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THE INFLUENCE OF EFFECTUATION AND TECHNOLOGY ORIENTATION ON FIRM PERFORMANCE IN THE RENEWABLE ENERGY SECTOR OF SOUTH AFRICA

BY

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A research report submitted to the Faculty of Commerce, Law and Management, University of the Witwatersrand, in partial fulfilment of the requirements for the degree of Master of Management in Entrepreneurship and New Venture Creation

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ABSTRACT

This research study analyses a conceptual model investigating the effect of firms' choice of effectuation or causation processes in strategy formation and firm performance, the effect of firms' technology orientation in firm performance, and the relationship between effectuation and technology orientation.

The study employed a quantitative approach, surveying data from 73 firms in the renewable energy sector of South Africa, using measurement instruments extracted from prior research. By means of multiple regression analysis, the study found that of the effectuation processes, the use of pre-commitments is significantly and positively associated with firm performance. Furthermore, it was found that a pioneering technology orientation is significantly and positively associated with firm performance. The study also found evidence to support the hypothesis that effectuation is closely linked with pioneering.

The study contributes to the field of effectuation research by continuing to move the field towards an intermediate phase, by providing valuable insight into the practicalities of the quantitative analysis of effectuation and the problems that arise therein, in particular, issues surrounding measurement aspects. Moreover, by examining performance differentials, this study seeks to increase the relevance of effectuation theory and expand it from a theory of mere description of entrepreneurial behaviour to a theory that identifies performance-enhancing measures. For practitioners and policy makers, this research provides valuable insight into the drivers of entrepreneurial success and the fostering of entrepreneurial activity both in start-ups and existing corporations to spur innovation, productivity, and growth in the economy.

DECLARATION

I, James Heydenrych, declare that this research report is my own work except as indicated in the references and acknowledgements. It is submitted in partial fulfilment of the requirements for the degree of Master of Management in the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination in this or any other university.

_____

James Heydenrych

Signed at ……

On the …….. day of …… 2013

DEDICATION

I dedicate this work to my parents, Clifford and Susan Heydenrych

ACKNOWLEDGEMENTS

I wish to extend my grateful thanks to all those who assisted me in the preparation of this research report.

In particular, I would like to thank my supervisors, Dr Jose Barreira and Prof Boris Urban, for their guidance and supervision.

I would also like to thank Merle Werbeloff for her advice and assistance in the analysis of the statistical results contained in this report.

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CHAPTER 1: INTRODUCTION

1.1 Purpose of the study

The purpose of this study was to establish the levels of effectuation and technology orientation in South African renewable energy firms and their respective influence on firm performance. Furthermore, this research investigates the relationship between effectuation and technology orientation.

1.2 Context of the study

South Africa faces numerous political, social and economic challenges, not limited to a backlog of infrastructure development, poor standards of education, high rates of crime and corruption, high level of unemployment, and a shortage of skilled labour. Perhaps foremost amongst these challenges, at least from an economic standpoint, is the massive and burgeoning rate of youth unemployment. In the third quarter of 2012, the unemployment rate in South Africa was measured at 25.5%, one of the highest in the world (Statistics South Africa, 2012)

The South African government has introduced new policy and institutional frameworks, such as the SEDA Technology Programme, the Technology Innovation Agency (TIA), the National Technology Transfer Centre (NTTC), and the Industrial Development Corporation venture capital fund and Jobs Fund, but the extent of the problem is so enormous that the government alone cannot tackle it. Compounding the crisis, the existing formal sector has proven to be unable to absorb the increasing number of unemployed youth and over recent year's tensions between labour and private sector employers has been seen to increase.

Much hope is being placed in small, medium and micro enterprises (SMMEs) to drive growth in the country's GDP and curtail the persisting unemployment crisis. It is now fairly well established that entrepreneurship is a key driver of economic

productivity. In free-market capitalism both job creation and increases in real per capita income have been shown to depend on entrepreneurial activity, particularly in the form of new firm formation (Birch, 1987; Shane, 1995). However, Global Entrepreneurship Monitor (GEM) research has shown that South Africa lags behind other developing countries in stimulating early-stage entrepreneurial activity. In 2008, South Africa's early-stage entrepreneurial rate was 7.8% – significantly behind the average of 13% for other middle to low income countries (Herrington, Kew, & Kew, 2009).

Against this background, entrepreneurship brings the promise of spurring innovation, productivity, and growth in the economy. In particular, high technology ventures can be characterised by the potential for high future profit and high growth (Zahra S. A., 1996b). However, such ventures face severe competition and operate in highly uncertain environments, made further complex in South Africa by emerging market dynamics.

This study seeks to investigate some of the key drivers of success in high technology firms, specifically firms in the renewable energy sector of South Africa, which will hopefully provide valuable insight to both practitioners and policy makers. The study is also of value to the field of entrepreneurship research, as it seeks to develop our understanding of the constructs of effectuation and technology orientation.

1.3 Problem statement

Businesses in high-growth, high technology industries face severe competition and operate in dynamic and hostile environments. For businesses based in Africa, the challenge to participate in the global economy of the 21st century will be to compete as world-class businesses where the focus is on high value-added human capital, based on creativity and innovation (Luiz, 2006). In transition economies, such as South Africa, where growth is often the primary goal of organisations, innovation can be particularly critical for firm profitability and survival (Antoncic & Hisrich, 2001)

As companies respond to global competition, there is a growing recognition of the pivotal role of technology in determining market success. As a result of this recognition, companies have increased their adoption of advanced technologies and, also, their introduction of technologically sophisticated products. These changing practices have alerted companies to the need for developing technology policies that 'fit' business strategy (Clark and Hayes, 1985; Collier, 1985; Zahra & Covin, 1993). This fit ensures the successful deployment of a company's technological capabilities and resources in pursuit of the goals of business strategy. Such effective deployment of technological resources helps to build a sustainable competitive advantage that enhances a company's financial performance (Porter, 1985).

Despite the weight of evidence that innovation and technology are strategic imperatives, there is a danger that firms in Africa are lagging. Technology and firm innovation cannot only create value, but aid in the internationalisation process that many firms in emerging countries are now undertaking (Urban & Barreira, 2009). For South African firms the rising trend towards globalisation presents multiple opportunities for international expansion, and a strong technology orientation can provide the necessary competitive advantage to compete globally (Urban & Barreira, 2009).

An important but unresearched aspect of this topic is whether companies which exhibit higher technology orientation (TO) and higher levels of effectuation outperform their counterparts.

1.3.1 *Sub-problems*

The first sub-problem is to analyse levels of effectuation at the firm level and to establish the relation between effectuation and firm performance

The second sub-problem is to analyse levels of TO at the firm level and to establish the relation between TO and firm performance

The third sub-problem is to establish whether a relationship exists between firms' effectuation and TO.

1.4 Significance of the study

The study fills a gap in that it will contribute to a growing body of research into effectuation and TO. In particular, this research heeds the call of prior studies (Perry, Chandler, & Markova, 2011; Read, Song, & Smit, 2009; Chandler G. N., DeTienne, McKelvie, & Mumford, 2011) to continue to move the effectuation research towards an intermediate phase by quantitatively testing the effectuation construct against existing constructs in entrepreneurship research.

Moreover, it will fill a gap in research pertaining to an emerging-country context. Particularly, research on firm innovation in the African context may be considered valuable, as very few empirical studies have been conducted that focus on innovation and technology in an emerging-country context (Urban & Barreira, 2009).

A deep and thorough understanding of effectuation and technology orientation is important not only for academic purposes but also because such an understanding is beneficial for both practitioners and policy makers. Potentially, the study could provide guidance to strategic leaders in high growth, high technology industries regarding the merits of pursuing effectuation and TO strategies.

For policy makers, one of the most important concerns in policy is the fostering of entrepreneurial activity both in start-ups and existing corporations to spur innovation, productivity, and growth in the economy (Sarasvathy, 2001). In free-market capitalism both job creation and increases in real per capita income have been shown to depend on entrepreneurial activity, particularly in the form of new firm formation (Birch, 1987; Shane, 1995). Moreover, government programmes and incentives could focus on established firms with higher levels of effectuation and TO rather than on potential individual entrepreneurs. Furthermore, effectuation processes allow the economy to experiment with more numbers of new ideas, as at lower cost effectuation processes allow the economy to experiment with more numbers of new ideas at lower cost (Sarasvathy, 2001).

1.5 Delimitations of the study

This research will focus on the South African renewable energy sector. Broadly, this industry comprises both companies involved in power generation as well as those involved in energy utilisation. A minimum firm size of 2 employees and a maximum of 200 employees (here a single respondent still can report for the entire firm) was used as a sampling selection criterion. This limitation will filter out the largest firms, where typical organisational inertia characteristics may bias entrepreneurial indicators (Jantunen, Saarenketo, & Kylaheiko, 2005).

The study will not attempt to predict the success of firms based on their level of effectuation and TO, or develop a scale of effectuation or TO. This research will not attempt to investigate other possible contributors to firm performance, such as entrepreneurial orientation.

1.6 Assumptions

This research relies on a number of latent assumptions:

1. The questionnaire will be easy to for the respondents understand.
2. A sufficient number of responses will be obtained to enable the use of multivariate data analysis techniques.
3. The respondents will be of suitable seniority in order to be able to share information on the strategy formation processes of the organizations they represent. Lack of knowledge of strategy will adversely affect the credibility of study.
4. Moreover, information provided by respondents will be conveyed honestly and truthfully.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

The literature review appraises the prevalent literature regarding the research questions of this study. The literature review forms the theoretical foundation on which this research is based.

The chapter begins by introducing the construct of entrepreneurial effectuation before delving deeper into the basis of the field of effectuation research and a discussion of the processes off effectuation and causation. Important considerations regarding the operationalisation of the effectuation construct are covered, and links between effectuation and firm performance are drawn.

Next, the technology orientation construct and its sub-dimensions are introduced. As with the review of the effectuation literature, considerations regarding the operationalisation of the TO construct are covered, and links between TO and firm performance are drawn. A possible, but unresearched, link between effectuation and TO that emerges for the literature review is framed.

Finally, following on from the literature, hypotheses pertaining to the problem statement proposed in section 1.3 are drafted, and the theoretical framework of this study is described.

2.2 Definition of causation and effectuation

Causation and effectuation are two alternative approaches that entrepreneurs use in the new venture development process (Sarasvathy, 2001). Causation is consistent with planned strategy approaches such as those espoused by Ansoff (1988), Brews & Hunt (1999), and Porter (1980). The planning and analysis required by such models assume conditions in which the distribution of outcomes in a group is predictable through calculation or statistical deduction (Sarasvathy, 2001).

Contrastingly, effectuation processes (Sarasvathy, 2001) are consistent with emergent (Mintzberg, 1978) or non-predictive strategies (Wiltbank *et al.*, 2006). Under conditions of uncertainty, unique circumstances make it difficult or impossible to draw statistical conclusions. Furthermore, there is no feasible way to calculate an expected return for a given course of action as often no precedent is set. Hence, instead of analysing alternatives and selecting the one with the highest expected return, the entrepreneur selects alternatives based on the logic of affordable loss. The entrepreneur maintains flexibility, utilises experimentation, and seeks to exert control over the future by making alliances and pre-commitments with potential suppliers, competitors, and customers (Chandler *et al.*, 2011).

Sarasvathy (2001: p245) defines effectuation as a process that "takes a set of means as given and focus on selecting between possible effects that can be created with that set of means." Sarasvathy contrasts effectuation processes to causation processes, which she states, "take a particular effect as given and focus on selecting between means to create that effect."

Effectuation is a means-driven process that enables the entrepreneur or organisation to exercise *control* over its environment and hence the future. Causation processes, conversely, are concerned with the strategic positioning of the organisation within an exogenous environment. The ability for a firm to position itself well in a given situation necessitates the ability to analyse its environment and *predict* the future (Chandler *et al.*, 2011).

In the following section the necessity to distinguish control-oriented strategies as independent from predictive strategies is discussed. Drawing from this, strategies that emphasise control are expounded.

2.3 Conceptualising control as independent from prediction

Most entrepreneurship research assumes that individuals engage in rational goal-driven behaviour when pursuing entrepreneurial opportunities (e.g., Bird, 1989). Thus, the predominant entrepreneurial decision model taught in many

business schools is a goal-driven, deliberate model of decision making referred to by Sarasvathy (2001) as a causation model (Perry *et al.*, 2011).

Following from this basis, mainstream strategic management studies espouse two fundamental prescriptions for how firms can strategically position themselves (Brews & Hunt, 1999): They should either *try harder to predict better* (rational strategies advocated by the planning school) or *move faster to adapt better* (adaptive strategies espoused by the learning school).

These two prescriptions differ primarily on the appropriate role of prediction in the decision process. Both these approaches are concerned with how the organisation positions itself within a given environment, but are distinguished by each approach's emphasis on prediction. Prediction is a central issue in strategy making owing to the presumption that what can be predicted can be controlled. Wiltbank *et al.* (2006), however, argue that prediction and control are independent processes. This implies that the pursuit of successful outcomes can occur through control-oriented approaches that may essentially be non-predictive.

Hence, Wiltbank *et al.* (2006) introduce control as a further dimension to strategy, yielding a two dimensional matrix with its axes as the emphasis on prediction and the emphasis on control, presented in Figure 1. Preeminent literature on management strategy has been plotted on this framework.

Approaches with a low emphasis on control are conceptualised as *positioning* strategies. In this case organisations are concerned with how the organisation *positions* itself within an exogenously given environment, whether it is by a planning or adaptive approach. Planning looks at prediction from a natural sciences standpoint, from where prediction is seen as very valuable. In this view, prediction enables control, allowing us to choose the appropriate means to proceed toward desired outcomes. Learning, which enables adaptation, comes at prediction from the opposite direction, avoiding it as much as possible. Adaptation argues that, in changing environments, moving faster to adapt will lead organizations forward more effectively than trying harder to predict. A key characteristic of both adaptive and planning approaches is their emphasis on how

the organisation *positions* itself within an exogenously given environment. The two approaches differ primarily in how they cope with that given uncertainty (Wiltbank *et al.,* 2006)

Approaches with a high emphasis on control, on the other hand, are conceptualised as constructive strategies. Here the organisation seeks to control its environment to its own end, taking either a visionary approach, or a transformative approach

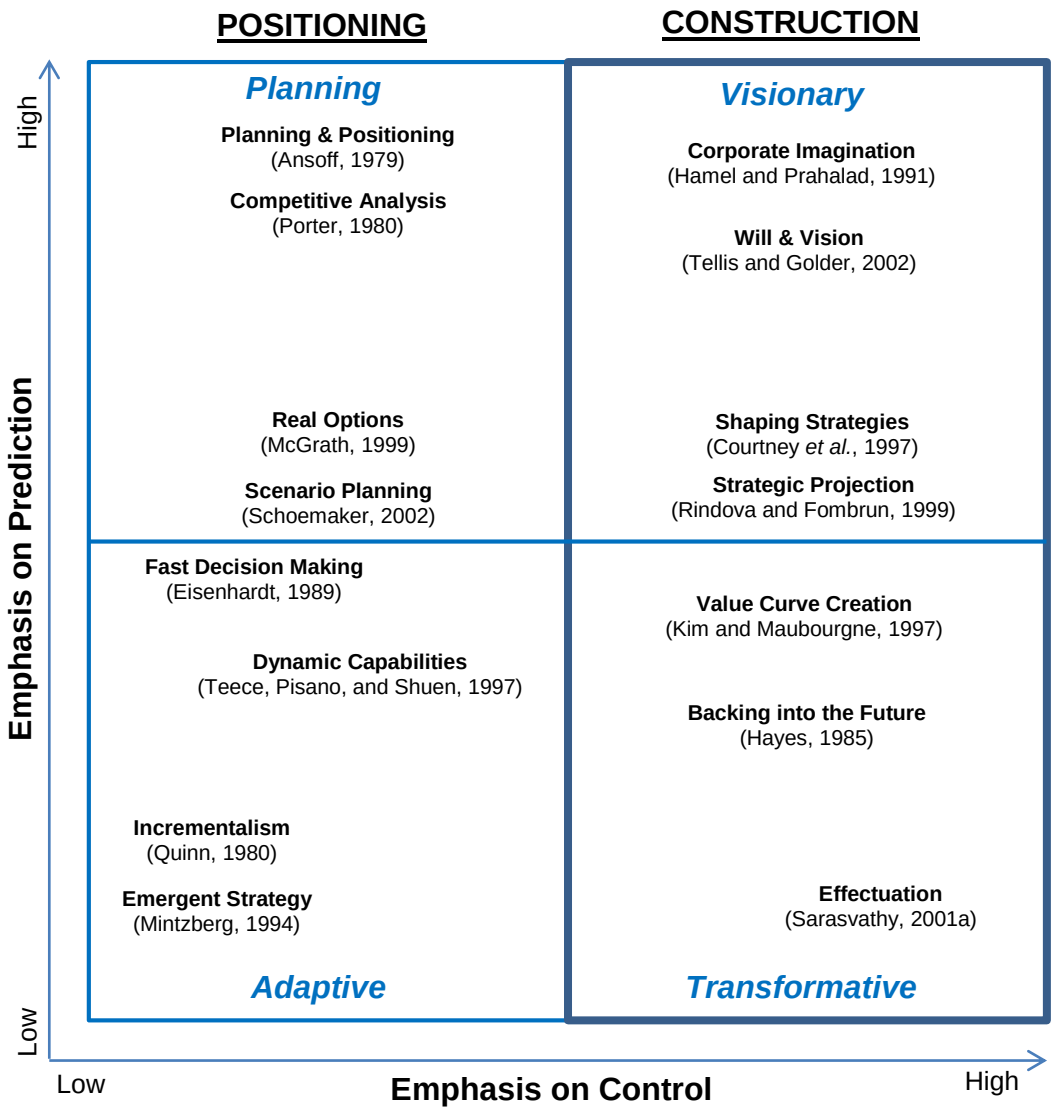


Figure 1: Framework of prediction and control (from Wiltbank *et al.*, 2006)

Deterministic frameworks in strategic management all share the basic notion that prediction is useful in strategy making because the consequences decisions can be predicted and hence a firm is able to control its position (Wiltbank *et al.,* 2006). This approach reflects positivist science, where empirical methods are used to test theories about causal connections in the physical environment. As entrepreneurs face uncertainties in the market, successful prediction of that environment enables them to navigate it, leading to continued favourable outcomes for the organisation (Porter, 1980)

The practical usefulness of prediction as a means of control depends crucially on certain features of the environment (Mintzberg, 1994). Empirically, 'how to achieve control, and how much control is achievable, depends upon the foresight horizon' (Lane & Maxfield, 1996, p. 217). When the strategist's foresight horizon appears relatively certain, prediction and control appear to have a co-extensive relationship. As this horizon becomes more uncertain, the relationship between prediction and control changes (Wiltbank *et al.,* 2006). In highly uncertain environments, such as those characterized by complexity (Alexrod & Cohen, 1999), rife with strong path dependencies and punctuated change, the independence of control from prediction becomes patent.

The conceptual framework for understanding prediction and control as distinct dimensions is grounded in Knight's (1921) seminal work on the relationship between unpredictability and profit. Knight identified three types of uncertainty: the first consisting of known distributions and unknown draws, the second consisting of unknown distributions and unknown draws, and the third consisting of non-existent distributions where the very instances are unclassifiable (subsequently known as Knightian uncertainty). The third type of uncertainty is the 'unknowable' (Wiltbank *et al.,* 2006).

'In environments characterized by Knightian uncertainty prediction can never be adequate for the purpose of control, even in principle, because of the role of human creative action in actually producing a non-existent, not just a hard-to-predict, future' (Wiltbank *et al.,* 2006, p998).

The central tenet that emerges from the argument of Wiltbank *et al.,* (2006) is that prediction and control - or causation and effectuation – are not polor opposites on a dichotomous scale. Rather the choice of an entrepreneur to use effectual or deterministic logis is hinged on the antecedent of uncertainty.

2.4 Causation and effectuation processes

In her seminal work, Sarasvathy developed five behavioural principles that relate to effectuation and causation. The behaviours linked to these principles, or sub-constructs, she proposed, could be observed and therefore could be tested using methods designed to capture behaviour to differentiate causation and effectuation. The five sub-constructs include (Perry *et al.*, 2011):

1. beginning with a given goal or a set of given means;
2. focusing on expected returns or affordable loss;
3. emphasizing competitive analysis or strategic alliances and pre-commitments;
4. exploiting pre-existing knowledge or leveraging environmental contingencies; and
5. trying to predict a risky future or seeking to control an unpredictable future.

An individual using causal logic will begin with a given goal, focus on expected returns, emphasize competitive analyses, exploit pre-existing knowledge, and try to predict an uncertain future. An individual using effectual logic will begin with a given set of means, focus on affordable loss, emphasize strategic alliances, exploit contingencies, and seek to control an unpredictable future (Perry *et al.*, 2011).

Table 1 contrasts causation and effectuation along the five sub-constructs discussed above.

Table 1: Contrasting Causation and Effectuation, from Sarasvathy (2001)

Issue	Causal frame	Effectual frame
View of the future	*Predictive*. Causal logic frames the future as a continuation of the past. Hence accurate prediction is both necessary and useful.	*Creative*. Effectual logic frames the future as shaped (at least partially) by wilful agents. Prediction is therefore neither easy nor useful.
Basis for taking action	*Goal-oriented*. In the causal frame, goals, even when constrained by limited means, determine sub-goals. Goals determine actions, including which individuals to bring on board.	*Means-oriented*. In the effectual frame, goals emerge by imagining courses of action based on given means. Similarly, who comes on board determines what can be and needs to be done, and not vice versa.
Predisposition toward risk and resources	*Expected return*. Causal logic frames the new venture creation problem as one of pursuing the (risk-adjusted) maximum opportunity and raising required resources to do so. The focus here is on the upside potential.	*Affordable loss*. Effectual logic frames the problem as one of pursuing adequately satisfactory opportunities without investing more resources than stakeholders can afford to lose. The focus here is on limiting downside potential.
Attitude toward outsiders	*Competitive analysis*. Causal frames promulgate a competitive attitude toward outsiders. Relationships are driven by competitive analyses and the desire to limit dilution of ownership as far as possible.	*Partnerships*. Effectual frames advocate stitching together partnerships to create new markets. Relationships, particularly equity partnerships drive the shape and trajectory of the new venture.
Attitudes toward unexpected contingencies	*Avoiding*. Accurate predictions, careful planning and unwavering focus on targets form hallmarks of causal frames. Contingencies, therefore, are seen as obstacles to be avoided.	*Leveraging*. Eschewing predictions, imaginative rethinking of possibilities and continual transformations of targets characterize effectual frames. Contingencies, therefore, are seen as opportunities for novelty creation - and hence to be leveraged.

In new venture creation, entrepreneurs following a causation process clearly define the objectives they want to accomplish up front and systematically search for entrepreneurial opportunities within developed industries that meet those objectives (Fiet, 2002).

They evaluate and select opportunities that maximize expected returns (Drucker, 1998). They employ analysis and planning activities as they seek to capitalise on their pre-existing knowledge and resources. Thus, the venture is envisioned from the beginning and all efforts are directed at achieving the pre-envisioned state.

According to Sarasvathy (2001: 251), the underlying logic behind causation is 'to the extent we can predict the future, we can control it.'

The theoretical foundations for the causation process derive from the rational decision making perspectives of neo-classical micro-economics (Stigler, 1952). And have been extensively expounded by researchers and thought leaders (Ansoff, 1965; Porter, 1980). In a causation process an individual makes rational choices based on all possible information relevant to his decision and an estimated expected utility for each option (Viale, 1992). Much of the existing entrepreneurship literature has theoretical foundations in the causation approach (Chandler *et al.,* 2011). For example, in the research on opportunity discovery, Fiet (2002) suggests that opportunity discovery results from a rational search process in which alternatives are identified and evaluated. The option with the highest expected return is rationally selected and implemented. According to the causational perspective, entrepreneurial opportunities are driven by exogenous forces, and the role of the entrepreneur is to examine the environment and existing projects in the marketplace, utilise a sequential screening process, and choose the project with the highest expected return (Casson & Wadeson, 2007). Managers in a causational frame 'rest on primitives, such as *product* and *market*, and on institutions, such as the *firm*, *industry*, and *economy*' (Sarasvathy, 2001, p. 261).

The business plan and its popularity in both entrepreneurship practice and education is another example of institutional conformity to the causation approach (Chandler *et al.,* 2011). Many textbooks on entrepreneurship are built around business planning models (e.g. Kuratko & Hodgetts, 2004; Timmons & Spinelli, 2004). The development of a business plan 'is a rational activity that assists the owners of new firms to earn larger profits through efficiency gains and/or increased sales' (Honig & Karlsson, 2004: 35). Although the empirical research regarding the effectiveness of business plans has been mixed (Honig & Karlsson, 2004; Liao & Gartner, 2006), the business plan with its step-by-step rational process is a primary deliverable in many university entrepreneurship programs.

In contrast, Sarasvathy (2001: 245) states that effectuation approaches ‘take a set of means as given and focus on selecting between possible effects that can be created with that set of means.’ In new venture creation, entrepreneurs following an effectuation approach might begin the new venture process with general aspirations to create a new venture, but as they make decisions and observe the results of those decisions, they utilise this new information to change course.

Because the future is unpredictable, entrepreneurs using an effectuation approach may try different approaches in the marketplace before settling on a business model (Chandler *et al.,* 2011). In addition, they are likely to put mechanisms into place that allow them to have some control over the outcome. According to Sarasvathy (2001: 251), the underlying logic is ‘to the extent we can control the future, we do not need to predict it.’

The theoretical foundations of an effectuation approach lie in cognitive science, particularly the work which emphasises entrepreneurial framing - how entrepreneurs view inputs (relevant or not), make inferences, perceive alternatives, and attend to constraints (Dew *et al.,* 2009). Sarasvathy's (2001) theoretical conceptualisation and the ensuing experimental and empirical work have demonstrated that entrepreneurs following an effectual logic are less likely to try to predict the future and are more likely to change their initial goals and visions for the new venture (Chandler *et al.,* 2011).

Rather than predicting the future, they are more likely to work with the means already within their control and make adjustments as necessary (Dew *et al.*, 2009). Using effectual logic they frame the future as resulting from co-creation by intentional agents (networks of partnerships consisting of investors, partners, and customers) who are ‘stitched together’ (Dew *et al.*, 2009). Goals emerge by developing potential courses of action that are based on the available means of who a person is, what they know, and whom they know. This dynamic and iterative process of effectuation is aptly described as a transformative process by Wiltbank *et al.,* (2006) (Figure 2).

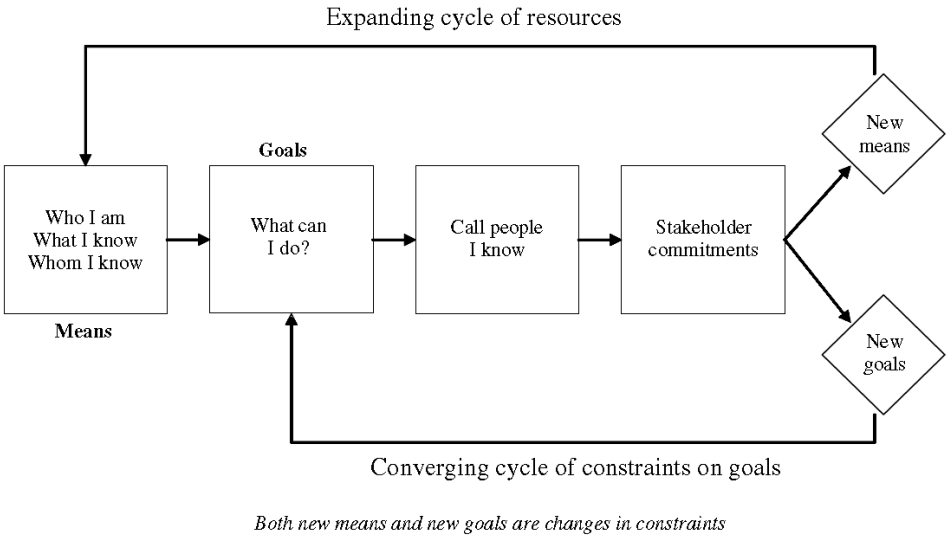


Figure 2: A transformative approach: the effectual process—dynamic and interactive (Wiltbank *et al.*, 2006)

Perry *et al.*, (2011) posit that, in the context of starting new businesses, effectual logic is emphasized in the earlier stages of venture creation with a transition to more causal strategies as the new firm and market emerge out of uncertainty into a more predictable situation. The rationalisation behind this is that effectual logic is likely to be more effective than causational logic in settings characterized by greater levels of uncertainty (Sarasvathy, 2001).

Central to Sarasvathy's theoretical conceptualisation of effectuation, is that 'before there are products, there is human imagination, and before there is a market, there are human aspirations' (Sarasvathy, 2001: 261).

In mainstream economics, researchers have thus far explained entrepreneurship not as the creation of artefacts by imaginative actors fashioning purpose and meaning out of contingent endowments and endeavours but as the inevitable outcome of mindless 'forces,' stochastic processes, or environmental selection (Sarasvathy, 2001: 261).

Instead, Sarasvathy (2001: 262) argues 'The essential agent of entrepreneurship, is an effectuator: an imaginative actor who seizes contingent opportunities and exploits any and all means at hand to fulfil a plurality of current and future aspirations, many of which are shaped and created through the very process of

economic decision making and are not given a priori.' The creation of economic artefacts demands imagination, inspiration, and protracted endeavour - both cooperative and competitive.

Based on the reading of Sarasvathy (2001), Chandler *et al.* (2011) have outlined four principles that differentiate causation and effectuation approaches:

1) ***Experimentation:*** a focus on short-term experiments to identify business opportunities in an unpredictable future (effectuation) versus prediction of an uncertain future by defining the final objective up front (causation),
2) ***Affordable Loss:*** a focus on projects where the loss in a worst-case scenario is affordable (effectuation) versus maximization of expected returns (causation),
3) ***Flexibility:*** exploitation of environmental contingencies by remaining flexible (effectuation) versus exploitation of pre-existing capabilities and resources (causation), and
4) ***Pre-Commitments:*** an emphasis on pre-commitments and strategic alliances to control an unpredictable future (effectuation) versus business planning and competitive analyses to predict an uncertain future (causation).

The key differences between causation and effectuation form the basis of the measures that Chandler *et al.,* (2011) subsequently developed. This is the measure that has been adopted by the present study.

2.5 Role of entrepreneurial expertise

Dew *et al.,* (2009) showed that in an exercise involving the evaluation of an entrepreneurial situation, expert entrepreneurs used effectual logics more and used causal logics less than MBA students. Dew *et al.,* (2009) also find that novices trained in traditional management techniques based on a causal logic use a different logical frame in their decision-making and a different set of

heuristics within that frame than expert entrepreneurs experienced in creating new ventures and new markets, who tend to employ more effectual techniques.

Practically, how to achieve control depends upon the foresight horizon (Lane & Maxfield, 1996). When the strategist's foresight horizon appears relatively certain, prediction and control appear to have a co-extensive relationship (Wiltbank *et al.,* 2006). In such environments firms employing causational logic may perform better than their counterparts. However, as this horizon becomes more uncertain, the relationship between prediction and control changes. In environments characterized by Knightian uncertainty, prediction and control are not just empirically mismatched; they are conceptually at odds (Wiltbank *et al.*, 2006).

Perry *et al.*, (2011) posit that, in the context of starting new businesses, effectual logic is emphasized in the earlier stages of venture creation with a transition to more causal strategies as the new firm and market emerge out of uncertainty into a more predictable situation. The rationalisation behind this is that effectual logic is likely to be more effective than causational logic in settings characterized by greater levels of uncertainty (Sarasvathy, 2001).

It is therefore conjectured that firm age and entrepreneurial experience will moderate the relationship between effectuation processes and firm performance.

2.6 Operationalising the effectuation construct

The effectuation stream of literature is in the early stages of construct development and has accordingly most often relied on qualitative methods to gather information (Chandler *et al.*, 2011). As research on effectuation transitions to the intermediate state, reliable and valid measures for qualitative analysis need to be developed (Perry *et al.*, 2011). A few studies have established measures of effectuation. Wiltbank *et al.*, (2009) developed a scenario-type instrument to capture hypothetical angel investment decisions in an innovative computer company. However, the focus of this study is only on prediction and control dimensions, and does not include experimentation, affordable loss, flexibility, and pre-commitments. Dew *et al.,* (2009) used think aloud protocols to capture

decision making. Chandler *et al.,* (2007) also offer an instrument that captures some aspects of causation and effectuation (Perry *et al.*, 2011). However, as is true with most measurement scales in the social sciences, these constructs were developed and validated as reflective constructs (MacKenzie *et al.*, 2005).

Chandler *et al.,* (2011), however, found in developing their measure that effectuation may in fact be a formative construct, as opposed to a reflective construct, based on empirical results obtained in their analyses and the conceptual differences among the subcomponents of effectuation. Chandler *et al.,* (2011) found that while Sarasvathy's (2001) proposal that causation and effectuation are two different approaches to new venture creation suggests a two-factor solution in which causation items should load on one-factor and effectuation items should load on another, their analyses revealed that causation items tended to load together, but effectuation items did not.

In reflective models, the latent construct exists independent of the measures, and the measures are merely reflections of the underlying construct, while in the case of a formative model it is implied that causality flows from lower-order indicators (items or sub-constructs) to the latent, higher-order constructs (Coltman *et al.*, 2008). In other words, for formative constructs the higher-order constructs are *formed* by the lower-order ones and for reflective constructs, the lower-order ones are designed to *reflect* the upper-order ones (Chandler *et al.*, 2011). Bollen and Lennox (1991) note that the traditional reflective models used in most social science research may not make sense for all constructs. Whether a construct should be validated as a formative or reflective construct should depend on theoretical considerations - namely, do the construct indicators attempt to reflect the underlying construct or do the indicators collectively form the construct (Diamantopoulos & Siguaw, 2006).

Furthermore, for formative constructs, where the lower-order measures shape the upper-order construct, the causal nature of the relationship also suggests that the lower-level indicators are defining characteristics of the construct and may therefore be independent of each other (MacKenzie *et al.*, 2005). This implies that the sub-components should not be changed or deleted; doing so might

substantially alter the upper-level construct (MacKenzie *et al.*, 2005). For the construct of effectuation, Chandler *et al.,* (2011) note that the multiple sub-dimensions are vital components of effectuation and together help define effectuation. Thus, the individual conceptual differences help form effectuation and their removal would imply that effectuation has a different meaning.

Perry *et al.,* (2011) state effectuation is a composite of several different cognitive processes and behaviours: (1) beginning with a set of given means; (2) decision making based on affordable loss; (3) emphasizing strategic alliances and pre-commitments; (4) exploiting environmental contingencies through flexibility and experimentation; and (5) seeking to control an unpredictable future. They argue, therefore, that effectuation as a construct does not exist independently of those measures and there is no reason to suppose that each of the five sub-components of effectuation should be highly correlated with each other. Hence, effectuation would be more accurately measured and validated using formative models (Perry *et al.,* 2011; Coltman *et al.*, 2008)

Chandler *et al.,* (2011) used methodologies consistent with the formative nature of the effectuation construct. Using these methodologies, they found that effectuation is better understood as a formative construct rather than as a reflective construct, and they provided a validated effectuation measure consisting of four sub-constructs: experimentation, affordable loss, flexibility, and pre-commitments.

Perry *et al.,* (2011) call for new measures to incorporate other elements of effectuation that are shown to be central to effectuation, for example, *beginning with a given set of means*. Furthermore, they call for future researchers to use different sample types and data collection methods and to include effectuation outcome variables as a means of validating effectuation as a formative construct (MacKenzie *et al.,* 2005).

MacKenzie *et al.,* (2005) suggested that when a composite construct is the focus of research, investigators may want to use a mixed indicator measurement model such as the one diagrammed in Figure 3. Using this model, the subdimensions

of effectuation can be measured as reflective constructs using multiple indicators of each subdimension (Perry *et al.*, 2011). In this way, multiple items can be developed that reflect decision making based on each of the subdimensions of effectuation. Each of the individual subdimensions, however, then must be aggregated to form a composite latent construct.

However, Perry *et al.*, (2011) advise that if effectuation is less central to a study or is part of a complex system of relationships, researchers may choose to use the composite indicator measurement model diagrammed in Figure 4, as opposed to the mixed indicator model. In this model, single items measure each subdimension and are aggregated as a composite formative measure (MacKenzie *et al.*, 2005).

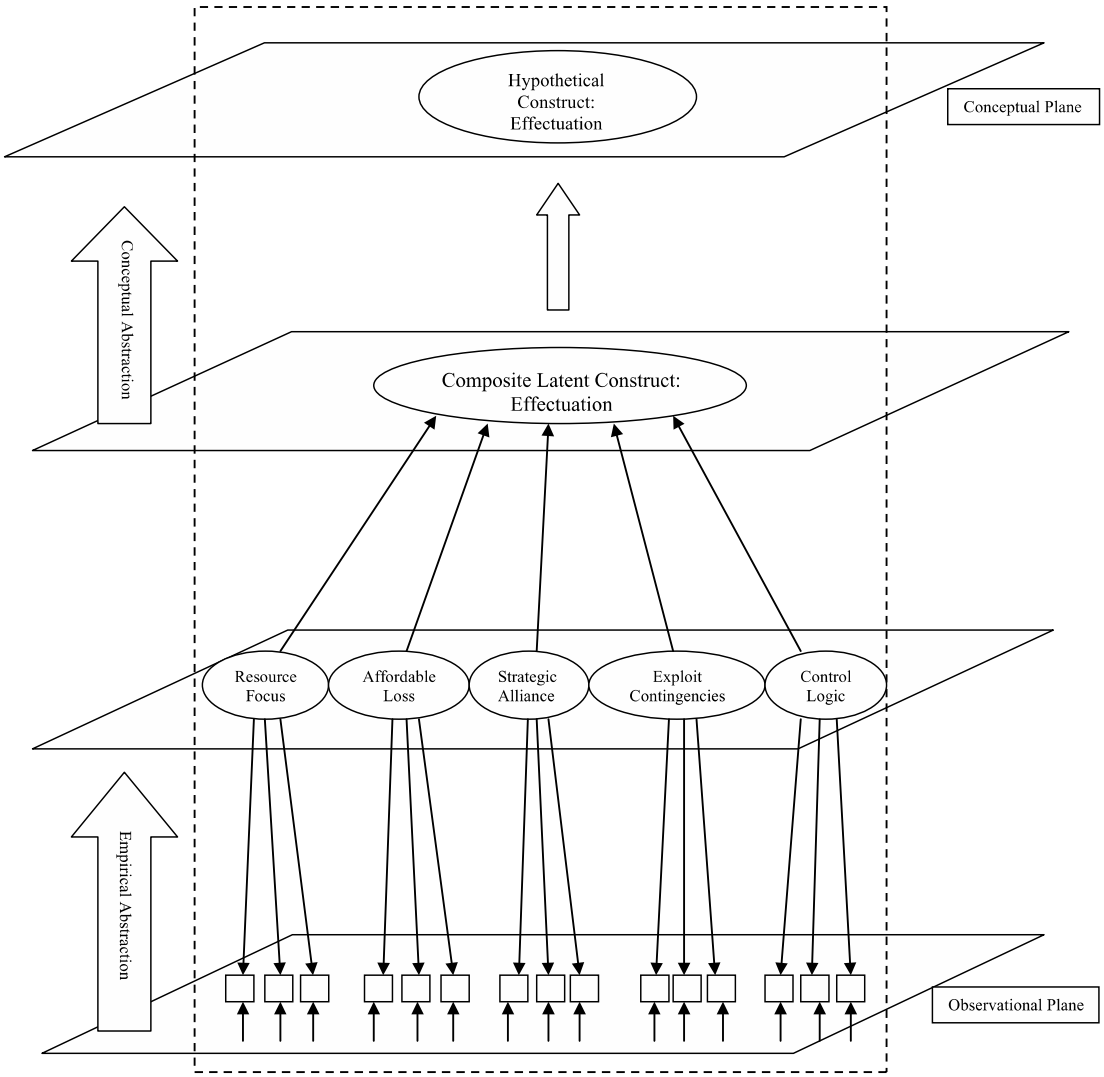


Figure 3: Mixed indicator model for effectuation (from Perry *et al.*, 2011)

Perry *et al.*, (2011) suggest that future researchers develop instruments that measure effectuation and causation related behaviours, in addition to developing instruments that measure cognitive effectuation and causation processes. Differentiating effectuation from other related constructs is a further measurement issue (Perry *et al.*, 2011).

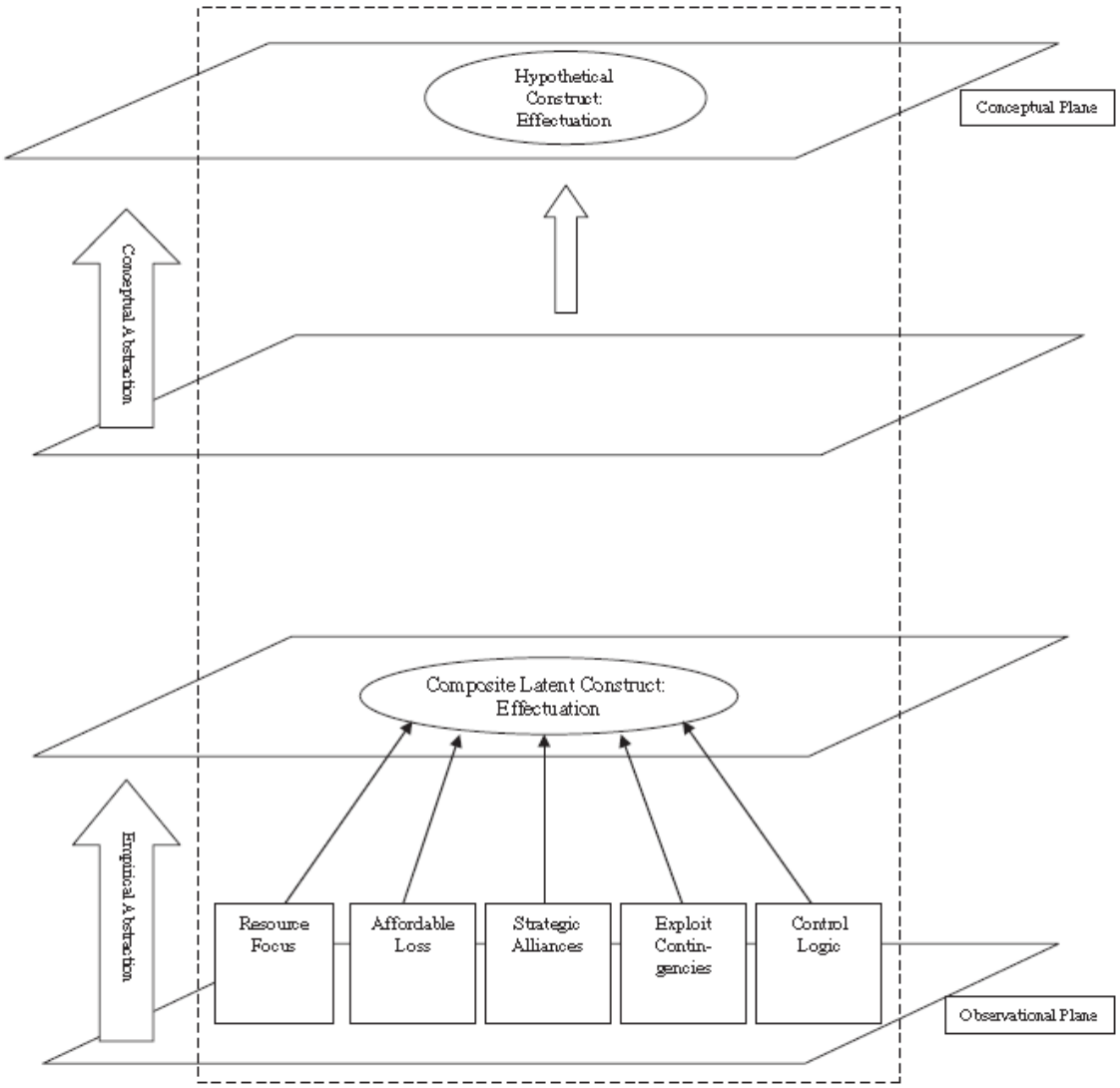


Figure 4: Composite indicator model for effectuation (from Perry *et al.*, 2011)

2.7 Link between effectuation processes and firm performance

The implications of effectuation for firm performance have not been studied systematically in past research. Much of the existing literature (Sarasvathy, 2001; Wiltbank *et al.,* 2006; Dew *et* al., 2008) has been of a conceptual nature; establishing the dimensions and heuristics of effectuation. Following from the conceptual literature, many of the early empirical effectuation articles have been experimental studies that focus on identifying how entrepreneurs and non-entrepreneurs process risks and returns (Dew *et al.,* 2009; Read *et al.*, 2009;

Sarasvathy, Simon & Lave, 1998; Sarasvathy & Dew, 2005; Sarasvathy et al., 1998).

As the field of effectuation research is only now progressing towards an intermediate phase (Perry *et al.*, 2011), few quantitative studies have been performed to investigate causal links between effectuation and other established constructs such as firm performance.

Wiltbank *et al.,* (2009) find that in cases of uncertainty, investors who emphasized control were generally more successful than investors who emphasized prediction. However, Wiltbank *et al.,* (2009) only examined effectuation as reflected by the sub-construct of control proposed to reflect effectuation, the study did not consider the subdimensions of experimentation, affordable loss, flexibility and pre-commitments as put forward by Chandler et al., (2011).

Read *et al.,* (2009) used a meta-analysis to detect variables that reflect five sub-constructs of effectuation in past studies and extract their influence on firm performance. The authors found positive and significant relationships between venture performance and the following:

i. means—'what I know that is relevant to starting a new venture';
ii. means—'what I know that is irrelevant to starting a new venture';
iii. means—'who I am that is relevant to starting a new venture';
iv. means—'who I am that is irrelevant to starting a new venture';
v. means—'who I know';
vi. partnership; and
vii. leverage contingency

The meta-analytic relationship between venture performance and affordable loss, however, was negative and not significant. Therefore, not all hypotheses were supported. It is worthwhile noting that probably none of the studies included in the meta-analysis conceptualized their variables in terms of effectuation. In creating the meta-analytic study, therefore, Read *et al.,* (2009) re-conceptualized the variables as effectuation variables.

Read *et al.,* (2009) posit, given that effectuation reflects the heuristics of expert entrepreneurs within their domain, a positive link between effectual approaches and new venture performance. The model they propose is presented in Figure 5.

Their findings from a sample of 9897 new ventures spanning industries, geographies, time and individual founders indicate that all the heuristics which describe effectuation (except Design, which they were not able to measure, and Affordable Loss, which returned insignificant results) are positively and significantly related to new venture performance.

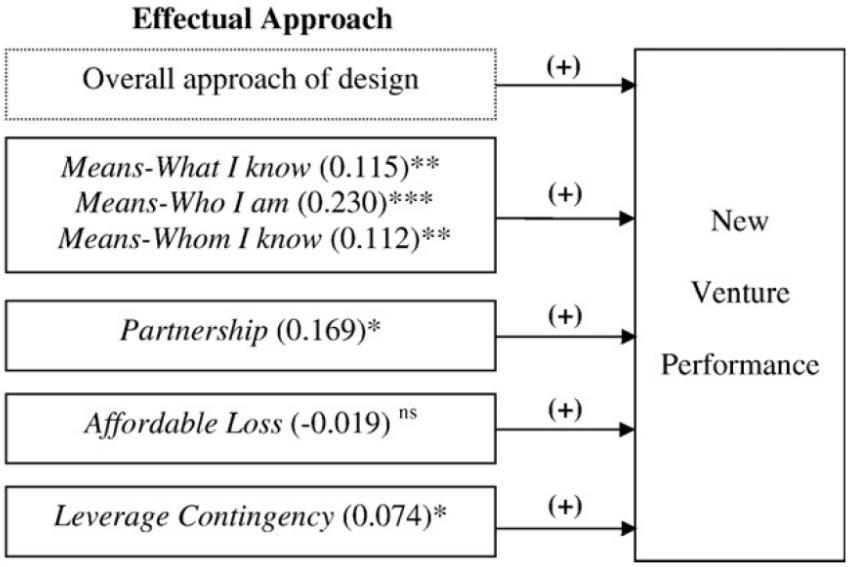


Figure 5: Theoretical model of effectual approaches and new venture performance (Read *et al.,* 2009)

Nienhuis (2010) finds that effectuation and causation approaches differ significantly in resulting performance. Specifically, he finds that causational market research has a positive influence on performance, while measurements of means-based, rather than goals-based action and a focus on partnerships both proved that these dimensions of effectuation positively influence performance. Apparently, not all effectual constructs are advantageous to start-up performance, and not all measurements within constructs point in the same direction, questioning the reliability of the effectuation constructs themselves (Nienhuis, 2010). This suggests avenues for further research on the effectual constructs

Two articles also posit that firms employing effectual strategies play a significant role as pioneer/leading firms in regional transformation (Harmeling, 2005) and (Castanhar, Dias, & Esperança, 2008). In particular with regard to high technology ventures.

Based on this literature, the first two hypotheses of this study are postulated:

H1: There is a positive association between effectuation processes and firm performance.

And, as the effectuation construct is closely linked with the causation construct:

H2: There is a negative association between causation and firm performance.

2.8 Consolidating effectuation literature

Perry *el al.,* (2011) show that effectuation research is transitioning to an intermediate state. A number of articles on effectuation and causation are summarised in Table 2 below.

To date, most of the empirical research on causation and effectuation has been either experimental studies that analyse the think aloud verbal protocols of entrepreneurs as they make decisions (e.g. Dew *et al.,* 2009; Sarasvathy *et al.*, 1998) or field studies that have gathered and analysed qualitative data (Sarasvathy and Kotha, 2001; Sarasvathy and Dew, 2005; Harmeling, 2005). To move the research stream from a nascent to an intermediate phase it is necessary to develop and validate quantitative measures (Perry el al., 2011). Wiltbank *et al.,* (2009) and Chandler *et al.,* (2011) have both developed such measures. Further studies are required to test effectuation against established entrepreneurship constructs (Perry el al., 2011).

Table 2: Summary of effectuation literature (source: own)

Article	Title	Research question	Theoretical contribution	Dependent variable	analysis
Sarasvathy (2001)	Causation and effectuation: towards a theoretical shift from economic inevitability to entrepreneurial contingency	How are firms created?	Effectuation is presented and contrasted with causation	n/a	Conceptual
Read and Sarasvathy (2005)	Knowing what to do and doing what you know: effectuation as a form of entrepreneurial expertise	How does effectuation relate to entrepreneurial expertise and venture performance?	Effectuation strongly linked to expertise	Entr. performance	Conceptual
Wiltbank, Dew, Read, Sarasvathy (2006)	What to do next? The case for non-predictive strategy	How do firms make decisions under uncertainty?	Effectuation discussed as a transformative process	n/a	Conceptual
Read, Song, & Smit (2009)	A meta-analytic review of effectuation and venture performance	How does effectuation relate to performance?	Effectuation possibly relates to venture performance	Venture performance	Meta-analysis
Wiltbank, Read, Dew, Sarasvathy (2009)	Prediction and control under uncertainty: outcomes in angel investing	How do control strategies compare to prediction strategies w.r.t investment success?	Control strategies outperform prediction strategies in uncertain environments	Investment success	Ordinary least squares regression
Nienhuis (2010)	Effectuation and causation: The effect of entrepreneurial logic on incubated start-up performance	To what extent do start-ups of different performance show differences in the amount of effectuation versus causation?	Effectuation and causation approaches differ significantly in resulting performance	Venture performance	Binary logistic regression
Perry, Chandler, & Markova (2011)	Entrepreneurial effectuation: A review and suggestions for further research	Literature Review	Consolidation of research and suggestions for future research	n/a	Conceptual
Chandler, DeTienne, McKelvie, & Mumford (2011)	Causation and effectuation processes: a validation study	Operationalising causation and effectuation sub-constructs	Research instrument	n/a	Exploratory factor analysis

2.9 Definition of technology orientation

The essence of Schumpeter's (1934) theory of creative destruction is that entrepreneurs distort the market equilibrium by introducing new product-market combinations or innovations. Sometimes, they use new technologies to do so. By innovating, entrepreneurs drive less productive firms out of the market and advance the production frontier. Innovation is therefore an important means by which entrepreneurial firms contribute to economic growth (Bosma, Jones, Autio, & Levie, 2007).

Innovation is the key to developing and successfully exploiting competitive advantages. Innovation coupled with continuous learning provides an edge. This combination brings something new into being: new products, new processes, new business models, and new markets. It can enable firms to bring more rapidly to the market, to customise those products, and to add new functionality to those products (Morris, Kuratko, & Covin, 2008).

Technology and innovation in entrepreneurial businesses is typically explained in a variety of ways. For instance, by:

1) describing how early-stage entrepreneurs and established business managers focus on the novelty (or unfamiliarity) of their products or services relative to customers' current experience (Bosma *et al.*, 2007),
2) focusing on levels of innovativeness in entrepreneurial businesses as measured by the degree of competition faced by the business, or
3) whether the business manager perceives that many, few or no other businesses offer similar products or services (Lee, Lee & Penning, 2001).

The literature approaces technology strategies employed by firms from a variety of perspectives and in a variety of contexts. For instance, Park & Bae (2004) propose several types of new venture technology and innovation strategies employed by firms in developing countries, particularly from a global entrepreneurship perspective. The strategies they propose include but are not limited to:

i. reactive imitation,
ii. proactive localisation,
iii. import substitution,
iv. creative imitation,
v. early market entry,
vi. global niche, and
vii. global innovation.

Strategic choice, although clearly important to all types of businesses, is of particular concern to technology-based ventures. Firms in a high-technology industry such as the renewable energy industry can, for example, implement a product market strategy aimed at achieving growth in terms of revenues or a strategy where the objective is growth in the value of the technology with a view to an eventual exit through-sale to a strategic partner. A firm that is pursuing a strategy of differentiation based on innovative new product introductions might benefit from the human capital development through years of experience in technical jobs. Such experience would provide insights into technical advances that might enhance product features (Park & Bae, 2004). Developing new product technology and having concern for technical expertise demonstrates the importance for new ventures in high-technology industries to select strategies which they can successfully execute. It has also been suggested that true measures of success for technological entrepreneurs is the extent to which they are able to develop and bring to market radically innovative new products and/ or services (Urban & Barreira, 2009). Radical innovations, characteristic or Schumpeterian entrepreneurship, are important not only for the positive economic impact they typically create but also because they fundamentally change the behaviour of consumers (Urban & Barreira, 2009).

Research on firm innovation in the African context may be considered valuable, as very few empirical studies that have been conducted previously focus on innovation and technology in the context of an emerging country. The majority of

research on firm innovation has been conducted in the United States and subsequently the generalisability of TO (Antoncic & Hisrich, 2001).

TO plays a significant role in stimulating firm innovation, encourages the development, diffusion, adoption and application of the very latest technologies (Urban & Barreira, 2009). This is particularly relevant in developing countries where great potential exists to 'import and adapt' technologies developed in industrialised countries (Von Broembsen, Wood & Herrington, 2005).

While the literature proposes a wide variety of technology and innovation *strategies*, there are a number of underlying dimentions which collectively explain all techology strategies.

Zahra & Covin, (1993) define TO, in their research, as 'the set of organisational decisions concerning (1) aggressive technological posture, (2) automation and process innovation, and (3) new product development.' These three areas are discussed in the following section.

Zahra (1996b) defines TO as 'the plan that guides a new venture's decisions on the development and use of technological capabilities.' This strategy covers six major areas. The first is selecting the pioneering posture, where a venture decides whether or not be among the industry's first companies to introduce new products (technologies) to the market. The second is determining the number of products to be introduced to the market. The third is choosing the extent of a venture's use of internal and external R&D sources. Internal sources usually refer to in-house R&D activities. External sources may include purchasing or licensing of technology from other companies, or joining strategic alliances to acquire that technology. The fourth is deciding the level of R&D spending. The fifth is selecting the combination (portfolio) of applied and basic research projects. Whereas basic R&D advances science, applied R&D leads to new products and technologies. The sixth, and final, dimension is the venture's use of patenting to protect any competitive advantages it might gain from its R&D activities (Zahra, 1996b).

The technological choices of a new venture are usually clarified in its technology strategy i.e., the plan that guides the accumulation and deployment of technological resources and capabilities (Zahra, 1996a)

2.10 Dimensions of technology strategies

The literature reveals a diverse number of potentially important dimensions of TO. A few articles present diverse 'lists' of potentially important components of technology policy (for example, Porter, 1983; Zahra & Covin, 1993; Zahra, 1996b). These articles and the dimensions of TO they expound is summarised in Table 3 below.

2.10.1 *Pioneering*

A pioneer is the first company to introduce a product, process or technology to a market (Zahra, 1996b). As Table 3 indicates, pioneering is one of the most widely recognized dimensions of technology strategy (Adler, 1989; Bell & McNamara, 1991; Burgelman & Maidique, 1988; Porter 1985; Utterback, 1994; Zahra 1996b). In the renewable energy industry, being first to market allows the firm to establish its products as the standard, which forces later entrants to follow the pioneer's rules of competition (Zahra, Nash, & Bickford, 1995). The pioneer can also target premium segments and achieve profitability (Covin & Slevin, 1990). Still, pioneering is risky because the venture must invest heavily in educating customers and developing the market, without guarantees of success (Porter, 1985).

Zahra (1996b) suggests that independent ventures will emphasize pioneering more than larger corporates. Notably, independent ventures may tend towards a pioneering TO because they recognize market needs early by maintaining close customer contact. Entrepreneurs can capitalize on their ventures' simple structure by making decisions quickly, monitoring progress in developing products, and reaching the market ahead of the competition. This suggests that flexibility may be associated with a pioneering TO.

Pioneering is also compatible with an entrepreneur's technological expertise (Zahra, 1996b). Entrepreneurs often establish ventures to pursue cutting-edge technologies (Cooper & Dunkelberg, 1986) and are likely to retain this orientation as they lead their firms. Independent venture owners may favour pioneering also because of its potential high profits (Bell & McNamara, 1991). In contrast, managers of larger firms may consider pioneering risky because if it is unsuccessful, the manager risks unemployment or damage to his/her reputation (Zahra, 1996b).

Pioneering is also essential for successful niche strategies - a strategy favoured by SMEs (Rosenbusch *et al.*, 2011; Hofer & Sandberg, 1987). This strategy requires pre-empting competitors from imitating the venture's products by offering distinctive products suited to their unique niches.

Zahra (1996b) suggests that larger companies will be less disposed to pioneer new technologies than SMEs as the limited autonomy given to corporations and excessive organizational reviews can handicap the corporate's ability to succeed as pioneers.

Zahra & Covin (1993) also describe the dimension of an aggressive technological posture. This dimension refers to the firm's preference for or propensity to use technology proactively in positioning itself (Oster, 1990). A firm that employs technology proactively aspires to be on the leading edge of technological change in the industry by building a reputation for being first in the industry to try new methods and technologies, being an industry leader in innovation efforts, and being an early industry entrant regarding innovation efforts (Adler, 1989). Companies sometimes have diverse technological postures because of differences in technological know-how, differences in appreciation of the potential role of technology in organizational operations (Foster, 1986), and variations in business strategy (Porter, 1983). Moreover, an aggressive technological posture can signal specific competitive initiatives and resource commitments by the firm (Porter, 1985).

2.10.2 *Number of new products*

Another important dimension of a venture's technology strategy is the number of new products introduced to the market (Adler, 1989; Ali, 1994; Lefebvre et al., 1992; Zahra and Covin, 1993). This dimension refers to the intensity of a firm's product development activities (Zahra, 1996b). Companies that pursue intensive product development activities tend to surpass their counterparts in the number and rate of new product introductions (Cooper, 1987). Frequent product introductions can meet customers' needs, generate profits, and pre-empt the competition. Rapid product introductions also enhance the firm's ability to differentiate itself from the competition (Acs & Audretsch, 1990).

Several factors suggest that larger firms may introduce more new products than small firms. Notably, because larger firms typically compete in broadly defined markets (Hofer & Sandberg 1987), they need to introduce many products to serve diverse customer needs. In addition, larger firms have access to the sponsors' financial resources, a factor that may allow them to introduce more products to the market. Access to the distribution channels and manufacturing facilities of the sponsor also facilitates new product introductions. Larger firms often serve the same markets as their sponsor (Feeser & Willard, 1989), which allows them to use the sponsor's resources and facilities. Finally, the well-rounded top management team of the large firm is a major advantage in developing and introducing new products (Hisrich & Peters, 1986).

The situation is different for small firms, which must overcome many obstacles in introducing new products. Small firms must build their own production facilities and establish distribution channels, which reduces the capital available for product introductions. Small firms may also lack the requisite variety of capabilities necessary for introducing a large number of products. Finally, the simple but centralized structures of the small firms cannot cope with the complex demands of frequent new product introductions.

2.10.3 *Internal and external R&D sources*

Ventures gain access to innovations from both internal and external sources (Burgelman and Maidique, 1988; Zahra and Covin, 1994). Because internal technological innovations require significant resources and capabilities but have uncertain outcomes, new ventures also use external sources that include purchasing innovations developed by other companies, joining technology alliances, and licensing (Pisano, 1990).

Zahra (1996b) finds small firms emphasize internal R&D activities more significantly than larger firms. Independent venture owners (executives) usually possess technological expertise (Knight, 1989), and are therefore unlikely to outsource this competence. Internal R&D gives the small firm control over the innovation process by focusing on those projects that enhance pioneering activities (Zahra, 1996b). Internal R&D also protects the venture's technological capabilities by keeping information proprietary (Teece, 1986).

Furthermore, Zahra (1996b) found that larger firms are expected to emphasize external R&D sources more than smaller firms, as larger firms required both the internal and external technology sources to offer the multitude of products they need to serve their broadly defined markets.

2.10.4 *Research spending*

R&D spending is a major indicator of commitment to technological innovation (Adler, 1989; Ali, 1994; Teece, 1986). It supports the development of new products (technologies) and the maintenance of a capable R&D staff (Zahra, 1996b).

Zahra (1996b) finds that larger firms spend more heavily on R&D activities than small firms. He theorises that larger firms must invest more in R&D than small firms to support the large number of products introduced to the market and also to finance external R&D activities. The sponsors of large companies can provide larger firms with a steady inflow of funds, which supports frequent product introductions. In contrast, small firms receive capital in lump sums, based upon

market performance (Fast, 1981), a factor that can cause frequent cash flow problems.

Given that R&D activities demand sustained investments, cash-poor small firms must be conservative in their R&D spending. Small firms also may find it difficult to obtain funds from external capital sources because R&D involves proprietary information or requires company-specific facilities and equipment (Zahra, 1996b).

Even if capital is available externally, small firms may have to pay higher interest rates than the sponsors of larger firms (Acs & Audretsch, 1990). New entrepreneurs face more difficulties in obtaining capital, as lenders perceive them as a greater risk (Evans & Jovanovic, 1989).

2.10.5 *Patenting*

While there are many ways for a company to protect its gains from technological investments, patenting is among the most widely used (Adler, 1989; Bell and McNamara, 1991; Teece, 1986). Patenting helps to delay imitation by other firms and protects the venture's gains from R&D spending and product introductions (Teece, 1986). Levin, Klevorick, Nelson, & Winter (1987) observe that patenting represents the most effective means of protecting new ventures' technological resources because other means may not be feasible. They also suggest that patents held by the technologically oriented venture are often its most marketable asset.

Zahra (1996b) finds small firms are expected fewer patents than larger firms simply because they introduce fewer products to the market. Larger firms tend to secure more patents because of their frequent product introductions and their expertise in dealing with the regulatory requirements associated with patenting, as obtaining patents can be time consuming and costly (Zahra, 1996b).

Table 3: Dimensions of Technology Strategy: An Overview of Supporting Literature (from Zahra, 1996b)

Reference (year)	Type of Contribution	Pioneer/ Follower	# of Products	Internal/ External Source	Applied/ Basic R&D	R&D Spending	Patenting
Adler (1989)	conceptual	✔	✔	✔	✔	✔	✔
Ali (1994)	conceptual	✔	✔			✔	
Bell & McNamara (1991)	conceptual	✔	✔	✔	✔	✔	✔
Burgelman & Maidique (1988)	conceptual	✔	✔	✔		✔	
Blurrill & Lee (1992)	empirical	✔	✔	✔	✔	✔	✔
Chakrabrti & Weisenfeld (1991)	empirical			✔	✔	✔	
Christensen (1992)	empirical	✔	✔	✔	✔	✔	
Dussague *et al.,* (1993)	conceptual	✔	✔	✔	✔	✔	✔
Kerin *et al.,* (1992)	conceptual	✔	✔	✔	✔	✔	✔
Kotabe (1992)	conceptual	✔	✔	✔	✔	✔	✔
Lefebvre *et al.,* (1992)	empirical	✔	✔			✔	
Maidique & Patch (1988)	conceptual	✔	✔	✔	✔	✔	
McCann (1991)	empirical		✔	✔		✔	
McGrath (1995)	conceptual	✔	✔	✔	✔	✔	✔
Morone (1993)	conceptual	✔		✔		✔	
Porter (1985)	conceptual	✔	✔	✔	✔	✔	✔
Teece (1986)	conceptual	✔				✔	✔
Utterback (1994)	conceptual	✔	✔	✔	✔	✔	✔
West (1992)	conceptual	✔	✔	✔	✔	✔	✔
Zahra & Covin (1994)	empirical	✔	✔	✔	✔	✔	✔
Zahra (1996)	empirical	✔	✔	✔		✔	

2.11 Operationalisation of the technology orientation construct

In order to operationalise a firm's level of TO, Urban and Barreira (2009) used several different dimensions of technology which they considered to be most relevant to an organisation's technology strategy. They based their core set of questions based on technology and competitive strategies from the Panel Study of Entrepreneurial Dynamics (PSED) survey (Gartner, Shaver, Carter & Reynolds, 2004). The PSED survey provides systematic, reliable data on those variables that explain and predict nascent entrepreneurship. Using cluster analysis, the measures for TO were categorised into three types of firms:

1. *first mover* - a pioneering entrepreneur with a disruptive technology that creates a new paradigm (operationalise with surrogate variable: was the product/service available five years ago?),
2. *practitioner* - an entrepreneur who employs current technology to improve products, services or processes,
3. *innovator* - an incremental strategy whereby an entrepreneur modifies or improves existing technology.

Zahra & Covin (1993) operationalise TO along the three dimensions of

1. aggressive technological posture,
2. automation and process innovation, and
3. new product development.

Park & Bae (2004) propose several types of new venture technology and innovation strategies employed by firms in developing countries, particularly from a global entrepreneurship perspective. They also used cluster analysis to categoriise firms into the folowing clusters:

1. reactive imitation,
2. proactive localisation,
3. import substitution,
4. creative imitation,
5. early market entry,
6. global niche, and
7. global innovation.

Zahra 1996b operationalise TO using a Likert-type self-report survey instrument capturing the dimensions of:

1. Pioneering posture - where a venture decides whether or not be among the industry's first companies to introduce new products (technologies) to the market.
2. Number of products to be introduced to the market.

3. Internal vs. external R&D sources - where internal sources refer to in-house R&D activities. External sources include purchasing or licensing of technology from other companies, or joining strategic alliances to acquire that technology.
4. Level of R&D spending.
5. Applied vs. basic research - where basic R&D advances science, applied R&D leads to new products and technologies. And finally,
6. The venture's use of patenting to protect any competitive advantages it might gain from its R&D activities

2.12 Role of moderating/mediating factors

2.12.1 *Age*

Rosenbusch *et al.* (2011) posit that the relationship between innovation and SME performance is stronger in younger firms than older firms. The influence of firm age on the innovation-performance relationship in SMEs is a matter of the firm's resources rather than their quality (Rosenbusch *et al.,* 2011). While new ventures draw on resources that are less specialised but flexibly deployable, mature firms have a specialised resource base that enables them to efficiently operate in given market conditions (Amit & Schoemaker, 1993; Thronhill & Amit, 2003). Established SMEs, in particular, might lose their initial competitive advantage of nimbleness as they reinforce core routines, processes and structures. In contrast, new ventures are free to create processes and structures to form specific, opportunity-related capabilities that are difficult to imitate, thus creating competitive advantage. Since new firms can be expected to be more flexible and agile than their more established counterparts, they are able to realise an extended time of operating under conditions of limited competition in cases where they pioneer innovations (Rosenbusch *et al.,* 2011).

2.12.2 *Size*

Zahra (1996b) found evidence to support that pioneering, a focus on applied R&D, and extensive use of the internal R&D sources were positively associated

with the performance of independent ventures, while a heavy R&D spending, the use of both internal and external R&D sources, frequent product introductions, and patenting were positively associated with the performance of corporate ventures. These findings indicate that size has a moderating role on the relationship between TO and firm performance.

2.12.3 *Environmental uncertainty*

Urban & Barreira (2009) find that TO is highly correlated with environmental hostility and dynamism. These findings resonate with research which has found that a key part of technology and innovation strategies is the interaction of that strategy with the venture's external environment (Zahra & Bogner, 1999). When the environment is characterised by complexity and dynamism, firms have to anticipate future scenarios and develop proactive technology strategies in ambiguous and unstructured surroundings (Rosenbusch *et al.,* 2001). This may suggest that TO may play a significant role in control-oriented strategies as a response to an uncertain environment.

Researchers have investigated the impact of the characteristics of the external environment (Rosenbusch *et al.,* 2001*;* Tsai *et al.*, 1991), especially the macro- and micro-environmental forces on firm performance. Macro conditions (e.g., governmental subsidy for the industry) affect the formation and survival of new ventures. Firm performance depends also on the conditions of the micro (or competitive) environment where new ventures must face the challenges posed by the industry and competition. These variables also affect the intensity of competition, hence the chances of survival of the young ventures. Micro-environmental conditions also determine the venture's ability to seize opportunities, thereby affecting firm performance. Industry conditions also greatly impact firm performance (Sandberg & Hofer, 1987). These conditions also impact the resources available to the venture and, as a result, its strategic choices (Tsai et al., 1991). Therefore, fit between the competitive environment and the strategy of the venture will influence firm performance. (Zahra, 1996b)

2.13 Link between technology orientation and firm performance

Schumpeter (1934) argues that innovation is an opportunity for entrepreneurial firms to gain rents through the temporary establishment of a monopoly and considers continuous innovation activity as the key source of long term entrepreneurial success. Since SMEs are nimbler than their larger counterparts, Rosenbusch *et al.,* (2011) argue they can move faster and hence maintain these monopoly rents for longer periods of time. The introduction of innovative products, services, processes, or business models tailored to attractive niches is an additional opportunity for small firms to stand out from the competition (Porter, 1980)

Zahra (1996a) found that pioneering is conducive to high return on assets (ROA). Moreover, the relationship between pioneering and ROA was strongest where the environment is dynamic and moderately heterogeneous. Under these conditions, pioneering may enable the firm to exploit the opportunities created by dynamism and heterogeneity- without concern over extreme hostility (Zahra, 1996a). However, as hostility increases and heterogeneity declines, an inverse and significant association is noted between pioneering and ROA. This indicates that followership is a better strategic option than pioneering in highly hostile and dynamic environments. (Zahra, 1996a)

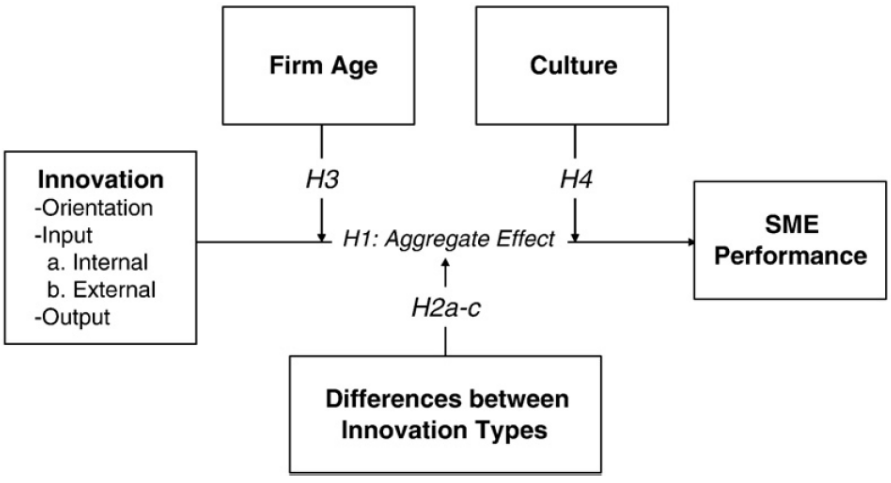


Figure 6: Conceptual model of innovation orientation and firm performance (Rosenbusch *et al.*, 2011)

Zahra (1996b) found evidence to support that pioneering, a focus on applied R&D, and extensive use of the internal R&D sources were positively associated with the performance of independent ventures, and a heavy R&D spending, the use of both internal and external R&D sources, frequent product introductions, and patenting were positively associated with the performance of corporate ventures. Furthermore Zahra (1996b) found that independent ventures outperformed corporate ventures, probably because of the high motivation of the independent venture owners who reaped the rewards of growth and profitability. Also, whereas corporate ventures may have greater access to the resources of their sponsors, political conflicts and rigid corporate controls might have reduced their ability to achieve competitive advantages (Zahra, 1996b).

Zahra & Covin (1993) found that the relationship between TO and firm performance is moderated by business strategy. This conclusion follows from the finding that the strength of the relationships between TO and performance varies across firms with different business strategy configurations. It also follows from the finding that high- and low-performing companies have different gestalts of associations between their TO and choice of business strategy. Hence, the fit of TO with business strategy is a significant predictor of firm performance. This highlights the need to align business strategy and technological choices as a precondition for superior firm performance (Zahra & Covin, 1993).

The dimensions of TO, whose alignments with business strategy are predictive of firm performance, vary on a strategy-by-strategy basis (Zahra & Covin, 1993). Although there are several ways to conceptualize 'fit,' the technology strategies that should be aligned with a particular business strategy can be operationally identified as those which significantly correlate with performance among firms with those strategies (Zahra & Covin, 1993). However, when TO is not significantly associated with performance among firms with a particular business strategy, that TO's fit with that business strategy would cease to be a managerial concern. This is because firms with these strategies will, by definition, perform roughly at their current level regardless of their decisions on the technology policy in question (Zahra & Covin, 1993).

It can, therefore, be argued that TO-business strategy fit is achieved in undifferentiated, low marketing intensity firms and middle-of-the-road firms when these firms utilise automation and advanced process innovation. Undifferentiated, low marketing intensity firms also excel when they adopt nonaggressive technological postures. Prudently aggressive, medium-breadth firms, on the other hand, realise a better technology-strategy fit when they emphasize an aggressive technological posture and new product development, but deemphasise automation and process innovation for achieving competitive advantage (Zahra & Covin, 1993). Finally, Zahra and Covin (1993) found all of the TO variables correlate significantly with performance in high profile, specialty firms as well as with low profile, narrowly-focused firms, despite the fact that these clusters have markedly different strategic thrusts.

However, Zahra & Covin's (1993) study observes that firms whose strategies are primarily built on technological competencies can run the risk of 'technological myopia' and possibly over-invest in developing those competencies. This occurs when these firms neglect other equally critical competencies. This was found to be the case, particularly in aggressive, medium-breadth firms. Perhaps in these companies executives are more easily deluded into believing in the integral virtue of high technological investments when they recognize that technology is a significant determinant of success in their industries (Zahra & Covin, 1993).

Based on this literature, the third hypothesis of this study is postulated:

H3: Firms with high TO will exhibit superior performance than firms with low TO

2.14 Link between technology orientation and effectuation processes

Zahra (1996a) found that pioneering is conducive to high return on assets (ROA). Moreover, the relationship between pioneering and ROA was strongest where the environment is dynamic and moderately heterogeneous. Under these conditions, pioneering may enable the firm to exploit the opportunities created by dynamism and heterogeneity- without concern over extreme hostility (Zahra,

1996a). However, as hostility increases and heterogeneity declines, an inverse and significant association was found between pioneering and ROA. This indicates that followership is a better strategic option than pioneering in highly hostile and dynamic environments. (Zahra S. A., 1996a).

These findings imply that environmental uncertainty is a significant factor in the relationship between TO and firm performance. Since it is theorised that effectual logic can be a competitive advantage in the context of high uncertainty, and since an association between a pioneering TO and uncertainty has been shown, it stands to reason that the effectuation construct should be associated with a pioneering TO.

The finding that TO is associated with hostility and dynamism is supported by Urban & Barreira (2009). These findings resonate with research which has found that a key part of technology and innovation strategies is the interaction of that strategy with the venture's external environment (Urban & Barreira, 2009; Zahra & Bogner, 1999).

When a fit between a firm's strategic and technological choices is achieved, the firm can employ its technological investments and capabilities to create a competitive advantage that supports its strategic goals and posture (Zahra & Covin, 1993).

Based on this literature, the fourth hypothesis of this study is postulated:

H4: Firm effectuation positively relates to TO.

2.15 Conclusion

Effectuation presents an interesting and important opportunity for entrepreneurship research because it identifies and questions basic assumptions of how individuals think and behave when starting businesses, and it offers an alternative explanation to causation that many believe has face validity (Perry *et al.*, 2011). Effectuation is particularly appropriate to entrepreneurship because it may better describe how, "in the absence of current markets for future goods and

services, these goods and services manage to come into existence" (Venkataraman, 1997, p. 120), and speaks to the essence of Schumpeter's (1934) theory of creative destruction. Effectuation appears to better describe the actual thoughts and behaviours that some entrepreneurs experience when starting a venture. As such, the effectuation related model of entrepreneurship is an important theoretical model.

Also central to the creation of goods and services, product and markets, and the notion of Schumpeterian entrepreneurship is the technology orientation of nascent and established firms. An understanding of TO is beneficial in new venture creation and in established firms in high-growth, high technology industries, as they relate to the profitability and competitiveness of the firm as well as to the overall economic performance of industry and the economy (Urban & Barreira, 2009).

Drawing on the emerging body of knowledge of effectuation and given the dearth of empirical evidence on the effect of effectuation and TO on firm performance, the following hypotheses have been formulated:

- **H1:** There is a positive association between effectuation processes and firm performance.
    - **H1a:** There is a positive association between experimentation and firm performance
    - **H1b:** There is a positive association between affordable loss and firm performance
    - **H1c:** There is a positive association between flexibility and firm performance
    - **H1d:** There is a positive association between pre-commitments and firm performance
- **H2:** There is a negative association between causation processes and firm performance.

- **H3:** Firms with high TO will exhibit superior performance than firms with low TO.
    - **H3a:** There is a positive association between a pioneering TO and firm performance
    - **H3b:** There is a positive association between an internal source TO and firm performance
    - **H3c:** There is a positive association between R&D spending and firm performance
    - **H3d:** There is a positive association between number of new products and firm performance
- **H4:** Firm effectuation positively relates to a pioneering TO.

Subsequently, the following conceptual framework is postulated (Figure 7).

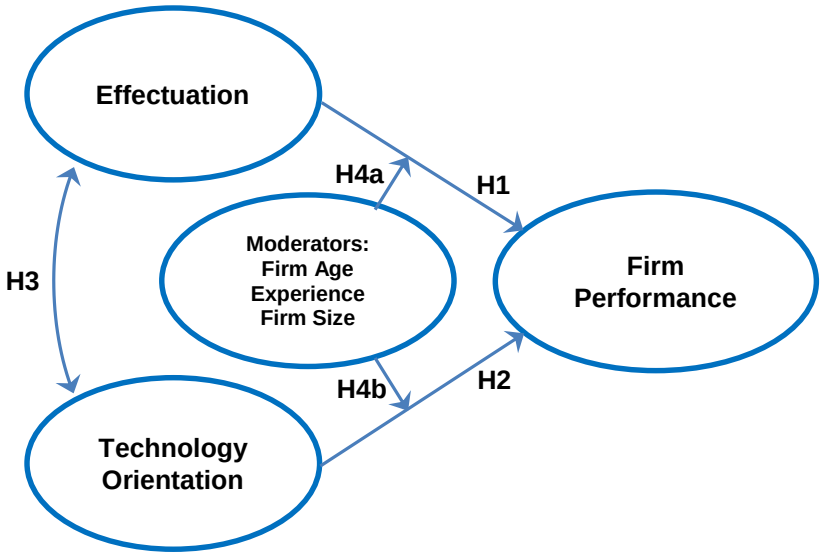


Figure 7 : Hypothesised model of TO, effectuation, and firm performance

CHAPTER 3: RESEARCH METHODOLOGY

3.1 Introduction

Chapter 2 explored the entrepreneurship literature that places effectuation and technology orientation in the greater context of entrepreneurship and identifies the constructs as key determinants of firm performance.

This chapter describes the research methodology used in this study. It initially explains the choice of research paradigm and design and the motivations thereof, and contextualises this research in the existing literature. Thereafter, the sampling frame, the research instrument and the procedure for data collection are expounded.

The chapter then extends the objectives of the research outlined in Chapter 1, and the hypothesis drawn in Chapter 2. In the process of answering the research questions, the basic hypotheses are broken down into a number of sub-hypotheses, in order to enable a rigorous analysis of each of the sub-constructs of effectuation and technology orientation.

Following an explanation of the analyses performed in this study, consideration is given to the scope and limitations of the research. Furthermore, the reliably and validity of the measures are assessed.

3.2 Research Paradigm

This research takes a quantitative approach. According to Cooper and Schindler (2011), quantitative research attempts to precisely measure something, for example, consumer behaviour, knowledge, or attitudes. A quantitative approach is most appropriate for this research as it seeks to continue to move effectuation research toward an intermediate state by using more explanatory type research typical of mature research streams. As research on effectuation transitions to the

intermediate state, reliable and valid measures for qualitative analysis need to be developed (Perry *et al.*, 2011)

3.3 Research Design

The firm was selected as the appropriate level of analysis for this study as it represents an aggregate of different individuals and business activities. The unit of analysis will be either the CEO, MD, or head of business development of the sampled firms. As TO and effectuation refer to a managers self-perception of a firms strategic orientation, what is really measured is the manager's self-perception which serves as a relevant proxy of the strategic orientation of the firm (Wiklund, 1999)

The research design takes a non-experimental, cross-sectional approach. This study will be an explanatory type research, investigating correlational and causal relationships between the research constructs. A cross-sectional approach is taken as it is beyond the scope and practicability of this research to conduct a longitudinal study.

3.4 Population and sample

3.4.1 *Population*

The targeted population of this study was firms operating in the renewable energy sector in South Africa. Firms in other high-growth, high-technology industries are excluded from this study in order to minimise the moderating effects of the environment which would vary between industries and to maintain the scope of the research at a practical level.

3.4.2 *Sample and sampling method*

The study employed a non-random, judgemental sampling technique with an element of convenience. Judgemental sampling is used when a sample is

selected where certain judgements are made on the overall population. The frame selection process for this study can be viewed as a trade-off between practical considerations on the one hand and the demands of randomisation and generalisability on the other (Cooper & Schindler, 2011).

Out of convenience, the sample only included firms in the renewable energy sector of South Africa. A sampling criterion was used where the minimum size criterion of the firms sampled was set at 2 employees and the maximum size criterion set at 200 employees. The database of firms in the sample frame was kindly provided by the Sustainable Energy Society of South Africa (SESSA). Davidsson (2004) suggests that firms are heterogeneous along many dimensions, and that one should acknowledge the heterogeneity, and allow for samples to have reasonable and balanced representation. Hence, as a consequence of restricting the sample frame to one industry, the generalisability of this study is strengthened. However, the important issue concerning sampling, in general, is not statistical but theoretical representativeness, i.e. the elements in the sample should represent the type of phenomenon that the theory makes statements about (Davidsson, 2004).

3.5 The research instrument

The research instrument took the form of a questionnaire survey. The survey comprised close-ended questions in order to facilitate quantitative analyses. The survey used seven-point Likert scale type questions in order to yield data which can be considered as an equal-interval measurement scale (Cooper & Schindler, 2011), hence proving sufficient for parametric statistical analyses.

The questionnaire comprises approximately seven questions reflecting each construct, as well as demographic and characteristic questions regarding the business. The literature review revealed previously established instruments on effectuation, TO and venture performance on which this instrument can be based. This will allow for meaningful comparisons with earlier work. The measurement items for each construct are expounded below.

3.5.1 *Effectuation and causation*

In this study the effectuation construct has been considered as a formative construct comprised of the sub dimensions of experimentation, affordable loss, flexibility and pre-commitments. The measurement instrument for the effectuation and causation constructs was adopted from the study of Chandler *et al.,* (2011), of which the purpose was to develop an instrument for future research and to facilitate quantitative analysis in the effectuation research. By adopting this instrument the present study maintains comparability with the existing literature and potentially with future research. Chandler *et al.,* (2011) is the first study that has developed Likert-type measures that capture the more broadly defined effectuation construct.

The *experimentation* construct was measured using a three item scale. Chandler *et al.,* (2011) observed an alpha of 0.78 for the same scale.

To measure *flexibility* a four item scale was used. Chandler *et al.,* (2011) achieved an alpha of 0.7 for flexibility.

The scale for *pre-commitments* was a two item scale. Chandler *et al.,* (2011) observed an alpha of 0.62 for pre-commitments.

The *causation* construct was measured using a seven item scale adapted from Chandler *et al.,* (2011). The scale in their study yielded an alpha of 0.78.

3.5.2 *Technology orientation*

The measure for technology orientation was adapted from Zahra (1996b). Utilising measures developed from past research maintains content validity. Each measure captures an important portion of the domain of the underlying theoretical construct. Zahra's original instrument consisted of approximately three questions to measure each sub construct of TO. It was desired, however, to attenuate the length of the questionnaire to about 50 items in order to shorten the length of time required to respond to the survey. Hence 9 items used to measure TO, capturing

the sub constructs of *pioneering, internal/external source*, *R&D*, and *number of products*.

3.5.3 *Firm Performance*

The dependent variable of this study is *Firm Performance*.

Firm performance was measured based on perceived measures. The use of subjective, self-report measures of performance is consistent with past research (Poon, Ainuddin, & Junit, 2006). There is research evidence that managers' perceptions of the performance of their firm is highly consistent with how the firm actually performed as indicated by objective measures (Poon, Ainuddin, & Junit, 2006). Furthermore, business owners tend not to reveal their business' financial data (Naman & Slevin, 1993) and asking for such data might preclude any response at all.

Poon *et al.,* (2006) assessed both growth and financial performance by asking respondents to rate their company growth, sales volume, market share, and profit using a scale ranging from 'very poor' (1) to 'very good' (5). Respondents rated these four performance criteria relative to that of competitors as well as benchmarked against their own expectations, thus yielding an 8-item performance scale with an alpha reliability of 0.86.

The measure for firm performance in the current study was a seven-item index that gauged the firm's sales, sales growth, and market share growth. Three of the items were based on objective measures, and four of the items were subjective questions, asking how satisfied the manager was with his company's performance. Responses to the all seven items were therefore averaged to develop the index used in the analysis.

This instrument is also very similar to the instrument used by Zahra (1996b), against which the findings of this research are contrasted.

3.5.4 *Moderating Variables*

3.5.4.1 Firm Age

Firm age was measured by a single item which asked in what year the venture was established. The variable of firm age was then later processed into two categories, younger firms and older firms in order to investigate its moderating effect.

3.5.4.2 Firm Size

Firm size was measured by two items. One item establishes the firms' size in terms of number of employees while the other established the firms' size in terms of financial annual turnover. The variable of firm size was then later processed using principal component analysis and then categorised into two sets, smaller firms and larger firms in order to investigate its moderating effect.

3.5.4.3 Entrepreneurial Experience

Because entrepreneurial experience has been proposed as one of the best predictors of success (Hisrich, 1990), and shown to explain variance in entrepreneurial performance (Poon *et al.,* 2006), this variable must be controlled for in the analysis. At the same time, it is important to note that the concept of effectuation arose out of the study of expert entrepreneurs, who are, by definition, not representative of the population of entrepreneurs as a whole. Because effectual entrepreneurship may be synonymous with expert entrepreneurship, the average or typical entrepreneur may not predominantly use effectuation. Thus, conducting research that compares expert entrepreneurs versus non-entrepreneurs or novice entrepreneurs is warranted (Perry *et al.*, 2011). The number of years an entrepreneur has been active as an entrepreneur was used as an indicator of entrepreneurial experience.

3.5.4.4 Environmental dynamism and hostility

Environmental dynamism and hostility is effectively controlled for by restricting the sampling specifically to the renewable energy sector of South Africa.

3.6 Procedure for data collection

The survey was solicited electronically, via the online tool *Survey Monkey,* in order to allow for the easy and rapid dissemination and collection of questionnaires. The database of firms in the sample frame was kindly provided by the Sustainable Energy Society of South Africa (SESSA).

Respondents were contacted with periodic reminder calls and emails in order to facilitate a suitable response rate.

3.7 Theoretical framework

The theoretical framework based on the hypotheses proposed in the literature review is presented in Figure 8 below. In order to illustrate the formative and reflective nature of the constructs in the model the framework was expanded to incorporate the sub-constructs of effectuation and TO.

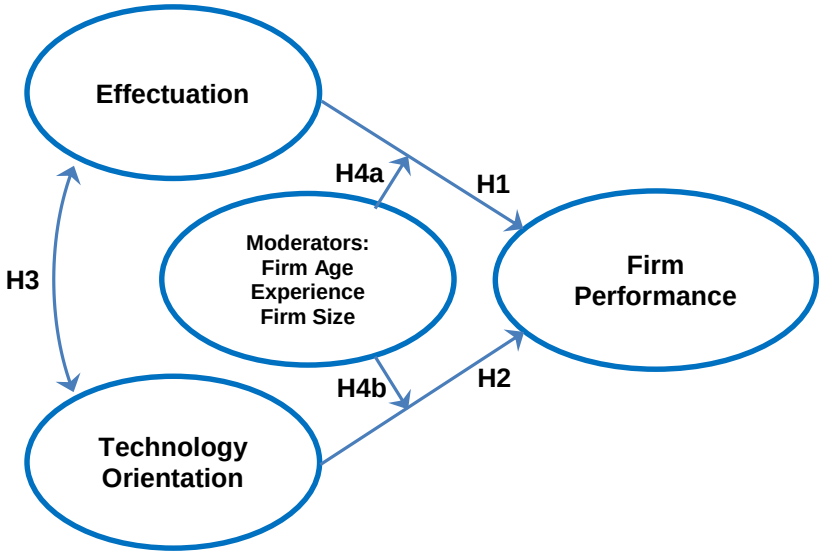


Figure 8 : Hypothesised model of TO, effectuation, and firm performance

This framework brings the model into alignment with the mixed indicator measurement model recommended by MacKenzie *et al.,* (2005) and diagrammed in Figure 3.

This expanded model is presented in Figure 9 below. In this framework the criterion variable is firm performance. The composite latent constructs of effectuation, and TO and the reflective construct of causation are defined as Level II variables. The sub-dimensions of effectuation and TO, placed on the Level I plane, are measured as reflective constructs using multiple indicators of each subdimension. Each of these indicators is an item in the research instrument, on the observational plane. Items on the on the observational plane are aggregated to form the Level I variables. Each of the individual sub-dimensions (Level I variables), are aggregated to form the composite latent constructs (Level II).

- **H2:** There is a negative association between causation processes and firm performance.
- **H3:** Firms with high TO will exhibit superior performance than firms with low TO.
    - **H3a:** There is a positive association between a pioneering TO and firm performance
    - **H3b:** There is a positive association between an internal source TO and firm performance
    - **H3c:** There is a positive association between R&D spending and firm performance
    - **H3d:** There is a positive association between number of new products and firm performance
- **H4:** Firm effectuation positively relates to a pioneering TO.

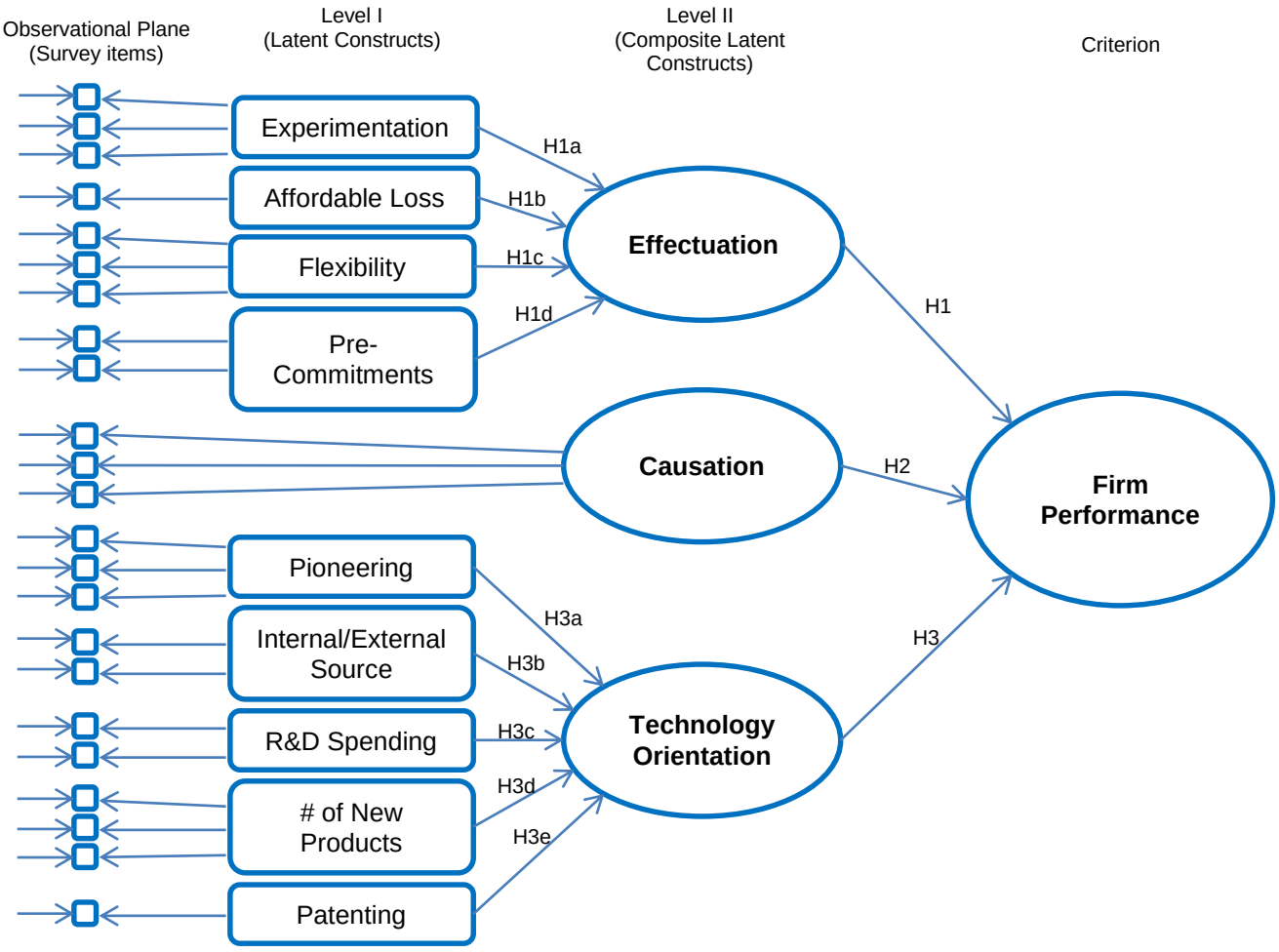


Figure 9: Expanded theoretical framework of constructs

3.8 Data analysis and interpretation

Chandler *et al.,* (2011) suggest effectuation is a formative construct. Following the characterisations of formative constructs explained in Diamantopoulos and Siguaw (2006), effectuation has been treated as a formative second order construct consisting of reflective first-order sub-components. From a practical perspective, this implies that commonly-espoused approaches and statistics to evaluate validity and reliability can be employed for the first order constructs (experimentation, affordable loss, flexibility, and pre-commitments) such as principal components analysis, Cronbach's alpha, etc. Furthermore, treating the sub-constructs as reflective constructs is appropriate, even though the second-order construct, effectuation, is a formative construct (Chandler *et al.,* 2011).

In order to investigate dependence relationships between the research variables, a multiple regression analysis was used to determine the effects of effectuation and TO on venture performance. Hair, Black, Babin, & Anderson (2010) state that multiple regression is the appropriate method of analysis when the research problem involves a single metric dependent variable presumed to be related to two or more metric independent variables. In the case of this research, firm performance is the dependent variable and effectuation and TO are independent variables hypothesised to have a causal relationship with venture performance (H1 and H2). However, since in this research both effectuation and TO are being treated as formative constructs, it is necessary to perform multiple regression using the underlying (level I) sub-constructs, and not the formative (level II) constructs (MacKenzie, Podsakoff, & Jarvis, 2005).

It is suggested by Cooper and Schindler (2011) to check correlational significance before embarking on regression analysis. MacKenzie *et al.,* (2005) argue that in formative constructs, due to the causal nature of the relationship, where the lower-order measures shape the upper-order construct, the lower-level indicators are defining characteristics of the construct and may therefore be independent of each other. This infers that the sub-components should not be changed or deleted; doing so might substantially alter the upper-level construct (Diamantopoulos & Siguaw, 2006; MacKenzie *et al.*, 2005). The dimensions of effectuation, as a formative construct, have been determined by the theoretical argument of Sarasvathy (2001) and not by qualitative research; hence changing the dimensions of the construct will conflict the logic of the concept of effectuation.

To analyse data with regard to H4, it was initially desired to use factor analysis to investigate the relationship between the factor structures of effectuation and technology orientation. Factor analysis is a statistical approach that can be used to analyse interrelationships among a number of variables and to explain these variables in terms of their common underlying dimensions (Hair *et al.*, 2010). However the number of responses to the survey was deemed inadequate to perform factor analysis (Hair *et al.*, 2010).

3.9 Limitations of the study

A quantitative approach might overlook certain issues that might otherwise arise through qualitative research. The sampling frame for the research is not ideal as a convenience sample is being used. It would be ideal to establish a complete list of firms active in the renewable energy sector in South Africa, so that simple random sampling could be used. This however is not practical as the industry is still to some extent in its inception, and to the authors knowledge no exhaustive database on firms active in the industry exists.

The generalisation of the study to other high-technology industries is perhaps questionable

The results should be interpreted with caution because the study examined only one industry, which raises a question about the generalizability of the findings to other industries as the effects of environmental hostility and dynamism are a significant antecedent to effectuation and TO. Likewise, because the data were collected from South African ventures, the results may not apply to other firms that are located elsewhere in the world.

In addition, the study's cross-sectional analysis neither permits causal inferences on the relationship between effectuation and TO on firm performance nor allows inferences about long-term firm performance.

Moreover, because the study's measures of firm performance focused on financial criteria, they may overlook other goals of corporate venturing. Future studies could consider nonfinancial goals in evaluating firm performance.

3.10 Validity and reliability of research

3.10.1 *External validity*

External validity refers to the research finding's ability to be generalised beyond the focal study - across persons, settings, and times (Cooper & Schindler, 2011). Threats to external validity come from the sampling frame, access to the sample,

the setting and history (Easterby-Smith, Thorpe, & Jackson, 2008). For example, research conducted in large organisations may not be comparable to small organisations,

The most direct approach to establish validity of the results is to obtain another sample form the population and asses the correspondence of the results from the two samples, in this way demonstrating that the results observed are not just the product of the selection of individuals or organisations (Easterby-Smith *et al.*, 2008). However, the assessment of multiple samples was beyond the scope of this research, as the study was limited to the South African renewable energy sector.

In the absence of an additional sample, an assessment of the R^2 or estimating the regression model on two or more subsamples can be conducted (Hair *et al.*, 2010).

3.10.2 *Internal validity*

Internal validity is refers to the systematic factors of bias latent within the research design (Easterby-Smith *et al.*, 2008). Internal validity is the ability of a research instrument to measure what it is that it alleges to measure i.e. does the research instrument actually measure what its designer claims it does (Cooper & Schindler 2011). The positivist approach adopted by this research seeks to maximize internal validity.

Peer review was consulted during the research process to ensure that analysis techniques and interpretation of results was thorough and adequate. Internal validity is further enhanced by maintaining a thorough audit trail for the data collection and analysis procedures.

3.10.3 *Reliability*

Reliability refers to the consistency of measurement in a composite variable formed by combining scores on a set of items, measured by Cronbach's alpha

coefficient (Easterby-Smith *et al.*, 2008). Reliability is concerned with estimates of the degree to which a measurement is free from random error - a measure is reliable to the degree that it supplies consistent results (Cooper & Schindler 2011). To ensure internal consistency the scales of effectuation, TO, and performance will have to satisfy a Cronbach's alpha of greater than 0.7 (Hair *et al.*, 2010). The measures of reliability and internal consistency are presented in section 4.4.1.

A further issue of reliability is the repeatability of the study. This is of particular significant concern in quantitative research. In this study reliability has been maintained by thorough documentation of the research methodology and process.

CHAPTER 4: PRESENTATION OF RESULTS

4.1 Introduction

In this chapter, the results of the study are presented. The data was analysed and the results are reported according to the research methodology detailed in the previous chapter. Tables are included for ease of presentation and comparison of results.

Firstly a description of the sample is presented, depicting the size of the sample and the demographics of the respondents.

Secondly the measurement aspects of the data analysis are expounded. This is the discussion of the results of the analysis of internal consistency and reliability, and an explanation of the appropriate subsequent actions that were required.

Lastly, the structural aspects of the model are presented. The result of the regression analysis for each hypothesis and moderator variables is presented. The decision to accept or reject the null hypothesis was based on a 95% confidence level. However, more detailed discussion of the findings is undertaken in the following chapter.

4.2 Sample description

A judgemental sampling frame with an element of convenience was employed during this study, according to the criteria discussed in Chapter 3. A total of 723 questionnaires were sent out to member companies of the *Sustainable Energy Society of South Africa* (SESSA). Only one person per company was contacted.

A total of 75 respondents completed the survey, a response rate of 10.4 percent. Weekly reminders were sending to the database in order to bolster the response rate. Two of the respondents had not completed a significant proportion of the questionnaire, and hence these were eliminated from the data set for the detailed analysis, leaving 73 responses for analysis. In addition, a further three

respondents had omitted between 1 and 4 questions. In order to resolve the missing data from these respondents the average response was calculated for each construct and each construct comprised of multiple items. In cases where all the items for a particular construct were omitted the response was eliminated from the regression model. This approach was deemed appropriate as the items showed suitable reliability.

4.2.1 *Demographic profile of respondents*

Descriptive statistics of the demographics of the sample are presented below.

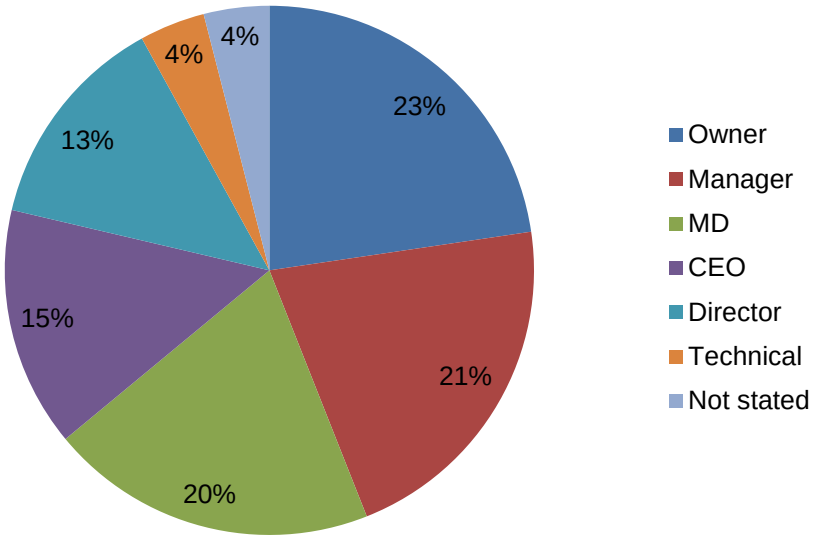


Figure 10: Position of respondents

The vast majority of respondents, over 90 percent, occupied a senior position in their company (i.e. owner, manager, CEO or director). This is to be expected as the majority of firms in the sample had between 2 and 5 employees (refer to Figure 14, below), and senior management was the point of contact with the companies.

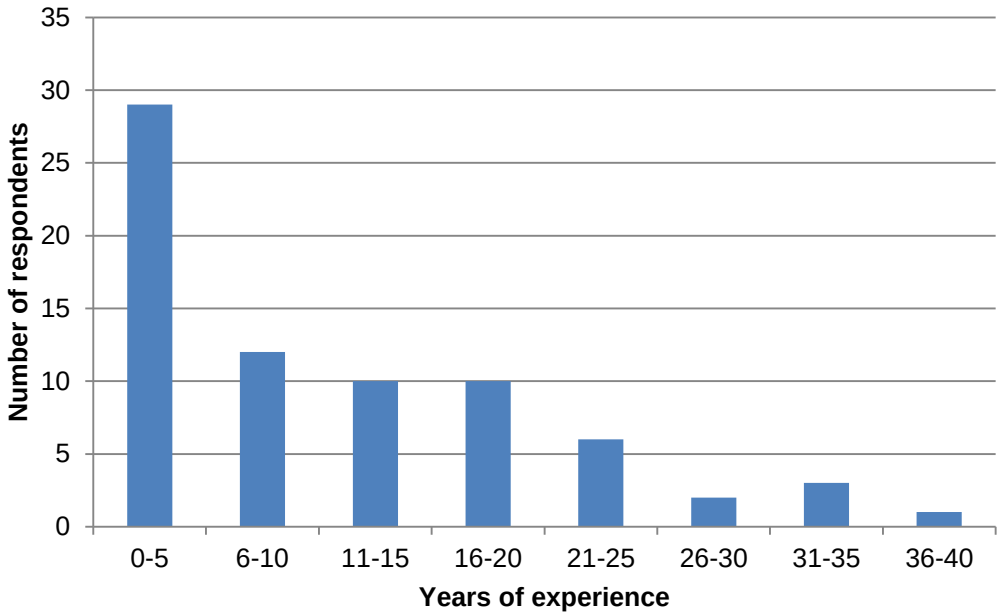


Figure 11: Experience of respondents

About 40 percent of the respondents had 5 years or less experience as an entrepreneur. Figure 11 shows the distribution of the number of years' experience in the sample. The distribution of experience can be seen to have a long tail, extending up to 40 years of experience as an entrepreneur.

4.2.2 *Demographic profile of companies represented*

The histogram showing the distribution of firm age of the sample is presented in Figure 12 below.

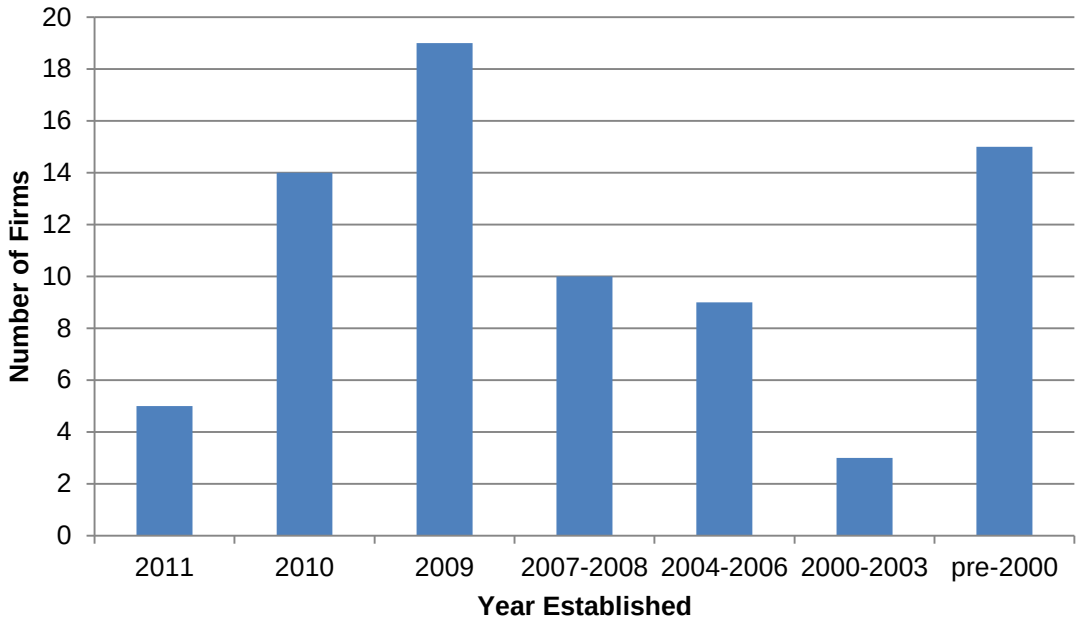


Figure 12: Age of responding firms represented in the sample

Just over half (51%) of the companies in the sample were established within the past three years, with the majority of companies (25%) aged between 2 and 3 years (i.e. established in 2009), 20% of the companies were 10 years or older.

The majority of firms (23%) in the sample achieved an annual turnover of between R1.5 million and R3.75 million, placing them in the small business category according to the National Small Business Act (Republic of South Africa, 1996). Twenty one percent (21%) of the companies in the sample classify as very small business, and fifteen percent (15%) classify as medium size business.

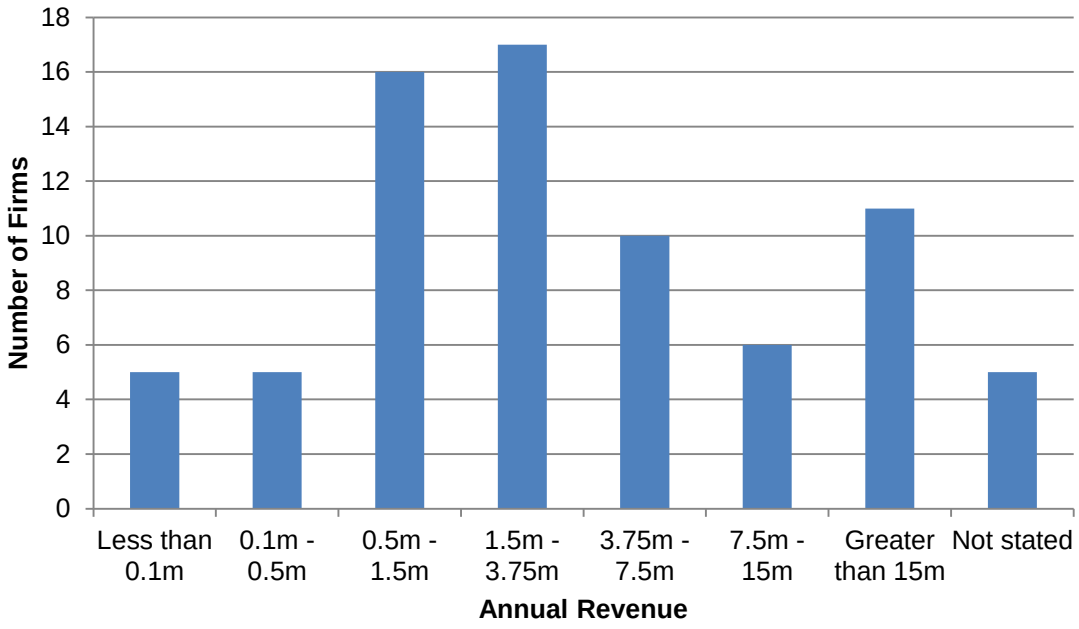


Figure 13: Annual turnover of responding firms represented in the sample

Approximately thirty five percent (35%) of companies employed between two and five people, and twenty four percent (24%) employed 6 to 10 people. This again places the majority of companies in the small business category according to the National Small Business Act (Republic of South Africa, 1996).

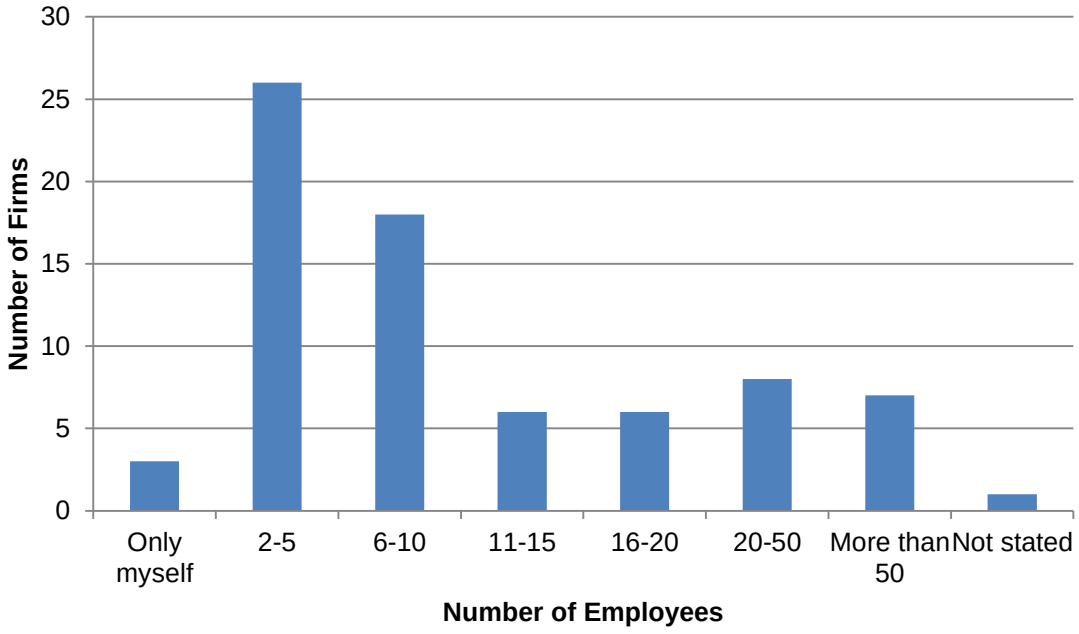


Figure 14: Number of employees of responding firms represented in the sample

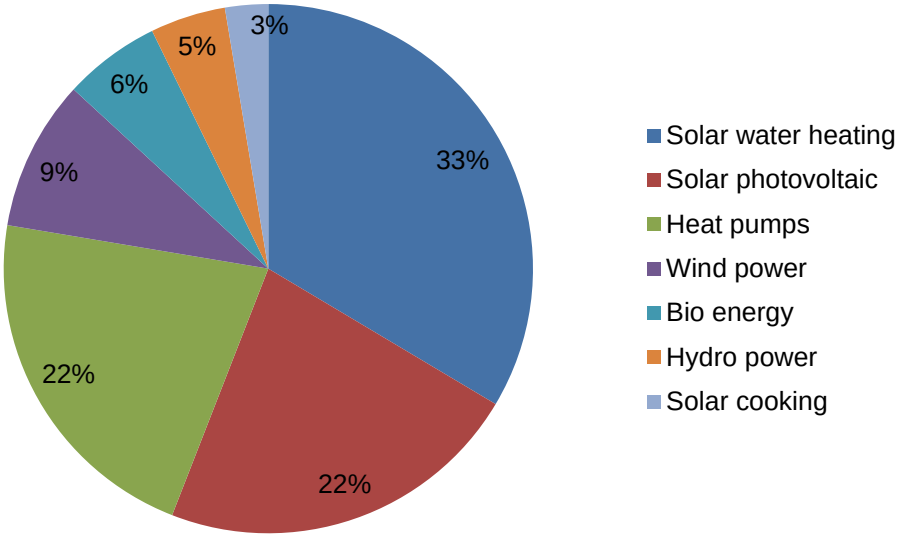


Figure 15: Industry sector of responding firms represented in the sample

Of all the firms represented in the sample, the majority (33%) were involved in the solar water heating sector of the renewable energy industry, with the next largest portion (22%) serving the solar photovoltaic market (Figure 15). The majority of firms in the sample were involved in installation (37%) or distribution of renewable energy products. Only a small number of firms were involved in manufacturing (14%) or research and development (6%) of renewable energy products (Figure 16).

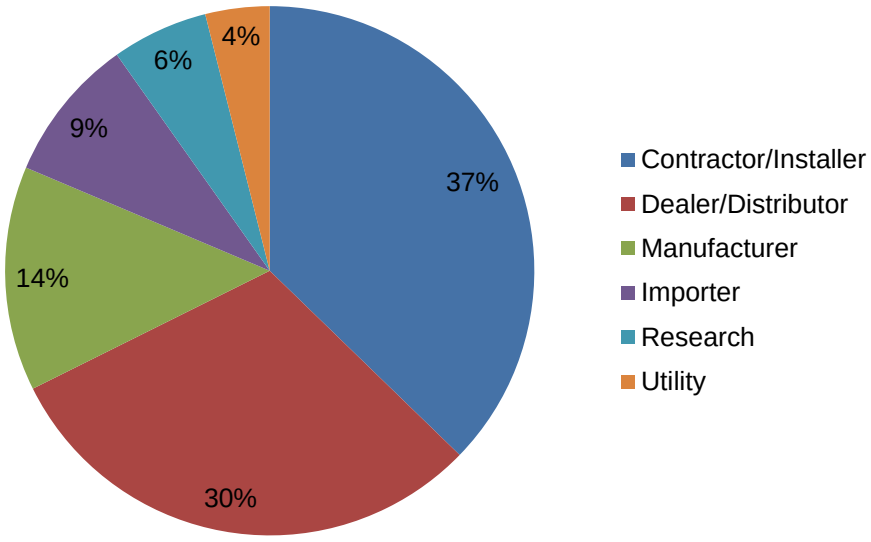


Figure 16: Business activity of responding firms represented in the sample

4.3 Correlational Analysis

To evaluate the hypothesised relationships between the variables, correlational analysis was employed. It has been suggested that the correlation significance should be checked before embarking on regressions (Cooper & Schindler, 2011). Descriptive statistics and correlations between the constructs are presented in Table 4 in which the Pearson correlation coefficients are reported, with the asterisks indicating the p-values. According to Hair *et al.,* (2010), a multiple correlation coefficient of 0.7 or above indicates a high relationship. Descriptive statistics of individual questionnaire items are presented in Appendix B.

4.4 Measurement aspects of the scales of the model

4.4.1 *Internal consistency and reliability of scales*

Reliability is concerned with estimates of the degree to which a measurement is free from random error. A measure is reliable to the degree that it supplies consistent results (Cooper & Schindler 2011). To ensure internal consistency the scales of effectuation, TO, and performance will have to satisfy a Cronbach's alpha of greater than 0.70 (Hair *et al.*, 2010). The Cronbach's alphas for each of the constructs are presented inTable 5 below.

As discussed in Chapter 3, in this study the effectuation construct has been considered as a formative construct comprised of the sub dimensions of experimentation, affordable loss, flexibility and pre-commitments.

The *experimentation* construct was measured using a three item scale. The scale showed a Cronbach's alpha of 0.69 which was deemed suitable for use in the regression analysis. By contrast, Chandler *et al.,* (2011) observed an alpha of 0.78 for the same scale.

Table 4: Descriptive statistics and correlations of study variables

Variable	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*	*16*
1. Experimentation	1.00															
2. Affordable loss 2	-0.18	1.00														
3. Flexibility	0.39*	-0.13	1.00													
4. Pre commitments	0.23*	-0.11	0.20	1.00												
5. Pioneering	0.34*	0.01	0.16	0.23*	1.00											
6. Internal source	0.26*	0.02	-0.03	0.14	0.44*	1.00										
7. External source	0.29*	-0.17	0.16	0.18	0.27*	0.25*	1.00									
8. R&D	0.34*	-0.06	0.07	0.18	0.47*	0.8*	0.75*	1.00								
9. Number of products	-0.24*	-0.10	-0.02	0.06	-0.44*	-0.47*	-0.20	-0.40*	1.00							
10. R&D Spending	-0.18	-0.20	-0.07	-0.02	-0.27*	-0.18	0.07	-0.06	0.44*	1.00						
11. Performance objective	-0.19	-0.25*	-0.02	-0.13	-0.14	-0.09	0.1	0.01	0.17	-0.01	1.00					
12. Performance subjective	-0.03	0.09	-0.22	-0.33*	-0.29*	-0.05	-0.2	-0.16	-0.02	-0.24	0.51*	1.00				
13. Effectuation	0.80*	-0.22	0.65*	0.55*	0.31*	0.21	0.32*	0.31*	-0.09	-0.07	-0.11	-0.17	1.00			
14. Causation	0.42*	-0.05	0.37*	0.4*	0.41*	0.23	0.18	0.26*	-0.15	-0.26*	0.05	-0.23	0.47*	1.00		
15. TO	0.42*	-0.05	0.15	0.26*	0.84*	0.73*	0.61*	0.86*	-0.50*	-0.20	-0.08	-0.28*	0.39*	0.40*	1.00	
16. Performance	-0.13	-0.08	-0.10	-0.26*	-0.25*	-0.07	-0.04	-0.07	0.05	-0.16	0.86*	0.89*	-0.16	-0.12	-0.19	1.00
Mean	2.71	4.04	1.99	2.65	3.02	4.31	4.38	4.35	3.29	2.95	4.58	4.10	2.47	1.97	3.69	4.23
Standard Deviation	1.37	2.13	1.00	1.48	1.35	1.89	1.77	1.45	6.79	2.13	1.77	1.52	0.87	0.95	1.20	1.47

The measure used for the *affordable loss* construct was a two item scale. The scale was seen to have negligible inter-item correlation (depicted in Figure 17 below) and as such the two items that formed the construct could not be considered as a scale for affordable loss. A likely explanation for this is acquiescence response bias, as one of the items was reversed. Winkler, Kanouse, and Ware (1982, p. 555) have defined '*acquiescence response set'* as the "tendency to agree with attitude statements regardless of content" and note that this response set is challenging "because it heightens the correlations among items that are worded similarly, even when they are not conceptually related." This suggests that it is possible that respondents simply answered questions according to a particular pattern or without properly considering the question. Hence, question 12, the item that was not reversed, was taken as the measure for affordable loss for the analysis. However, in the analysis both items were included in case interesting results emerged. Item 12 was named "affordable loss 1" and item 13 "affordable loss 2".

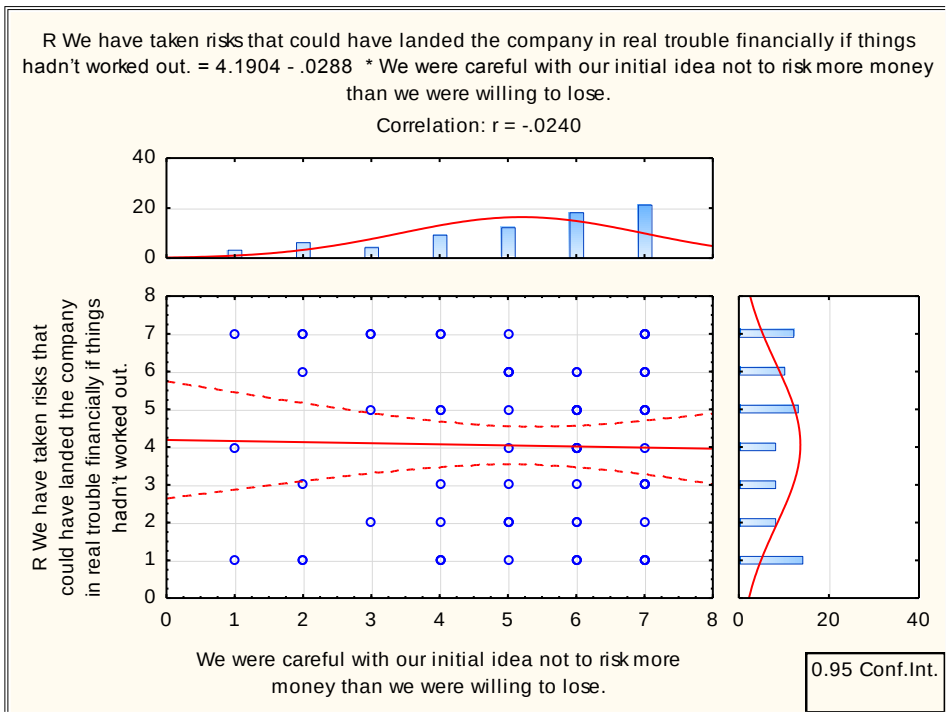


Figure 17: Inter-item correlation of the affordable loss construct

To measure *flexibility* a four item scale was used. Similarly to the affordable loss measure, the reversed item in the flexibility measure showed no correlation with

the other items in the scale. This can again be explained by acquiescence response bias. After eliminating the reversed item Cronbach's alpha for the Flexibility scale increased from 0.34 to 0.71. Chandler *et al.,* (2011) achieved an alpha of 0.7 for flexibility.

The scale for *pre-commitments* was a two item scale which yielded an alpha of 0.79. By contrast Chandler *et al.,* (2011) observed an alpha of 0.62 for pre-commitments.

The *causation* construct was measured using a seven item scale adapted from Chandler *et al.,* (2011). The scale in this study yielded an alpha of 0.9.

The measure for *technology orientation* was adapted from Zahra (1996b). For the purposes of this research TO was analysis as a formative construct consisting of the sub dimensions of pioneering, internal source, external source R&D, and number of new products.

The measure for *pioneering* was a scale consisting of four items. The scale showed an alpha of 0.83. The *internal source* construct was measured with a two item scale, showing an alpha of 0.84. *R&D spending* and *number of new products* were each one item scales.

Firm performance was measured using three objective and four subjective items. The reliability of the scale was investigated for the objective items only the subjective items only and for both objective and subjective items combined. It was found that the Cronbach's alpha for the objective scale was 0.77, and for the subjective scale the alpha was observed to be 0.88. For the Combined scale an alpha of 0.85 was seen. As all the scales for firm performance showed suitable reliability the combined scale was chosen for use in the analysis.

Table 5: Cronbach's alphas and inter-item correlations

Variable	Cronbach's alpha	Average inter-item correlation
Experimentation	0.69	0.42
Affordable loss	-	-
Flexibility	0.71	0.47
Pre commitments	0.79	0.65
Effectuation	0.75	0.30
Causation	0.90	0.57
Pioneering	0.83	0.58
Internal source	0.65	0.35
External source	0.84	0.72
R&D	0.63	0.46
Performance - objective	0.77	0.53
Performance - subjective	0.88	0.65
Performance – combined scales	0.85	0.48

4.4.2 *Validity*

Intercorrelations between the sub-constructs of the level II variables – effectuation and TO – were assessed in order to determine the suitability of the variables for multiple regression analysis. Intercorrelations are presented in Table 6, below. As was expected, weak and insignificant correlations are observed between the sub-constructs of effectuation and between the sub-constructs of TO. This supports the appropriateness of using a formative model to analyse these constructs.

4.4.3 *Distributions*

For each of the variables, tests of the assumptions of normality were performed. By applying tests for normality, and by calculating the Kolmogorov-Smirnov and Shapiro-Wilk statistics, test scores indicated that normality was violated for a number of items. Where necessary, transformations were applied.

The variables of experimentation, affordable loss 1, flexibility, pre-commitments, number of products, and causation were found to fail the tests of normality. Log transformations were applied to all of these variables, and it was found that this

action was suitable. In addition to applying tests of normality, histograms of the variables were also manually observed to confirm that the transformed variables satisfied normality. Variables that were transformed are marked with the prefix “T” in the presentation of results.

Table 6: Intercorrelations of level II sub-constructs

Variable	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*
1. T Experimentation	1.00														
2. T Affordable loss 1	0.01	1.00													
3. Affordable loss 2	-0.39*	0.22	1.00												
4. T Flexibility	0.18	0.06	-0.13	1.00											
5. T Pre commitments	0.26	-0.02	-	-0.06	1.00										
6. T Causation	0.42*	0.19	-0.20	0.21	0.27	1.00									
7. Pioneering	0.21	-0.18	0.20	0.01	0.02	0.13	1.00								
8. Internal source	0.35*	0.14	-0.15	0.03	0.15	0.37*	0.39*	1.00							
9. External source	0.14	0.36*	-0.03	0.14	0.07	0.05	0.23	0.26	1.00						
10. T Number of products	-0.09	0.30	-0.08	0.29	0.04	-0.07	-0.37*	-0.26	-0.20	1.00					
11. R&D Spending	-0.09	-0.01	-0.20	0.02	0.11	-0.15	-0.07	-0.24	0.13	-0.04	1.00				
12. Performance	-0.16	0.28	0.14	-0.18	-0.21	-0.11	-0.42*	-0.19	-0.06	-0.03	-0.25	1.00			
13. T Experience	-0.17	-0.09	0.22	0.30	-0.30	-0.10	-0.04	0.08	0.27	-0.08	-0.08	0.04	1.00		
14. Age	0.15	0.25	-0.05	0.28	0.10	0.17	-0.22	0.09	0.15	-0.01	0.12	-0.10	0.41*	1.00	
15. T Size PC	-0.25	0.09	-0.10	0.06	0.05	-0.28	-0.42*	-0.30	-0.02	0.27	0.15	0.25	0.25	0.42*	1.00

4.5 Structural aspects of the model

4.5.1 *Results pertaining to hypothesis 1*

Hypothesis 1 posits that firms with higher dimensions of effectuation will exhibit superior performance. As the effectuation construct was deemed to be a formative construct, sub hypotheses were necessitated in order to test each of the effectuation sub constructs against firm performance this yielded four sub-hypotheses as such:

- **H1a:** There is a significant association between experimentation and firm performance
- **H1b:** There is a significant association between affordable loss and firm performance
- **H1c:** There is a significant association between flexibility and firm performance
- **H1d:** There is a significant association between pre-commitments and firm performance

Regression models were built for each of the hypotheses, and furthermore each hypothesis was tested for the moderation effects of firm age, firm size and entrepreneurial experience. This therefore necessitated three regression analyses for each of the sub hypotheses, resulting in a total of twelve regression models pertaining to hypothesis 1. Tables presenting the results of each regression model are presented in Appendix C. A summary of all the regression models concerning hypothesis 1 is presented in Table 8, below.

Evidence was found for the positive relationship between pre-commitments and firm performance (with a regression coefficient of 0.703), significant at the 0.05 level. This finding supports hypothesis H1d. The significance of pre-commitments as a predictor for performance was strongest when size was used as a

moderator. Table 7 shows the regression model with pre-commitments as a predictor for firm performance with the interaction effect of firm size.

The regression models with experimentation and flexibility as predictors for firm performance were also found to be significant at the $p<0.05$ level, when firm size was used as a moderator. However, the significance of the models were due to the strong significance of size as a predictor for performance, and the experimentation and flexibility measures did not contribute to the significance of their respective regression models. Nevertheless, the relationships between experimentation and flexibility and firm performance were seen to be positive with regression coefficients of 0.5 and 0.6 respectively.

The regression output of the base model (pre-commitments vs. performance), plus the model with experience as the moderator variable and the interaction variable (pre-commitments * size) is reflected in Table 7 below.

Table 7: Regression model of pre-commitments and performance with firm size as a moderator

	Base model		**Incl. moderator**	
Predictor	**B**	**p**	**B**	**p**
Intercept	2.497	*	2.868	
T Pre commitments	-0.703	*	-1.143	
T Size PC	1.711	*	1.449	
T Precommitments*Size			0.310	
R2 base	0.140			
ΔR2	0.001			
F(2,65) base	5.301	**		
F(3,64) with moderator	3.508	*		

An analysis of the results detailed in Table 7 reveals that the independent variable pre-commitments was found to be a significant predictor of performance at the $p<0.05$ level. The correlation coefficient shows a positive association between pre-commitments and firm performance. (Note: a negative coefficient indicates a positive relationship as all items except the six performance items were coded with “strongly agree” as a 1 and “strongly disagree” as a 7, while for firm performance a

Table 8: Summary of regression analysis results for effectuation and causation

H	Level	Predictor1	Base model *p*	R^2 base	Predictor 1 *B*	Moderation	ΔR^2	Moderation effect	Interac effect sig
H1	2	T Effectuation		0.0375	-0.874	T Experience	0.0053	T Effectuation changed from -0.874 to -0.325	
H1	2	T Effectuation		0.0295	-0.726	Age	0.0131	T Effectuation changed from -0.726 to 0.097	
H1	2	T Effectuation	*	0.1198	-0.955	T Size PC	0.0044	T Effectuation changed from -0.955 to 0.829	
H1a	1	T Experimentation		0.0375	-0.585	T Experience	0.0010	T Experimentation changed from -0.585 to -0.419	
H1a	1	T Experimentation		0.0256	-0.450	Age	0.0566	T Experimentation changed from -0.45 to 0.25	
H1a	1	T Experimentation	*	0.1001	-0.496	T Size PC	0.0287	T Experimentation changed from -0.496 to 2.732	
H1b	1	T Affordable loss 1		0.0123	0.243	T Experience	0.0001	T Affordable loss 1 changed from 0.243 to 0.266	
H1b	1	Affordable loss 2		0.0040	-0.037	T Experience	0.0008	Affordable loss 2 changed from -0.037 to -0.073	
H1b	1	T Affordable loss 1		0.0115	0.225	Age	0.0000	T Affordable loss 1 changed from 0.225 to 0.215	
H1b	1	Affordable loss 2		0.0105	-0.066	Age	0.0066	Affordable loss 2 changed from -0.066 to 0.055	
H1b	1	T Affordable loss 1		0.0734	0.107	T Size PC	0.0013	T Affordable loss 1 changed from 0.107 to -0.342	
H1b	1	Affordable loss 2		0.0753	-0.046	T Size PC	0.0094	Affordable loss 2 changed from -0.046 to -0.432	
H1c	1	T Flexibility		0.0194	-0.453	T Experience	0.0004	T Flexibility changed from -0.453 to -0.323	
H1c	1	T Flexibility		0.0156	-0.404	Age	0.0128	T Flexibility changed from -0.404 to 0.254	
H1c	1	T Flexibility	*	0.1055	-0.612	T Size PC	0.0305	T Flexibility changed from -0.612 to 3.277	
H1d	1	T Pre commitments		0.0674	-0.713*	T Experience	0.0091	T Pre commitments changed from -0.713* to -0.247	
H1d	1	T Pre commitments		0.0611	-0.641*	Age	0.0211	T Pre commitments changed from -0.641* to 0.122	
H1d	1	T Pre commitments	**	0.1402	-0.703*	T Size PC	0.0010	T Pre commitments changed from -0.703* to -1.143	
H2	2	T Causation		0.0189	-0.453	T Experience	0.0016	T Causation changed from -0.453 to -0.169	
H2	2	T Causation		0.0834	-0.520	T Size PC	0.0052	T Causation changed from -0.52 to 1.019	

Two-tailed tests, n=73, * $p<0.05$, ** $p<0.01$

7 indicates superior performance [“highly satisfied”] and a 1 inferior performance [“highly dissatisfied”]).The new interaction variable “experimentation*experience” was not found to be significant. The base model was found to be a significant predictor of firm performance at the $p<0.01$ level.

4.5.2 *Results pertaining to hypothesis H2*

Hypothesis H2 posited that firms exhibiting higher levels of causation will exhibit superior performance. Unlike effectuation, causation has been found to be a reflective construct. As such, all items in the causation scale directly reflect the construct and the analysis of hypothesis H2 did not require sub-hypotheses.

Table 9: Regression model of causation and performance with experience as a moderator

	Base model		Incl. moderator	
Predictor	**B**	**p**	**B**	**p**
Intercept	4.648	***	4.489	***
T Causation	-0.453		-0.169	
T Experience	-0.123		-0.041	
T Causation*Exp			-0.159	
R2 base	0.019			
ΔR2	0.002			
F(2,56) base	0.540			
F(3,55) with moderator	0.383			

Table 10: Regression model of causation and performance with firm size as a moderator

	Base model		Incl. moderator	
Predictor	**B**	**p**	**B**	**p**
Intercept	2.558	*	1.653	
T Causation	-0.520		1.019	
T Size PC	1.465		2.081	
T Causation*Size			-1.059	
R2 base	0.083			
ΔR2	0.005			
F(2,64) base	2.913			
F(3,63) with moderator	2.041			

Table 9 and Table 10 show the results of the regression output of the base model (casuation vs. performance) with the moderation effects of entrepreneurial experience and firm size respectively. Analysis of the results of the regression model reveals that causation was not found to have a significant relationship with firm performance, despite having a regression coefficient of 0.520. Furthermore, the R^2 of the model was found to be very weak, at 0.083. This indicates that the variation in firm performance is not well explained by causation. Therefore, the null hypothesis has to be accepted.

4.5.3 *Results pertaining to hypothesis H3*

Hypothesis 3 posits that a firm's technology orientation is positively associated with its performance. As discussed in Chapter 3, in this study TO will be analysed in the dimensions of pioneering, internal/external source, R&D spending, and number of products. In order to analyse the association between TO and firm performance a formative model was used. This lead to the formation of the following sub-hypotheses:

- **H3a:** There is a significant association between pioneering and firm performance
- **H3b:** There is a significant association between internal source and firm performance
- **H3c:** There is a significant association between R&D spending and firm performance
- **H3d:** There is a significant association between number of products and firm performance

Regression models were built for each of the hypotheses, and furthermore each hypothesis was tested for the moderation effects of firm age, firm size and entrepreneurial experience. This therefore necessitated three regression analyses for each of the sub hypotheses, resulting in a total of twelve regression models pertaining to hypothesis 3. Tables presenting the results of each

regression model are presented in Appendix C. A summary of all the regression models concerning hypothesis 3 is presented in Table 12, below.

Evidence was found to support hypothesis H3a, that there is a positive association between pioneering and firm performance, significant at the $p<0.05$ level. However the positive association between pioneering and firm performance was seen to be fairly weak, with a regression coefficient of approximately 0.3. For all the other dimensions of TO - internal source, R&D spending, and number of new products - a lack of significance meant that no evidence could be found to support their association with firm performance.

The present study found that pioneering, internal source, and R&D spending, were positively associated with firm performance for smaller firms, while external source had a negative association. The opposite was the case for larger firms.

Table 11 shows the results of the regression analysis of number of products against performance with the moderation effect of firm size. This particular regression model yielded a total R^2 of 0.223 which is the highest ranked R^2 of all the regression models in this study, indicating the model showing best fit. This model shows the moderation effect of firm size on the relationship between number of products and firm performance.

Table 11: Regression model of number of products and performance

	Base model		**Incl. moderator**	
Predictor	**B**	**p**	**B**	**p**
Intercept	0.646		3.554	
T Number of products	-0.052		-2.457	
T Size PC	2.581	*	0.334	
T Number of products*Size			1.765	
R2 base	0.163			
ΔR2	0.059			
F(2,34) base	3.312	*		
F(3,33) with moderator	3.148	*		

Table 12: Summary of regression analysis results for TO

H	Level	Predictor1	Base model *p*	R^2 base	Predictor1 B	Moderation	ΔR^2	Moderation effect	Interac. effect sig
H3	2	TO		0.0334	-0.223	T Experience	0.0220	TO changed from -0.223 to 0.048	
H3	2	TO		0.0464	-0.257	Age	0.0850	TO changed from -0.257 to 0.406	*
H3	2	TO	*	0.0958	-0.200	T Size PC	0.0234	TO changed from -0.2 to 1.045	
H3a	1	Pioneering		0.0896	-0.334*	T Experience	0.0137	Pioneering changed from -0.334* to -0.129	
H3a	1	Pioneering	**	0.1440	-0.301*	T Size PC	0.0230	Pioneering changed from -0.301* to 0.735	
H3b	1	Internal source		0.0014	0.005	T Experience	0.0093	Internal source changed from 0.005 to 0.134	
H3b	1	External source		0.0033	-0.039	T Experience	0.0299	External source changed from -0.039 to 0.194	
H3b	1	Internal source		0.0716	-0.019	T Size PC	0.0527	Internal source changed from -0.019 to 1.095	
H3b	1	External source		0.0713	0.013	T Size PC	0.0087	External source changed from 0.013 to -0.466	
H3c	1	R&D		0.0024	-0.032	T Experience	0.0257	R&D changed from -0.032 to 0.226	
H3c	1	R&D Spending		0.0241	-0.112	T Experience	0.0060	R&D Spending changed from -0.112 to -0.207	
H3c	1	R&D		0.0078	-0.078	Age	0.0966	R&D changed from -0.078 to 0.484*	**
H3c	1	R&D Spending		0.0267	-0.110	Age	0.0127	R&D Spending changed from -0.11 to -0.272	
H3c	1	R&D		0.0713	-0.015	T Size PC	0.0095	R&D changed from -0.015 to 0.617	
H3c	1	R&D Spending	*	0.1048	-0.128	T Size PC	0.0279	R&D Spending changed from -0.128 to -0.798	
H3d	1	T Number of products		0.0488	0.352	T Experience	0.0059	T Number of products changed from 0.352 to 0.043	
H3d	1	External source		0.0021	-0.019	Age	0.0112	External source changed from -0.019 to 0.146	
H3d	1	T Number of products		0.0897	0.450	Age	0.0713	T Number of products changed from 0.45 to -0.711	
H3d	1	T Number of products	*	0.1630	-0.052	T Size PC	0.0594	T Number of products changed from -0.052 to -3.457	

Two-tailed tests, n=73, * p<0.05, ** p<0.01

In order to represent the moderation effect of firm size, principal component analysis was used to split the sample into two groups, “smaller firms” and “larger firms.” The regression coefficient of number of new products was found to be -0.052 in the case of smaller firms while for larger firms the regression coefficient was found to be -2.547. This suggests that larger firms which market more products tend to perform better than those who market fewer products, while the opposite is true in the case of smaller firms, where it was observed that firms marketing more products performed worse than their counterparts. Figure 18 shows the scatter plots for number of products vs. firm performance for the two categories of firm size. This depicts the moderation effect of firm size on the relationship between number of products and firm performance in graphical form.

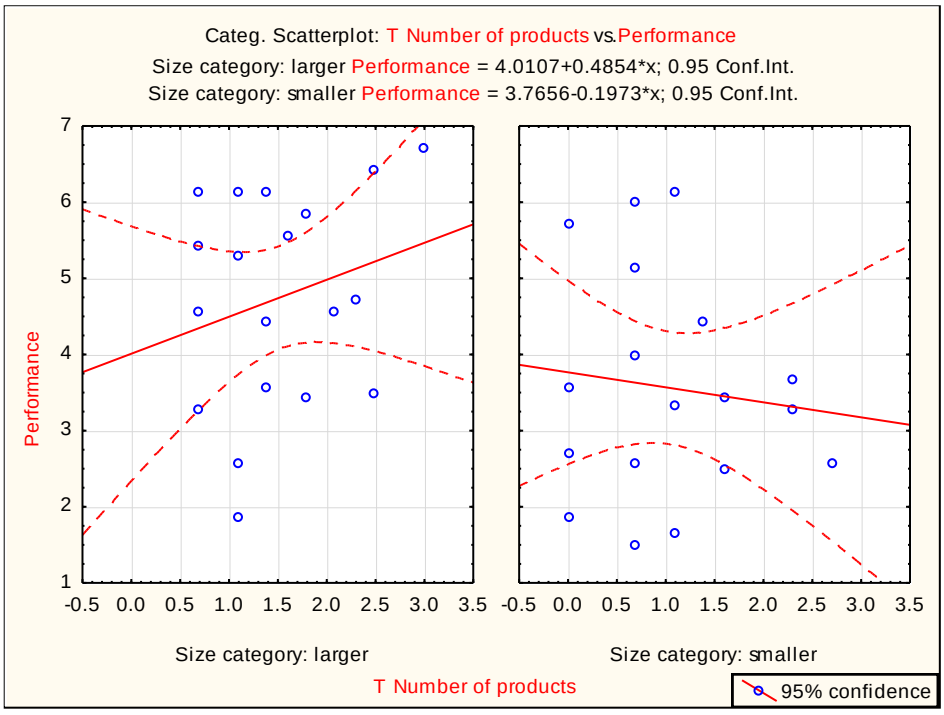


Figure 18: The moderation effect of firm size on the relationship between number of products and firm performance

Hypothesis H3 was also analysed, in the interest of thoroughness, as a reflective construct, with all items in the scales of pioneering, internal/external source, R&D spending, and number of products loading directly onto the TO construct. The results of the regression model of TO against performance with firm size as a moderator are presented in Table 13, below.

Table 13: Regression model of TO against performance

	Base model		Incl. moderator	
Predictor	**B**	**p**	**B**	**p**
Intercept	3.176	*	-1.201	
TO	-0.200		1.045	
T Size PC	1.323		4.544	
TO*Size			-0.933	
R2 base	0.096			
ΔR2	0.023			
F(2,65) base	3.443	*		
F(3,64) with moderator	2.886	*		

The regression model of TO against performance was found to be significant at the $p<0.05$ level for both the base model and the model including size as a moderator. However, the regression coefficient of TO indicates a fairly weak association between TO and firm performance in this sample.

4.5.1 *Results pertaining to hypothesis H4*

Table 14: Correlation analysis for hypothesis H4

Variable	*1*	*2*	*3*	*4*	*5*
1. Experimentation	1.00				
2. Affordable loss	-0.18	1.00			
3. Flexibility	0.39*	-0.13	1.00		
4. Pre commitments	0.23*	-0.11	0.2	1.00	
5. Pioneering	0.34*	0.01	0.16	0.23*	1.00

Hypothesis H4 posited a positive association between effectuation and a pioneering TO. The results of the correlational analysis, presented in Table 14, revealed a significant association between pioneering and the effectuation processes of experimentation and pre-commitments. According to Hair *et al.,* (2010), a multiple correlation coefficient of 0.7 or above indicates a high relationship. The correlation coefficients between pioneering and experimentation (0.34) and between pioneering and pre-commitments (0.23) indicate moderately positive associations. This evidence supports hypothesis H4,

but the association between effectuation and pioneering was weaker than expected. The affordable loss and flexibility sub-constructs were found to have virtually no correlation with pioneering.

4.6 Summary of the results

This chapter aimed to provide an overview of the results of the study. The chapter covered the demographics of the sample, the data processing and measurement aspects of the model, and finally the structural results of the model which pertain to the hypothesis outlined in Chapter 3.

In summary, evidence was found to support hypothesis H1d, that there is a positive association between pre-commitments and firm performance. However, the results pertaining to hypotheses H1a through H1c did not display sufficient significance for the hypotheses to be accepted. Despite the lack of significance positive associations were observed between the sub-dimensions of effectuation and firm performance. No evidence was found to support hypothesis H2.

With regard to hypothesis H3, evidence was found to support hypothesis H3a, that there is a significant and positive association between a pioneering TO and firm performance. However, the results pertaining to hypotheses H3b through H3d did not display sufficient significance for the hypotheses to be accepted. The study also found that pioneering, internal source, and R&D spending, were positively associated with firm performance for smaller firms, while external source had a negative association. The opposite was the case for larger firms.

Some evidence was found to support hypothesis H4 - effectuation processes are positively associated with TO. The study observed a significant and moderately positive association between experimentation and pre-commitments and pioneering.

CHAPTER 5: DISCUSSION OF THE RESULTS

5.1 Introduction

The purpose of this chapter is to discuss the results of the research that were presented in the previous chapter. The discussion also seeks to compare the findings of this research with the theoretical foundation drawn from previous literature as expounded in Chapter 2.

The chapter begins with a discussion of the demographic profile of the sample. The results pertaining to the structural aspects of the model are then discussed, covering the findings on each hypothesis. The measurement aspects of the model are then subsequently discussed. Finally the discussion places this research in relation to the greater context of entrepreneurship research.

5.2 Demographic profile of respondents

5.2.1 *Demographic profile of respondents*

5.2.1.1 Level

The vast majority of respondents, over 90 percent, occupied a senior position in their company (i.e. owner, manager, CEO or director). This is to be expected as the majority of firms in the sample had between 2 and 5 employees (refer to Figure 14), and senior management was the desired point of contact with the companies. Collecting data on technology and strategy from a single key executive, typically the CEO is consistent with the prior research on smaller or specialized firms (Zahra & Covin, 1993). Furthermore, CEOs are the persons most knowledgeable of their firms' overall strategies (Zahra & Covin, 1993).

5.2.1.2 Experience

About 40 percent of the respondents had 5 years or less experience as an entrepreneur. Figure 11 shows the distribution of the number of years' experience in the sample. The distribution of experience can be seen to have a long tail, extending up to 40 years of experience as an entrepreneur.

5.2.2 *Demographic profile of companies represented*

5.2.2.1 Age

Just over half (51%) of the companies in the sample were established within the past three years, with the majority of companies (25%) aged between 2 and 3 years (i.e. established in 2009), 20% of the companies were 10 years or older. This coupled with the finding that the majority of business owners in the sample had less than 5 years of experience indicates that the respondents in this study are inexperienced or novice entrepreneurs. Sarasvathy (2001) proposed that expert entrepreneurs frame decision problems using an effectual logic. While it has been found that experience has a weak relationship with performance it plays a significant role in the development of 'deliberate practice' which in turn is significant in the development of entrepreneurial expertise (Ericsson, 2006). Dew et al (2009) find that expert entrepreneurs differ from novices in analogical reasoning, holistic and conceptual thinking, and weighting of predictive information.

Dew *et al.,* (2009) find that novices trained in traditional management techniques based on a causal logic use a different logical frame in their decision-making and a different set of heuristics within that frame than expert entrepreneurs experienced in creating new ventures and new markets, who tend to employ more effectual techniques.

Based on the respondents in the sample of this study being predominantly novices, and in accordance with Dew *et al.,* (2009), it is therefore expected to find higher levels of causation in the results than effectuation.

5.2.2.2 Size

The majority of firms (23%) in the sample achieved an annual turnover of between R1.5 million and R3.75 million, placing them in the small business category according to the National Small Business Act (Republic of South Africa, 1996). Twenty one percent (21%) of the companies in the sample classify as very small business, and fifteen percent (15%) classify as medium size business.

Approximately thirty five percent (35%) of companies employed between two and five people, and twenty four percent (24%) employed 6 to 10 people. This again places the majority of companies in the small business category according to the National Small Business Act (Republic of South Africa, 1996)

Both the responding firms' number or employees and annual turnover was combined to create the index for firm size in this study. Principal component analysis was used to join the two items into the index, following which the index was categorised into "larger firms" and "smaller firms" in order to use the index as a moderator variable.

5.2.2.1 Sector and Bus activity

Of all the firms represented in the sample, the majority (33%) were involved in the solar water heating sector of the renewable energy industry, with the next largest portion (22%) serving the solar photovoltaic market (Figure 15). The majority of firms in the sample were involved in installation (37%) or distribution of renewable energy products. Only a small number of firms were involved in manufacturing (14%) or research and development (6%) of renewable energy products (Figure 16). Since the majority of the firms in the sample were involved primarily in installation and distribution of products as opposed to R&D and manufacturing, it is expected to find low levels across the dimensions of TO (pioneering, internal source, number of products, patenting and R&D).

5.3 Discussion pertaining to hypothesis H1

Hypothesis H1, “there is a significant positive association between effectuation processes and firm performance” was broken down into four sub-hypotheses according to the requirements of a formative construct. The sub-hypotheses are listed again below:

- H1a: there is a significant association between experimentation and firm performance.
- H1b: There is a significant association between affordable loss and firm performance
- H1c: There is a significant association between flexibility and firm performance
- H1d: There is a significant association between pre-commitments and firm performance

Evidence was found for the positive relationship between pre-commitments and firm performance (with a regression coefficient of 0.703), significant at the 0.05 level. The significance of pre-commitments as a predictor for performance was strongest when size was used as a moderator. It is worth noting, however, that Chandler *et al.,* (2011) found in their study that the pre-commitments sub-construct loaded onto both effectuation and causation.

The regression models with experimentation and flexibility as predictors for firm performance were also found to be significant when firm size was used as a moderator. However, the significance of the models were due to the strong significance of size as a predictor for performance, and the experimentation and flexibility measures did not contribute to the significance of their respective regression models. Nevertheless, the relationships between experimentation and flexibility and firm performance were seen to be positive with regression coefficients of 0.5 and 0.6 respectively.

These findings agree favourably with the findings of Wiltbank *et al.,* (2009) who found empirical evidence in support of the arguments in the theory of effectuation,

specifically, that efforts anchored on existing means, using the principles of affordable loss, pre-committed partnerships, and leveraging surprise, can provide useful benefits under uncertainty.

However, no evidence for hypothesis H1b, affordable loss, could be detected. This finding bears resemblance with the findings of Real *et al.,* (2009) who found the meta-analytic relationship between venture performance and affordable loss was negative and not significant. Read *et al.,* (2009) also found all other dimensions of effectuation in their study, namely means oriented, partnerships and leverage contingency, to yield a positive and significant association with firm performance. Although the present research does not include leverage contingency as a sub-dimension of effectuation and adopts experimentation and flexibility instead of means oriented, the results of the present study compare favourably with the finding of Read *et al.,* (2009). It is worthwhile noting that probably none of the studies included in the meta-analysis conceptualised their variables in terms of effectuation. In creating the meta-analytic study, therefore, Read *et al.,* (2009) re-conceptualised the variables as effectuation variables.

Despite the fact that no support was found for the affordable loss sub-construct, it is important to note that this does not imply that the construct should be eliminated as a sub-construct of effectuation. MacKenzie *et al.,* (2005) argue that in formative constructs, due to the causal nature of the relationship, where the lower-order measures shape the upper-order construct, the lower-level indicators are defining characteristics of the construct and may therefore be independent of each other. This infers that the sub-components should not be changed or deleted; doing so might substantially alter the upper-level construct (Diamantopoulos & Siguaw, 2006; MacKenzie *et al.*, 2005). The dimensions of effectuation, as a formative construct, have been determined by the theoretical argument of Sarasvathy (2001) and not by qualitative research; hence changing the dimensions of the construct will conflict the logic of the concept of effectuation.

A possible explanation for the poor levels of significance found in the relationship between effectuation and firm performance is that the study sample did not reflect particularly high levels of effectuation (with an average mean of 2.7 on a scale of

7, where a lower number represents a higher level), as opposed to causation (with a mean of 1.9). This is likely attributable to the low levels of entrepreneurial experience indicated in the sample. Dew *et al.,* (2009) find that novices trained in traditional management techniques based on a causal logic use a different logical frame in their decision-making and a different set of heuristics within that frame than expert entrepreneurs experienced in creating new ventures and new markets, who tend to employ more effectual techniques.

To date, there are few studies against which the findings of the present research can be directly contrasted. Wiltbank *et al.,* (2009) found that in cases of uncertainty, investors who emphasized control were generally more successful than investors who emphasized prediction. While the afore-mentioned meta-analytic study of Real *et al.,* (2009) found positive and significant relationships between venture performance and the following: (1) means orientation, (2) partnerships, and (3) leverage contingency and a negative and not significant relationship between venture performance and affordable loss.

5.4 Discussion pertaining to hypothesis H2

In line with contemporary research, it was expected that causation would be significantly associated with firm performance. Contrary to expectations, no evidence for hypothesis 2 could be detected. However, this finding in itself, and that a significant relationship between effectuation and firm performance was observed, supports the argument that firms employing more effectual strategies exhibit superior performance than those employing causational strategies in the particular context of this study.

There is a wealth of research that supports the relationship between a causational approach to strategy formation and firm performance (e.g. Ansoff, 1979; Porter, 1980). The emphasis in the causation literature is on a high degree of prediction in order for companies to strategically position themselves. Deterministic frameworks in strategic management all share a basic conception: prediction is useful in strategy making because the consequences of what can be predicted can be controlled (Wiltbank *et al.*, 2006).

Practically, how to achieve control depends upon the foresight horizon (Lane & Maxfield, 1996). When the strategist's foresight horizon appears relatively certain, prediction and control appear to have a co-extensive relationship (Wiltbank *et al.,* 2006). In such environments firms employing causational logic may perform better than their counterparts. However, as this horizon becomes more uncertain, the relationship between prediction and control changes. In environments characterised by Knightian uncertainty, prediction and control are not just empirically mismatched; they are conceptually at odds (Wiltbank *et al.*, 2006). The present study argues that in highly dynamic and uncertain environments, firms using an effectual logic will outperform their counterparts.

Interestingly, Wiltbank *et al.,* (2009) also found no support for the direct relationship of prediction (i.e. causation) to outcomes in their study of prediction and control in angel investing. They suggest there could be several explanations for this result; one theoretically intriguing possibility is that the uncertainty in angel investing may undermine the effectiveness of predictive approaches (Wiltbank *et al.*, 2009). This is further evidence that effectual logic leads to superior performance in an uncertain environment.

5.5 Discussion pertaining to hypothesis H3

Hypothesis H3, "Firms with high TO will exhibit superior performance than firms with low TO" was broken down into four sub-hypotheses in order to analyse the independent dimensions of the construct. The sub-hypotheses are listed again below:

- H3a: There is a significant association between a pioneering TO and firm performance
- H3b: There is a significant association between an internal source TO and firm performance
- H3c: There is a significant association between R&D spending and firm performance

- H3d: There is a significant association between number of new products and firm performance

Evidence was found to support hypothesis H3a, that there is a positive association between pioneering and firm performance, significant at the $p<0.05$ level. However the positive association between pioneering and firm performance was seen to be fairly weak, with a regression coefficient of approximately 0.3. For all the other dimensions of TO - internal source, R&D spending, and number of new products - a lack of significance meant that no evidence could be found to support their association with firm performance.

The finding of a general lack of significance for the relationship between the dimensions of TO and firm performance is in stark contrast with prior literature. For example, Zahra (1996b) found evidence to support that pioneering, a focus on applied R&D, and extensive use of the internal R&D sources were positively associated with the performance of independent ventures, and a heavy R&D spending, the use of both internal and external R&D sources, frequent product introductions, and patenting were positively associated with the performance of corporate ventures.

Interestingly, one area where the results of the current study do agree with Zahra's (1996b) findings is the moderation effect of firm size. The present study found that pioneering, internal source, and R&D spending, were positively associated with firm performance for smaller firms, while external source had a negative association. The opposite was the case for larger firms. Table 15, shows the interaction effect of the firm size variable in the present study's analysis. Incidentally, number of products was not found to differ with the moderation of firm size. This finding also agrees with that of Zahra (1996b). However, it must be reiterated that the associations between internal/external source, R&D spending, and number of products with firm performance were not found to be significant in the present study. The discussion above only illuminates the moderation effect of firm size.

Evidence for the significant association between TO and firm performance has been found by other studies operationalizing TO in alternate fashion. Park & Bae (2004) regard TO, product market maturity, and target market as key determinants of new venture performance. Park & Bae (2004) operationalised TO into 7 distinct new venture strategies: (i) reactive imitation, (ii) proactive localization, (iii) import substitution, (iv) creative imitation, (v) early-market entry, (vi) global niche, and (vii) global innovation. Zahra & Covin (1993) operationalised TO into (i) an aggressive technological posture, (ii) automation and process innovation, and (iii) new product development. Their study suggests that an aggressive technological posture can be financially rewarding, although the pay-off from this orientation is not always guaranteed. Zahra & Covin (1993) argue that while TO, strategic choices, and the fit between them are of crucial importance for financial performance, an emphasis on technology cannot singularly ensure high performance. When a fit between a firm's strategic and technological choices is achieved, the firm can employ its technological investments and capabilities to create a competitive advantage that supports its strategic goals and posture (Zahra & Covin, 1993).

Table 15: Moderation effect of firm size on the relationship between TO and firm performance

Pioneering changed from -0.301 to 0.735
Internal source changed from -0.019 to 1.095
External source changed from 0.013 to -0.466
R&D changed from -0.015 to 0.617
T Number of products changed from -0.052 to -2.457

The finding that pioneering is a significant predictor of firm performance is consistent with the literature. Zahra (1996a) found that pioneering is conducive to high return on assets (ROA). Moreover, the relationship between pioneering and ROA was strongest where the environment is dynamic and moderately heterogeneous. Under these conditions, pioneering may enable the firm to exploit the opportunities created by dynamism and heterogeneity- without concern over extreme hostility (Zahra, 1996a). However, as hostility increases and heterogeneity declines, an inverse and significant association is noted between

pioneering and ROA. This indicates that followership is a better strategic option than pioneering in highly hostile and dynamic environments. (Zahra S. A., 1996a)

Hypothesis H3 was also analysed, in the interest of thoroughness, as a reflective construct, with all items in the scales of pioneering, internal/external source, R&D spending, and number of products loading directly onto the TO construct. The regression model of TO against performance was found to significant at the $p<0.05$ level for both the base model and the model including size as a moderator. However, the regression coefficient of TO indicates a fairly weak association between TO and firm performance in this sample.

Despite the low significance of the present study's results, research on firm innovation in the African context may be considered valuable, as very few empirical studies that have been conducted previously focus on innovation and technology in the context of an emerging country (Urban & Barreira, 2009). Therefore, an empirical study of this nature is potentially valuable given that technology and innovation are central to the growth of economic output, productivity and employment (Urban & Barreira, 2009).

5.6 Discussion pertaining to hypothesis H4

Hypothesis H4 posited a positive association between effectuation and a pioneering TO. The results of the correlational analysis revealed a significant association between pioneering and the effectuation processes of experimentation and pre-commitments. According to Hair *et al.,* (2010), a multiple correlation coefficient of 0.7 or above indicates a high relationship. The correlation coefficients between pioneering and experimentation (0.34) and between pioneering and pre-commitments (0.23) indicate moderately positive associations. This evidence supports hypothesis H4, but the association between effectuation and pioneering was weaker than expected. The affordable loss and flexibility sub-constructs were found to have virtually no correlation with pioneering.

It is worth noting that experimentation was found to have a significant, moderately positive association with all of the dimensions of TO, while affordable loss and flexibility were seen to have virtually no correlation with any of the TO dimensions.

As Zahra (1996a) shows evidence that the relationship with a pioneering TO and firm performance is influenced environmental uncertainty, and since it has been shown that effectuation is highly associated with uncertainty (Sarasvathy, 2001; Wiltbank *et al.*, 2009) , the results of this study suggest that perhaps the relationship between TO and firm performance is moderated by effectuation. Therefore, it is possible that pioneering firms employing a effectual logic will achieve superior performance in uncertain environments to pioneering firms employing a causational approach. The rationalisation behind this is that effectual logic is likely to be more effective than causational logic in settings characterized by greater levels of uncertainty (Sarasvathy, 2001). The present study's finding of a moderately positive association between effectuation and TO supports this argument.

However, it is required to investigate the relationship between effectuation and TO using more sophisticated analysis than correlational analysis.

5.7 Discussion pertaining to measurement aspects of the study

This study establishes scale reliability and validity in the context of an emerging country. Concerns have been expressed as to whether imported instruments would stand up to validation across countries (Nkosi & Roodt, 2004). Measurement items used in this study compare well in terms of reliability and validity to the original findings of Chandler *et al.,* (2011) and Zahra (1996b) for the scales of effectuation and TO, respectively. However, some comment must be made as to the generally low levels of significance observed in the analysis. Problems with this instrument were found regarding common method variance and acquiescence response set.

Winkler, Kanouse, and Ware (1982, p. 555) have defined "*acquiescence response set"* as the "tendency to agree with attitude statements regardless of content" and note that this response set is challenging "because it heightens the correlations among items that are worded similarly, even when they are not conceptually related." Although Winkler *et al.,* (1982) focused specific attention on the effects of acquiescence on scale development processes, it is easy to see how this form of bias might also cause spurious relationships between two or more constructs (Podsakoff, MacKenzie, Lee, & Podsakoff, 2003). Thus, acquiescence may also be a potential cause of artifactual variance in the relationships between two or more variables, other than the true variance between these variables (Podsakoff *et al.*, 2003). Evidence for acquiescence response set in the present study's results can be seen by the positive correlation between causation and effectuation processes, and by the positive correlation between questionnaire items 24 and 25, where both items measured affordable loss but one of the items was reverse-scaled.

Reverse coding of scale items was intended as a contingency in anticipation of response set. The basic logic here is that reverse-coded items are like cognitive "speed bumps" that require respondents to engage in more controlled, as opposed to automatic, cognitive processing (Podsakoff *et al.*, 2003).

Furthermore, it is speculated that the measure of firm performance suffered from self-report bias. In general, research participants want to respond in a way that makes them look as good as possible. "Thus, they tend to under-report behaviours deemed inappropriate by researchers or other observers, and they tend to over-report behaviours viewed as appropriate" (Donaldson & Grant-Vallone, 2002, p. 247). Managers' perceptions of their environments also do not always reflect the objective qualities of their markets and industries. Such mismatches may arise from ineffective competitive analyses, poor environmental analyses, cognitive biases or managerial hubris (Zahra & Bogner, 1999)

The problems found with common method variance and response set in the effectuation and causation variables suggest that the measurement items may need refinement. Wiltbank *et al.,* (2009) provide an alternate measure for

effectuation aspects in their study of effectuation in angel investing. Their scale, however, only measures the dimension of prediction and control, as opposed to the operationalisation of effectuation as perceived by Chandler *et al.*, (2011). It is recommended for further research that the instrument for effectuation is revised to mitigate the negative effects of response bias. Podsakoff *et al.*, (2003) make recommendations for controlling common method biases. Donaldson & Grant-Vallone (2002), however, suggest minimum of two data sources are needed to help rule out the validity threats of self-report and mono-method bias.

5.8 Conclusion

This chapter aimed to explain the results of this research and identify where the findings either draw parallels or contrast with the existing literature.

In summary, evidence was found to support hypothesis H1d, that there is a positive association between pre-commitments and firm performance. However, the results pertaining to hypotheses H1a through H1c did not display sufficient significance for the hypotheses to be accepted. Despite the lack of significance positive associations were observed. No evidence was found to support hypothesis H2.

With regard to hypothesis H3, evidence was found to support hypothesis H3a, that there is a significant and positive association between a pioneering TO and firm performance. However, the results pertaining to hypotheses H3b through H3d did not display sufficient significance for the hypotheses to be accepted. The study also found that pioneering, internal source, and R&D spending, were positively associated with firm performance for smaller firms, while external source had a negative association. The opposite was the case for larger firms. These findings are in line with existing literature.

Some evidence was found to support hypothesis H4 - effectuation processes are positively associated with TO. The study observed a significant and moderately positive association between experimentation and pre-commitments and pioneering.

Lastly, the discussion turned to measurement aspects of the model and identified possible causes of the lack of significance that were observed in the analysis.

CHAPTER 6: CONCLUSIONS, IMPLICATIONS AND RECOMMENDATIONS

6.1 Introduction

The final chapter of this study aims to provide an overview of its findings and a summary of the discussion thereof. Some commentary of the managerial implications and recommendations of the study is made. Finally suggestions for further research are made

6.2 Conclusions of the study

Businesses in high-growth, high technology industries face severe competition and operate in dynamic and hostile environments. For businesses based in Africa, the challenge to participate in the global economy of the 21st century will be to compete as world-class businesses where the focus is on high value-added human capital, based on creativity and innovation (Luiz, 2006). In transition economies, such as South Africa, where growth is often the primary goal of organisations, innovation can be particularly critical for firm profitability and survival (Antoncic & Hisrich, 2001). Furthermore, in environments characterised by high uncertainty, the ability of the entrepreneur to predict and control his environment is strained. As the foresight horizon becomes more uncertain, the relationship between prediction and control changes and the appropriateness of a deterministic approach to strategy formation is brought into question (Wiltbank *et al.*, 2006). Effectuation offers an approach to strategy formation that enables the entrepreneur to control his exogenous environment and hence can be particularly critical for firm profitability and survival.

This study sought to establish the levels of effectuation and technology orientation in South African renewable energy firms and their effect on firm performance. After an extensive literature review, hypotheses were formed to the end of investigating each of the research questions proposed in Chapter 1.

Measurement instruments to capture the variables in question were derived from existing research in order to maintain construct validity, to investigate the generalisability of the constructs and to enable comparison to the existing research. Multiple regression analysis was used in order to investigate dependence relationships between the research variables.

In summary, evidence was found to support hypothesis H1d, that there is a positive association between pre-commitments and firm performance. However, the results pertaining to hypotheses H1a through H1c did not display sufficient significance for the hypotheses to be accepted. Despite the lack of significance positive associations were observed. The finding of positive associations between effectuation dimensions and firm performance agree favourably with the findings of Wiltbank *et al.,* (2009) and Real *et al.,* (2009).

No evidence was found to support hypothesis H2. This finding draws parallel with Wiltbank *et al.,* (2009) also found no support for the direct relationship of prediction (i.e. causation) to outcomes in the context of a highly uncertain environment. Wiltbank *et al.* (2009) conjecture uncertainty may undermine the effectiveness of predictive approaches.

With regard to hypothesis H3, evidence was found to support hypothesis H3a, that there is a significant and positive association between a pioneering TO and firm performance. However, the results pertaining to hypotheses H3b through H3d did not display sufficient significance for the hypotheses to be accepted. The study also found that pioneering, internal source, and R&D spending, were positively associated with firm performance for smaller firms, while external source had a negative association. The opposite was the case for larger firms. These findings are in line with existing literature. This finding supports the findings of Zahra (1996b).

Some evidence was found to support hypothesis H4 - effectuation processes are positively associated with TO. The study observed a significant and moderately positive association between experimentation and pre-commitments and pioneering. There is little existing literature which address the dimensions of TO

together with the dimensions of effectuation, however, the support for hypothesis H4 does tie in with the work of Zahra (1996b), Sarasvathy, (2001) and Wiltbank *et al.*, (2009), particularly with reference to the underlying effect of environmental uncertainty.

Lastly, some important considerations regarding measurement aspects of the effectuation construct were raised by this research. Problems encountered were common method variance and response set, leading to a lack of significance in the findings of this study. It is therefore strongly recommended for future research to investigate and refine the measurement instruments of the effectuation and causation, particularly in the context of a developing country.

This study contributes to effectuation literature in several ways: First, it heeds the call of literature (Perry *et al.*, 2011; Chandler *et al.,* 2011; Read *et al.*, 2009) to transfer effectuation from its original field of conceptual research into the realm of empirical research. This study provides valuable insight into the practicalities of the quantitative analysis of effectuation and the problems that arise therein, in particular, issues surrounding measurement aspects.

Secondly, this study tests the associations between effectuation and other dependent and independent variables of TO and firm performance. Acknowledging and examining performance differentials increases the relevance of effectuation theory and expands it from a theory of mere description of entrepreneurial behaviour to a theory that identifies performance-enhancing measures (Brettel, Engelen, & Küpper, 2011).

Thirdly, this study also contributes to establishment of scale validity and reliability in an emerging country context. To date, much of the research on effectuation has been conducted in the United States (e.g. Dew *et al.*, 2009; Chandler *et al.*, 2011; Read *et al.*, 2009; Wiltbank *et al.*, 2009)

6.3 Implications and Recommendations

This study emphasises the challenge and opportunity for firms in emerging economies to adopt technology and act entrepreneurially, which can optimise and maximise developmental efforts. A deep and thorough understanding of effectuation and technology orientation is important not only for academic purposes but also because such an understanding is beneficial for both practitioners and policy makers. Potentially, the study could provide guidance to strategic leaders in high growth, high technology industries regarding the merits of pursuing effectuation and TO strategies.

At the macroeconomic level, one of the most important concerns in policy is the fostering of entrepreneurial activity both in start-ups and existing corporations to spur innovation, productivity, and growth in the economy (Sarasvathy , 2001). In free-market capitalism both job creation and increases in real per capita income have been shown to depend on entrepreneurial activity, particularly in the form of new firm formation (Birch, 1987; Shane, 1995). Moreover, government programmes and incentives could focus on established firms with higher levels of effectuation and TO rather than on potential individual entrepreneurs. Furthermore, effectuation processes allow the economy to experiment with more numbers of new ideas, as at lower cost effectuation processes allow the economy to experiment with more numbers of new ideas at lower cost (Sarasvathy, 2001).

At the level of the firm, both effectuation and TO are central to entrepreneurship, and particularly the essence of Schumpeter's (1934) theory of creative destruction. Both effectuation and TO seek to describe how, in the absence of current markets for future goods and services, these goods and services manage to come into existence, which is arguably the central tenet of entrepreneurship research. An understanding of effectuation and TO is beneficial in new venture creation and in established firms in high-growth, high technology industries, as they relate to the profitability and competitiveness of the firm as well as to the overall economic performance of industry and the economy (Sarasvathy, 2001; Zahra, 1996b; Urban & Barreira, 2009).

6.4 Suggestions for further research

Due to in the intermediate state of effectuation research and the methodology and scope limitations of this study, there are numerous suggestions for future research in the field that emerge from this study. The suggestions which follow are based on problems that were encountered while conducting this study and also the commentary on future research that emerged from the literature review.

Firstly, it is strongly suggested that future research further develops the measurement instrument for effectuation to make it more robust against acquiescence response set and common method variance. This can perhaps be achieved by designing a scenario-based instrument. Furthermore it would be highly beneficial to pursue longitudinal studies and minimise the reliance on self-report measures.

This study restricted the sample frame to one industry in order to control of environmental uncertainty. However, since the role of uncertainty has been found to be critical to the choice between effectuation and causation strategy, it is necessary to expand the sample frame across multiple industries in order to understand the moderating effect of environmental uncertainty on the relationship between effectuation and performance. Furthermore it is suggested that the sample frame is extended to improve generalisability

It is suggested that future research continues to pursue quantitative research in order continue to move the field of effectuation research toward an intermediate state by exploring the relationships between effectuation and established constructs.

In particular, besides uncertainty there are other antecedents to the choice between effectuation and causation that would be of use to investigate. Such proposed antecedents to effectuation are human capital, cognition and heuristics, opportunity recognition and entrepreneurial orientation. Further research is also needed to empirically investigate the moderating effect of expertise and firm size on effectuation.

Moreover, as opposed to investigating effectuation's influence on ultimate performance, it is suggested further research such questions as does the choice between effectuation or causation have an impact on the costs of incubating new ventures and the time taken to get the venture up and running.

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APPENDIX A: ACTUAL RESEARCH INSTRUMENT

No.	Item	Scale
1	How many people (including you) are employed by your firm?	Ordinal
2	In what year was your firm established? - Open-Ended Response	Ratio
3	In what sector is your company involved? - Solar water heating	-
	In what sector is your company involved? - Heat pumps	-
	In what sector is your company involved? - Solar photovoltaic	-
	In what sector is your company involved? - Wind power	-
	In what sector is your company involved? - Hydro power	-
	In what sector is your company involved? - Solar cooking	-
	In what sector is your company involved? - Bio energy	-
	In what sector is your company involved? - Other (please specify)	-
11	What is your company's primary business activity? - Manufacturer	-
	What is your company's primary business activity? - Dealer/Distributor	-
	What is your company's primary business activity? - Contractor	-
	What is your company's primary business activity? - Importer	-
	What is your company's primary business activity? - Research	-
	What is your company's primary business activity? - Utility	-
	What is your company's primary business activity? - Other	-
18	What is your position in the company?	-
19	How many years of experience do you have as an entrepreneur?	Ratio
20	What is your company's approximate annual sales revenue?	Ordinal
21	We experiment with different products and/or business models.	Likert (7pt)
22	The products/services that we now provide are substantially different than we first imagined.	Likert (7pt)
23	We tried a number of different approaches until we found a business model that worked.	Likert (7pt)
24	We were careful with our initial idea not to risk more money than we were willing to lose.	Likert (7pt)

25*	We have taken risks that could have landed the company in real trouble financially if things hadn't worked out.	Likert (7pt)
26	We allow the business to evolve as opportunities emerge.	Likert (7pt)
27	We adapt what we are doing to match the resources we have.	Likert (7pt)
28	We are flexible and take advantage of opportunities as they arise.	Likert (7pt)
29*	Some of our actions have restricted our flexibility and adaptability.	Likert (7pt)
30	We use agreements with customers, suppliers and other organizations and people to manage uncertainty.	Likert (7pt)
31	We use pre-commitments from customers and suppliers as often as possible.	Likert (7pt)
32	We analyse opportunities and select what we think will provide the best returns in the long run.	Likert (7pt)
33	We develop our strategy to take advantage of resources and abilities.	Likert (7pt)
34	We design and plan business strategies.	Likert (7pt)
35	We design and implement measures to make sure we meet our objectives.	Likert (7pt)
36	We research and select target markets and do competitive analysis.	Likert (7pt)
37	We have a clear and consistent vision for where we want to end up.	Likert (7pt)
38	We design and plan production, operations and marketing efforts.	Likert (7pt)
39	The policy of this firm has been to always consider the most up-to-date technology available.	Likert (7pt)
40	We have a long tradition and reputation in our industry of attempting to be first to try out new methods and equipment.	Likert (7pt)
41	We spend more than most firms in our industry on new product development.	Likert (7pt)
42	This firm is usually amongst the first to introduce new products to the market.	Likert (7pt)
43	This company develops its own products internally.	Likert (7pt)
44	This company contracts out a major portion of its R&D activities.	Likert (7pt)
45	This company uses licencing agreements (or similar) extensively to acquire technology.	Likert (7pt)

46	This company holds important patent rights.	Likert (7pt)
47	How many new products (including modification in existing products) has your firm introduced to markets? - Number of new products:	Ratio
48	Please indicate your firm's actual spending on R&D as a percent of sales in 2011.	Ordinal
49	Please indicate your company's sales growth over the past three years.	Ordinal
50	Please indicate your company's market share growth over the past three years.	Ordinal
51	Please indicate your company's net profit after tax as a percent of sales for the past year.	Ordinal
52	How satisfied are you with the company's sales growth?	Likert (7pt)
53	How satisfied are you with the company's market share?	Likert (7pt)
54	How satisfied are you with the company's return on equity?	Likert (7pt)
55	How satisfied are you with the company's net profit margin?	Likert (7pt)

APPENDIX B: DESCRIPTIVE STATISTICS

#	Item	Mean	Standard Deviation
D1	If you are a founding member of this firm, how many years of experience do you have as an entrepreneur?	11.03	10.20
D2	What is your company's approximate annual sales revenue?	3.92	1.99
E1	We experiment with different products and/or business models.	2.23	1.64
E2	The products/services that we now provide are substantially different than we first imagined.	2.93	1.91
E3	We tried a number of different approaches until we found a business model that worked.	2.75	1.79
E4	We were careful with our initial idea not to risk more money than we were willing to lose.	2.75	1.81
E5	We have taken risks that could have landed the company in real trouble financially if things hadn't worked out.	3.85	2.20
E6	We allow the business to evolve as opportunities emerge.	1.92	1.23
E7	We adapt what we are doing to match the resources we have.	2.24	1.52
E8	We are flexible and take advantage of opportunities as they arise.	1.65	1.05
E9	Some of our actions have restricted our flexibility and adaptability.	4.33	1.98
E10	We use agreements with customers, suppliers and other organizations and people to manage uncertainty.	2.56	1.68
E11	We use pre-commitments from customers and suppliers as often as possible.	2.59	1.65
C1	We analyse opportunities and select what we think will provide the best returns in the long run.	1.60	1.13
C2	We develop our strategy to take advantage of resources and abilities.	1.67	1.09
C3	We design and plan business strategies.	1.99	1.30
C4	We design and implement measures to make sure we meet our objectives.	1.89	1.24
C5	We research and select target markets and do competitive analysis.	2.20	1.34
C6	We have a clear and consistent vision for where we want to end up.	1.80	1.28
C7	We design and plan production, operations and marketing efforts.	2.09	1.32
T1	The policy of this firm has been to always consider the most up-to-date technology available.	2.08	1.41
T2	We have a long tradition and reputation in our industry of attempting to be first to try out new methods and equipment.	2.73	1.59

T3	We spend more than most firms in our industry on new product development.	3.44	1.86
T4	This firm is usually amongst the first to introduce new products to the market.	3.48	1.93
T5	This company develops its own products internally.	3.71	2.20
T6	This company contracts out a major portion of its R&D activities.	4.47	2.18
T7	This company uses licencing agreements (or similar) extensively to acquire technology.	3.99	2.21
T8	This company holds important patent rights.	4.57	2.19
T9	How many new products (including modification in existing products) has your firm introduced to markets?	3.20	6.72
T10	Please indicate your firm's actual spending on R&D as a percent of sales in 2011.	2.87	2.16
P1	Please indicate your company's sales growth over the past three years.	4.61	2.45
P2	Please indicate your company's market share growth over the past three years.	3.88	2.44
P3	Please indicate your company's net profit after tax as a percent of sales for the past year.	3.79	2.60
P4	How satisfied are you with the company's sales growth?	3.43	2.11
P5	How satisfied are you with the company's market share?	3.40	2.03
P6	How satisfied are you with the company's return on equity?	3.56	2.07
P7	How satisfied are you with the company's net profit margin?	3.53	2.08

APPENDIX C: MULTIPLE REGRESSION ANALYSES RESULTS

C.1 Results pertaining to hypothesis 1a: There is a significant association between experimentation and firm performance

Table 16: Regression model of experimentation and performance with experience

	Base model		Incl. moderator	
Predictor	**B**	**p**	**B**	**p**
Intercept	4.783	***	4.648	***
T Experimentation	-0.585		-0.419	
T Experience	-0.090		-0.013	
T Experimentation*Exp			-0.100	

R2 base	0.037
ΔR2	0.001
F(2,57) base	1.110
F(3,56) with moderator	0.747

Table 17: Regression model of experimentation and performance with age

	Base model		Incl. moderator	
Predictor	**B**	**p**	**B**	**p**
Intercept	4.462	***	3.831	***
T Experimentation	-0.450		0.250	
Age	0.041		0.212	
T Experimentation*Age			-0.186	

R2 base	0.026
ΔR2	0.057
F(2,68) base	0.894
F(3,67) with moderator	2.000

Table 18: Regression model of experimentation and performance with size

	Base model	Incl. moderator

Predictor	B	p	B	p
Intercept	2.571	*	-0.493	
T Experimentation	-0.496		2.732	
T Size PC	1.541	*	3.751	*
T Experimentation*Size			-2.345	

R2 base	0.100
ΔR2	0.029
F(2,65) base	3.616 *
F(3,64) with moderator	3.156 *

C.2 Results pertaining to hypothesis 1b: There is a significant association between affordable loss and firm performance

Table 19: Regression model of affordable loss 1 and performance with experience

	Base model		Incl. moderator	
Predictor	**B**	**p**	**B**	**p**
Intercept	4.019	***	4.002	***
T Affordable loss 1	0.243		0.266	
T Experience	-0.048		-0.037	
T Affordable loss 1*Exp			-0.015	

R2 base	0.012
ΔR2	0.000
F(2,57) base	0.354
F(3,56) with moderator	0.233

Table 20: Regression model of affordable loss 1 and performance with age

	Base model		Incl. moderator	
Predictor	**B**	**p**	**B**	**p**
Intercept	3.965	***	3.972	***
T Affordable loss 1	0.225		0.215	
Age	0.020		0.017	
T Affordable loss 1*Age			0.003	

R2 base	0.011
ΔR2	0.000
F(2,68) base	0.394
F(3,67) with moderator	0.259

Table 21: Regression model of affordable loss 1 and performance with size

	Base model		Incl. moderator	
Predictor	**B**	**p**	**B**	**p**
Intercept	1.986		2.352	
T Affordable loss 1	0.107		-0.342	
T Size PC	1.589	*	1.320	
T Affordable loss 1*Size			0.322	

R2 base	0.073
ΔR2	0.001
F(2,65) base	2.573
F(3,64) with moderator	1.721

Table 22: Regression model of affordable loss 2 and performance with experience

	Base model		Incl. moderator	
Predictor	**B**	**p**	**B**	**p**
Intercept	4.388	***	4.559	***
Affordable loss 2	-0.037		-0.073	
T Experience	-0.059		-0.154	
Affordable loss 2*Exp			0.021	

R2 base	0.004
ΔR2	0.001
F(2,57) base	0.115
F(3,56) with moderator	0.091

Table 23: Regression model of affordable loss 2 and performance with age

	Base model	Incl. moderator

Predictor	B	p	B	p
Intercept	4.406	***	3.924	***
Affordable loss 2	-0.066		0.055	
Age	0.024		0.146	
Affordable loss 2*Age			-0.031	

R2 base	0.011
ΔR2	0.007
F(2,68) base	0.362
F(3,67) with moderator	0.390

Table 24: Regression model of affordable loss 2 and performance with size

	Base model		Incl. moderator	
Predictor	**B**	**p**	**B**	**p**
Intercept	2.298	*	3.860	
Affordable loss 2	-0.046		-0.432	
T Size PC	1.565	*	0.421	
Affordable loss 2*Size			0.287	

R2 base	0.075
ΔR2	0.009
F(2,65) base	2.645
F(3,64) with moderator	1.974

C.3 Results pertaining to hypothesis 1c: There is a significant association between flexibility and firm performance

Table 25: Regression model of flexibility and performance with experience

	Base model		Incl. moderator	
Predictor	**B**	**p**	**B**	**p**
Intercept	4.383	***	4.337	***
T Flexibility	-0.453		-0.323	
T Experience	-0.007		0.020	
T Flexibility*Exp			-0.067	

R2 base	0.019
ΔR2	0.000
F(2,57) base	0.564
F(3,56) with moderator	0.377

Table 26: Regression model of flexibility and performance with age

	Base model		Incl. moderator	
Predictor	**B**	**p**	**B**	**p**
Intercept	4.234	***	3.815	***
T Flexibility	-0.404		0.254	
Age	0.059		0.188	
T Flexibility*Age			-0.187	

R2 base	0.016
ΔR2	0.013
F(2,68) base	0.539
F(3,67) with moderator	0.654

Table 27: Regression model of flexibility and performance with size

	Base model		Incl. moderator	
Predictor	**B**	**p**	**B**	**p**
Intercept	2.026	*	-0.382	
T Flexibility	-0.612		3.277	
T Size PC	1.887	*	3.637	*
T Flexibility*Size			-2.745	

R2 base	0.105	
ΔR2	0.030	
F(2,65) base	3.833	*
F(3,64) with moderator	3.357	*

C.4 Results pertaining to hypothesis 1d: There is a significant association between pre-commitments and firm performance

Table 28: Regression model of pre-commitments and performance with experience

	Base model		Incl. moderator	
Predictor	**B**	**p**	**B**	**p**
Intercept	4.948	***	4.557	***
T Pre commitments	-0.713	*	-0.247	
T Experience	-0.123		0.065	
T Pre commitments*Exp			-0.244	

R2 base	0.067
ΔR2	0.009
F(2,57) base	2.059
F(3,56) with moderator	1.546

Table 29: Regression model of pre-commitments and performance with age

	Base model		Incl. moderator	
Predictor	**B**	**p**	**B**	**p**
Intercept	4.565	***	3.921	***
T Pre commitments	-0.641	*	0.122	
Age	0.050		0.216	
T Precommitments*Age			-0.191	

R2 base	0.061
ΔR2	0.021
F(2,68) base	2.214
F(3,67) with moderator	2.000

Table 30: Regression model of pre-commitments and performance with size

	Base model		Incl. moderator	
Predictor	**B**	**p**	**B**	**p**
Intercept	2.497	*	2.868	
T Pre commitments	-0.703	*	-1.143	
T Size PC	1.711	*	1.449	

T Precommitments*Size		0.310

R2 base	0.140	
ΔR2	0.001	
F(2,65) base	5.301	**
F(3,64) with moderator	3.508	*

C.5 Results pertaining to hypothesis 1: There is a significant association between firm effectuation and firm performance

Table 31: Regression model of effectuation and performance with experience

	Base model		Incl. moderator	
Predictor	**B**	**p**	**B**	**p**
Intercept	4.973	***	4.556	***
T Effectuation	-0.874		-0.325	
T Experience	-0.068		0.185	
T Effectuation*Exp			-0.337	

R2 base	0.037	
ΔR2	0.005	
F(2,57) base	1.110	
F(3,56) with moderator	0.834	

Table 32: Regression model of effectuation and performance with age

	Base model		Incl. moderator	
Predictor	**B**	**p**	**B**	**p**
Intercept	4.617	***	3.921	***
T Effectuation	-0.726		0.097	
Age	0.058		0.254	
T Effectuation*Age			-0.222	

R2 base	0.029	
ΔR2	0.013	
F(2,68) base	1.032	
F(3,67) with moderator	0.992	

Table 33: Regression model of effectuation and performance with size

	Base model		Incl. moderator	
Predictor	**B**	**p**	**B**	**p**
Intercept	2.631	*	1.056	
T Effectuation	-0.955		0.829	
T Size PC	1.776	*	2.887	
T Effectuation*Size			-1.247	
R2 base	0.120			
ΔR2	0.004			
F(2,65) base	4.425	*		
F(3,64) with moderator	3.025	*		

C.6 Results pertaining to hypothesis 2: There is a significant association between causation processes and firm performance

Table 34: Regression model of causation and performance with experience

	Base model		Incl. moderator	
Predictor	**B**	**p**	**B**	**p**
Intercept	4.648	***	4.489	***
T Causation	-0.453		-0.169	
T Experience	-0.123		-0.041	
T Causation*Exp			-0.159	
R2 base	0.019			
ΔR2	0.002			
F(2,56) base	0.540			
F(3,55) with moderator	0.383			

Table 35: Regression model of causation and performance with size

	Base model		Incl. moderator	
Predictor	**B**	**p**	**B**	**p**

Intercept	2.558	*	1.653
T Causation	-0.520		1.019
T Size PC	1.465		2.081
T Causation*Size			-1.059

R2 base	0.083
ΔR2	0.005
F(2,64) base	2.913
F(3,63) with moderator	2.041

C.7 Results pertaining to hypothesis 3a: There is a significant association between a pioneering TO and firm performance

Table 36: Regression model of pioneering and performance with experience

	Base model		Incl. moderator	
Predictor	**B**	**p**	**B**	**p**
Intercept	5.361	***	4.710	***
Pioneering	-0.334	*	-0.129	
T Experience	-0.112		0.255	
Pioneering*Exp			-0.120	

R2 base	0.090
ΔR2	0.014
F(2,57) base	2.806
F(3,56) with moderator	2.152

Table 37: Regression model of pioneering and performance with size

	Base model		Incl. moderator	
Predictor	**B**	**p**	**B**	**p**
Intercept	3.522	**	0.382	
Pioneering	-0.301	*	0.735	
T Size PC	1.200		3.493	
Pioneering*Size			-0.772	

R2 base	0.144

ΔR2	0.023	
F(2,65) base	5.467	**
F(3,64) with moderator	4.276	**

C.8 Results pertaining to hypothesis 3b: There is a significant association between an internal source TO and firm performance

Table 38: Regression model of internal source and performance with experience

	Base model		Incl. moderator	
Predictor	**B**	**p**	**B**	**p**
Intercept	4.193	***	3.610	***
Internal source	0.005		0.134	
T Experience	-0.050		0.253	
Internal source*Exp			-0.069	

R2 base	0.001	
ΔR2	0.009	
F(2,57) base	0.040	
F(3,56) with moderator	0.201	

Table 39: Regression model of internal source and performance with age

	Base model		Incl. moderator	
Predictor	**B**	**p**	**B**	**p**
Intercept	2.163		-1.834	
Internal source	-0.019		1.095	
T Size PC	1.583		4.493	**
Internal source*Size			-0.838	

R2 base	0.072	
ΔR2	0.053	
F(2,65) base	2.507	
F(3,64) with moderator	3.028	*

Table 40: Regression model of internal source and performance with size

	Base model		Incl. moderator	
Predictor	**B**	**p**	**B**	**p**
Intercept	2.163		-1.834	
Internal source	-0.019		1.095	
T Size PC	1.583		4.493	**
Internal source*Size			-0.838	
R2 base	0.072			
ΔR2	0.053			
F(2,65) base	2.507			
F(3,64) with moderator	3.028	*		

Table 41: Regression model of external source and performance with experience

	Base model		Incl. moderator	
Predictor	**B**	**p**	**B**	**p**
Intercept	4.361	***	3.432	***
External source	-0.039		0.194	
T Experience	-0.034		0.537	
External source*Exp			-0.134	
R2 base	0.003			
ΔR2	0.030			
F(2,57) base	0.095			
F(3,56) with moderator	0.641			

Table 42: Regression model of external source and performance with age

	Base model		Incl. moderator	
Predictor	**B**	**p**	**B**	**p**
Intercept	4.184	***	3.469	***
External source	-0.019		0.146	
Age	0.033		0.224	
External source*Age			-0.043	
R2 base	0.002			
ΔR2	0.011			

F(2,68) base	0.072
F(3,67) with moderator	0.302

Table 43: Regression model of external source and performance with size

	Base model		Incl. moderator	
Predictor	**B**	**p**	**B**	**p**
Intercept	1.942		4.044	
External source	0.013		-0.466	
T Size PC	1.646	*	0.093	
External source*Size			0.355	

R2 base	0.071
ΔR2	0.009
F(2,65) base	2.497
F(3,64) with moderator	1.856

C.9 Results pertaining to hypothesis 3c: There is a significant association between R&D spending and firm performance

Table 44: Regression model of R&D and performance with experience

	Base model		Incl. moderator	
Predictor	**B**	**p**	**B**	**p**
Intercept	4.353	***	3.256	**
R&D	-0.032		0.226	
T Experience	-0.047		0.570	
R&D*Exp			-0.143	

R2 base	0.002
ΔR2	0.026
F(2,57) base	0.068
F(3,56) with moderator	0.540

Table 45: Regression model of R&D and performance with age

	Base model		Incl. moderator	
Predictor	**B**	**p**	**B**	**p**
Intercept	4.447	***	2.102	
R&D	-0.078		0.484	*
Age	0.032		0.665	*
R&D*Age			-0.151	**
R2 base	0.008			
ΔR2	0.097			
F(2,68) base	0.266			
F(3,67) with moderator	2.601			

Table 46: Regression model of R&D and performance with size

	Base model		Incl. moderator	
Predictor	**B**	**p**	**B**	**p**
Intercept	2.103		-0.414	
R&D	-0.015		0.617	
T Size PC	1.616	*	3.493	
R&D*Size			-0.479	
R2 base	0.071			
ΔR2	0.009			
F(2,65) base	2.495			
F(3,64) with moderator	1.875			

Table 47: Regression model of R&D spending and performance with experience

	Base model		Incl. moderator	
Predictor	**B**	**p**	**B**	**p**
Intercept	4.464	***	4.722	***
R&D Spending	-0.112		-0.207	
T Experience	0.001		-0.149	
R&D Spending*Exp			0.050	
R2 base	0.024			
ΔR2	0.006			

F(2,57) base	0.703
F(3,56) with moderator	0.579

Table 48: Regression model of R&D spending and performance with age

	Base model		Incl. moderator	
Predictor	**B**	**p**	**B**	**p**
Intercept	4.350	***	4.796	***
R&D Spending	-0.110		-0.272	
Age	0.054		-0.062	
R&D Spending*Age			0.039	

R2 base	0.027
ΔR2	0.013
F(2,68) base	0.931
F(3,67) with moderator	0.914

Table 49: Regression model of R&D spending and performance with size

	Base model		Incl. moderator	
Predictor	**B**	**p**	**B**	**p**
Intercept	2.167	*	3.943	*
R&D Spending	-0.128		-0.798	
T Size PC	1.795	*	0.485	
R&D Spending*Size			0.487	

R2 base	0.105	
ΔR2	0.028	
F(2,65) base	3.805	*
F(3,64) with moderator	3.265	*

C.10 Results pertaining to hypothesis 3d: There is a significant association between number of new products and firm performance

Table 50: Regression model of no. of products and performance with experience

	Base model		Incl. moderator	
Predictor	**B**	**p**	**B**	**p**
Intercept	3.386	***	3.741	**
T Number of products	0.352		0.043	
T Experience	0.116		-0.046	
T Number of products*Exp			0.140	

R2 base	0.049
ΔR2	0.006
F(2,31) base	0.795
F(3,30) with moderator	0.578

Table 51: Regression model of no. of products and performance with age

	Base model		Incl. moderator	
Predictor	**B**	**p**	**B**	**p**
Intercept	3.259	***	4.528	***
T Number of products	0.450		-0.711	
Age	0.081		-0.247	
T Number of products*Age			0.279	

R2 base	0.090
ΔR2	0.071
F(2,37) base	1.823
F(3,36) with moderator	2.303

Table 52: Regression model of no. of products and performance with size

	Base model		Incl. moderator	
Predictor	**B**	**p**	**B**	**p**
Intercept	0.646		3.554	
T Number of products	-0.052		-2.457	
T Size PC	2.581	*	0.334	

T Number of products*Size	1.765

R2 base	0.163	
ΔR2	0.059	
F(2,34) base	3.312	*
F(3,33) with moderator	3.148	*

C.11 Results pertaining to hypothesis 3: There is a significant association between TO and firm performance

Table 53: Regression model of TO and performance with experience

	Base model		Incl. moderator	
Predictor	**B**	**p**	**B**	**p**
Intercept	5.066	***	4.060	***
TO	-0.223		0.048	
T Experience	-0.056		0.521	
TO*Exp			-0.156	

R2 base	0.033	
ΔR2	0.022	
F(2,57) base	0.984	
F(3,56) with moderator	1.093	

Table 54: Regression model of TO and performance with age

	Base model		Incl. moderator	
Predictor	**B**	**p**	**B**	**p**
Intercept	5.094	***	2.712	*
TO	-0.257		0.406	
Age	0.022		0.646	*
TO*Age			-0.175	*

R2 base	0.046	
ΔR2	0.085	
F(2,68) base	1.656	
F(3,67) with moderator	3.379	*

Table 55: Regression model of TO and performance with size

	Base model		Incl. moderator	
Predictor	**B**	**p**	**B**	**p**
Intercept	3.176	*	-1.201	
TO	-0.200		1.045	
T Size PC	1.323		4.544	
TO*Size			-0.933	

R2 base	0.096	
ΔR2	0.023	
F(2,65) base	3.443	*
F(3,64) with moderator	2.886	*

APPENDIX D: CONSISTENCY MATRIX

Table 56: Consistency matrix

Sub-problem	Literature Review	Hypotheses or Propositions or Research questions	Source of data	Type of data	Analysis
The first sub-problem is to analyse levels of effectuation at the firm level and to establish the relation between effectuation and firm performance	Perry, Chandler, & Markova, (2011); Chandler G. N., DeTienne, McKelvie, & Mumford, (2011); Sarasvathy, (2001); Wiltbank, Dew, Read, & Sarasvathy, (2006); Read, Song, & Smit, (2009); Wiltbank, Read, Dew, & Sarasvathy, (2009)	• **H1:** There is a positive association between effectuation processes and firm performance. ○ **H1a:** There is a positive association between experimentation and firm performance ○ **H1b:** There is a positive association between affordable loss and firm performance ○ **H1c:** There is a positive association between flexibility and firm performance ○ **H1d:** There is a positive association between pre-commitments and firm performance	Questionnaire	Interval	Multiple regression
The second sub-problem is to analyse levels of TO at the firm level and to establish the relation between TO and firm performance	As above; Porter (1980); Ansoff (1965)	• **H2:** There is a negative association between causation processes and firm performance.	Questionnaire	Interval	Multiple regression

Sub-problem	Literature Review	Hypotheses or Propositions or Research questions	Source of data	Type of data	Analysis
The third sub-problem is to establish whether a relationship exists between firms' effectuation and TO.	Zahra, (1996b); Zahra, (1996a); Zahra & Bogner (1999); Zahra & Covin, (1993); Urban & Barreira, (2009); Park & Bae, (2004)	• **H3:** Firms with high TO will exhibit superior performance than firms with low TO. ○ **H3a:** There is a positive association between a pioneering TO and firm performance ○ **H3b:** There is a positive association between an internal source TO and firm performance ○ **H3c:** There is a positive association between R&D spending and firm performance ○ **H3d:** There is a positive association between number of new products and firm performance	Questionnaire	Interval	Correlational analysis and descriptive statistics