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Exploring survival and failure on the edge of commercialisation in Australian technology-based start-ups

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Abstract: Several stage models have attempted to clarify management priorities during the early stages of business growth. However, more focused and context-specific studies are needed. This study seeks to clarify the early stages of technology-intensive companies in Australia. It bridges the aforementioned gap by answering the following research questions: (1) How do the experiences of managers in technology-based start-ups relate to the assumptions of stages of growth theory in the Australian context? (2) What context-specific viewpoints should be considered when using stage frameworks in the Australian context?

In this retrospective multiple case study, we develop a four-stage framework describing the early stages of technology-intensive companies through three in-depth case studies. We use the sequential incident technique and semi-structured interviews for data collection. For triangulation purposes, three perspectives were analysed in each company studied: one from company management, one from operations management and one from marketing management. This study makes a preliminary test of the applicability of the framework and analyses context-specific viewpoints. Recognising these viewpoints is necessary when using this framework in Australia.

The research focus of this study is limited by the context involved, the three cases examined and the study's focus on the first phase of the framework. The applicability of the results to other contexts is therefore limited. The findings of the study may be effectively used in intermediary organisations as a framework for predicting the early stages of technology-intensive companies. Context-specific viewpoints and their effect on the early stages of companies have not been widely investigated. This work considers and provides new insights into the growth and management of technology-intensive companies in Australian context.

Keywords: stages of growth, growth process, sequential incident technique, entrepreneurship, micro-entrepreneurship

1. Introduction/Background

Company growth can be studied from multiple perspectives. The literature in this area includes perspectives, such as static equilibrium theories (e.g. Coase, 1937), stochastic models (e.g. Gibrat, 1931), transaction cost theories (e.g. Williamson, 1975), economics of growth theories (e.g. Penrose, 1959), resource-based theories (e.g. Penrose, 1959), evolutionary theories (e.g. Nelson and Winter, 1982), organisational ecology theories (e.g. Hannan and Freeman, 1977), strategic adaptation theories (e.g. Sandberg and Hofer, 1982), motivational theories (e.g. McClelland, 1961) and configuration theories (e.g. Churchill and Lewis, 1983; Greiner, 1972). This study focuses on the latter, which is the configuration perspective. Most other perspectives are concerned with the factors that lead to growth, but the configuration perspective deals with the actual growth process. According to Davidsson and Wiklund (2006), the configuration perspective focuses on how managerial problems occur and how they can be dealt with during the presumed growth of a firm in typical stages of development.

The configuration models developed during the past few decades vary widely in terms of their focus industry, use of empirical evidence, number of stages and other factors (e.g. Siu and Kirby, 1998). Recent reviews of the literature have shown that numerous stage models abound (see Levie and Lichtenstein, 2010; Muhos et al., 2010; Phelps et al., 2007). In the management literature, generic analyses of these models have shown neither consensus nor empirical confirmation of the stages theory because many of such models and frameworks are conceptually based. However, focused empirical models have produced consistent findings. Empirical studies have mostly examined technology-based firms. Empirical tests by Hanks et al. (1993) and Kazanjian and Drazin (1990), among others, have provided support for the applicability of technology-based, firm-focused models.

The main findings of 14 recent empirically based stage models that centre on technology-intensive companies were synthesised into a four-stage self-evaluation framework (Muhos, 2011) to test the main results of the models. The framework was preliminarily tested in Thailand, Finland and Taiwan (Muhos et al. 2016, Muhos et al. 2014a, Muhos et al. 2014b). The findings initially supported the applicability of the framework in these contexts. Moreover, some context-specific viewpoints were emphasised and further analysed. An in-depth analysis of the experiences of the managers of case businesses will allow an examination of the gaps between reality and the stage models, as well as highlight potential paths for the further development of these models. The present study aims to explore a new business context and describe the early developmental stages of technology-intensive companies in Australia.

In this research, the first stage of the reference framework will be tested in technology-based start-ups in the Australian business context. The start-up period is critical for the survival of a new company; decisions made during the early stage of growth have a definitive influence on the lifespan, productivity and success of a company. An empirical and context-specific understanding of the underlying processes of start-up growth is urgently needed. This study bridges such a gap by answering the following research questions: (1) How do the experiences of managers in technology-based start-ups relate to the assumptions of stage frameworks in the Australian context? (2) What context-specific viewpoints should be considered when using stage frameworks in the Australian context?

This retrospective multiple case study clarifies which viewpoints the managers of technology-based businesses highlight in this critical stage. Through three cases, we explore these experiences from the beginning of conception and development to the edge of commercialisation and compare the managerial experiences to a literature describing the early stages of technology intensive firms. This study makes a preliminary test of the applicability of the service framework to the Australian technology-based start-ups and analyses context-specific viewpoints, which must be considered when using a service framework. Context-specific viewpoints and their effect on the start-up stage of companies have not been widely studied.

2. Early stages of service-based companies: framework

In this chapter, the early phases of growth in technology-based firms are described. This study devises a reference framework based on a meta-analytical synthesis of recent studies focused on technology businesses and the empirical stages of growth. The main phases of growth were identified earlier on the basis of an extensive literature review (see Muhos, 2011). From an analysis of 14 recent and relatively consistent models (Abetti 2001, Garengo & Bernardi 2007, Hanks et al. 1991, Hanks & Chandler 1992, Hanks et al. 1993, Hanks & Chandler 1994, Kaulio 2003, Kazanjian 1988, Kazanjian & Drazin 1989, Kazanjian & Drazin 1990, Mitra & Pingali 1999, Poutziouris et al. 1999, Smith et al. 1985, Stam 2007, Swiercz & Lydon 2002, Van de Ven et al. 1984), the early stages of technology-intensive SMEs were identified as (1) **conception and development**, (2) **commercialisation**, (3) **expansion** and (4) **stability/renewal**. The *first* two stages of the four-stage self-evaluation framework for early-stage service-based companies were devised in this analysis as a reference frame to describe what happens during the critical early development from the establishment of a firm to the edge of commercialisation. The main assumptions of the reference stage framework are presented in Table 1.

Table 1: Developmental characteristics of technology-based start-ups: assumptions of the self-evaluation framework

Stage	Description
1. Conception and development	The newly established firm is owner dependent (1-A1*). The objectives are product and/or technology development (1-A2) and the establishment of an early customer base (1-A3). The main activities relate to the business idea (1-A4), identification of a market (1-A5) and resource mobilisation (1-A6). The development of a working prototype is started (1-A7). The management is informal, flexible and creative (1-A8); communication is face to face (1-A9), and the owner makes the decisions (1-A10). The organisation functions as a product development team (1-A11). The cash flow falls into the red because of the lack of a product at this point (1-A12).
2. Commercialisation	This stage begins with early reference customers (2-A1). The objectives are the creation of a business and the commercialisation of the product (2-A2). This stage is characterised by early manufacturing (2-A3), marketing (2-A4) and initial technical challenges (2-A5). The company learns to make its product and produce it (2-A6). The management style is participative (2-A7) and coordinative (2-A8). The owner and/or a small number of partners dominate the nucleus of the administrative system (2-A9). Resource generation and survival are key issues (2-A10). The amount of negative cash flow decreases (2-A11).

*1-A1 = Stage 1, Assumption 1 (This coding will also be used in the subsequent parts of this study.)

The framework described above serves as the reference framework for this study. This framework is used to analyse and reflect upon the experiences of managers during the early stages of firm growth.

3. Method

This study is a retrospective multiple case study with a holistic research strategy (Saunders et al., 2007; Yin, 1989). According to Yin (1989, p.23), 'a case study is an empirical inquiry that: investigates a contemporary phenomenon within its real-life context; when the boundaries between phenomenon and context are not clearly evident; and in which multiple sources of evidence are used'. The sequential incident technique (SIT), a specific form of the critical incident technique (CIT) (Edvardsson and Roos, 2001; Fisher and Oulton, 1999; Flanagan, 1954), is used. Figure 1 presents the research process.

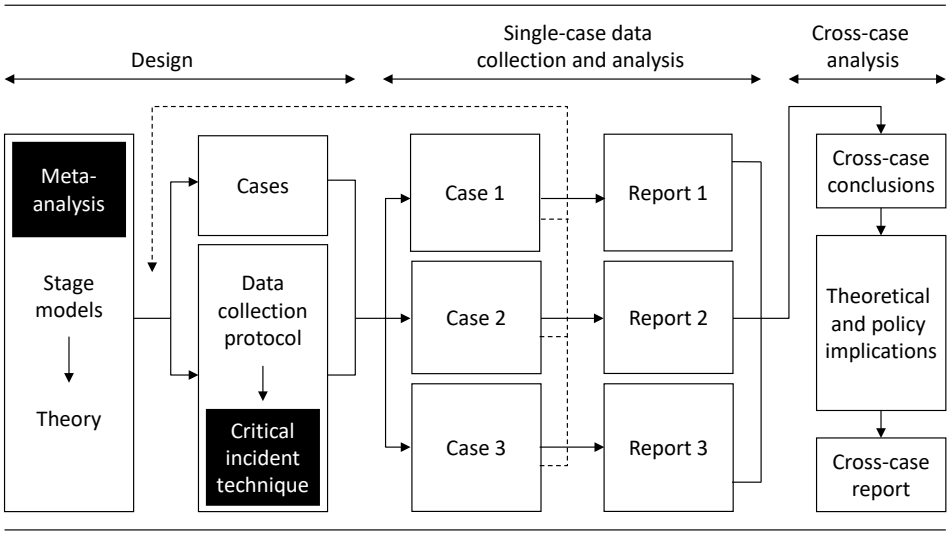

Figure 1: The research process of this study (modified from Yin, 1989)

Three technology-based start-ups were analysed with the use of CIT and semi-structured interviews conducted in 2016. For triangulation purposes, we examined three managerial viewpoints from each case company: one from company management, one from operations management and one from marketing management. The case studies followed the guidelines established by Yin (1989). In an overview of CIT methods, Gremler (2004) recognises several variants of CIT, including SIT, which was created to consider the sequential character of the process being studied (see Stauss and Weinlich, 1997). Case studies using SIT clarify the main stages of the process under analysis prior to the data collection. This approach is advantageous if the process has already been defined empirically. In this study, the critical incidents are reflected in the sequential framework presented in the theoretical section. The case reports are based on three separate case studies.

The key indicators of growth and the main characteristics of the case companies analysed in this study are summarised in Table 2

Table 2: Key characteristics of the case companies

Case	Established	Employees	Sales ($)	Assets ($)	Industry
A	2011, operations started 2014	6	50,000	40,000	Innovation combining software and hardware for renewal energy systems in buildings
B	2015	4	30,000	8,000	Disruptive digital visualisation innovation for architecture
C	2013 (closed down 2015)	0 (8)	13,000	N/A	Research-based construction material innovation

This study seeks to clarify what happens during the very early stages of growth in technology-based start-ups in the context of Australia. Private-owned case companies were selected on the basis of their focus on new technology and the 'newness' of the firm. Three case companies were analysed from managerial perspectives with the use of SIT and semi-structured interviews conducted in 2016 (Edvardsson and Roos, 2001; Fisher and Oulton, 1999; Flanagan, 1954). For this study, a critical incident was considered to be an extreme behaviour, either outstandingly effective or ineffective with respect to attaining the general aims of the activity (Fisher and Oulton, 1999).

4. Results

In this chapter, a case-by-case analysis of the critical incidents related to the start-up stage is provided. Aspects that are parallel and contradictory to the assumptions of the framework are first presented in a quantified form to test the applicability of the framework to each case. Then, the contradictory aspects are analysed further to point out potential context-specific aspects that should be considered in Australia.

Case A: Combined software and hardware innovation for renewal energy systems in buildings

Case A is a start-up aiming towards a new type of disruptive innovation (software and hardware) for renewal energy systems in buildings. The company was originally established in 2011, but it became operational as late as 2014. By the end of 2015, it had two employees, $50,000 sales and $40,000 worth of assets. By the time of the interviews in 2016, it had grown to a six-employee firm standing on the edge of commercialising its innovation. Likewise, it was moving from stage 1, conception and development, to stage 2, commercialisation.

In case A, 84% of all the coded incidents were parallel in comparison to the assumptions of the reference framework. The majority of the incidents were positive. Moreover, according to the interviewees' evaluations, the framework fit their experiences very well at this stage.

Table 3: Key parallel aspects found in case A

Assumption	Key parallel aspects
A1.1	Early on, case A was very dependent on the diligent and visionary founder: *Firstly, to start with, I was doing everything. …they decided to leave, and I decided to continue on my own. They could see it was going to take a while, and they thought it should be happening faster. They didn't even hang around until we had a minimum viable product. They were Impatient. They didn't share my longer-term vision.*
A1.2	The objective was product development. *We do software, but we also have a piece of hardware which we don't manufacture. We just buy it off the shelf, but it still needs to be assembled, and we need packaging, we need to manage the deployment of these things. So we're putting in place the systems to handle scale. … not only deployment support but also training for the installers and tools to help with the installation.*
A1.3	The minimum viable product was experimented with early B2B customers who supported development, generated feedback and provided new opportunities. The firm got traction, created a very good profile and secured a lot of leads to good customers. *We're targeting specific customer segments, which we think have the potential to scale.*
A1.4	The definition and validation of the business idea took time: *I had a different idea to start with* [in 2011]. *So we started to explore that and decided that wasn't what I wanted to do. I was just doing that on the side at the time.*
A1.5	In a fast-moving market, the firm chose to *stay nimble*. The company scanned opportunities in a diverse set of potential target markets beyond the original target market, and pivoted to find what customers really need. This approach provided results: We have clear channels that we're targeting in terms of customer segments, which are ready to scale.
A1.6	The generation of financial resources took time even with help of a mentor (that ended up being an investor): *In Australia, at the moment, to raise a seed, the round of investment can take six to nine months. …the period of time it took to raise that first round of investment. The period from going from starting to talk to people to getting those first yeses wasn't that long. What took time was negotiating the shareholders' agreement, so the legal work, and then actually accessing the money. … assuming I raise by the end of this year, I could easily have spent eight months of those two years simply trying to raise money. So it takes a person out of the company for that period of time.*
A1.7	Management needed to be creative and flexible in orchestrating a set of interns, contractors, mentors, hired experts, etc. to reach the target, generating a *minimum viable product* that customers are ready to pay for.
A1.10	The owner made the key decisions. As an example of a typical reflection of owner-centric decision making, the founder reflects on one of the many similar types of decisions: *I made a decision to focus on off-the-shelf hardware. That has been a good decision.* Another example is as follows: *Lots of things went wrong, but ultimately, I think I learned from them, and I can't say now in retrospect that they were negative in the longer term. It's good to be reminded of that.*
A1.11	According to the founder, *the first person who I hired as a full-time staff was the CTO. That took a big burden off because he's now responsible for product development …all the staff that we've employed have been technical. In fact, two of our casual staff are final-year students, engineering.*
A1.12	The founder reflects on the situation before getting the minimum viable product in front of the paying customers: *I was funding it myself, just bootstrapping.*

A small proportion of the experiences of the managers was somewhat contradictory. The contradictions recalled by the interviewees were related to assumptions A1.1, A1.2, A1.3, A1.11 and A1.12. These contradictions are presented in Table 4. At this stage, only a few of the incidents were related to the commercialisation stage.

Table 4: Key contradictions found in case A

Assumption	Key contradictions
A1.1	Owner dependency was intentionally lowered to support the team of owners. The owners of case A, who had a strong technical/marketing background, were supported by taking on a mentor with strong business expertise and network. The role of the mentor was to help prepare the business in raising capital.
A1.2	Case A was originally established with another business idea. Technology development started as late as 2014 with another business idea: *So legally, it was established in 2011, but nothing happened.* Moreover, case A did not develop all technologies in the company but decided to *focus on off-the-shelf hardware*, which enabled focus on software with better margins.
A1.3	Instead of purely searching for a customer base, the firm aimed to build a base of 'development partners': *Basically, we were solving a problem for them that they couldn't find a solution otherwise, so they were both a customer and a partner, or, if you like, the development partner.*
A1.11	In addition to building a product development team, case A took on a person whose main responsibility was to prepare the firm for scaling. Case A also extended the product development team by hiring contractors to speed up the development of a prototype.
A1.12	The company built the minimum viable product with 'development partners'. The company obtained forerunner customers in 2015 and was able to raise its first round of investment at the end of 2015: *We want to make our current money last as long as we can so that we can get as many customers as possible, the evaluation of the company for the next capital raise is as high as possible and the current shareholders aren't diluted.*

Case B: Disruptive digital visualisation innovation for architecture

Case B provides a disruptive digital visualisation innovation (product and services) for several industries, including architecture. The company was established in 2015, and by the end of 2015, it had two employees, $30,000 in sales and $8,000 worth of assets. By the time of the interviews in 2016, it had grown to a six-employee firm standing on the edge of commercialising its innovation. Likewise, case B was moving from stage 1, conception and development, to stage 2, commercialisation.

In case B, 92% of the coded incidents were parallel in comparison to the assumptions of the reference framework. The majority of the incidents were positive. According to the interviewees' evaluations, the framework fit their experiences very well at this stage.

Table 5: Key parallel aspects found in case B

Assumption	Key parallel aspects
A1.1	The interviewees reflected on the effects of owner dependency in a start-up: *…you can do as much as you want if you're on a roll; for example, I once spent 72 hours straight without a break. If you burn the candle from both ends, it won't last long. We're trying to promote taking a break. …we're splitting the projects down the middle. We're just doing that until we can get enough money behind us to incorporate into a company.*
A1.2	Technology is a central element of the business: *…most of our work today has been in the areas of* [main technology development] *or* [technology 2 development]. According to the founders, access to the key decision makers in large customer organisations is guaranteed by the exiting technology: *Exciting technology gets us through the door. …we've had access to CEOs and heavy headers in the industry that just come in here …to try this thing.*
A1.3	On one hand, the establishment of an early customer base is supported by the exiting technology: [main technology] *demos… Out of those, we get access to the decision makers, who then decide to hire us to produce a product for them. So rather than advertise on social media or anything like that, we don't do any of that. …a hands-on demonstration is very important.* On the other hand, *a lot of times, we end up pursuing certain leads that eventually don't go anywhere because the people, while they're excited about seeing the technology, don't understand what's involved in potentially producing what they're after.*
A1.4	The business idea was being developed*: It's kinda like the difference between renting and office and having a purpose-built office. When they realise they can have that, they're all like, well, let's go for option number two because that really matches the need. …for a lot of people, they don't want something super complicated; they want something simple, so we need to be able to come up with a concept that they can, we can, output cheaply and affordably and still meet their requirements. … So it's probably a different idea when it comes to expansion.*
A1.5	Identification of the market involved a struggle between the high-margin custom product market and the scalable market with low margins. Moreover, the firm needed to prepare for the potential future saturation of the market: *...we need to start looking at what can we do within the visualisation industry to make it, I guess, achieve that unique selling proposition, that unique point of difference.*
A1.6	Resource mobilisation in a start-up is a creative process. One of the founders has another business for moneymaking. The human resources are limited, and the technology-oriented founders need to divide their *time between marketing and producing the product.* The founders plan to hire a CEO and a sales manager. Technology does not require heavy investments: *We just sit in front of the computer and produce the product*.
A1.8	The management is flexible and creative: *We do need to be flexible and we do need to be creative, but that's also the nature of our industry.* The nature of the industry is flexible: *It can be done at any time. So say, I wanna have a day off during the day; that's fine. I just continue to work into the evening with my programming, or on the weekend, or whatever.*
A1.9	In the firm, most of the issues are regularly solved face to face, which was confirmed during the interview, when the two founders were interviewed together. *So we've naturally assumed certain roles. These other things that neither of us like doing and we've had to sort of divide and say, well, you know, tough, we're gonna have to do this and you do that and I'll do this, but there are more roles that we've sort of naturally assumed.*
A1.11	The organisation has the basic characteristics of a product development team. *Ok, so basically, we like to jokingly say that I'm the arts and he's the smarts. …that kind of sums it up.* The founders' key areas of expertise relate to product development. *…our strengths are, and that's kind of where the process is.*
A1.12	Until the time of the interview, the company focused on custom products and did not have a scalable baseline product for the market. *The problem was, we kind of started this with very little finances, so we didn't have the money to pursue that structure right away. …there were points where the cash flow got really tight for a while, and that had an impact on, I guess, morale, and questions of are we gonna be able to do this or not, you know, they came up.*

A small proportion of the managers' experiences was somewhat contradictory. The contradictions recalled by the interviewees were related to assumptions A1.2 and A1.8. These contradictions are presented in Table 6.

Table 6: Key contradictions found in case B

Assumption	Key contradictions
A1.1	According to the founder, in case B, the original owner-dependent team was supported by organising regular meetings with *business mentors or business people.*
A1.2	The key objective of the founders was to develop a successful business: *We are, both [founder 1] and [founder 2], very creative people, and we're both specialists in our field. …I've learned that just because you're good at what you do and you have a great skillset and a great product to offer, that's not enough. …That's only really half of it. The other half is actually managing a successful business.*
A1.7	Instead of developing a prototype, case A started offering customised products. Each new customer represents a pivot that generates revenue and valuable feedback. However, *our business isn't exclusively focused on [the main technology] either; that's just a way in the door. We can also produce* [technology 1] *for computers, or for a smartphone or a tablet, all that sort of stuff. …No, we also do* [technology 2], *as well*, *and* [technology 3].
A1.8	*…we have gone straight into commercialisation.* Case A developed its minimum viable product early and started pivoting with revenue. The selected approach required more coordinative management than one typical for a pure product development team.
A1.11	In contrast to a typical product development team, the organisation includes some characteristics of commercialisation stages. *We're still kind of developing and forming the company in the process. Does that make sense? … So it's a bit of both.* Following a typical lean start-up process, the company experiments its business model and product with paying customers, and generates revenue 'from day one'.
A1.12	The firm is a clear example of the 'affordable loss' principle in action: *…we can't afford to advance ourselves through research without really too much risk. Because we're a small outfit, we can offer a much more affordable process. …we focus all our attention on buildable staff. …as far as our staff goes, there's really nothing that we don't have or can't get access to, if we need it. We're exporting our creativity, our minds; we're not selling stuff, we don't have to purchase equipment and pay for storage and we don't have staff to manage it all. I think it may have helped us to get things up and running quicker… We're determined to do this debt free. We don't need any investors or anything, just doing our own thing.*

Case C: Research-based construction material innovation

Case C is a research-based academic spin-off start-up that aimed to disrupt a specific type of construction material market controlled by large industrial players. The company was established in 2014, and before its shutdown by the end of 2015, it had, during that year, a maximum of eight employees, $13,000 in sales of a prototype and no assets. By the time of the interviews, case C failed to commercialise its technology and was eventually closed down.

In case B, 81% of the coded incidents were parallel in comparison to the assumptions of the reference framework. The majority of the incidents were negative and reflected the failure of the business, which led to its closure before the end of year 2015. Moreover, according to the interviewees' evaluations, the framework fit their experiences very well until the shutdown. The parallel characteristics are condensed, as shown in the following table:

Table 7: Key parallel aspects found in case C

Assumption	Key parallel aspects
A1.1	The dependency on the owner's vision was described by the founder: *I was working very hard and a lot of nights to just try to make it happen. But it was enjoyable.* The dynamics between the founders had a huge impact on the survival of the business: *…the dynamics between myself and the other co-owner, the researcher. … He basically eventually sought to pull out, and that was the catalyst for… and I said, 'well, without you, we're not gonna have a product'. And that was a catalyst for the process of shutting it down.*
A1.2	The firm aimed at commercialising a construction material innovation with a potential to disrupt that specific segment of construction materials and products. In an academic spin-off, the researchers have to adjust to the requirements of the business playbook … *when you start researching, you don't know what other researchers are doing unless they have already published it or put it on patents. …So people [competitors and potential large customers] are hiding or doing or somewhat burying the process; they might not necessarily want to tell you until you actually go knock on their door, and they politely tell you, 'we're working on something similar; we're not interested'.*
A1.3	The company aimed at the market with a large development partner: *As far as it became clear that the only way this was going to be commercialised was with a large industry support, we didn't even try with anyone else*. The company received some interest but no contract: [Large potential customer 1, 30% market share] *did express interest in it early on, so we thought that that would be the case, and it was. They did express interest, and they did look at the numbers and the research; they looked at it more closely in* [European country]. *Well, I did follow up with the person from* [large potential customer 2] *a few times. That was my contact. …they had the most capabilities to actually take the product to market.*
A1.4	In negotiations with [large potential customer 1], it was found that *this part relied on a raw material and the energy price.* The innovation was *energy intensive, and because of the high cost of gas and oil, the product wasn't commercially viable* [for that customer].
A1.5	The company worked hard to identify a viable market. *Tweaking with the concepts and with the technique, that was really interesting. …I really enjoyed the experimentation. I felt that was really positive. … We're working towards something that, if it happened, could go well one day. …* [Large potential customer 1] *did express interest in it early on, so we thought that that would be the case. …the cheaper oil and gas, especially gas, were, the more viable the products were. And that was the thing.* [Large potential customer 2] stated at the end with no clear reason, *'We don't want to speak to you anymore'.*
A1.8	The management was characterised as informal, flexible and creative: *…it was a very interesting thing to be involved with and to get a buzz out of seeing this thing go. Working with a large team, helping these…sometimes I feel a lot of engineering graduates don't get to work on anything in a part of your project that has anything of value. … we're working towards something that, if it happened, could go well one day.*
A1.9	The communication was face to face in both positive and negative issues, as described by the founder.
A1.10	The conflict of interests between the research goals and the business goals is a clear example of the decisive power of the owners: *His attitude was like, 'I'm a researcher, and that's all I do'. …and I said, 'well, without you'.*
A1.11	The team could be characterised as an academic product development team. The founders hired good PhD students for product development. They were the ones who actually did the research to produce the results necessary for the validation of the business model.
A1.12	The cash flow fell into the red, as the company did not manage to generate a commercially viable product. *So really, we only had 2013–2015; we had those two owners. We didn't pay ourselves a lot because there was no income. …we had finance. We really didn't grow; it didn't happen.*

A small proportion of the experiences of the managers was somewhat contradictory. The contradictions recalled by the interviewees were related to assumptions A1.2 and A1.8. The contradictions are presented in Table 8.

Table 8: Key contradictions found in case C

Assumption	Key contradictions
A1.2	Case C was a research-based spin-off that was struggling through its early lifecycle between its research identity and practitioner identity: *…is when you start researching.*
A1.8	The founders did not have a shared vision of business development. In the priorities of one of the founders, research overrun business development needs: *I think he probably didn't realise that if you're actually trying to commercialise this, you've got to pull your finger out and work hard. His attitude was like, 'I'm a researcher, and that's all I do'.* That experience was shared as a learning experience for the future: *Maybe try to bring my friends on, be friends. We might have fun. I don't think you'll ever find a partner who works this hard.*

5. Cross-case analysis

Altogether, 170 critical incidents were found in the cases. Of these critical incidents, 143 were parallel to the assumptions of the framework, and 27 were contradictory to such assumptions. The majority of the incidents were thus parallel to the framework. Cases A and B, which succeeded in commercialising their product, reported mainly positive (share of positive incidents: case A, 61%; case B, 71%) incidents, whereas case C, which failed to commercialise, reported mainly negative incidents (share of negative incidents: 60%). The number of incidents related to the assumptions of the framework for each case company is presented in Table 9.

Table 9: Cross-case analysis of the companies: parallel and contradictory managerial experiences

Assumptions	Case A P* / C**	Case B P / C	Case C P / C	Total P / C
A1.1 The newly established firm is owner dependent.	3 / 1	5 / 1	5 / -	13 / 2
A1.2 The objective is product and/or technology development…	5 / 3	7 / 1	2/ 1	14 / 5
A1.3 …and the establishment of an early customer base.	9 / 1	14 / -	5 / -	28 / 1
A1.4 The main activities relate to the business idea…	1 / -	4 / -	3 / -	8 / -
A1.5 …identification of a market…	5 / -	5 / -	6 / -	16 / -
A1.6 …and resource mobilisation.	8 / -	7 / -	4 / -	19 / -
A1.7 The development of a working prototype is started.	3 / -	- / 5	- / -	3 / 5
A1.8 The management is informal, flexible and creative,	- / -	4 / 1	1 / 2	5 / 3
A1.9 communication is face to face	- / -	1 / -	2 / -	3 / -
A1.10 and the owner makes the decisions.	3 / -	- / -	1 / -	4 / -
A1.11 The organisation functions as a product development team.	3 / 2	7 / 1	2 / -	12 / 3
A1.12 The cash flow falls into the red because of the lack of a product at this point.	1 / 2	4 / 6	2 / -	7 / 8

In this study, each of the assumptions was preliminarily tested with three cases. The cases revealed context-specific perspectives that should be considered when using such models in the Australian context of technology-based start-ups. These perspectives are presented in the following paragraphs.

Assumption A1.1 was supported by all three cases. However, in cases A and B, which survived the conception and development stage, owner dependency was intentionally lowered by supporting the team of owners by mentors or other types of external business advisors. The founders with technical background needed support in business expertise, business networks and financing.

Assumption A1.2 was supported by all three cases. In addition to the tunnel focus on product/technology development, surviving cases A and B experiment on different technologies, use creatively off-the shelf solutions to generate better margins faster, and focus early on the scalability of the business model and on management capability, with a recognition of the limitations in their own expertise. The academic spin-off (case C), failing to commercialise its product, faced a serious internal conflict of interests between its basic research and commercial product development objectives.

Assumption A1.3 was supported by all three cases. In addition to just building an early customer base, case A considered forerunner customers as strategic development partners and co-created the product together with them.

Assumption A1.4 was supported by all three cases. No specific contradictions were pointed out.

Assumption A1.5 was supported by all three cases. No specific contradictions were pointed out.

Assumption A1.6 was supported by all three cases. No specific contradictions were pointed out.

Assumption A1.7 was supported only by one case. Instead of building a scalable prototype, case A offered customised products for paying customers who provided revenue and valuable feedback; it pivoted again and aimed to generate a scalable business model. Moreover, case A simultaneously implemented 'just in case' service business models based on other related technologies.

Assumption A1.8 was supported by two cases. As a contradictory aspect, case A developed a commercial 'minimum viable product' early, which required more coordinative management than one typical for a pure product development team. In case C, the managerial collaboration suffered from a conflict of interest. The founders did not have a shared vision of business development, as in the priorities of one of the founders, research overrun business development needs.

Assumption A1.9 was supported by two cases. No specific contradictions were pointed out.

Assumption A1.10 was supported by two cases. No specific contradictions were pointed out.

Assumption A1.11 was supported by all three cases. In addition to building a product development team, case A took on a person whose main responsibility was to prepare the firm for scaling, and this approach speeded up development through the hiring of external contractors. Case B was developing and forming the company in the process, which required more than a product development team early on. Following a typical lean start-up process, the company experimented on its business model and product with paying customers, and generated revenue 'from day one'.

Assumption A1.12 was supported by all three cases. However, case A built the minimum viable product in development partnerships with the paying customers, and was able to raise a first round of investment when needed. Case B is a clear example of a lean start-up type of growth strategy with the 'affordable loss' principle in action. The company offers technological expertise and is selling a virtual product, which opens opportunities for rapid scaling. The company is determined to develop its business debt free without external investors.

6. Discussion

In this study, a four-stage self-evaluation framework for early-stage technology-based companies was developed. Table 1 in the second section details the start-up stage of the framework. This study used the first stage of the framework as a set of assumptions tested by three case studies. The research questions were as follows: *(1) How do the experiences of managers in technology-based start-ups relate to the assumptions of stage frameworks in the Australian context? (2) What context-specific viewpoints should be considered when using stage frameworks in the Australian context?* The applicability of stage 1 of the four-stage framework was explored in this study; an explorative analysis of context-specific viewpoints was also provided. Recognising these viewpoints is necessary when utilising the framework in the Australian context.

Using the three case studies, the authors answered the first research question by utilising SIT. Three cases from Australia were analysed to test how the experiences of the managers were related to the assumptions of the framework. The applicability of the framework to these cases was preliminarily tested in the context of Australia by analysing the number and content of parallel aspects in relation to the assumptions of the framework. The results of the analysis are provided in Sections 4 and 5, the results and cross-case analysis. The majority of the assumptions of the framework were supported by the experiences of the owner–managers of the Australian technology-based start-ups.

The context-specific perspectives were examined to answer the second research question. The context-specific viewpoints are presented in Sections 4 and 5. Many of these viewpoints on the conception and development stage were rooted in the Australian start-up context. The business context provided mentors and business advisors with business expertise, networks and financing that were capable of supporting technology-oriented start-up growth. It enabled awareness of management capability requirements, efficient experimentation, use of creative off-the shelf solutions, early consideration of scalable business models and, therefore, the expectation of better margins faster. The context allowed forerunner customers to serve as strategic development partners who speeded up the process by co-creating the product–market fit. Paying customers generating revenue and providing valuable feedback helped generate a scalable business model. The effective use of external contractors, available in the context, speeded up the process.

Cases A and B, at the edge of succeeding to commercialise their technology, had different growth strategies. Case A built the minimum viable product in development partnerships with the paying customers and was able to raise a first round of investment when needed. Case B is a clear example of a lean start-up type of growth strategy with the 'affordable loss' principle in action. The company offers technological expertise and is selling a digital product, which opens opportunities for rapid scaling. The company is determined to develop its business debt free without external investors. Case C failed to commercialise its product and faced a serious internal conflict of interests between its basic research and commercial product development objectives. Moreover, it seemingly did not succeed in using the external support provided by the context at full scale. Agile growth strategies selected by cases A and B are clearly visible in the data.

Interim summary and conclusion

In conclusion, this study formulated and preliminarily tested the start-up stage of a four-stage framework that describes the early stages of technology-based companies. The empirically based stage framework seems to be an effective tool for reflecting on and predicting the challenges faced by a company during its early developmental stages. Moreover, this study revealed a number of context-specific viewpoints contradictory to the framework: Companies in different contexts face culture- and context-specific issues during their early growth. Growth is a multi-dimensional phenomenon, and every service-based start-up is, to some extent, unique. The start-up definition provided by Blank and Dorf (2012), 'a start-up is an organisation in search of a scalable, repeatable and profitable business model', seems to fit cases A and B, which succeeded in their first steps towards the full-scale commercialisation of their product in the Australian business context.

The case study strategy that uses SIT proved effective for the open-ended analysis of early growth; it considered the sequential character of the process. The construct validity of the study is based on a sound research plan, multiple sources of evidence, synergy between quantitative and qualitative data and an established chain of evidence. Analytic generalisation (generalisation to a theory) is possible when building context-specific frameworks applicable to the Australian context. The research focus of this study is limited to the context studied and the number of cases involved. The findings of this study cannot be directly generalised to other countries or business contexts, and they depend on the time of data collection. Reproducing the same case study in the same environment at a later time would change some of the findings. However, the case study protocol was followed, and a database was established, and these allow the further testing of the findings.

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