their career prospects. Thus, for engineering students without curricular entrepreneurship support, these forms of support may be the only way they become exposed and motivated to start technology ventures (Gorman et al., 1997; Kraaijenbrink et al., 2010; Saeed et al., 2015; Trivedi, 2016). Unsurprisingly, recent research recommends engineering schools have extracurricular support programs to gain entrepreneurial experience along with the knowledge they gain from the courses (Besterfield-Scare et al., 2016).

Further, this study includes the organisational entities of a university in support of entrepreneurship, such as incubators, centres, TTOs, and entrepreneurship clubs as extracurricular support. Such entrepreneurial infrastructure provides an architecture upon which to build a robust, enduring, and effective UBEE (Fetters et al., 2010). Entrepreneurship centres or entrepreneurship development clubs help normalise and legitimate entrepreneurship as a career path by sponsoring and hosting programs, such as business plan competitions, internships, workshops, guest speakers, and networking events (Morris et al., 2013; Rice et al., 2014; Pittaway et al. 2015).

Students observe that the university leadership endorses and supports entrepreneurship by committing its own resources, including space, personnel, governance, policy and organisational processes. Centres for entrepreneurship and their activities encourage entrepreneurial idea formation (Belitski, 2019). TTOs (including incubators, accelerators) require clear policies and procedures around intellectual property and equity (Bolzani et al., 2021) and can be a source of knowledge, talent, equipment, working spaces, and digital infrastructure (Defazio et al., 2017; Audretsch and Belitski, 2019). These infrastructure elements are particularly important for technology universities and engineering students, who are more likely to require prototyping, technology development, and commercialisation as part of their technology-based entrepreneurial pursuits. Hence, based on these arguments, the following hypothesis is put forth:

H2: The perceived extra-curricular support positively influences the perceived entrepreneurial self-efficacy of engineering students.

In addition to testing these hypotheses, we explore the qualitative responses to identify differences across elements of extra-curricular support, and perceptions of their impact by students in Indian engineering colleges.

Methodology

The target population for this study was final year undergraduate engineering students from five technical universities in South India that have entrepreneurial infrastructure in their ecosystems such as incubators, entrepreneurship centres, and entrepreneurship clubs. Moreover, these universities offer only extra-curricular entrepreneurial support programs and do not provide an entrepreneurial curriculum. In order to maximise the heterogeneity of the sample, students from different course majors and five different institutes were selected across the three states in South India.

Data was collected using online surveys. Participants from the institutions were contacted through their faculty coordinators. An email was sent to the faculty coordinators of each institute seeking their permission to collect data from their students and their support in contacting students. The faculty coordinators sent the email with the survey link to their students. Table 1 shows the demographic profile of the respondents. A total of 314 surveys were received of which 114 (36.3%) were females, 199 (63.38%) were male, and one was marked as 'other.'

Data for all three variables (EI, ESE, perceived extra-curricular support) were collected on a five-point Likert scale from 'strongly agree' to 'strongly disagree.' In this study, EI (dependent variable) is defined as an intention to start a business (Iakovleva and Kolvereid, 2009). Adopted from Veciana et al. (2005), this study measured EI using the question 'Have you ever seriously considered starting your own firm?' followed by a 'yes' or 'no' prompt. ESE was measured by the skills specific scales devised by De Noble et al. (1999). Participants were asked to rate themselves on how capably they believed they performed each task such as risk and uncertainty management, innovation and product development, interpersonal and networking management, opportunity recognition, procurement and allocation of critical

Table 1 Demographics of the respondents.

		Count percent
Age		
18–20	88	28.02
21–23	206	65.6
24–26	8	2.5
More than 24	12	3.8
Gender		
Female	114	36.3
Male	199	63.3
Other	1	0.3
Work experience		
No	284	90.4
Yes	30	9.5
Stream		
Biotechnology	1	0.3
Computer Science/IT	52	16.5
Electronics/Electrical	27	8.5
Mechanical	50	15.9
Other	184	58.5

resources. The questions on extracurricular support were adapted from Trivedi (2016), adapted from Kraaijenbrink et al., 2010), which had a high Cronbach's alpha (0.87). This study added two questions to Trivedi's scale to measure the extracurricular support. Previous research has not paid much explicit attention to the influence of entrepreneurial infrastructure such as entrepreneurship development clubs or entrepreneurship centres on EI. This study aims to fill this shortcoming by adding questions specific to incubators and entrepreneurial development clubs.

Some of the closed-ended questions in this survey instrument consisted of an open component to gather responses that could not be captured with closed-ended answers. It encouraged students to express their general feelings on the issue being surveyed in the question. For instance, one such question was: 'Please specify the entrepreneurial support initiative within your university ecosystem that you believe can enhance your ability to successfully launch a new venture. Also, provide reasons for your answer (Why/Why not)?' Students were asked to choose among a given set of answer options, such as a hackathon, Bootcamp, business plan competitions, entrepreneur guest speaker series, entrepreneurial development clubs, and others. A comment box was provided for the students to express the reason they thought these initiatives enhanced their abilities to successfully launch new ventures. They were also encouraged to mention other such initiatives that were not given in the options.

Analysis

Confirmatory Factor Analysis (CFA) was carried out followed by Structural Equation Modeling (SEM) using the 'R' statistical programme with the help of the Lavaan package. A maximum likelihood method was used to estimate the parameters.

Entrepreneurial intentions. Students were asked if they ever intended to start a new venture. The majority of the students, 212 (67.5%), responded 'yes' to the question "Have you ever seriously considered starting your own firm?" In comparison with GEM India reports (Global Entrepreneurship Monitor Consortium, 2019), this sample exhibits higher entrepreneurial intentions. This may be related to the demographics of the sample as well as the engineering focus.

Reliability and validity. The constructs ENT (Extra-curricular support for Entrepreneurship) and SE had high values of Cronbach's alpha and composite reliability of ensuring their construct reliability (refer Table 2). A good rule of thumb is that standardised factor loadings should be 0.5 or above, ideally 0.7 or higher (Hair et al., 2010). Higher factor loadings (refer Table 3) and AVE of ENT and SE ensured the convergent validity of the initial model. The AVE and Cronbach's alpha of ENT is 0.56 and 0.93 ensuring the convergent validity of the new model.

Table 2 Reliability and validity.

Constructs	Cronbach's alpha	Composite reliability	AVE
ESE	0.80	0.81	0.58
ENT	0.93	0.93	0.56

Furthermore, Harman's single factor test was performed to detect the presence of common method variance. All the variables were loaded into an EFA and an unrotated factor solution was examined. Four factors with eigenvalues greater than 1 were extracted and collectively accounted for 62.39% of the variance. The first factor accounted for 37.27% of the variance, which is below the threshold of 50%. This suggests that common method variance might not be a serious concern in this study (Podsakoff et al., 2003).

Testing structural model and mediation analysis. Once the CFA model was found to be fit and satisfactory, the structural model was tested integrating the CFA model. Mediation analysis was performed on the proposed model which has ENT, ESE as a mediator and EI. All the factor loadings were above 0.5, which is considered good (Hair et al., 2010).

Primarily, three paths were tested to establish the indirect effect. As presented in Table II, the relation between ESE and EI is 0.43 and statistically significant at 5% level (Path a), thus supporting H1, confirming that ESE leads to EI. The relation between extra-curricular support (ENT) and ESE is 0.42 and statistically significant below 5% level (Path b), which provides support for H2, confirming that ESE is related to perceptions about extra-curricular support (ENT).

The relation between ENT (extra-curricular support) and EI (by-passing ESE), is negative but statistically not significant (Path c). As shown in Table 4, 'ab' is the indirect effect path, which is 0.13 (unstandardized) and with a total effect (unstandardized) of 0.09. Since ab is statistically significant, the model assures that ESE acts as a mediator between ENT and EI.

The chi-square statistic suggested a significant value (chi-sq. = 304.6, df = 146, p value = 0.000, CMIN = 2.06). Other fit indices, such as GFI (0.90), CFI (0.94), TLI (0.93), SRMR (0.04) and RMSEA (0.06) suggested a good model fit. These indices confirm this SEM output model, which is statistically valid for the theoretical model with SE, EI and ENT.

As presented in Fig. 2, the path analysis revealed that extracurricular support programs (ENT) had no significant direct relationship (−0.03) with entrepreneurial intentions (EI) of students. Yet extra-curricular support (ENT) had a statistically significant relationship (0.43) with the entrepreneurial self-efficacy (ESE) of students, (H2 supported). And, in turn, entrepreneurial self-efficacy beliefs (SE) of students had a significant relationship (0.42) with the entrepreneurial intention (EI) of students (H1 supported) as shown in Table 5.

Qualitative analysis. The survey instrument included an open-ended question, which asked respondents to identify specific entrepreneurial support initiatives which they believed would enhance their ESE. These responses reinforce the causal relationship between constructs due to the subjective attribution of

Table 3 Factor loadings of ESE and ENT.

	Estimate	Standard Error	*z*-value	P(>|z|)	Factor loadings
Entrepreneurial Self-Efficacy					
I can..					
..see new market opportunities for new products and services.	1.000				0.620
.. discover new ways to improve existing products.	0.828	0.109	7.599	0.00	0.534
.. identify new areas for potential growth.	1.041	0.119	8.744	0.00	0.640
.. design products that solve current problems.	1.224	0.13	9.418	0.00	0.714
.. create products that fulfill customers' needs.	0.925	0.113	8.178	0.00	0.586
.. form partner or alliance relationship with others.	1.011	0.122	8.312	0.00	0.598
.. identify potential sources of funding for investment.	1.070	0.129	8.324	0.00	0.599
Extra-curricular support for Entrepreneurship (ENT)					
My university..					
.. arranges for mentoring and advisory services for wouldbe entrepreneurs	1.000				0.739
.. provides creative atmosphere to develop ideas for new business start-ups.	1.038	0.076	13.596	0.00	0.772
.. invites successful entrepreneurs for experience-sharing.	0.938	0.073	12.851	0.00	0.731
.. creates awareness of entrepreneurship as a possible career choice.	1.048	0.079	13.332	0.00	0.758
.. motivates students to start a new business.	1.161	0.085	13.587	0.00	0.77
.. arranges conferences and workshops on entrepreneurship.	0.910	0.072	12.622	0.00	0.719
.. provides students with the financial means needed to start a new business.	1.141	0.091	12.483	0.00	0.712
.. has well equipped incubator which provides support to university start-up firms.	1.097	0.083	13.292	0.00	0.756
.. has an Entrepreneurship Development Club/Cell which organizes events and programmes to promote entrepreneurship among students.	1.028	0.078	13.217	0.00	0.75
.. organizes business plan competitions and case teaching for entrepreneurs	1.100	0.079	13.913	0.00	0.786
.. helps students to build required network for starting a firm	1.129	0.082	13.721	0.00	0.778

Table 4 Path coefficients and mediation analysis.

Regressions:	Unstandardised estimate	P(>|z|)	Standardised estimate
EI - ESE (a)	0.43	0.00	0.42
ESE - ENT (b)	0.29	0.00	0.43
EI - ENT (c)	−0.03	0.45	−0.05
Indirect and total effect			
ab - Indirect effect	0.13	0.00	0.18
Total effect	0.09	0.02	0.14

the causes by the participants, and enable pin-pointing sub-constructs of the entrepreneurial infrastructure as specific causes.

Of the students who responded, 148 (47.1%) said that entrepreneurship development clubs in their universities would help them enhance their ESE. This was followed by business plan competitions, with 112 (35.7%) responses. Entrepreneur guest speaker series was the third highest initiative chosen by students, with 109 responses (34.7%), followed by Bootcamps (31.5%) and Hackathons (27.1%).

In addition to these initiatives, they were asked to suggest other initiatives as well as the reason they thought would enhance their ESE. Initiatives such as entrepreneurial skill development programs, pitching competitions, internships, workshops, international conferences and seminars were mentioned as initiatives students believed would enhance their ESE.

Some of the remarks were concerning why they think the support initiatives would enhance ESE, and they are listed in Table 6.

Interestingly, some students reported the initiatives they would like to have in their institutes include design and development programs, a minor program in entrepreneurship for students from all streams of engineering, ideation camps, workshops specific to risk mitigation, and so on. These findings are particularly relevant as those engineering colleges provide only extracurricular entrepreneurship support programs and their engineering curriculum does not include entrepreneurship training. Few of the respondents commented that their institutes focused on job placements and curriculum (rather than an entrepreneurial focus), and that opportunities should be provided to students with entrepreneurial interests, while some complained that despite their interest in entrepreneurship, they could not participate in entrepreneurial support initiatives because of the academic workload.

Limitations. This study was constrained to South India and the sample size was limited to 314. Future research should aim to collect data from a larger sample size and could include a wider range of universities to explore cross-institutional effects or cross-country effects. The qualitative analysis was limited to binary responses and free text, in a way that limited establishing a clearer causal link between any one initiative or their combination to ESE and EI.

We acknowledge that this study is geographically limited to five colleges across three states in India. However, this is an improvement upon the many studies that only sample from one college or university. Due to the uniformity of technical colleges across India, these results are generalisable across many more of the nearly 5000 technical colleges in India. While India was the site for this study, the lack of higher quality educational systems and more comprehensive curricular and extra-curricular support for entrepreneurship may be generalisable to other developing economies like Pakistan, Brazil, Nepal, etc that each have hundreds of similar technical colleges.

We also acknowledge limitations in theoretical scope. This research has farreaching implications for other areas of professional development, beyond entrepreneurship, and it has implications for students from other disciplinary backgrounds, we have focussed on the literature at the intersection of engineering education, entrepreneurship education and developing economies. There is ample scope for further research beyond these literatures, as indicted in the ensuing discussion and implications section.

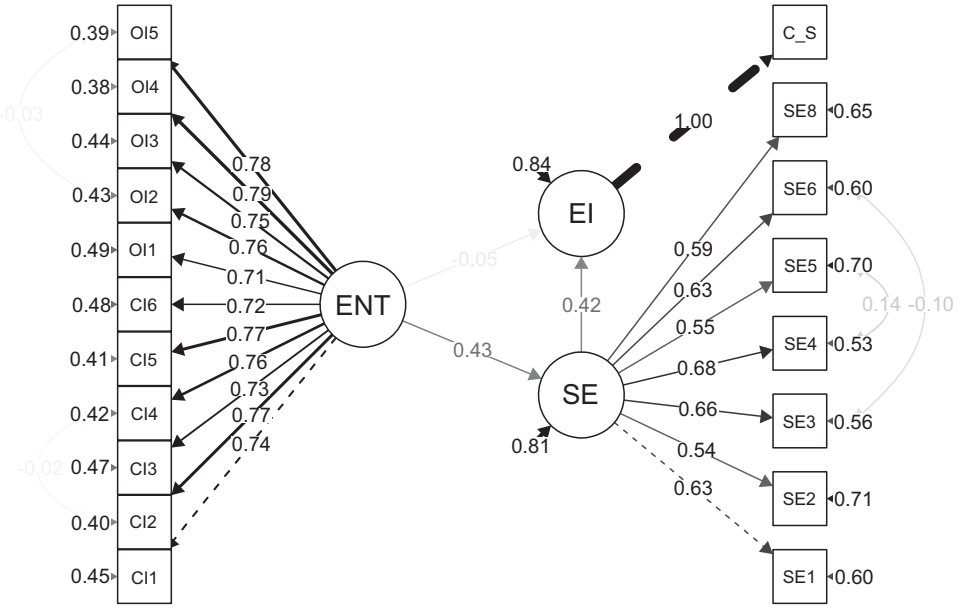

Fig. 2 Final SEM model.

Table 5 Results of hypotheses.

H1. *The higher the perceived entrepreneurial self-efficacy of engineering students, the stronger their entrepreneurial intentions.*	Supported	0.42***
H2. *The perceived extra-curricular support for entrepreneurship positively influences the perceived entrepreneurial self-efficacy of engineering students*	Supported	0.43*

***$p < 0.001$; *$p < 0.01$.

Table 6 Initiatives that enhance ESE.

Initiatives (responses)	Student remarks
Entrepreneurship development clubs (47.1%)	• Conduct various entrepreneurship development initiatives • Developing entrepreneurial skills • Provides knowledge about entrepreneurship
Business plan competitions (35.7%)	• Stimulate minds • Helps in Idea generation • Learn from mistakes • Open up avenues for finding investors
Entrepreneurial guest speaker series (34.7%)	• Increases knowledge. • Motivates students. • Opportunity to learn from their experience.
Bootcamps (31.5%)	• Good training. • Platform to learn and increase knowledge. • Help create your own ideas. • Learn about current trends
Hackathons (27.1%)	• Immense brainstorming. • Out-of-box thinking. • Help create your own ideas.
Seed capital	• Enables product development

Discussion and implications

The extra-curricular entrepreneurial support programs positively influence the ESE beliefs of engineering students, which in turn influence their EI in the hypothesised way. While the sample of this study is specific to students in engineering universities in South India, the observed patterns are consistent with the more generalised findings that link ESE to EI (Zhao et al., 2005; Wilson et al., 2007; Austin and Nauta, 2016; Krueger et al., 2000; Saeed et al., 2015; Sesen, 2013; Baluku et al., 2019).

Specific to university-based entrepreneurial support programs, this study reveals that such programs enhance indirectly entrepreneurial thinking and encourage students to start up new ventures by influencing their beliefs on their opportunity recognition skills, innovation and product development skills, interpersonal and networking skills, skills related to procurement and allocation of critical resources.

The magnitude of the indirect effect is revealed by the SEM model, clearing showing that the initiatives in the ESE do not directly trigger EI, but first develop ESE (0.43), which then has the flow-on effect of increasing EI (0.42) for this cohort. These effect sizes are similar to other studies with business students and with curricular programs, indicating that extra-curricular programs can be a substitute to curricular programs, and would likely enhance them, too.

This mediating effect confirms that situational or personal factors alone are poor predictors of EI and such factors have an indirect influence on intentions through influencing key attitudes and beliefs such as ESE to start up, emphasising the significance of intention models (Krueger et al., 2000; Boyd and Vozikis, 1994). In plain terms, students do not develop EI simply by going through the motions of entrepreneurship; a leap of faith in their own abilities is required for them to draw on such exercises to confidently pursue it as a profession. The previous literature supports this mediating nature of ESE, where entrepreneurial support initiatives have an indirect effect on EI through ESE

(Yang et al., 2017; Baluku et al., 2019; Zhao et al., 2005). A similar pattern of results was obtained by Saeed et al. (2015) who found that ESE acted as a mediator between entrepreneurial support within universities and EI for business students. This mediating effect shows that the development of EI does not happen by osmosis, simply by participating in extra-curricular programs. Having the confidence to engage and interact with the programs in the environment is a component of SCT that is brought to light in this study. But, it also requires further research to explore the relationship between programs and ESE development. Questions remain about causality, such as whether a minimum level of ESE is required to engage with these programs. Further research is also required to study other moderating factors, like the level of engagement in the programs, right down to their learning designs.

This study confirms that engineering curriculum design lacks the space to include entrepreneurship support programs (Shekhar and Bodnar, 2020). This is troubling because of the missed opportunities to foster technology entrepreneurship due to the extreme complementarity of engineering and entrepreneurship. Such research on extra-curricular sources for engineering students would extend the more general research linking ESE and EI to higher aspirations (Herron and Sapienza, 1992), entrepreneurial careers (Wilson et al., 2007) and venture formation (Baluku et al., 2019; Austin and Nauta, 2016; Bandura, 1989; Middleton et al., 2020; Pocek et al., 2022).

The qualitative analysis here corroborates prior findings of individual initiatives that affect ESE, including clubs (Pittaway et al., 2015; Padillo-Angulo, 2019), workshops (Pruett, 2012), mentoring and peers (Pruett, 2012; Miles et al., 2017; Baluku et al., 2019), competitions, guest talks, bootcamps and hackathons. Some initiatives like mentoring are unsurprising, given the extensive research done in this area (e.g. St-Jean and Mathieu, 2015; Laviolette et al., 2012; Baluku et al., 2019; Wang, 2014).

What is notable in the findings of this study, is the breadth of entrepreneurial support programs revealed, and the range of sources of self-efficacy they represent (enactive mastery experience, observational learning and social persuasion). This breadth clearly indicates two things. First, it suggests that there is no one single silver bullet solution to generating ESE. Questions remain whether the effects of one program can substitute another, whether their effects are additive, multiplying or might accidentally cancel each other out. In a similar vein, do experiences that decrease ESE have a longer lasting effect and almost permanently turn students off EI (see also Piperopoulos and Dimov, 2015)? Our findings and each of these questions call for further research to isolate their individual, clustered and combined effects, especially inclusive of temporal effects. Second, the breadth of ESE sources shows the need for universities to legitimate entrepreneurship by committing resources towards the extracurricular support. While student clubs can be self-sufficient and organise their own guest talks, it is highly uncommon for business plan competitions, workshops, hackathons or access to seed capital to occur without the university's organisational support. This insight prompts further research into the tangible and intangible support conferred upon entrepreneurship as a career by the university. Such research needs to be mindful of potential overlap between constructs such as the clubs versus the networking opportunities they afford.

Engineering colleges like the ones in this study may use extra-curricular programs to strike a balance between the rigid and intensive engineering curriculum versus entrepreneurial support activities. This balancing act applies to the university as well as the students. As shown by students in this study, entrepreneurial support initiatives were perceived as beneficial, but the intense academic workload inhibited their ability to participate in entrepreneurial activities. This has been identified as a barrier to deliver extra curricular entrepreneurship support to engineering students (Duval-Couetil et al., 2016). This is in line with findings of Ooi and Khor (2018) who points out that coursework and academic focussed curriculum prevented engineering students from participating in extra-curricular activities. Participation in extracurricular activities depends on their academic timetable (Ooi and Khor, 2018). Some tensions may be resolved by creatively embedding entrepreneurship within the curriculum. For example, universities could offer academic credit points for participating in entrepreneurial support initiatives or favour work-placements in entrepreneurial ventures.

The implications for practice are for engineering universities to support a wide range of extracurricular support initiatives that complement each other and can be taken in different sequences. In this way, students who discover one initiative can discover others, and gradually develop mastery towards EI, as well as the social capital to put those intentions into practice. Where multiple types of universities are in close proximity to each other, multi-disciplinary teams can be instigated by opening initiatives up across universities, as seen in Stockholm and Denmark (Pocek et al., 2022).

Conclusion

There are four major findings in the current study. First, this study found that the extracurricular entrepreneurial support programs were positively related to ESE among engineering students. Second, the ESE among these students were positively related to the EI of students. Third, ESE plays a mediating role in the relationship between entrepreneurial support programs and EI of students. Finally, this study identified multiple types of extra-curricular entrepreneurial support initiatives which students perceived enhanced their ESE beliefs, many of which depend on the university to support the initiative.

This study reinforces the significance of extra-curricular entrepreneurial support programs in creating entrepreneurial mindsets, especially in the absence of entrepreneurship curriculum. These programs become more critical in saturated job markets where employers are looking for an entrepreneurial differentiator or where graduates may seek to start their own venture as an alternative career path (Duval-Couetil et al., 2016).

From an employability perspective, the primary outcome of entrepreneurial support programs is not the number of start-ups created, but rather the development and strengthening of cognitive beliefs, abilities, skills and competencies. The ESE generated in students would help them cope with challenging and uncertain situations, goal attainment and would help them persist throughout an entrepreneurial career (Bandura, 1989). Universities that are committed to building a strong and robust UBEE should regularly develop, review, and update new entrepreneurial support initiatives. The participation rate of students and their ESE levels could be used as indicators to review such initiatives. The findings of this study are relevant, particularly for an emerging economy like India, where both central and state governments are making efforts to encourage and foster entrepreneurial activities by launching schemes and policies favourable for start-ups and entrepreneurs, and ultimately regional and national economic development.

Data availability

The datasets generated and analysed as part of this study are not publicly available. At the time of ethics approval, it was not considered to make them public. However, a private copy of the data can be made available from the corresponding author on reasonable request.

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Competing interests
The authors declare no competing interests.

Ethics approval
The study has been approved by the Human Research Ethics Committee (approval number: 018095 S at the University of Notre Dame Australia).

Informed consent
Informed consent to participate and publish the results were obtained from the respondents.

Additional information
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