Effectual Customer Co-creation in the Fuzzy Front End of New Product Development

by

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ABSTRACT

Increasingly, customer co-creation is advocated as a means to generate valuable knowledge in the innovation process and enhance new product development (NPD) success. In particular, customer co-creation activities are considered to minimize the "fuzziness" of the front end of NPD. However, there is a dearth of research regarding how firms effectively utilize customer co-creation activities in the fuzzy front end (FFE) of NPD. The thesis applies a novel framing using effectuation theory, referring to a logic of entrepreneurial expertise – a dynamic and interactive process of creating new artefacts in the world – to investigate co-creation in the FFE of NPD.

This thesis, firstly, seeks to assess how co-creation activities, in comparison to traditional market research activities, relate to the creativity of the product concept. Secondly, it examines the way effectuation logic strengthens the co-creation-early performance (i.e. FFE) relationship. The inquiry develops a conceptual framework together with hypothesized relationships, around focal constructs. These are as follows; customer co-creation activities, traditional customer facing activities, effectuation, creativity of the product concept, and early performance. The hypotheses are tested vis-à-vis the direct relationship between customer co-creation activities and the creativity of the product concept, and between creativity of the product concept and early performance. The study also compares the effect of customer co-creation activities with traditional customer facing activities. Furthermore, a mediation role of creativity of the product concept is tested, followed by the testing of a moderation and a moderated mediation role of effectuation.

A large scale cross-sectional survey was conducted using UK and US medium and large sized firms with experience of customer co-creation in the FFE of NPD. 205 usable responses were finally prepared for data analysis. The measurement model was carefully assessed by using the PLS-SEM approach, since the conceptual model included

both formative and reflective measures. In testing the hypotheses, PLS-SEM and PROCESS Macro approaches were rigorously applied.

The results, firstly, highlight that the use of customer co-creation activities is positively related to the development of highly creative concepts at the FFE of NPD. Secondly, they demonstrate that effectuation plays an important role when firms use customer co-creation activities by enhancing the creativity of product concept. Its impact also increases early performance when firms develop highly creative product concepts. Additionally, results show that an effectuation approach is particularly beneficial for medium sized firms working on incremental innovation projects.

Based on these empirical results, the thesis theoretically strengthens the customer co-creation paradigm by conceptualizing customer co-creation activities, as well as examining their impact on the creativity of the product concept. Moreover, the thesis contributes to the advancement of knowledge of effectuation by applying it to the FFE of NPD context. Not only enhancing generalizability of effectuation, but the results also highlight the linkage between effectuation and customer co-creation activities.

In practice, this research provides NPD professionals with valuable insights. Specifically, these include: (1) on when to use specific type of customer co-creation activities in the FFE of NPD, (2) the importance on focusing on measuring creativity of the product concept at the FFE of NPD, and (3) the advantages of adopting effectuation logic for firms in developing highly creative concepts during the FFE of NPD.

Finally, the thesis discusses opportunities for future research and the limitations of this study.

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“And we know that in all things God works for the good of those who love him, who have been called according to his purpose” (The Bible, Romans. 8:28)

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Chapter 1 Introduction

1.1 Motivations and Imperatives of the Thesis

Since von Hippel's (1978) introduction of the customer active paradigm, co-creation with customers has received scholarly attention from various business contexts. These include services (Payne, Storbacka & Frow, 2008; Perks, Gruber & Edvardsson, 2012), small and medium sized enterprises (Coviello & Joseph 2012), and business-to-business markets (Noordhoff, Kyriakopoulos, Moorman, Pauwels & Dellaert 2011). Co-creation for innovation, where outcomes are new products or services, has recently come to the fore and is the focus of this research (Al-Zu'bi & Tsinopoulos, 2012; Mahr, Lievens & Blazevic, 2014; Gemser & Perks, 2015). These studies illustrate the growing number of firms that are applying customer co-creation in their innovation process. This is also reflected by the 2010 European Community Innovation Study (CIS), which indicated 27% of firms in the EU collaborate with customers (Eurostat, 2013). This figure has dramatically increased since its 2004 survey results (10%) (Eurostat, 2008; Mahr et al., 2014).

Customer co-creation for innovation occurs when customers and firms co-produce valuable knowledge for the firm's innovation process (Mahr et al., 2014). More specifically, customer co-creation activities can be understood in terms of contribution and selection activity in the New Product Development (NPD) process (O'Hern & Rindfleisch, 2010). Prominent narratives of applying co-creation have flourished in the innovation management field. For example, Dewalt, one of the leading manufacturers of power tools, deeply connects with their community of over 10,000 customers (www.dewaltinsights.com) so that they are able to not only improve their product, but also gather invention submissions from their customers. Furthermore, LEGO encourages

their customers to submit their own designs for new products, as well as allowing the customers to vote and leave feedback on these designs (Milbrath, 2016).

Despite extensive scholarly and professional interest, very little research is dedicated to understanding how firms address the high levels of uncertainty and risk associated with co-creating new products with customers, especially in the context of the Fuzzy Front End (FFE) of NPD. Customer co-creation involves outsourcing critical innovation tasks to the customer to generate and evaluate new product offerings (O'Hern & Rindfleisch, 2010). Studies have suggested that, in doing so, firms must empower customers involved in the process, develop agility and responsiveness, change plans and alter its usual NPD routines and processes (e.g., Hoyer, Chandy, Dorotic, Krafft & Singh, 2010; Fuchs & Schreier, 2011; Coviello & Joseph, 2012).

Specifically focusing on the FFE of NPD, including opportunity identification, idea generation, and concept development, FFE is characterized by high uncertainty where forecasting is elusive and difficult (Eling, Griffin & Langerak, 2014). Even though the FFE literature indicates that customer co-creation would be advantageous in reducing "fuzziness" in NPD (e.g., Alam, 2006), there is surprisingly little research on clarifying the role of customer co-creation in the FFE of NPD. This study addresses this research gap by investigating customer co-creation activities in terms of generation and evaluation activities. In doing so, it presents two research questions and provides insights on developing a higher creative product concept, as well as enhancing early performance via creativity of the product concept.

Next, in the thesis, it is proposed that effectuation theory can provide a valuable and alternative approach to explaining and exploring co-creation management in the FFE of NPD. Effectuation theory has its roots in the Entrepreneurship field and is particularly suitable for contexts where NPD decision-makers face high levels of uncertainty. Effectuation refers to "a logic of entrepreneurial expertise, a dynamic and interactive process of creating new artefacts in the world" (Fisher, 2012: 1024). Effectuation logic

proffers a step-wise agile process that leverages available resources and emphasizes flexibility and adaptation (Saravathy, 2001, 2008). In this research context, effectuation is treated as an organizational construct and is embedded in the routines and structures of a firm. It is viewed as a mind-set or orientation that is company-wide (Brettel, Mauer, Engelen & Küpper, 2012; Werhahn, Mauer, Flatten & Brettel, 2015).

Specifically, effectuation logic is a multi-dimensional construct, including (1) means driven, whereby firms seek to build on existing resources, such as customers or experiences, rather than put effort towards investing in new ones; (2) affordable loss, which involves controlled risk-taking, or mindful trial and error, in collaborating with customers; (3) partnerships, whereby firms develop deliberate engagement with customers; (4) agility, whereby firms easily move across and integrate diverse knowledge bases; and (5) control, whereby firms explicitly reject inevitable trends (Sarasvathy, 2001; Read, Song & Smit, 2009b; Chandler, DeTienne, McKelvie & Mumford, 2011; Brettel et al., 2012; Sarasvathy, Kumar, York & Bhagavatula, 2014).

Co-creation shares theoretical common ground with effectuation based on the notion that effectuation provides the logic for the ”willing to co-create” of expert entrepreneurs through the identification of available means, where firms might get insights about how they can co-create value from effectuation theory (Read & Sarasvathy, 2012). However, researchers are unclear as to the types of capabilities and strategic mind-sets firms need to have when they co-create with customers. The thesis asserts that applying the effectuation lens to co-creation would be one of approaches to help firms effectively perform co-creation activities. This research contributes to the emerging school of thought that examines the nature of underlying capabilities, resources and cultural orientations for co-creation (Coviello & Joseph, 2012; Mahr et al., 2014). To date, this body of research has a very limited empirical foundation. Furthermore, most research thus far has focused on linear, predictable and structured innovation processes based on causation models to explain how organizations manage

co-creation (Hoyer et al., 2010). Yet, the unpredictable and uncertain nature of co-creating with customers seems at odds with the usual innovation approaches that are driven by predetermined goals and rational approaches to problem solving.

1.2 Research Objectives and Research Questions

With the motivations and imperatives for this research as addressed in the previous section, its aim is to investigate the relationship between effectuation and the creativity of product concept, as well as early performance through customer co-creation activities in the FFE of NPD. Therefore, the study seeks to address the following two research questions:

Firstly, how do customer co-creation activities relate to creativity of the product concept, compared to traditional customer facing activities?

Secondly, does effectuation relate to the co-creation-early performance relationship?

1.3 Methodology and Summary of Results

Firstly, the conceptual framework was developed to depict the hypothesized relationships investigated in the research, and contains five focal constructs. These are customer co-creation activities, traditional customer facing activities, effectuation, creativity of product concept, and early performance.

The model tests the positive relationship of customer co-creation activities and creativity of the product concept (H1a) and early performance (H1b). Secondly, the effect of customer co-creation activities is compared with traditional customer facing

activities on the creativity of the product concept (H2a) as well as on early performance (H2b). Thirdly, the model examines the path from creativity of the product concept to early performance (H3). Fourthly, the model is hypothesized to show the mediation effect of creativity of the product concept between customer co-creation activities and early performance (H4). Fifthly, it focuses on the moderation role of effectuation on the relationship between customer co-creation activities and the creativity of the product concept (H5a). Moreover, it examines the indirect effect of customer co-creation activities on early performance mediated by creativity of the product concept and moderated by effectuation (H5b).

Based on the conceptual framework, the research utilized a large scale cross-sectional survey method. Appropriate measures of focal constructs in this research framework were identified and developed by adopting them from prior literature. The final questionnaire was distributed to medium and large sized firms, which had experiences of working with customers, in the UK and the US. After data examination, 205 usable responses were analysed in order to develop the measurement model.

In the data analysis, the measurement model was carefully assessed by PLS-SEM, focusing on verifying validities. In the structural model stage, hypothesized relationships between constructs were investigated. More specifically, detailed steps were involved in (1) obtaining latent variable scores through a hierarchical component model (HCM), (2) obtaining path coefficients of the structural model from PLS-SEM, and (3) verifying further relationships such as mediation, moderation, and moderated mediation through PROCESS Macro. Lastly, PLS-MGA was conducted for the control variables (refer to Figure 4.9).

In summary, in response to the first research question, findings confirm that the use of customer co-creation activities is positively related with developing highly creative concepts at the FFE of NPD. Moreover, responding to the second research question, the results highlight that effectuation plays an important role when firms use customer co-

creation activities by enhancing creativity of the product concept. Additionally, its impact is positively associated with early performance via creativity of the product concept.

1.4 Contributions

This thesis offers contributions and implications for both theory and practice. Firstly, the research challenges the traditional view applied to the FFE of NPD, which follows causation logic such as planning and predicting the future. Also, it asserts that using effectuation logic is appropriate to develop creative product concepts in the FFE of NPD. The empirical results confirm the applicability of effectuation in the FFE, thereby expanding the realm of the theory (Read, Dew, Sarasvathy, Song & Wiltbank, 2009a). Moreover, the research contributes to the linking of effectuation theory with co-creation by providing empirical results (Read & Sarasvathy, 2012; Vargo & Lusch, 2017).

Secondly, the present research sheds light on the customer co-creation paradigm by conceptualizing customer co-creation activities, as well as examining their impact on the creativity of the product concept. More specifically, the thesis characterizes customer co-creation activities in terms of generation and evaluation by incorporating creativity process perspective in the FFE (Eling et al., 2014) and developing measures.

The research also contributes to FFE literature by providing insights on reducing fuzziness in the front end of NPD. After integrating theories of FFE with co-creation activities, the results provide clear answers for finding ways to minimize fuzziness in the front end of NPD by co-creating with customers (Zhang & Doll, 2001; Kim & Wilemon, 2002; Chang, Chen & Wey, 2007). At the same time, the study contributes to NPD and innovation literature by examining the role of key factors in NPD performance.

In practice, this research provides NPD professionals with valuable insights in applying customer co-creation activities. The findings should also highlight how these dimensions operate and relate to specific types of co-creation activities, in terms of customer co-creation generation and evaluation.

Furthermore, the findings will help firms understand how specific dimensions of effectuation can support co-creation effectiveness. Specifically, NPD professionals are encouraged to recognize their competency, resources, and networks before getting involved with NPD projects. Also, NPD professionals should not only develop the agility aspect of effectuation, but they also need to control where their NPD is going, which would enable them to know that their actions will result in the desired outcomes (Sarasvathy et al., 2014). Above all, the research recommends that firms should develop and improve entrepreneurial traits within their NPD teams to maximize their co-creation activities in the FFE.

1.5 Structure of Thesis

The following chapters will proceed as follows. Chapter two elaborates on core areas of the research to elicit the research gaps of the thesis. Firstly, the chapter looks at FFE; specifically, it provides a context for the study and reviews the literature on the fuzzy front end of NPD. In the second section, research streams exploring overall customer value co-creation are presented and then this is narrowed down to focus on the concept of customer co-creation activities in NPD. In the third section, effectuation theory is briefly explained and reviewed, followed by details of the core dimensions of effectuation. Then, the link between effectuation theory and co-creation with the FFE is put forth to explain the relevance of applying the effectuation theory. Finally, the research gaps and research questions are provided at the end of the chapter.

Chapter three provides the conceptual framework and hypotheses to answer the research questions presented in chapter two. The conceptual framework depicts the relationships investigated in the research, and contains five focal constructs. The following section offers hypotheses.

Chapter four justifies the methodological approach that this thesis takes, followed by an explanation of the details of the survey development procedure, such as adapting measures and questionnaire confirmation. Subsequently, the chapter details the data collection process, including survey distribution to the target sample, initial data examination and sample demographics. In the last section, the chapter articulates the data analyses processes in detail to test the research hypotheses.

Chapter five demonstrates data analysis and tests hypotheses. In the first section of the chapter, in assessing the measurement model, validity issues between measures and corresponding indicators are verified. After common method bias is addressed, the second section explains the results from the structural models, whether hypothesized relationships between constructs are supported or not by utilizing various statistical techniques such as the hierarchical component model (HCM), PLS-SEM, PROCESS Macro, and PLS-MGA.

Chapter six discusses and interprets empirical findings, then highlights its contributions to both theory and practice, followed by a deliberation on the limitations and opportunities for future research.

Chapter 2 Literature Review

2.1 Introduction

This chapter reviews the relevant bodies of literature that underpin the thesis. It identifies a gap in the research base and highlights the novelty of this investigation. Whilst there is much interest in the co-creation phenomena, research gaps can be particularly found in the context of fuzzy front end (FFE) of new product development (NPD). Specifically, research is sparse in its application of effectuation theory as a key perspective in FFE performance in NPD, with a few exceptions (Read et al., 2009a). The structure of the literature review is illustrated in Figure 2.1 below.

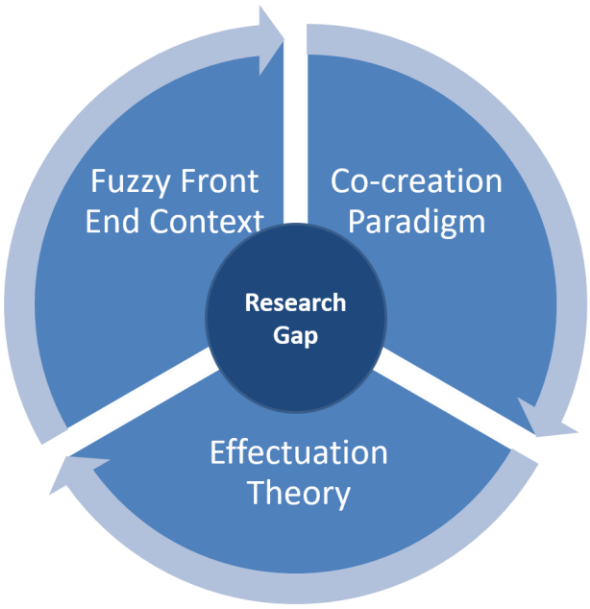


Figure 2.1 Focal Areas of the Thesis

The first section provides a context for the study and reviews the literature on the fuzzy front end of NPD. It is important to understand what is meant by the FFE, its characteristics, and how the FFE has been researched in the Innovation Management field. Specifically, several frameworks that holistically depict the FFE are discussed in this section. Conceptual literature theorizing the FFE is presented, followed by empirical studies, which specifically focus on the factors that increase success and make FFE more effective. How firms can reduce uncertainty around the FFE is reviewed, followed by how empirical research on FFE measures performance. Measuring FFE performance is an emerging, important issue for researchers. Finally, the sub-section of the chapter touches briefly on the traditional customer facing activities applied to FFE, as well as reviews of empirical studies of the FFE dealing with collaboration, which leads to the research gap.

In the second section of this chapter, research streams exploring overall customer value co-creation are presented and then this is narrowed down to focus on the concept of customer co-creation activities in NPD. Firstly, the section draws from the evolution of the co-creation paradigm since its initial discussion of the customer active paradigm (von Hippel, 1978). Particularly, it reviews prior research on co-creation in innovation. Through examining the different perspectives that make up the co-creation paradigm, the author draws key insights representing the co-creation phenomena. Also, customer co-creation activities are characterized and specified, based on prior research. The literature review on co-creation identifies the need for the study to address the research gap in which firm-level factors might leverage customer co-creation activities in the FFE of NPD.

The third section reviews the literature on effectuation theory. In the first sub-section, the concept of effectuation and the research stream developing the theory is briefly explained and reviewed. This is followed by the core dimensions of effectuation. Finally,

the link between effectuation theory and co-creation in FFE is explained to answer the question of why this theory is relevant.

In the last section, the research position is presented with a summary of the structure and the focus of the literature. The gap in the literature is then identified, which this thesis addresses through the research questions.

2.2 The Fuzzy Front End (FFE) of NPD

One of the main focuses of this research is how firms engage and co-create with customers in the FFE of NPD, and the FFE provides the context for the study. In this section, the FFE is defined and this is followed by the evolution of the FFE model. Then the section discusses the issue of performance measurement in the FFE, as well as the empirical research streams on the FFE (in relation to customer engagement). The review on FFE enables the author to conceptualize the context of the study, as well as determine the outcome constructs of FFE. Lastly, research gaps in the FFE in relation to co-creation are identified.

2.2.1 What is the Fuzzy Front End?

Definition of the Front End of the NPD Process

Smith & Reinertsen (1991) were among the first authors to use the term *Fuzzy Front End* in a new product development context, to describe the earliest stage of the NPD process. They emphasized "the start date of team alignment," meaning all time and activities spent before the NPD project has officially begun (Reid & de Brentani, 2004). In particular, Reid & de Brentani (2004) categorize literature defining the FFE into two categories, which can be termed the narrow view and the broad view. The narrow view

of looking at the FFE includes discussions even before the actual NPD project starts. In other words, early FFE includes activities and time spent on exploratory discussions of problems and opportunities for the new product ideas in the organization (March, 1991; Urban & Hauser, 1993; Leifer, McDermott, O'Connor, Peters, Rice & Veryzer, 2000).

Most literature discusses the scope of the FFE as it expands to have new concepts, which is related to the broad view of the FFE, including activities such as idea generation/evaluation, and concept development (e.g., Eling et al., 2014). In line with this, Kim & Wilemon (2002: 270) state, "The period between when an opportunity is first considered and when an idea is judged ready for development". Specifically, Cooper (1996) notes that "up-front homework" including activities that occur before development begins: such as (1) initial screening, (2) market, user, and competitive studies, (3) technical and manufacturing appraisals, and (4) financial analysis. Therefore, in the broad view, the FFE also comprises idea generation and the concept development phases. Later literature defining the FFE specifies activities in the FFE with decision making for evaluating new product ideas/concepts for further development stages (Kijkuit & Van Den Ende, 2007; Florén & Frishammar, 2012; Eling et al., 2014).

Therefore, following the more recent perspective on the FFE, the thesis takes Eling et al. (2014)'s view of the FFE as a dynamic process with each FFE task specified into generation and evaluation phase. The key tasks in the FFE include problem identification, idea generation, and product concept development (Eling et al., 2014).

First, looking into the main tasks in the FFE, in the opportunity identification phase, NPD team members gather all potential problems or opportunities from inside and outside of the organization. Opportunity is defined as "a business or technology gap, that a company or individual realizes, that exists between the current situation and an envisioned future in order to capture competitive advantage, respond to a threat, solve a problem, or ameliorate a difficulty" (Koen, Ajamian, Boyce, Clamen, Fisher, Fountoulakis, Johnson, Puri & Seibert, 2002: 7). In this phase, it is important for firms to

seek and gather as much information as is possible, which motivates and initialises potential ideas for the new product. To do this, NPD members need to embrace the outside world including the market, governments, customers, and economic and technological changes that evolve constantly. Along with the amount of information they gather in this stage, it is also important for firms to know which information would be useful for NPD they are involved in. Amongst the array of external sources, one of the most important is customer knowledge and experience (Cooper, 1996; Alam, 2006).

Second, the idea generation phase of FFE is where ideas for new products are generated, examined, studied, and evaluated from various idea sources and methods (Koen et al., 2002). Direct contact with customers and users, as well as working and collaborating with other functions within the organization and with other companies are part of this phase.

The third phase of FFE is concept development. Activities and decision making in concept development are not only limited to the product specifications and the product's basic physical configuration, but also the extended product offerings, including services after-sale (Krishnan & Ulrich, 2001). A concept has "a well-defined form, including both written and visual description that includes its primary features and customer benefits combined with a broad understanding of the technology needed" (Koen et al., 2002: 7). In other words, in this phase, besides the definition of the product concept, go/kill decision making criteria relate to the specification of a product positioning strategy, and target market definition. In addition, it includes delineation of the product benefits to be delivered, and agreement on essential and desired product features, attributes and specifications (Cooper, 1990). Therefore, it is crucial for gatekeepers to make the decision on whether to go/kill the concept before moving it forward to the development stage (Cooper, 1990; Reid & de Brentani, 2004).

There is a consensus in the literature that the key activities (phases) in the FFE can be narrowed down to three main phases: opportunity/problem identification, idea

generation, and concept development (Koen et al., 2002; Eling et al. 2014). In particular, according to Eling et al. (2014), each stage of the FFE comprises generating phases during opportunity identification, idea generation, and concept development and evaluation (selection) phases after an opportunity has been identified, an idea has been generated, and a concept has been developed. Therefore, the present research follows Eling et al. (2014)'s specification with generation and evaluation phases in each stage of the FFE, because various activities of NPD occur and relate to different types of customer involvement within the FFE context. Various activities in either the generation or selection phase in each FFE stage characterise different types of activities as well as association with firms' capabilities under the FFE context.

Fuzziness of Front End

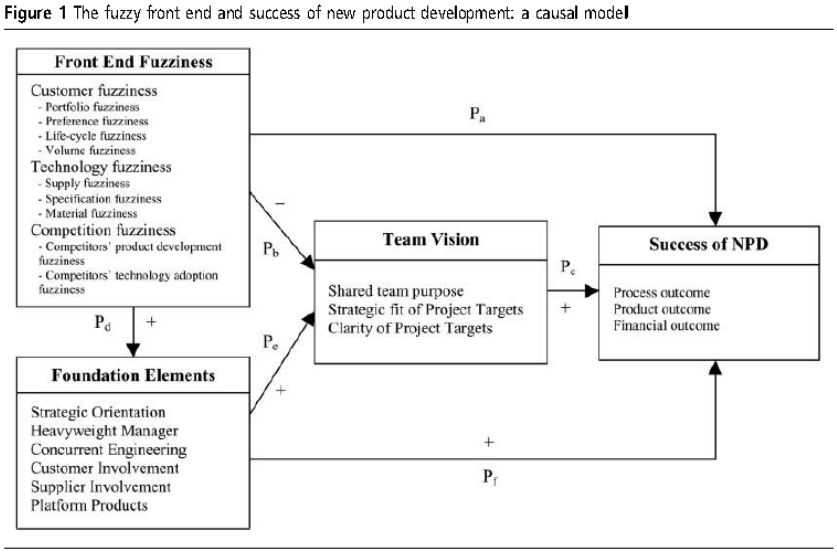
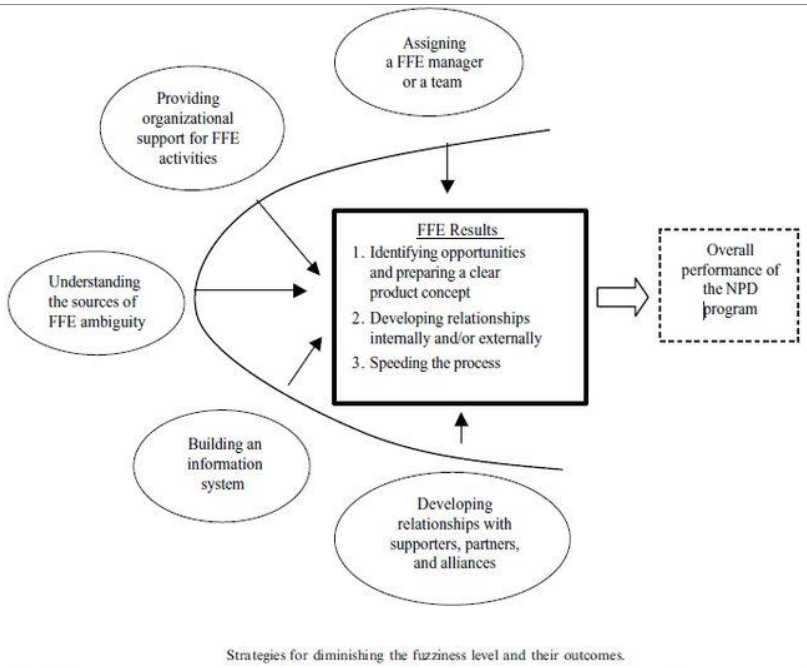
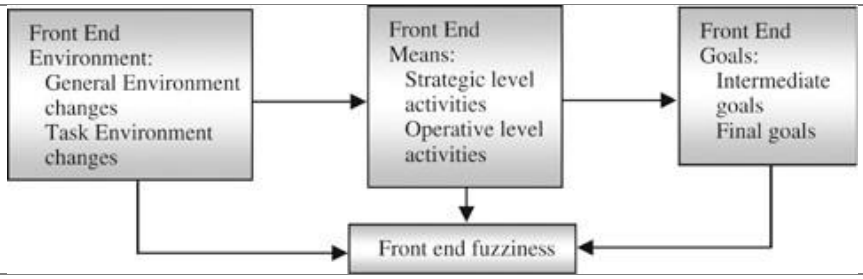
Fuzziness is the concept synonymous with uncertainty that characterizes the FFE (e.g., Zhang & Doll, 2001; Kim & Wilemon, 2002; Alam, 2006; Chang et al., 2007). Specifically, Zhang & Doll (2001: 4) define the fuzziness in the front-end of NPD as the "environmental uncertainty related to market changes, emerging technological developments, and the evolving competitive situation". According to Kim & Wilemon (2002), the development phase begins when the "fuzziness level" of an idea decreases under the certain point of "approval level," where the management decides to commit to the further development of a project. To reach the "approval level," a firm is assured on internal and external situations such as the potential risk, time, and available resources for further development of the project (Kim & Wilemon, 2002).

Fuzziness exists mainly due to lack of information. Zhang & Doll (2001) develop a construct of fuzziness of front end by specifying it in terms of customer, technology, and competition. With the fuzziness model, they propose that the fuzziness in the front end of NPD has negative impact on the success of NPD as well as team vision. However, perceiving the high level of fuzziness motivates a firm to develop a coping method to avoid the fuzziness, therefore, it positively relates to its strategic orientation. Later,

Chang et al. (2007) specify fuzziness with (1) sub-dimensions of uncertainty, which is the lack of information, (2) equivocality, which is the diversity of interpretation, (3) complexity, which refers to the range of difference, and (4) variability, which refers to the rate of change.

Important questions can therefore be raised about how firms can reduce fuzziness in the front end of NPD. A major concern to improve the effectiveness of the FFE is to minimize the uncertainty in the FFE (Moenaert, Meyer, Souder & Deschoolmeester, 1995; Zhang & Doll, 2001; Kim & Wilemon, 2002). For example, Frishammar, Florén, & Wincent (2011) show that reducing uncertainty and equivocality in the FFE results in success from their case study. Their study shows the insight that participants who have proficiency in sense making can reduce equivocality, which is consistent with the notion that early customer involvement might also reduce the fuzziness of the front end of NPD (Alam, 2006). Moreover, Herstatt, Verworn & Nagahira (2004) present their study indicating that German firms, which integrate corporate functions early, also reduce uncertainty during the FFE, while Verworn (2009) shows that Japanese firms are likely to have initial planning during the FFE, which positively impacts NPD success.

Table 2.1 Models Describing Fuzziness of the Front End

Model	Research	Model Figure
The fuzzy front end and success of new product development: a causal model	Zhang & Doll (2001: 98)	
Models for diminishing fuzziness level	Kim & Wilemon (2002: 276)	 Strategies for diminishing the fuzziness level and their outcomes.
A framework for defining 'front-end fuzziness'	Chang, Chen & Wey (2007: 472)	

2.2.2 FFE Models

This section reviews prior literature with a view to explaining and synthesizing different models of the FFE. These models are categorized in terms of two perspectives: (1) FFE as a holistic process with sequential and linear stages vs. a dynamic process (e.g., Cooper, 1988, 1994; Khurana & Rosenthal, 1997, 1998; Koen et al., 2002; Florén & Frishammar, 2012; Eling et al., 2014), and (2) FFE as an information process (e.g., Reid & de Brentani, 2004; de Brentani & Reid, 2012).

FFE as a Holistic Process (Sequential vs Non-Sequential)

Since Cooper (1994) discussed "up-front homework" describing the FFE, the following literature looks at the FFE as a holistic process whilst developing and theorizing it in both incremental and radical innovation contexts (Khurana & Rosenthal, 1997, 1998; Reid & de Brentani, 2004). Specifically, Cooper (1994) describes the FFE as the early part of his model of NPD, known as the Stage-gate® model, which consists of idea generation, preliminary assessment, and concept development, which explains Stage 1, 2, and 3 (Cooper, 1988, 1994). The model is linear and sequential as screened ideas can go forward right after the go/kill decision. At the first gate, NPD starts with idea generation for new products through various sources and activities. Then they are screened through "must" and "should" criteria which could include feasibility and product advantage (Cooper, 1988). The next stage is preliminary assessment, which takes further technical and market assessment with a constrained budget, followed by evaluation with updated information. The next stage is the concept definition, which is the last stage of "predevelopment" of NPD (Cooper, 1988). It is important to define clear concepts through this stage based on a product protocol, which contains an agreement between technical and marketing people on project details such as target market, product concept, positioning strategy, and product requirement and attributes.

Similarly, Khurana & Rosenthal (1998) have offered a stylized model of the front end of NPD, which divided the front-end process into three phases, (1) pre-phase zero:

preliminary opportunity identification, idea generation, market and technology analysis, and product & portfolio strategy, (2) phase zero: product concept, and (3) phase one: feasibility and project planning. According to them, the role of the core team, the project leader, the executive assessment review, and senior management are crucial in determining whether they pledge to the funding and advance to the next step, or decide not to do this (the continue/no-go decision) (Khurana & Rosenthal, 1998).

In contrast, Koen et al. (2002) present a "new concept development" (NCD) model. In the model as shown in Table 2.2, firms control five key elements, which are opportunity identification, opportunity analysis, idea generation and enrichment, idea selection, and concept definition with their engine such as leadership, culture, and strategy. The outer portion depicts the influencing factors such as organizational capabilities, environmental factors, and technologies. With a circular shape, this NCD model suggests that "ideas are expected to flow, circulate, and iterate between and among all the five elements" (Koen et al., 2002: 9). The main advantage of this model lies in the notion that it can shorten the total cycle time of product development whilst allowing the inherent dynamics of ideas in the loop to interrupt the FFE.

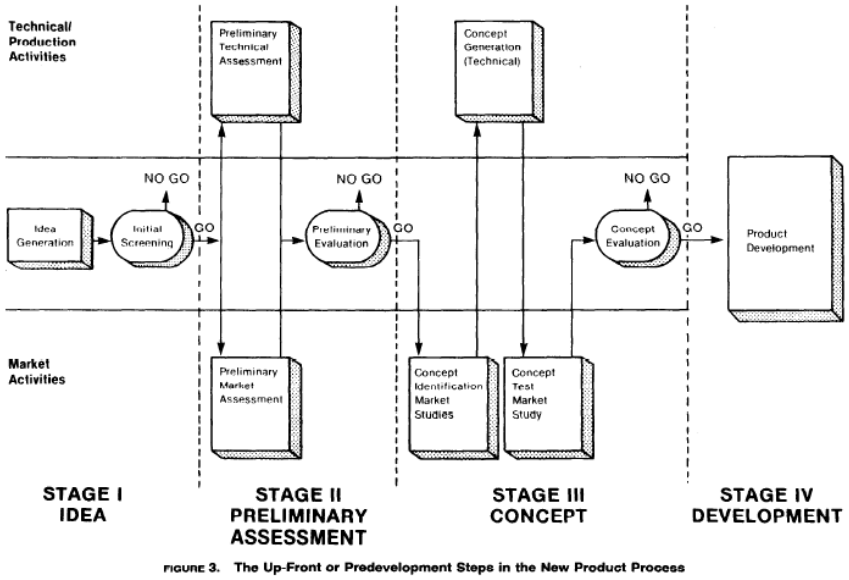
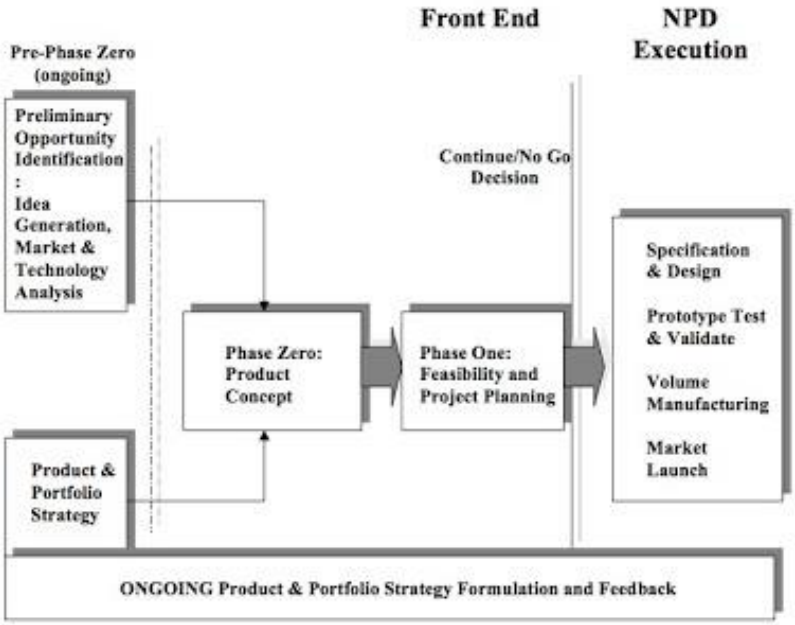
Similarly, Florén & Frishammar (2012) develop a comprehensive framework of front end. More specifically, the "idea" representing a recognized opportunity is transformed into a product concept, which is expected to become a corroborated product definition. The framework explains that ideas and concepts take some interrelated sub-activities, which are refinement and screening. Then the development advances to alignment, where a firm strategically aligns an idea with its internal and external environment, and legitimization, which acknowledges the willingness to draw on organizational commitment. The framework contains some insights: (1) refinement and screening, which are two main activities in the development are interrelated and performed with mutual interaction, and (2) no distinct phase, which indicates that high degrees of formalization are not necessarily adaptable for these front-end projects.

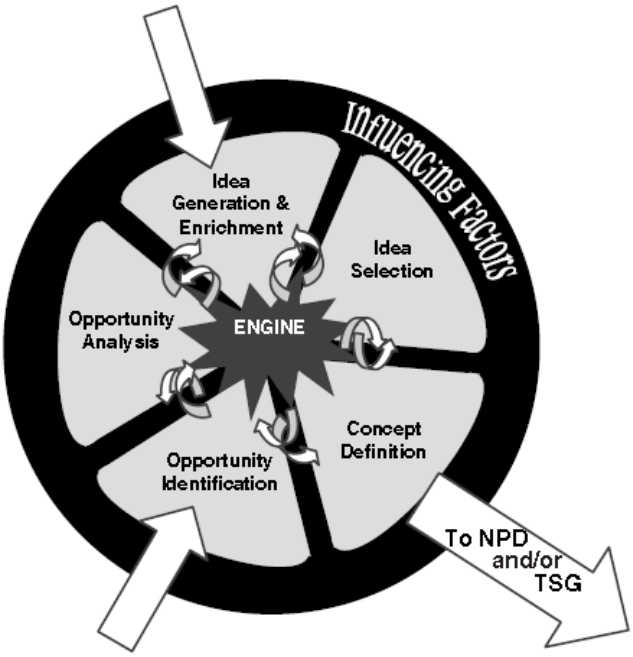
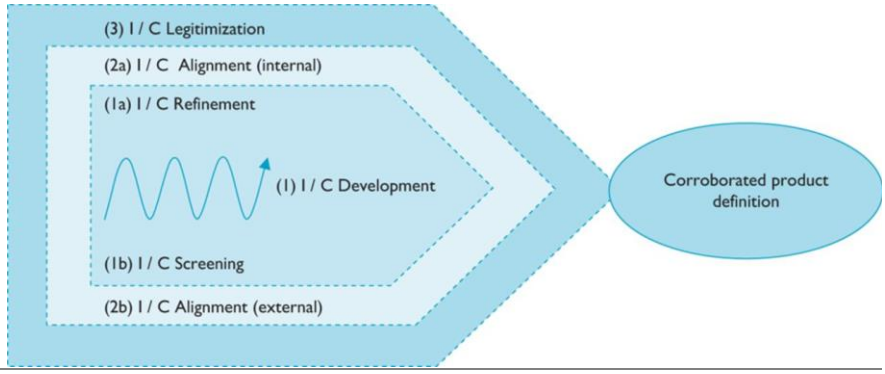
However, the dynamic approach for viewing the FFE is criticized by practitioners with the fact that it is difficult to implement in the real world (Gassmann, Sandmeier & Wecht, 2005). Eling et al. (2014) describe the sequential but dynamic process of FFE with three key activities: opportunity identification, idea generation, and concept development by applying the creativity perspective (Finke, Ward & Smith, 1992; Lubart, 2001). By adopting the creativity perspective, their model distinguishes the main tasks in the FFE. However, their model is open to dynamics within each task during the FFE by specifying each stage in terms of generation and evaluation phases. In other words, a motivated NPD team will "move back and forth between the FFE tasks in a non-sequential manner with several rounds of problem, idea, and concept refinement" (Eling et al., 2014: 958). Therefore, this model eventually, combines the linear and sequential model of the stage-gate model but it allows for dynamics between tasks during the FFE.

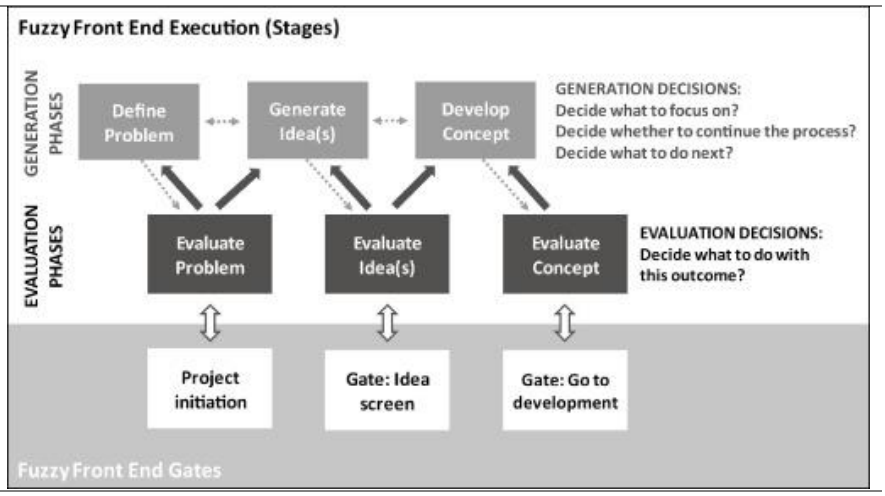
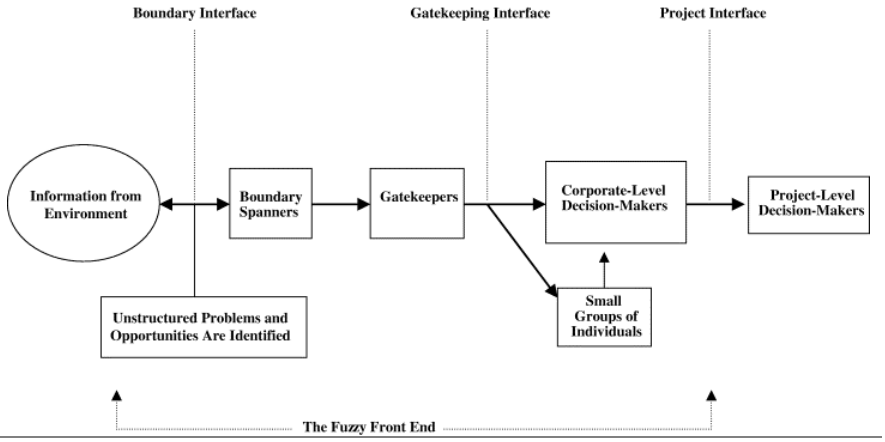
FFE as Information Processing

Some research on FFE shows how firms process information during the front-end of NPD (e.g., Reid & de Brentani, 2004; de Brentani & Reid, 2012). In the radical innovation context, Reid & de Brentani (2004) developed the model of FFE by adopting absorptive capacity (Cohen & Levinthal, 1990). Particularly, in uncertain environments, this model discusses roles and interfaces when encountering the flow of information in the organization during the FFE. In the model, there are three different decision making interfaces, which are the boundary interface, the gatekeeping interface, and the project interface. In the boundary interface, individuals who are called "boundary spanners" encounter information from the environment. Then, in the gatekeeping interface, individuals create a flow of information from the environment into the organization. Next, in the project interface, information in the organization flows into a project team from senior management or the organization. De Brentani & Reid (2012) advance their model by adding propositions about factors that could influence the effectiveness of information flow into a project team during the FFE.

Table 2.2 Theoretical Models of Fuzzy Front End

Model	Research	Model Figure
Linear and Sequential Perspective		
Up front/ predevelopment steps model	Cooper (1988: 243, 1996)	 FIGURE 3. The Up-Front or Predevelopment Steps in the New Product Process
A Stylized Model of the Front End of NPD	Khurana & Rosenthal (1997, 1998: 59)	

Nonsequential and Dynamic Perspective		
New concept development model	Koen et al. (2001: 8)	
Comprehensive framework of the Front End of NPD	Florén & Frishammar (2012: 22)	

Combining Sequential and Dynamic Views		
Model of Fuzzy Front-End Execution Decisions*	Eling, Griffin & Langerak (2014: 958)	
Information Processing View		
Model of Fuzzy Front-End Information Flow and Decision-Making Process: Discontinuous Innovations	Reid & de Brentani (2004: 178); de Brentani & Reid (2012)	

Note: * This research adopts Eling et al. (2014)

2.2.3 Why Is the FFE Important in the NPD?

Based on a comprehensive literature review on FFE, the importance of the FFE is emphasized (e.g., Murphy & Kumar, 1997; Kim & Wilemon, 2002). Specifically, "quality, costs, and timing" need to be determined during the FFE for successful NPD (Verworn, Herstatt & Nagahira, 2008). The lower the effort to optimize these key elements in the FFE, the higher their impacts to improve the whole innovation process (Smith & Reinertsen, 1991; Verganti, 1999). The quality of the new product project and front-end

activities needs to be clearly defined and implemented during the FFE, as they impact subsequent and later stages in the NPD (Cooper 1990; Cooper & Kleinschmidt, 1994).

Next, the importance of the FFE rests on the notion that costs spent in the FFE could play a major role in leveraging the effectiveness of front-end activities (Cooper, 1990). For example, since only 7.1 percent of total expenditures on the new product project is spent on front-end activities (Cooper, 1990), there are opportunities that firms invest in this stage to make a large improvement with relatively lower costs at later stages (Cooper, 1990; Kim & Wilemon, 2001). For example, an error found in a software package during the FFE can be easily corrected compared to one found at a later stage. This may lead to significantly higher expenses associated with the correction of errors to related materials such as manuals and inventories (Thomke & Fujimoto, 2000). Therefore, actions and decision made in the FFE have the highest impact on the outcome of the project (Verganti, 1999; Thomke & Fujimoto, 2000).

The impact of the FFE on the success of NPD has been empirically tested by Verworn (2009). Verworn (2009) argues that early involvement of all functions as well as initial planning contribute to NPD success. Moreover, Markham (2013) provides evidence, which verifies the notion that front-end success is a strong predictor of NPD performance variables. More specifically, he shows that established front-end programs, using a front-end process, resource allocation, and involving champions improve the chance of front-end success. In turn, Florén & Frishammar (2012) state that mistakes and unclear product definition during the FFE may cause high costs and/or great difficulties at later stages of NPD.

2.2.4 Measuring FFE Performance

The previous section leads to the following questions: how can FFE performance be measured? Would it be similar to NPD performance? Even though measuring performance could be similar to NPD performance and stems from it, the present

research considers the specific circumstances of the FFE and that it occurs in the early stages of NPD. Moreover, activities during the FFE are relatively intangible in nature, focusing on generating ideas and developing product concepts, therefore measuring FFE performance needs to consider this aspect.

Before discussing more specific elements of measuring FFE performance, the author reviews early research on the FFE to probe what the main purpose is as a result of the FFE as well as how they measure FFE performance. Firstly, early research on conceptualizing the FFE stresses that the main purpose of the FFE activities should be product definition (Khurana & Rosenthal, 1997; Florén & Frishammar, 2012). Through the predevelopment stages, project definition should be done, that is, identifying user needs and wants, undertaking a detailed technical appraisal about the likelihood of completion, the costs and time to develop, as well as investigating potential legal issues or problems to be faced (Cooper, 1990). Also, at the end of the stage of "concept definition", the purpose is to define the exact product's concept and strategy (Cooper, 1988). A winning concept definition should be competitive so that it is beneficial and valuable to the customer (Cooper, 1988). Even though defining product concept at the end of the FFE is not an easy job to do (Khurana & Rosenthal, 1997), a well-defined concept contributes to the understanding of subsequent development costs, time, market potential, and risk (Kim & Wilemon, 2001). Furthermore, Florén & Frishammar (2012) argue "corroborated product definition" as the main outcome of the FFE, and consider that a well-developed concept represents proxies for envisioning the FFE.

Early empirical literature on investigating the impact of FFE shows several different approaches in measuring a FFE performance. Specifically, these early studies adopt *ex post facto* study, which is also referred to "SAPPHO", to compare one commercial success and one commercial failure as a dependent measure (e.g., Cooper & Kleinschmidt, 1993; Moenaert et al., 1995; Murphy & Kumar, 1997). However, since this approach deals with commercially launched products to link antecedents in the FFE,

realistically it is difficult to link actual impact of the FFE activities to commercial success and failure.

Moreover, other empirical research on the FFE uses NPD performance to link factors in the FFE (e.g., Gruner & Homburg, 2000; Langerak, Hultink & Robben, 2004b; Markham, 2013). Some research uses new product performance measures, including both subjective and objective measures in their study, given that they treat the FFE as one variable in the research framework (e.g., Gruner & Homburg, 2000; Langerak et al., 2004b; Markham, 2013).

In sum, NPD performance in project level work is typically measured by market size and share, revenue, revenue growth, profitability, return on investment (ROI), break-even time, speed to market, development cost, and time to launch (Griffin & Page, 1996; Reid & de Brentani, 2010). However, it is inappropriate to use the most traditional standard measures in the FFE, following O'Connor's (1998) argument that assessments of market potential, size, and growth are not factors during early stages of NPD. Recent research on FFE has tried to develop the appropriate measures for assessing FFE performance based on the consideration of such constraints. In particular, measuring FFE outcomes can be categorized into two parts. One is related to directly assessing outcomes (concepts) of the FFE, such as creativity of concept (Eling et al., 2014), and the other concerns the potential value which the FFE outcome will bring about later, e.g., concept competitive advantage potential (Poskela & Martinsuo, 2009) or ability to attract capital (Reid, Roberts, & Moore, 2015).

Therefore, this thesis considers two main outcome constructs that can be measured at the FFE. One is the "creativity of product concept." The other is named "early performance," which includes the concept competitive advantage potential and the ability to attract capital. The author elaborates these further in the following sub-sections.

Creativity of Product Concepts

Creativity is an important component in the process of co-creation with customers (Roberts, Baker & Walker, 2005). Creativity refers to "the production of novel and useful ideas," indicating a creative idea should be different from what has been done before, but it cannot be just different for the sake of being different (Amabile, 1996). In other words, creativity includes both novelty and meaningfulness as two dimensions (Im & Workman, 2004). Measuring the creativity of the product concept would be a relevant outcome measure for FFE performance, because the main outcome throughout the FFE process of the NPD is a new product concept (Kim & Wilemon, 2002).

One group of research measures the creativity of products as a dependent variable for NPD success (e.g., Moorman, 1995; Im & Workman, 2004; Im, Montoya & Workman, 2013; Eling et al., 2014). While Eling et al. (2014) focus on measuring the creativity of the product concept in the FFE, most research measures the dependent variable as the outcome of NPD (e.g., Im & Workman, 2004; Im et al., 2013). In this research, measuring the creativity of the product concept as a direct outcome of the FFE plays an important role as a link between customer co-creation activities and early performance.

Competitive Advantage Potential and Ability to Attract Capital as FFE Outcome

Another component of FFE performance might measure benefits and value that the developed concepts are able to bring to the firm. Growing research has developed these measures of assessing successful FFE for the firm. For example, Verworn (2009) developed FFE performance measures using two dimensions: efficiency and overall satisfaction, by utilizing last-incident method, which asks about describing the development of the last product brought to the market. Efficiency measures the degree of agreement between financial and personnel resources during the FFE, and overall satisfaction assesses R&D managers' attitude toward their FFE execution (Verworn, 2009). Similarly, Bertels, Kleinschmidt & Koen (2011) adopt the construct of "advantage" and "portfolio" to determine FFE performance.

Moreover, Poskela & Martinsuo (2009) adopt the concept of competitive advantage to measure its potential from the developed concepts. Because the nature of the FFE is quite explorative and intangible, it is reasonable to focus on evaluating concepts which is the core outcome of the FFE (Poskela & Martinsuo, 2009). Furthermore, Reid & de Brentani (2010), in the explorative study, developed the "early performance" construct. Early performance consists of two elements, which are (1) early success with customers and (2) ability to attract capital (Reid & de Brentani, 2010). This follows the idea that customers who are satisfied with the product at first can accept it later (Griffin & Page, 1996), and the importance to interested investors in the prelaunch stage (Zider, 1998), especially for start-ups (Timmons & Spinelli, 2004).

2.2.5 Engaging with Customers in the FFE

Traditional Customer Facing Activities

In this section, traditional customer facing activities such as focus group interviews and surveys are briefly discussed. Above all, these traditional customer facing activities are characterized as "passive" or "unidirectional" (Cui & Wu, 2017). Specifically, these activities discussed in this sub-section are utilized in the empirical part of this thesis and are used in comparison with customer co-creation activities.

One good example of traditional customer facing activities that firms use as a practice of gathering customer input is known as the "Voice of the Customer" (VOC) as a part of quality function deployment (QFD). The VOC refers to "a hierarchical set of *customer needs* where each need (or set of needs) has assigned to it a priority which indicates its importance to the customer" (Griffin & Hauser, 1993: 2, italic added), based on the definition of customer need, "a description of the benefit to be fulfilled by the product or service in the customer's own words" (Griffin & Hauser, 1993: 4). The VOC starts from conducting a focus group interview or a one-on-one interview with customers to identify customer needs. Then firms structure customer needs into a hierarchy,

measured importance, and measured customer perceptions of a developing product (Griffin & Hauser, 1993).

In addition to the VOC, market research techniques and methodologies such as surveys have been widely used to get to know customer needs and wants even in the FFE of NPD context. For example, a survey is a useful tool for getting to know a customer's opinion and insight. However, indeed, the use of structured inquiry could limit the depth and breadth of customer contribution (Nambisan, 2002). Therefore, it would be challenging for firms to select customers who can submit their contribution on new product ideas (von Hippel, 1988).

In sum, with traditional firm-led innovation, customers play a passive role providing their knowledge as a form of traditional market research activities. In the present research context, these activities include surveys, focus group interviews, in-depth interviews, observation, ethnography, and concept testing. In this case, customers rarely suggest new product ideas/concepts.

Collaboration in FFE

Early research on FFE focuses on integration of intra-organization (e.g., Moenaert et al., 1995). For example, Moenaert et al. (1995) discuss integration between R&D and Marketing during development. They argue that communication flows within the organization during the NPD influence innovation success (Moenaert et al., 1995).

Moreover, some literature asserts that market oriented firms are more likely to enhance their NPD performance (Atuahene-Gima, 1995; Langerak, Hultink & Robben, 2004a). Specifically, Langerak et al. (2004a) offer partial support for the impact of market orientation on front-end proficiency. The results suggest that understanding of customer needs and wants is crucial for firms to ensure a clear product definition (Cooper, 1988).

Furthermore, some insightful research on the FFE suggests that early collaboration with customers in NPD is a key strategy for firms to minimize uncertainty (Alam, 2006). Even though the collaborative activities have been utilized in the FFE as discussed in the previous section, these activities have been either unidirectional or reactive to customers' input (e.g., Griffin & Hauser, 1993).

Recently, the realm of collaboration during the FFE goes to the level of co-creation, even though more research needs to be done. Particularly, Bertels et al. (2011) provide valuable insights to facilitate the proficiency of dispersed collaboration to understand tacit knowledge flows within NPD teams. This study sheds light on co-creation activities during the FFE by encouraging NPD practitioners to actively engage with communities to better understand their communication in situations where team members are geographically distant or culturally different (Bertels et al., 2011). This notion is consistent with the theoretical work of Kijkuit & van den Ende (2007), which adopted a social network perspective in the front-end process. They suggest that sufficient prior related knowledge between members of the network lead to the successful generation and development of ideas with mutual understanding (Kijkuit & van den Ende, 2007).

In line with this, some scholars investigate the FFE process with an open innovation perspective (e.g., Gassmann et al., 2005; Brunswicker & Hutschek, 2010). In particular, Gassmann et al. (2005) argue that successful integration of customer knowledge results from applying explorative probe-and-learn procedure, which enables cycles of learning from customers' feedback, which lead to subsequent FFE modification resulting from what firms learn. Moreover, Brunswicker & Hutschek (2010) present an open innovation and external search perspective presenting the framework of how firms systematically operate the FFE. They argue that a systematic and interactive search process enables innovation managers to find appropriate experts from other industries for their effective and efficient ideation (Brunswicker & Hutschek, 2010).

Even though this prior literature opens the discussion on the FFE in conjunction with the co-creation phenomenon, it is questionable whether this eventually leads to the notion that it is important for firms to interact outside of the company, including with customers in the FFE of NPD. Specifically, empirical research is rare with regards to focus on co-creation in the FFE despite the recent call for research (Hoyer et al., 2010; Coviello & Joseph, 2012). In the next section, the author elaborates more on the co-creation paradigm to narrow down the research gap, which is the focus of the present research.

2.3 Customer Co-creation

The aim of this section is to focus on the conceptualization of customer co-creation activities applicable to this research. First, the author discusses the research streams of the co-creation paradigm in terms of its characteristics, followed by conceptualization and characterization of customer co-creation activities. Finally, the author will define and develop the customer co-creation activities construct for this research.

2.3.1 Co-creation Paradigm: Toward Developing the Value Co-creation Concept

Embracing the customer into the firm is the core issue that the marketing discipline deals with. Marketing scholars enthusiastically and continuously have done research on the issue of how firms integrate and synthesize customer input for successful performance. Specifically, the concept of customer orientation/market orientation provides firms with insights of how to process information accumulated from customers (e.g., Kohli & Jaworski, 1990; Narver & Slater, 1990; Deshpandé, Farley & Webster, 1993). Later, the concept of marketing evolves to not only firms adding value from customers, but also customers' benefits from their contributions to firms' business, which conceptualizes "value co-creation" (Vargo & Lusch, 2008; AMA, 2013).

The purpose of firms and customers in the co-creation of value is to contribute to firms by highlighting the customer's perspective and to improve the early process of identifying customer's needs and wants (Lusch & Vargo, 2006; Payne et al., 2008). Customer value is defined as an "interactive relativistic preference experience" (Holbrook, 1996), i.e., "the argument is that experience defines what is valuable to a customer," (Payne et al., 2008: 84). That is, "value co-creation takes place through mutually beneficial interactions among actors within business ecosystems" (Kohtamäki & Rajala, 2016: 4).

However, pursuing value creation with customers is not limited to being discussed in the marketing discipline but also the innovation management discipline. Given the overall concept of co-creation lies in creating value by collaboration among all participants in the process, the value is realized as the process goes on, which can be differentiated in terms of production and consumption. While the marketing discipline delves into co-creation on the consumption side (which later is conceptualized as value-in-use [Ranjan & Read, 2014]), the innovation discipline focuses more on the production side of co-creation (Gemser & Perks, 2015).

The following discussion summarizes the core research conceptualizing co-creation. Then the discussion moves on to conceptualizing the production side of co-creation, which is the locus of the present research.

DART Model

Converging the discussion of co-creation from the marketing and innovation disciplines, the concept of co-creation is developed and suggested by scholars in terms of its characteristics evolved from the market orientation perspective. Above all, actively working with customers provides important insights from the two-sided interactions, while listening to customers provides passive feedback that is only from one-sided activity (Prahalad & Ramaswamy, 2004). Prahalad & Ramaswamy (2000, 2004) suggest

that the DART model explains the value co-creation of the company-customer interaction with four building blocks: dialogue, access, risk assessment, and transparency. Firstly, dialogue implies shared learning and communication between two equal problem solvers, because it includes interactivity, engagement, and a propensity to act (Prahalad & Ramaswamy, 2004). Secondly, access starts with information and tools. Customers are able to effectively participate in a company's business. Thirdly, customers might not want to actively participate in the firm's NPD when they think there is high risk in doing so. Therefore, companies should disclose all the information to their customers before they work together. Lastly, firms need to be transparent to their customers throughout their business as their customers get more accessible to information and knowledge that firms share. A combination of these four building blocks enable firms to create and transform value, embedded in customer's personalized experience into theirs.

Value Co-creation from Service Dominant Logic

Vargo & Lusch (2004, 2008) put forward the notion of service-dominant logic (S-D logic). S-D logic has been widely applied to explain the co-creation phenomena. S-D logic refers to the overarching mind-set of a unified understanding of the purpose and the nature of organizations and their ecosystems. Fundamental propositions offer the insight, which is the basis on which to build the value co-creation concept, that is: "the customer is always the co-creator of value" (Vargo & Lusch, 2006: 7). Through this fundamental premise, it is noticeable that the customer is the core actor in creating value for both the firm and customer themselves. In particular, the nature of service, which is characterized as being activities and interaction, enables customers not only to participate, but also to collaborate the whole process of service; they thereby obtain value from the opportunity of co-creation which is a desirable goal from the customer's point of view (Payne et al., 2008; Vargo & Lusch, 2008; Perks et al., 2012). Furthermore, applying key insights of S-D logic regarding customer, marketing, and knowledge, Payne

et al. (2008) discuss the value co-creation process. The process elaborates the roles of suppliers and customers by showing how they collaborate to create value and highlights the importance of core competencies.

In sum, experience is the crucial element to construct value co-creation (Kohtamäki & Rajala, 2016). When the value is derived through interaction with the firm and its offerings, customers assess and determine the value throughout their mental process, which relates to customer's value co-creation process (Payne et al., 2008; Ranjan & Read, 2014).

Constructing Value Co-creation

Another critical aspect of value co-creation lies in the phrase "working with the customer," which relates to collaboration in the new product/service development process. Initially, Vargo & Lusch (2004: 10) present their fundamental premise 6 (FP6) in the S-D logic as the "customer is always the coproducer". This approach shows the similarity of concept between co-production and co-creation. However, later Vargo & Lusch (2008) refine their FP6 to the customer is always a co-creator of value. The main reason they refine FP6 is that they argue that the use of the term "production" is not appropriately fitted under the S-D logic (Payne et al., 2008). Then Lusch & Vargo (2006) describe coproduction and value co-creation as two separate constructs by acknowledging that the two are linked as "nested concepts with the co-production being a subordinate concept to that of co-creation of value." One criterion distinguishing these two is that co-production relates to "productivity" of customer while value co-creation deals with "consumption" act, which can be an inclusive concept (Lusch & Vargo, 2006; Etgar, 2007). Another point can be made to separate co-production and value co-creation lies in the notion that "production is generation of potential value, whereas usage is generation of real value" (Grönroos, 2011: 283). Furthermore, Ranjan & Read (2014) determine the concept of value co-creation as a

super-ordinated one on co-production and value-in-use. In other words, co-production and value-in-use are key dimensions constructing the concept of value co-creation.

Therefore, the use of co-production under the co-creation paradigm still makes sense in that actors are involved and participate throughout the co-production process, which results in potential value rather than realized value. In other words, "whereas value propositions may be coproduced by actors, the outcome is that the realized value is co-created by the actors." (Kohtamäki & Rajala, 2016: 6). In line with this, the author adapts the concept of co-creation in the context of NPD and innovation process, which could be mainly overlapped with the concept of co-production, as one dimension of value co-creation (Lusch & Vargo, 2006; Ranjan & Read, 2014).

2.3.2 Conceptualization of Customer Co-creation in NPD

Co-creation in NPD is closely related to the concept of "co-production[1]" (Ranjan & Read, 2014). Particularly, in the first part of this section, the author elaborates the conceptualization of co-creation in NPD/innovation literature. Specifically, recent research in NPD/innovation discipline defines customer co-creation as "a collaborative NPD activity in which customers actively contribute and/or select the content of a new product offering" (O'Hern & Rindfleisch 2010: 86). Therefore, following O'Hern & Rindfleisch (2010) and Greer & Lei (2012), the thesis defines customer co-creation activity as a *"collaborative activity with customers in generating and evaluating creative new products"*[2].

[1] From this point on, the author uses "co-creation" in NPD/innovation

[2] This is also aligned with the notion of customer co-development, referred to as "actively involving customers in the development of new products," (Candi, van den Ende & Gemser, 2016: 418) with the customer centricity perspective (O'Hern & Rindfleisch, 2010).

2.3.3 Two Main Research Streams of Customer Co-creation

In this section, the author details two main schools of co-creation literature in the NPD/innovation context. Throughout the literature review of co-creation, the important aspects to construct customer co-creation is to have customers be (1) "active" and (2) "collaborative" to create/innovate valuable things throughout firms' NPD/Innovation process (Cui & Wu, 2017). "Activeness" of participants emphasizes on motivations of participants in the process as well as identification of "appropriate" partners for their process. "Collaboration" hinges on the *bidirectional* relationship within the process.

The author elaborates two schools of customer co-creation based on literature review. The first is the user innovation school of research, focusing on the "activeness" aspect of co-creation, and the second is firm-driven customer relationship management school of research, focusing on "bidirectional collaboration" with the customer. Discussing these two perspectives on co-creation in NPD/innovation leads to (1) the way to construct the co-creation activities construct in this research, and (2) draws a research gap to find out the core factor(s) which the firm might need to possess.

Stimulating "Activeness" of User: Co-creation with User Innovation Perspective

First of all, the user innovation perspective focuses more on "activeness" of user in co-creation. Ever since von Hippel (1978) presented the customer active paradigm (CAP) as opposed to manufacturer active paradigm (MAP), the user innovation school of research has been focusing on resolving questions such as (1) "who is innovating?" (2) "how do we identify and characterize the innovators?", and (3) "how to access innovation residing in customers?" (Gemser & Perks, 2015).

In particular, some scholars seek to identify appropriate customer co-creators for successful NPD (Gemser & Perks, 2015). Research applying the lead user perspective brings another insight on the co-creation paradigm (von Hippel, 2005). By definition, lead users are individuals or firms that (1) can encounter needs even before a product

becomes popular in the marketplace, and (2) are positioned to benefit significantly by obtaining a solution to those needs (von Hippel, 1988). Based on the user innovation perspective, it is important for firms to find their lead users, which would result in the creation of commercially attractive products from their knowledge and information (Franke, von Hippel & Schreier, 2006). Lead users innovate because they have needs that are not met with current products (von Hippel, 2005). Further, they are able to develop novel solutions in advance, which eventually result in developing commercially attractive products (e.g., Morrison, Roberts & von Hippel, 2000; Lüthje, 2004; Lüthje, Herstatt & von Hippel, 2005). For example, product concepts developed by lead user at 3M showed eight times higher sales potential than traditionally developed concepts (Lilien, Morrison, Searls, Sonnack & von Hippel, 2002). Similarly, Poetz & Schreier (2012) provide insightful findings that show that new product ideas generated by users are better in terms of novelty and customer benefit compared to ones generated by professionals.

Research also expands the user innovation perspective to answer the question of, how ordinary users/customers with relatively less product knowledge influence NPD (e.g., Kristensson, Gustafsson & Archer 2004; Magnusson, 2009). In particular, Kristensson et al. (2004) investigated who contributes more creative ideas for future mobile phone services among advanced users, ordinary users and professional product developers. Their results suggest that ordinary users create more original and valuable ideas, whereas professional developers and advanced users create more easily realizable ideas (Kristensson et al., 2004).

Secondly, the user innovation perspective concerns the generation and dynamics of the community and its impact on innovation. For firms, their effort to recognize customers' unmet needs can be found not just by working with individual lead users, but also engaging in user communities. Prior research has provided benefits from user communities regardless of who takes the initiative to develop them first. Specifically,

within the user community, a series of experiments and trial-and-error learning take place by members, which leads to the narrowing down and developing of more feasible versions of new product concepts (Mahr & Lievens, 2012). Within the user community, members actively engage community activities as well as freely sharing their knowledge, therefore these interactions form collective knowledge in the community (Mahr & Lievens, 2012).

Thirdly, as important as the community is, from the firm's point of view, firms need to enhance the accessibility for users to get involved in the NPD process. Prior research in user innovation touches on the toolkit as the key solution for resolving this issue (von Hippel, 2001). The problem could be easily solved by adopting user toolkits for innovation. Rapid technology advancement enables firms to set up easy to use toolkits for getting users involved in their problems (e.g., Franke & Piller, 2004; Jeppesen, 2005). For the effective knowledge transfer and communication, firms need to perfectly interpret customers' solutions into their professional language, which enables ordinary customers to easily input their thoughts into the toolkit (von Hippel & Katz, 2002). Therefore, users can utilize toolkits to input their solutions as well as do trial-and-error experiments on a given set of product options (Piller, Ihl & Vossen, 2010).

The research on toolkits has dealt with not only the issue of how toolkits work but has been researched in the context of mass customization (e.g., Thomke & von Hippel, 2002; Jeppesen & Molin, 2003; Franke, Keinz & Schreier, 2008), and also how firms utilize it as a form of co-creation (Jeppesen, 2005). Specifically, Jeppesen (2005) argues that the use of toolkits is an even stronger form of customer interaction during NPD by enabling customers to access essential information in the user domain, which leaves them to carry out their input.

In sum, the leading to areas for future research, firstly, user innovation literature has not much focused on "creating sustainable producer firm-user interaction" (Hienerth, Lettl & Keinz, 2014: 848), even though the toolkit approach facilitates firm-user

interaction within constrained solution spaces (Ogawa & Piller, 2006). Furthermore, the lead user approach is high risk in finding and verifying appropriate users/participants for their successful NPD, which leaves the question of how firms manage these risks (Hienerth et al., 2014). Therefore, the present research synthesized co-creation activities which the user innovation literature investigated with case studies, and linking them with firm specific factors to see how firms are able to leverage these activities in the FFE of NPD.

Maximizing "Collaboration": Firm-driven Strategy with Customer Co-creation

Next, there is research that focuses on the "collaboration" aspect of co-creation, trying to focus on issues like (1) "how to help customers innovate?", (2) "the development of the customer co-creation construct", and (3) "costs of customer co-creation" as a down side of co-creation (Gemser & Perks, 2015). Particularly, in this research, terminologies such as "customer interaction," "customer involvement" or "customer participation" are interchangeably used to define the bidirectional collaboration between the firm and the customer in the NPD context. Considering that the main objective of customer co-creation is to utilize the information and capabilities of customers and users for the innovation process, this research views customer co-creation as a firm-driven strategy and application of customer centric management (O'Hern & Rindfleisch, 2010; Piller et al., 2010). This area of research specifically looks at the question of how firms manage and leverage situations where customers are involved in the NPD process. Above all, the outcome of the "collaboration" should be creative to determine co-creation at the end of the NPD process.

On the one hand, the "relationship" aspect of collaboration also has been investigated through customer co-creation phenomena (e.g., Gruner & Homburg, 2000; Alam, 2006; Fang, 2008; Cui & Wu, 2017). Gruner & Homburg (2000) investigate the impact of the intensity of customer interaction on each NPD stage, which refers to the degree to which customers exchange their knowledge and cooperate with firms during NPD.

Similarly, Sawhney, Verona & Prandelli (2005) enrich the co-creation concept by characterizing the interaction between a firm and customers in terms of direction, intensity and richness. The advance of internet technology helps the interaction to have a continuous dialogue, to be more intense, and to share experiential knowledge between both parties (the firm and the customer). Further, Sawhney et al. (2005) argue that the size and scope of the participants increase due to firm's ability to get a mediated third party or communities which is able to reach out potential customers.

Moreover, customer participation is defined as the degree to which the customer is involved in producing and delivering products and services (Dabholkar, 1990; Fang, 2008; Chang & Taylor, 2016; Cui & Wu, 2017). Specifically, Fang (2008) specifies that customers are categorized in terms of their role, which is either (1) an information source, or (2) co-developers (Fang, 2008; Cui & Wu, 2017). In this context, customers as co-developers are referred to as taking part in the NPD working closely with NPD practitioners, which overlaps with the concept of customer co-creation. Customers as co-developers can have "continuous" interaction with NPD employees, meaning that they mutually communicate with NPD practitioners throughout the NPD process (Cui & Wu, 2017). Most recently, Chang & Taylor (2016) show their meta-analysis results, which reveal that customers' participation in the ideation and launch stages of NPD improves new product financial performance directly as well as indirectly through acceleration of time to market.

Furthermore, prior research that explores the impact of the intensity of co-creation with innovation performance draws on further questions on how to decompose the intensity of co-creation. Hoyer et al. (2010) define customer co-creation with dimensions in terms of the degree and the scope of co-creation. In their conceptual framework of co-creation, the degree of co-creation includes both the scope of activities as well as their intensity. The scope of co-creation refers to firm's inclination to collaborate with customers across all stages of the NPD process, while the intensity of co-creation

involves the extent to which firms rely on co-creation to develop products within a certain stage of NPD (Hoyer et al., 2010). In line with this, Mahr et al. (2014: 599) take a knowledge management perspective and define customer co-creation as "customers coproduce knowledge that is valuable for the firm's innovation process". Their conceptualization of co-creation focused on resulted value throughout co-creation activities rather than measuring actual customer co-creation activities.

The decomposition of co-creation is not limited to drawing the degree and scope of customer co-creation activities during NPD process, but probing in detail the nature of co-creation. The key nature of customer co-creation is the locus of control that how much firms allow customers to participate/contribute the NPD process (O'Hern & Rindfleisch, 2010). Fuchs & Schreier (2011: 17) define "empowerment" as a strategy "companies that allow customers to create (ideas for) new product designs or to decide which products should be produced". Along with this, O'Hern & Rindfleisch (2010) specify customer co-creation in terms of "contribution" and "selection" considering these are key phases in the co-creation process. Recently, Ranjan & Read (2014) suggest a definition of "co-production[3]" with three different dimensions. Co-production, also as a dimension of overarching construct of value co-creation, can be understood as sharing of customers' knowledge, input, ideas throughout their interaction with firms when firms are willing to allow/control these interactive activities with customers in the NPD process (Ranjan & Read, 2014). Specifically, "equity" dimension of co-creation captures the notion that "firm's willingness to share control in favour of consumer empowerment" (Ranjan & Read, 2014: 292).

Therefore, this research stream draws attention to looking at the issue that relates to, from firm's side, the degree of which firm control over customers' involvement in their innovation process (e.g., Hoyer et al., 2010; O'Hern & Rindfleisch, 2010). Even though

[3] Co-creation

little research on this firm's perspective discusses the downside of co-creation, recently, Hoyer et al. (2010) deal with the costs of co-creation as a moderator impacting co-creation, along with firm-level impediments such as sharing of intellectual property and information overload. Later, following Hoyer et al. (2010), Mahr et al. (2014) suggest the "value of customer co-created knowledge" includes a "cost" dimension in the construct that firms pay the costs of their knowledge created by customers. These costs include firms' efforts to identify appropriate customers as well as knowledge transfer with customers during co-creation (Hoyer et al. 2010; Mahr et al., 2014).

In conclusion, the firm-driven strategic perspective of research on co-creation contributes to developing the co-creation construct as a multi-dimensional construct, and then applying it to empirical research to assess its impact on innovation performance. Even though this empirical research of co-creation sheds light on co-creation in innovation, little research has shown either (1) what kind of customer co-creation activities impact the firm's NPD process (not just measuring the degree of customer co-creation during NPD) or (2) specifying firm specific factors which stimulate its impact. This might be because this prior research mainly focuses on developing he co-creation construct, then verifying its relationship with other factors. Therefore, it is meaningful for the present research to see whether a firm's competence/mind-set contributes to leveraging customer co-creation for developing new product concepts with potential competitiveness and high creativity.

2.3.4 Customer Co-creation in NPD in the FFE

Specifically, this section elaborates on specific co-creation activities from the previous literature in terms of generation or evaluation activities. These are well summarised in Table 2.3. Based on the definition of customer co-creation activities as joint collaboration of NPD working with active customers, these customer co-creation activities include idea contest, idea rating/voting, crowdsourcing, communities,

workshops, creative problem solving techniques, discussion forums, toolkits, and lead user meetings.

Decomposing Customer Co-creation in NPD

As discussed, this research follows the notion that customer co-creation is a multidimensional construct, characterized by a generation and evaluation phase in each task of FFE (O'Hern & Rindfleisch, 2010; Eling et al., 2014). The way of characterizing customer co-creation in terms of the generation and evaluation phase is gaining consensus in the literature (e.g., O'Hern & Rindfleisch, 2010; Piller et al., 2010; Fuchs & Schreier, 2011; Eling et al., 2014). Given that firms have controls over co-creation activities throughout the NPD process, they want to leverage customer-generated value. Then the important criteria for firms to distinguish innovation tasks would be what roles customers play in the NPD process (Fuchs & Schreier, 2011; Gemser & Perks, 2015). That is, customers' behaviours and thought processes would be different when they generate ideas/knowledge from when they select/evaluate ideas/concepts in the NPD process (Ward, 2001).

Some research has applied this approach to characterize customer co-creation. Firstly, O'Hern & Rindfleisch (2010) provide a conceptual typology of customer co-creation with respect to contribution and selection. Considering contribution as one continuum, it ranges from control to empowerment as a low (fixed) degree of contribution to a high degree of contribution (open). On the other dimension, selection of NPD contribution is dichotomized as firm-led versus customer-led selection. With these two dimensions, they suggest four types of co-creation, collaborating (open and customer-led), tinkering (open and firm-led), co-designing (fixed and customer-led), and submitting (fixed and firm-led) (O'Hern & Rindfleisch, 2010). Similarly, Piller et al. (2010) suggest three characteristics forming the conceptual dimensions of typology of customer co-creation, which consist of (1) the degree of freedom, (2) the degree of collaboration, and (3) the progress of the NPD process, respectively. The degree of freedom of the task means the

nature of the task assigned to customers (i.e. narrow and predestined vs. open and creative task), while the degree of collaboration refers to the structure of the underlying relationships in customer co-creation (i.e. one to one dyadic collaboration vs. networks of customers). These two criteria offer four different co-creation activities in the FFE, idea contest, idea screening, communities for idea generation, and product discussion forum. Particularly, two dimensions, freedom and collaboration, are overlapped with O'Hern & Rindfleisch's (2010) criteria, even though the way to measure them are different.

Therefore, dividing co-creation activities in terms of customers' roles, either they are in generation phases or evaluation/selection phases of a certain task, is adopted by recent research. This approach is also supported by a creativity perspective (Eling et al., 2014). Above all, consistent with prior research on customer co-creation typology (O'Hern & Rindfleisch, 2010; Piller et al., 2010), as well as adopting a cognitive creativity scheme (Dahl & Moreau, 2002) into the FFE context (e.g., Eling et al., 2014), the present research assumes that customers are able to participate in generation and selection/evaluation phases in the FFE. Specifically, in the FFE, during the generative phases in the FFE, co-creation activities are concerned with retrieval and listing problems and with opportunities, associations and combinations of new ideas/concepts with existing memory, while during evaluative activities in the FFE an NPD project team finds ways to modify and elaborate developed ideas, consider implications, and assess the limitations within co-creation activities (Moreau & Dahl, 2005). As can be seen in Figure 2.2 below, activities are depicted in the specific stages with customer co-creation in the FFE. The following section will briefly describe specific customer co-creation activities used in developing the construct.

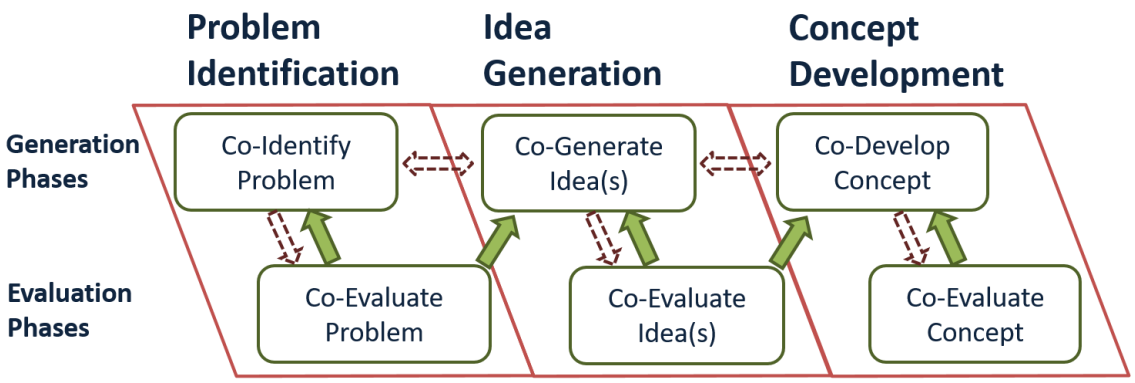


Figure 2.2 Customer Co-creation in the FFE

Source: adapted from Eling et al. (2014)

Generation and Evaluation by Community

Firms can work with *customers in communities*. Firms engage various types of customer communities to identify customer needs and obtain customer insights for their new products. These communities might be either user generated communities or firm generated ones. For example, firms such as IBM, BMW, and Nokia aggressively invest and run customer communities for gathering customer inputs on their products (Mahr & Lievens, 2012). On the other hand, through *discussion forums*, customers share their experience of usage of products. Even though obtaining innovative ideas for products is not the primary objective in the forum, customers' input can be useful for firms wanting to make product improvements (Piller et al., 2010). Research on community argues that firms need to continuously engage customer communities and discussion fora to maximize the effectiveness of knowledge creation by customers (e.g., Hienerth & Lettl, 2011; Mahr & Lievens, 2012).

Generation and Evaluation by Dyadic Co-creation Activities

A co-creation workshop refers to having a working session with customers to develop ideas (Roberts et al., 2005). In this workshop, a firm applies *creative problem solving*

techniques such as brainstorming to facilitate the activities. This differs from focus group meetings or in-depth interviews, co-creation workshops enable bi-directional interaction with customers, encouraging customers' active involvement in the process, which makes it possible to identify customer needs and generate new product ideas (Roberts et al., 2005; Hargadon & Bechky, 2006).

Furthermore, when firms have close *connections with lead users*, firms might not only identify their complex needs but also convert their valuable inputs into new product ideas (Lilien et al., 2002). Specifically, engaging with lead users is beneficial for firms in accumulating knowledge and insights, which therefore eventually turns into creative new product ideas/concepts (Hienerth et al., 2014).

As a result of technology advancements, customer co-creation activities via *toolkits* are necessary for firms to have many ideas effectively organized as well as have participants easily access and submit the most valuable ones for given product ideas/concepts (von Hippel & Katz, 2002; Jeppesen, 2005). Firms provide toolkits as a platform for customer participation such that customers play with it to compose a product concept along certain feature dimensions (Bartl, Jawecki & Wiegandt, 2010). Participants also get instant feedback on their actions from other participants and firm NPD professionals, which enables a trial-and-error based process with the accumulation of knowledge of new product concepts (von Hippel & Katz, 2002; Piller et al., 2010). It is suggested that, with user-friendly accessible toolkits, customers can access the toolkit and engage their inputs with more enthusiasm and satisfaction, in turn, companies effectively transfer these inputs into their solution (von Hippel & Katz, 2002).

Generation and Evaluation by the Individuals and the Crowd

Idea contests are defined as IT-based and time-limited competitions arranged by a firm calling on the public or a specific target group to make use of their expertise, skills or creativity to submit a solution for a particular task (Piller et al., 2010; Adamczyk,

Bullinger & Möslein, 2012). On the other hand, *idea screening* and *idea rating/voting* are quite similar activities in that firms have customers select or evaluate their product ideas/concepts (Piller et al., 2010). Firms might apply either one of these activities in their NPD process, or might subsequently utilize idea contests and idea rating/voting idea contests. For example, Threadless, a Chicago-based fashion company encourages individual customers to submit their designs to the company (Ogawa & Piller, 2006). They also ask customers to select/vote for the T-shirts that they think should be produced. On the other hand, Muji, a Japanese manufacturer of consumer goods, invites customers only to submit their ideas in the NPD process (Ogawa & Piller, 2006). The main issue in asking customers for idea contest/idea rating is how firms incentivize/motivate their active participation (O'Hern & Rindfleish, 2010; Piller et al., 2010). Moreover, these co-creation activities include the competitive element, which motivates and challenges customers to achieve their psychological goals (Adamczyk et al., 2012).

Crowdsourcing refers to "the act of taking a task once performed by an employee and outsourcing it to a large, undefined group of people external to the company in the form of an open call" (Howe, 2008; Bayus, 2012: 226). This activity is similar with idea contest/rating activity when firms ask for ideas/concepts about products they are developing. For example, Dell has launched an initiative named "Idea Storm" in which users are invited to suggest new product ideas and product improvement (Poetz & Schreier, 2012). Moreover, a crowdsourcing platform such as "InnoCentive" enables firms to search for opportunities to get solutions from external experts, which they cannot solve internally (Mahr, Rindfleisch & Slotegraaf, 2015).

In conclusion, it is important to note that the combination of these customer co-creation activities can generate synergies on effective and appropriate knowledge integration in the NPD process (Hienerth et al., 2014). For example, toolkits in user community enable the facilitation of lead users, with advanced knowledge and needs, to

actively participate in the NPD (Franke et al., 2008). The present research forms the multilevel customer co-creation construct by including definitions of these activities in terms of customer's roles in generation and evaluation phases in NPD.

Even though the construct of "customer co-creation activities" in the FFE of NPD is developed using various activities with customers, a question can be asked whether implementing these activities increases the chance of developing more creative product concepts throughout the FFE. That is, it is reasonable to assume that not all circumstances enable firms to develop highly creative concepts by utilizing customer co-creation activities because they are not a panacea but are methods accelerated in a certain context with a combination of other factors (Hoyer et al., 2010). For example, firms with certain skillsets, mind-sets, or cultures might activate customer co-creation more effectively. However, research is limited on firm level factors that leverage co-creation activities in the FFE of NPD, and there are calls for further research (Hoyer et al., 2010). Specifically, the research considers effectuation logic, which a firm can implement during the FFE of NPD in order to leverage its customer co-creation activities.

Table 2.3 List of Customer Co-creation Activities in the Fuzzy Front End of New Product Development

Customer Co-creation Activities	Definition	Customer co-creation characteristics	Examples	Related literature
Idea contest	IT-based and time-limited competitions arranged by an organization or individual calling on the general public or a specific target group to make use of their expertise, skills or creativity in order to submit a solution for a particular task (Adamczyk,	Generation	Threadless Muji, Ben & Jerry	Ogawa & Piller (2006), Sawhney et al. (2005), Piller & Walcher (2006), Terwiesch & Xu (2008), Ebner, Leineister, & Krcmar (2009),

	Bullinger, & Moslein, 2012; Piller et al., 2011)			Fuller, Hatter, & Faullant (2011)
Idea screening	Having customers select ideas with highest potential out of lots of submitted ideas (Piller et al., 2011)	Evaluation	Threadless	Toubia & Flores (2007)
On-line voting/rating	having customers cast a vote/rating for selecting developed ideas (Ogawa & Piller, 2006; O'Hern & Rindfleisch, 2010)	Evaluation	DEWmocracy.com O'Neill	Piller & Walcher (2006), Fuchs, Prandelli, & Schreier (2010)
Crowdsourcing	"the act of taking a task once performed by an employee and outsourcing it to a large, undefined group of people external to the company in the form of an open call (Bayus, 2012: 226; Howe 2008)	Generation/ Evaluation	Ideastorm by Dell, InnoCentive	Ogawa & Piller (2006), Jeppesen & Lakhani (2010), Bayus (2012) Poetz & Schrier (2012), Mahr, Rindfleisch, & Slotegraaf (2015)
Engaging customer communities	connecting customer communities which more focus on generating novel ideas and concepts (Piller et al., 2011)	Generation	Sun Microsystems' Jini Project Ikeafans.com, Volkswagen Golf GTI car community, Nokia BetaLabs	Sawhney & Prandelli (2000), Jeppesen & Molin (2003), Von Krough, Spaeth, & Lakhni (2003), Jeppesen & Frederiksen (2006) Franke & Shah (2003), Fuller, Jawecki, & Muhlbacker, (2007), Mahr & Lievens (2012)
Co-creation workshop	having a working session with customers to develop ideas by applying creative problem-solving techniques such as brainstorming (Roberts et al., 2006)	Generation/ Evaluation	Microsoft, Lego	Roberts et al., (2006)
Discussion forum	connecting it which "customers primarily exchange their usage experiences and support each other in using the product" (Piller et al.,	Generation	John Deere Harley-Davidson smart-club.de OnStar	Prahalad & Ramaswamy (2005)

	2011: 14)		network of GM	
Lead user meeting	Let lead users involve in the NPD project (von Hippel, 2005)	Generation/ Evaluation	3M	Lilien et al., (2004), Al-Zu'bi & Tsinopoulos (2012)
Use of customer toolkit	Toolkit for information input from outside (Piller et al., 2010)	Generation/ Evaluation	Open source software, Lego	Von Hippel & Katz (2002), Jeppesen (2005), Franke & Piller (2004), Prugl & Schreier (2006), Franke, Keinz, & Schreier (2008)
Creative problem solving with customers	Getting customers involved in various creative problem solving techniques during the FFE	Generation/ Evaluation	Ideo	Hargadon & Bechky (2006),

2.4 Effectuation Logic

This section introduces the concept and principles of effectuation theory along with theory development, which is the Behavioural Theory of Entrepreneurial Firm. Secondly, the section briefly reviews empirical research that has applied effectuation theory. Thirdly, the discussion continues by addressing the research gap by linking effectuation and co-creation and the FFE of NPD.

2.4.1 Effectuation Theory

Sarasvathy (2001) put forward effectuation theory to explain the process whereby entrepreneurs develop new ventures. She argues that expert entrepreneurs use effectuation logic for the successful new business development as a result of interviews with 27 expert entrepreneurs (Sarasvathy, 2001). Effectuation logic presents a somewhat different logic, that is, “To the extent we can control the future, we do not

need to predict it", in contrast to the causation logic: "To the extent we can predict the future, we can control it" (Sarasvathy, 2003: 208). Specifically, causation logic takes an effect (a goal) as given and focuses on selecting between the means to create that effect, while effectuation logic takes a set of means as given and focus on selecting between possible effects that can be created with that set of means (Sarasvathy, 2001). For example, classic marketing strategy suggests entrepreneurs adapt causation logic to reach the target customers by defining the market first then applying segmentation, targeting, and positioning (STP) approach. However, with effectuation logic, the process starts from customer identification (through asking these questions such as Who am I? What do I know? Who do I know?). After defining segments through effectual partnerships and "selling," entrepreneurs add more segments and partners, then finally define/create one of several possible markets for their business (Sarasvathy, 2003; Read et al., 2009a).

It is also necessary to compare alternative perspectives within Entrepreneurship; for example, "entrepreneurial bricolage" with effectuation. The reason is because Fisher (2012) considers both effectuation and bricolage as alternative theoretical perspectives for similarly describing entrepreneurial action as well as considering resource constraints. The concept of bricolage refers to "making do by applying combinations of resources at hand to new problems and opportunities" (Baker & Nelson, 2005: 33). Bricolage is an action-oriented perspective in solving problems that entrepreneurs encounter. They might carry out bricolage by making do with what is available in order to overcome challenges and create opportunities (Baker & Nelson, 2005). The concept of bricolage is similar to effectuation in that it focuses on available resources at hand and encourages experimentation in the course of solving problems (Fisher, 2012).

However, Baker and Nelson (2005) builds on the theory describing the following process when entrepreneurs are confronted with a penurious environment that is resource constrained, which is considered as a boundary condition. Rather, effectuation focuses

on dealing with contingent factors under highly uncertain environments in order to create new artefacts. Therefore, in conjunction with FFE, effectuation addresses more general environmental uncertainty and makes decisions based on high uncertainty, while bricolage is concerned with more resource limited situations. Furthermore, bricolage discusses reaching out to new customers or suppliers as one of the options of domains in making do. On the other hand, effectuation strongly recommend connecting with others “whom they know” in order to expand their means. In the FFE of NPD, such as idea generation, effectuation encourages working with external partners rather than bricolage, whereas bricolage concerns reaching out to others when bricoleurs already have ideas of what they could do. Therefore, effectuation is a more appropriate theory in this research context.

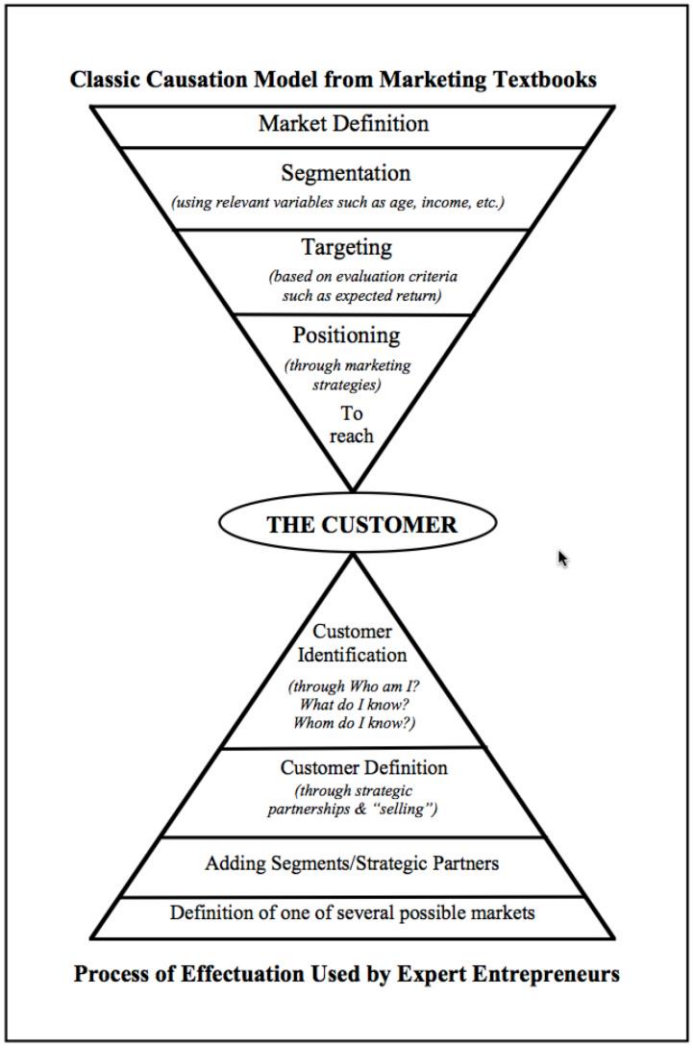


Figure 2.3 Effectuation Logic vs. Causation Logic in Marketing Strategy

Source: Sarasvathy (2003)

2.4.2 The Behavioural Theory of the Entrepreneurial Firm (BTEF)

The effectuation logic explains the information process of entrepreneurs when they develop new businesses. Moreover, at the organizational level, it is perceived as a "muddling through" approach adopted by the organization (Lindblom, 1959). In line with this, Dew, Read, Sarasvathy & Wiltbank (2008) suggest "the behavioural theory of the entrepreneurial firm" (BTEF). They suggest entrepreneurial firms, given the situations where its markets or firms are still vague (in the process of developing or not

yet existing), to apply the effectual behaviour, which displays an "exaptive" rather than an adaptive orientation in its ecological interactions (Dew et al., 2008). BTEF stems from Cyert & March (1963)'s "A Behavioural Theory of the Firm" (BTF), which asserts the notion that firm's decision making involves finding satisfactory solutions rather than in optimizing the best outcome based on bounded rationality of human behaviour (Simon, 1959). The BTF provides behavioural insights for the established firm, which it later evolves to the notion that most firms are fundamentally heterogeneous (Teece, Pisano & Boerneric, 2002). BTEF expands the BTF to the entrepreneurial firms' context.

Even though most research that has adopted effectuation logic has focused on the innovation process of small firms (e.g., Read et al., 2009b; Coviello & Joseph, 2012; Berends, Jelinek, Reymen & Stultiëns, 2014), little research has discussed it in the context of the medium or large-sized established firms (e.g., Brettel et al., 2012; Blauth, Mauer & Brettel, 2014).

Applying effectuation logic in the context of small firms, for example, Coviello & Joseph (2012) suggest the need for effectuation capabilities for enhancing performance in small and medium sized enterprises (SME) with radical innovation because of their qualitative study. Berends et al. (2014) conducted a process study of the innovation process in small manufacturing firms. They found that the NPD process in small firms relies on effectuation during early phases of a project and on causation in later phases, consistent with insights of effectuation theory.

Recently, to see if the theory is beneficial for a firm's innovation process, in particular, Brettel et al. (2012) applied effectuation logic to the research and development (R&D) context to investigate whether it enhances R&D outcome and efficiency. In the medium and large sized firm, their results support their notion that the effectual dimensions are likely to have positive relationships with R&D performance in highly innovative projects. That is, their results suggest different R&D approaches are required in different degrees of innovativeness.

Furthermore, empirical works of effectuation logic also discuss effectuation orientation of employees, which has been conceived as a strategic orientation which directs the organization's strategic behaviour (Gatignon & Xuereb, 1997). That is, strategic orientation, which is an underlying business philosophy or culture of an organization, will affect the behavioural decision making and enactment for action of key players in the organization (Werhahn et al., 2015). Therefore, such an effectuation orientation, as a strategic direction with effectuation logic, is recommended for NPD professionals to enhance creativity during their NPD process (Blauth et al., 2014). Therefore, this recent research of effectuation theory gives insights that effectual logic can be applicable to NPD practitioners who are involved in the FFE of NPD of medium and large sized established firms.

2.4.3 Core Dimensions of Effectuation Construct

Sarasvathy (2001, 2003) offers principles for effectuation logic as well as testable propositions, and these principles have become the dimensions of effectuation constructs (Perry, Chandler & Markova, 2012). Further conceptual and empirical literature on effectuation theory contributes to clarifying the breadth and depth of effectuation logic. On the one hand, some theoretical works of effectuation theory explore each principle of effectuation logic by differentiating it from other similar concepts (e.g., Sarasvathy & Dew, 2008; Dew, Read, Sarasvathy & Wiltbank, 2009; Fisher, 2012). On the other hand, other conceptual and empirical works strengthen effectuation logic principles (e.g., Sarasvathy et al., 2014), or develop scales of the effectuation construct for examining the role of effectuation around other factors (e.g., Chandler et al., 2011; Brettel et al., 2012; Werhahn et al., 2015). Empirically, Read et al. (2009b) conducted a meta-analysis by taking samples from new venture studies to show the relationship between effectual principles and new venture performance. They transform variables used in these studies in terms of dimensions of effectuation, and

their results mostly support the notion that the use of effectuation logic contributes to new venture performance.

In this research, names of dimensions have been adapted slightly to fit within the research context. Five dimensions of effectuation include means-driven, affordable loss, partnerships, agility, and control. Nicknames are also mentioned in the inside parenthesis except affordable loss following Sarasvathy (2008).

Means-driven (Bird-in-hand)

Means-driven is defined as an approach which seeks to use all available means at hand at the beginning of a project. Means, at an individual level, can be encapsulated as "Who I am", "What I know," and "Whom I know" (Sarasvathy, 2001). At the organizational level, these means can be extended to resources such as existing competencies and experiences, skilled employees and experts, networks, and tangible assets (Brettel et al., 2012). A firm with a means-driven perspective would base a new product opportunity on existing knowledge and experience (Brettel et al., 2012). In effectuation logic, firms first exploit all possible existing resources and then combine these with external insights (Brettel et al., 2012; Coviello & Joseph, 2012). Firms can co-create new opportunities by leveraging their customer portfolio (Coviello & Joseph, 2012).

Affordable Loss

This dimension relates to decision making during the FFE as new product developers constantly have to make trade-off decisions and take actions. Affordable loss refers to "committing in advance to what one is willing to lose rather than investing in calculations about expected returns" (Sarasvathy, 2008: 21). Utilizing this logic, new product developers try to limit risk by understanding what they can afford to lose at each stage of the process rather than first targeting a return that seeks to minimize the risk (Sarasvathy, 2008). Under conditions of high uncertainty in the FFE of NPD an

affordable loss approach is useful for firms when effectively trying to manage external input from customers by focusing on the downside of risk (Brettel et al., 2012).

Partnerships (Crazy Quilt)

Partnership refers to the act of deliberately seeking external partners and obtaining their commitment to expand the firms' means (Brettel et al., 2012). In linking it with the co-creation paradigm, Coviello & Joseph (2012) suggest firms should develop "customer mobilization" for successful performance. Customer mobilization is defined as a firm's ability to assemble resources for NPD as well as activate them through deliberate customer engagement and being open to customer-initiated efforts (Coviello & Joseph, 2012). Specifically, customer mobilization concerns resource acquisition and activation from customers by facilitating their early commitments (Coviello & Joseph, 2012).

Agility (Lemonade)

Agility refers to a willingness to change when confronted with new information, means or surprises (Coviello & Joseph, 2012). This means having a flexible stance and being able to quickly integrate customer ideas into firm practice. Firms with agility are comfortable in "exploring ideas and exploiting solutions with various customers" (Coviello & Joseph, 2012: 99). Since firms are aware of the worst case of scenario, they can embrace the unexpected (Brettel et al., 2012). Firms are ready for challenging unforeseen consequences which may arise from customer input (Kim & Mauborgne 2004).

Control (Pilot-in-the-Plane)

Control contains the effectuation logic that focuses on the controllable aspects of an unpredictable future, which is the overarching logic of effectuation above other four

dimensions rooted in the Knightian perspective[4] (Sarasvathy, 2001; Dew et al., 2008; Sarasvathy et al., 2014). Rather, Sarasvathy (2008) refines the concept of control to add it to the fifth principle of effectuation logic, considering "control" driven by human beings, not by other environmental trend or factors. In other words, "the pilot-in-the-plane principle is an explicit rejection of inevitable trends" (Sarasvathy et al., 2014: 74). That is related to the notion that the environment is endogenous so that it is can be categorized into either controllable or uncontrollable (Werhahn et al., 2015). Therefore, effectuators focus on what they are able to control, then uses it to transform and reshape the uncertain environment (Sarasvathy et al., 2014).

2.4.4 Application of Effectuation Theory

There is growing empirical work which uses effectuation as theoretical lens. One group of effectuation literature delves into the depth of the theory on entrepreneurships: start of new firms (Sarasvathy, 2001), conceptualization of effectuation (Dew & Sarasvathy, 2002), entrepreneurial opportunities (Sarasvathy, Dew, Velamuri & Venkataraman, 2003), strategy under unpredictable situation, (Wiltbank, Dew, Read & Sarasvathy, 2006), and the suggestions of the behavioural theory of the entrepreneurial firm (Dew et al., 2008). Moreover, growing research furthers strategies of SME and entrepreneurship under the locus of effectuation logic, for example, suggesting valuable insights of issues in relation with the use of social media (Fischer & Reuber, 2011), bottom of pyramid (Koepplin, Weiss & Hoegl, 2016), and venture founder team diversity (Kristinsson, Candi & Sæmundsson, 2016). The other group of literature more recently has started to empirically investigate effectuation's application in various strategic contexts, such as firm level R&D projects (Brettel et al., 2012), small firms' product

[4] Sarasvathy (2001: 250-251) elaborates the perspective, which distinguishes the concept of 'risk' from 'uncertainty' with statistical metaphor.

innovation processes (Berends et al., 2014), radical innovation (Coviello & Joseph, 2012), and marketing (Read et al., 2009a).

2.4.5 Effectuation and Co-creation

This section details the intersection of literature on effectuation and co-creation. Drawing on the research gap identified in section 2.3, which suggests that effectuation theory could be useful in the FFE of NPD in order to leverage customer co-creation activities, it first highlights the intersection of effectuation and co-creation, then moves to a detailed discussion of the reasons why the effectuation logic can be an important theoretical lens for looking at customer co-creation activities, i.e., the lack of discussion on firm's strategic mind-set to leverage their co-creation activities in the FFE of NPD.

Overall, effectuation (Sarasvathy, 2001) and S-D logic (Vargo & Lusch, 2004, 2008) share common theoretical ground (Read & Sarasvathy, 2012). The intersection between these two independent streams of research overlaps in the area surrounding the activity of co-creation (Read & Sarasvathy, 2012). Specifically, while S-D logic emphasizes the customer as co-creator of value, effectuation suggests "co-creation as a heuristic that expert entrepreneurs learn for controlling the uncertainties of making new firms, products and markets" (Read & Sarasvathy, 2012: 225). That is, effectuation provides the logic for the "need to co-create" with the information processing perspective within expert entrepreneurs. For example, Bettencourt, Lusch & Vargo (2014) explain the marketing process in a value co-creation paradigm, which takes a new approach by identifying their means, "who they are?" "what they know?" and "whom they know?" based on effectuation logic.

Narrowing the intersection of effectuation and co-creation down to the NPD context, co-creation in NPD literature has tried to shed light on firm's strategic stance with co-creation, as touched on in the previous section. Among those, Coviello & Joseph (2012) offer effectual capabilities as the key factors for performing a successful innovation

process. By focusing more on small and young technology firms, they urge that effectual capabilities, which are characterized into (1) customer mobilization, (2) mindful trial-and-error, and (3) learning agility, play crucial roles for firms making difference in their innovation performance.

Given one aim for applying effectuation logic is to obtain pre-commitment from participants, it clearly links a goal of co-creation, which is to capture "activeness" from customers. According to Coviello & Joseph (2012), customer mobilization refers to the ability more than the communication and coordination with customers, which suggest activating customers through deliberate engagement in NPD and so being open to their efforts. Therefore, mobilized customers facilitate their early commitments to NPD.

Also, as discussed in the earlier section, effectuation accelerates the quality of "working with customers" in NPD, which is another crucial characteristic of co-creation (Read et al., 2009a; Coviello & Joseph, 2012). Particularly, to enable firm's innovation performance, Coviello & Joseph (2012) offer mindful trial-and-error as an effectual capability, which refers to one of explorative learning types characterized as (1) real time experience and (2) iteration (Miner, Bassoff & Moorman, 2001; Coviello & Joseph, 2012). They argue that mindful trial-and-error during NPD facilitates information flow between a firm and customers, which eventually generates real time shared knowledge and leads to enhance firm's memory that is valuable to the NPD.

Moreover, agility is a key aspect for firms to have in order to develop highly creative new products with customers (Coviello & Joseph, 2012). According to Coviello & Joseph (2012), agility is characterized by (1) nimble approach to learning, (2) (cognitively) flexible attitude, and (3) potential ability to learn, such as forward looking and frame breaking. For example, under the context of the FFE of NPD, firms with learning agility can quickly explore external knowledge and acquire and coordinate resources with various customers as well as recognize flexibility (Coviello & Joseph, 2012). They show

evidence that the learning agility of successful firms in innovation is likely to help them be forward looking and frame breaking (Coviello & Joseph, 2012).

Lastly, considering that co-creation is an activity to develop new products by jointly working with customers, it is important to know what constitutes creative new products throughout this collaborative process (e.g., Dahl & Moreau, 2002; Read et al., 2009a; Mahr et al., 2014). Even though the creativity literature suggests some antecedents of enhancing creativity on various situations in NPD, these also overlap with a key aspect in effectuation logic. In particular, these antecedents somewhat intersect with key aspects of effectuation, e.g., agility, which is related to explaining individual cognitive process. For example, analogical thinking is a key element for generating ideas for new products by transferring existing knowledge to construct new ideas (Finke et al., 1992; Dahl & Moreau, 2002). In other words, agile new product practitioners might more effectively facilitate knowledge exchanges during co-creation activities with analogical thinking. Moreover, agility enables them to be open to alternatives (such as those suggested by customers) during co-creation activities, which can lead to more creative outcomes (Sternberg, O'Hara & Lubart, 1997).

In sum, effectuation and co-creation are deeply interrelated with each other in complementary and interchangeable ways, mainly because these constructs are central to human and information flow (Read et al., 2009a; Read & Sarasvathy, 2012). Above all, given that major overlaps occur in co-creation activities (Read & Sarasvathy, 2012), it is reasonable to bring effectuation to resolve research problems in co-creation, since effectuation offers a practical process for tackling both role and goal ambiguities in co-creation (Read et al., 2009a).

Even though there are clear overlaps between co-creation and effectuation in NPD, effectuation has not been brought into the co-creation literature (Vargo & Lusch, 2017). Therefore, based on literature review on co-creation in NPD, the research gap is

identified that shows a lack of empirical research looking at the company's strategic point of view utilizing co-creation in the FFE of NPD.

2.4.6 Effectuation and the FFE of NPD

This section discusses the intersection of effectuation logic in the FFE of NPD. Before discussing it, NPD/Innovation literature asserts that it has relied on viewing the NPD process through causation logic across all stages (Berends et al., 2014). That is, the traditional view of the NPD process in established firms, even including the FFE of NPD, recommends firms set goals first, then identify clear new product definitions based on market research to predict future sales by following a causation logic (Read et al., 2009a).

However, based on the recent research on effectuation theory and innovation, applying effectuation logic might be more suitable at the early stages of the NPD process (Brettel et al., 2012). For example, the work by Berends et al. (2014) shows that innovators rely on effectuation during the early phases of a project, having an effect in later phases. That is mainly because the aim of entrepreneurship includes initiating and generating ideas for new products in their new business development by following effectuation logic (Sarasvathy, 2001).

Then, a question arises on how to minimize the uncertainty needs to be resolved in the FFE, as discussed in the section 2.2. The author argues that effectuation theory delivers insightful guidance to answer this question. Effectuation logic advises expert entrepreneurs to begin with available means in higher levels of uncertainty, which also characterizes the FFE making predictable planning difficult (Kim & Wilemon, 2002). Similar to the notion that it is beneficial for expert entrepreneurs to adopt effectual logic at the beginning of their early business development, new product practitioners need to be flexible on the change of product definition and transformation in the FFE (Read et al., 2009a). For example, Read et al. (2009a) posit that a marketing manager

with effectuation will likely be sceptical about taking and utilizing predictive information (such as market data) and are likely to leverage their own experience and intuition. Likewise, product managers, in the FFE, are likely to draw on their prior experience in dealing with uncertainty (Read et al., 2009a).

Further, Coviello & Joseph (2012) suggest firms attempt the aforementioned mindful trial-and-error during the innovation process to enrich organizational knowledge; it is also possible to try experimentation with low cost in the FFE (Chandler et al., 2011). A series of trial-and-error during the FFE eventually converges the better options for the new product concepts by removing poorly performed options early, in turn the experience accumulates firms NPD learning for the future, which reduces the uncertainty around the FFE.

Next, effectuation logic helps to understand the individual information process during the innovation process. In particular, de Brentani & Reid (2012) specify the information flow in the FFE in a radical innovation context, based on absorptive capacity which describes firms' process of obtaining and internalizing external information (Cohen & Levinthal, 1990). In the course of recognizing and assimilating new information into the organization, individual decision makers such as boundary spanners, gatekeepers and project brokers play crucial roles in bringing about information flow in the FFE (Reid & de Brentani, 2004; de Brentani & Reid, 2012). Drawing detailed key factors influencing the effectiveness of these decision makers, de Brentaini & Reid (2012) address that quality and speed are two crucial aspects of information that affect the effectiveness of information flow. As they propose, the individuals as boundary spanners need to be able to perceive or recognize information patterns in the external environment; effectuation also explains the information process of expert entrepreneurs in creating and making decisions on their business development with effectual logic. Specifically, they have a flexible attitude (or even taking surprising news as an opportunity) on contingency. In

this regard, the effectual logic provides convincing reasons for new product practitioners to apply it in the FFE of NPD.

Nevertheless, there is little research which empirically delves into the linkage between the effectuation logic and the FFE of NPD. Eventually, insights from effectuation theory are expected to contribute to leveraging firms' co-creation activities in the FFE of NPD.

2.5 Research Position, Gap, and Questions

2.5.1 Research Position

The literature review presents the research context, core constructs, and theoretical background and how they support the study. Firstly, for research context, the literature on the FFE of NPD is reviewed. The sequential view of the FFE consistent with the one from Eling et al. (2014) is adopted for this study. Also, the review builds solid grounds for the issue of how to measure FFE performance.

As to the core issue of this research, the co-creation literature is reviewed. Customer co-creation activities are defined as "active" and "bidirectional" collaboration with customers in the FFE of NPD following customer-centred perspectives (O'Hern & Rindfleisch, 2010; Greer & Lei, 2012). However, the main focus of the research lies in the combination of the joint innovation context from the firm's point of view (Candi, van den Ende & Gemser, 2016), even though customer co-creation constructs are developed based on activities from studies of user innovation context (e.g., Piller et al., 2010). These customer co-creation activities are characterized in terms of generation and evaluation phases in each activity utilized during the NPD, after identifying customer co-creation activities throughout prior co-creation literature.

Effectuation logic is the theoretical lens applied in this research, as well as the core construct that plays an important role in the research framework. The theory of the behavioural entrepreneurial firms to the firms' co-creation during the FFE is applied. The aim is to expand the locus of effectuation logic developed for entrepreneurs to a NPD manager/practitioner of a firm level in the context of the NPD process. Moreover, prior empirical research applying effectuation logic in the NPD context provides insight and helps to identify the research gap for this study. The section introduces the core dimensions of effectuation, followed by the linkage of effectuation and co-creation and the FFE of NPD.

Taken together, the author positions the present research in the overlapped area of these three issues: FFE context, customer co-creation activities, and effectuation theory.

2.5.2 Research Gap

Above all, co-creation in the FFE context is the main focus, and where prior research calls for further research, specifically, balancing the firm's control and the customers' contributions (Hoyer et al., 2010). Given that the chapter rationalizes the link between effectuation theory and co-creation paradigm, this research uniquely applies the effectuation theory to empirically examine its impact during co-creation activities on the product concept developed in the FFE. In addition to it, little research has investigated the multiple FFE performance constructs, including both creativity of product concept and early performance, as well as their relationships, specifying the indirect effect of customer co-creation on early performance through the creativity of product concept in the FFE.

Even though recent research addresses the importance of co-creation and customer involvement in the FFE (Mahr et al., 2014), little is yet known about how firms engage in various ways with customers during this phase, which may result in different outcomes of the FFE of NPD (Coviello & Joseph, 2012). While the user innovation literature has

focused on issues such as identifying and choosing the right users, developing toolkits, and engaging in communities; other literature on firm-driven customer relationship has focused on measuring the degree of relationship (or interaction) to link FFE performance. The present research takes a different approach to measure customer co-creation activities by synthesizing actual co-creation activities during the FFE, and then linking them to performance measures.

Prior research does not appear to clearly answer the question of how firms leverage these co-creation activities through their competence, which is what motivates this investigation.

Throughout the literature review on effectuation theory, the author identifies the insights that the logic is applicable to the situation where a firm develops new products with customer, and that further empirical research is much needed when specifically examining whether a firm's strategic behaviour positively affects its co-creation activities during the FFE (Coviello & Joseph, 2012). (See Figure 2.4 which revisits Figure 2.1)

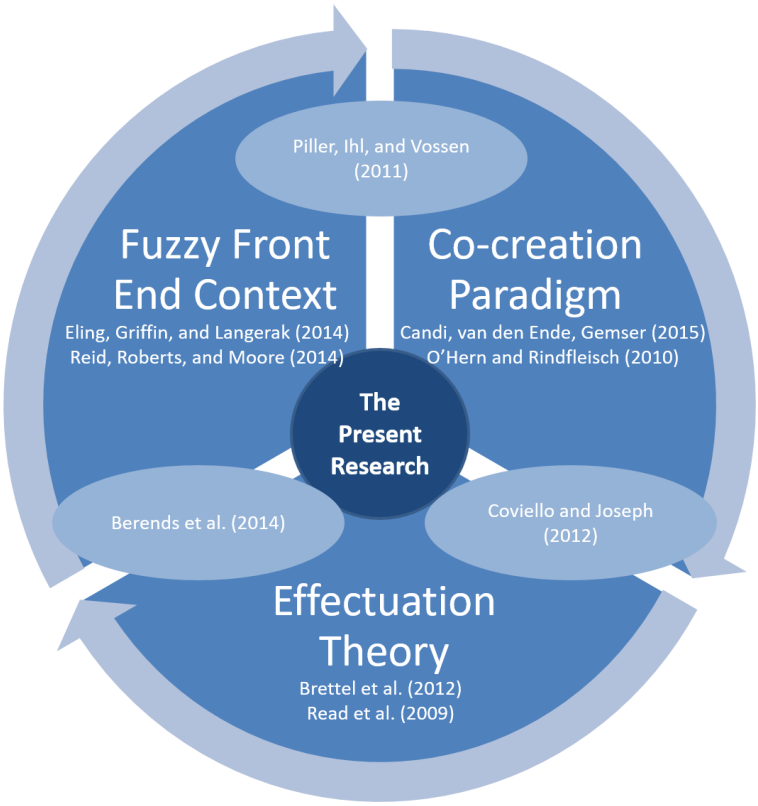


Figure 2.4 Research Gap

2.5.3 Research Questions

In summation, the study aims to examine whether and how effectuation logic is related to early performance through customer co-creation activities in the FFE of NPD. To achieve this aim, the study seeks to address the following two research questions:

- How do customer co-creation activities relate to creativity of the product concept, compared to traditional customer facing activities?
- Does effectuation logic relate to the co-creation-early performance relationship?

Chapter 3 Conceptual Framework and Hypotheses Development

3.1 Effectual Customer Co-creation Conceptual Framework

In response to the research questions arising from the literature review, a conceptual framework is developed. It depicts the relationships investigated in the research, and comprises five focal constructs as follows; customer co-creation activities, traditional customer facing activities, effectuation, creativity of product concept, and early performance, as can be seen in Figure 3.1. The following sections describe the details of the hypotheses.

First, the model seeks to investigate the positive relationship between customer co-creation activities and the creativity of product concept (H1a) as well as between customer co-creation activities and early performance (H1b). The path coefficient of customer co-creation activities is compared with traditional customer facing activities on the creativity of product concept (H2a) as well as on early performance (H2b). Furthermore, the model examines the path from the creativity of product concept to early performance (H3). Next, the model is expected to show the mediation effect of the creativity of product concept between customer co-creation activities and early performance, which implies customer co-creation activities enhance early performance through the creativity of the product concept (H4). Moreover, this framework focuses on the role of effectuation between customer co-creation activities and the creativity of product concept (H5a). Furthermore, the model extends the indirect effect of the effectuation influences in early performance via the creativity of the product concept (H5b).

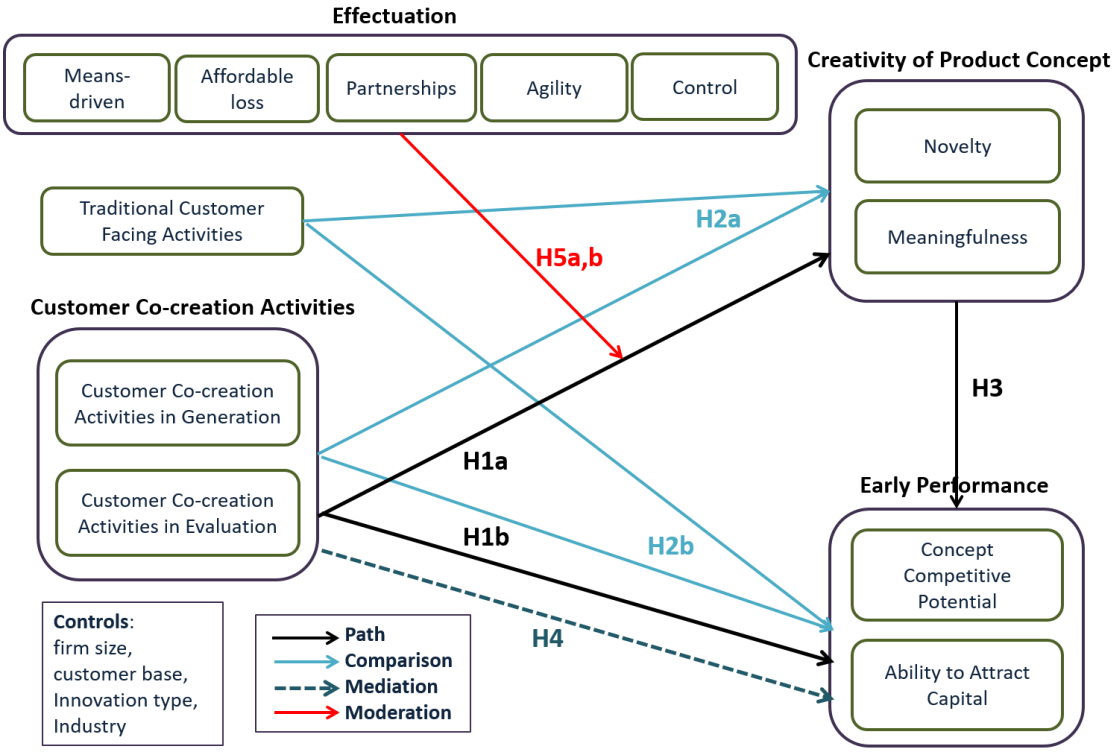


Figure 3.1 The Conceptual Model

3.2 Hypotheses Development

3.2.1 Customer Co-creation Activities

Creativity of the Product Concept

Based on the conceptual framework proposed above, the research develops hypotheses, which posits that customer co-creation activities in the FFE of NPD are positively associated with the creativity of product concept, based on the previous research (e.g., Lilien et al., 2002; Al-Zu'bi & Tsinopoulos, 2012). Firstly, creativity literature suggests that team level factors such as the diversity of team members influences creative outcomes (e.g., Woodman, Sawyer & Griffin, 1993; Sethi, Smith & Park, 2001; Perry-

Smith, 2006; Hülsheger, Anderson & Salgado, 2009). Specifically, research shows that NPD projects which include diverse members in ideation are positively related to NPD creativity (Olson, Walker & Ruekert, 1995; Sethi et al., 2001). Particularly, if diversity is relevant to the NPD tasks among team members such as knowledge or expertise, it positively affects innovation. This is mainly because the broadness of cognitive resources from team members can be incorporated during team activities (Hülsheger et al., 2009). In particular, if customers who are participating in NPD have knowledge and expertise are able to generate more divergent insights and ideas, this in turn might contribute to developing a creative product (Magnusson, Matthing & Kristensson, 2003; Troy, Hirunyawipada & Paswan, 2008).

Secondly, during customer co-creation activities, customer needs and wants can be identified via active knowledge exchange among team members (Olsen et al., 1995; Sethi et al., 2001). For example, when product developers are motivated to directly involve customers in working on customers' needs/problems, they can contribute to more innovative solutions (Kanter, 1988; Sethi et al., 2001). To solve an innovation-related problem, and to develop new ideas, need-related information and problem-solving capabilities need to be brought to a single locus (von Hippel, 1994). It has been found (Kristensson et al., 2004) that customers are able to actively develop need-related product information to fit their needs if they are motivated and involved in the NPD process. In line with this, Magnusson (2009) shows that ordinary users with user knowledge can contribute to inspiring creative new product ideas.

Thirdly, these co-creation activities are designed for enhancing the ability to develop creative outcomes by NPD team members. For example, Roberts et al. (2005) show that interactive co-creation workshops with customers, benefit firms for developing innovative concepts. Given the notion that creativity can be better developed through facilitating the atmosphere for distributing creative solutions (Roberts & Darler, 2017), the use of customer co-creation activities also enables to stimulate customer's creative

behaviour in the NPD. Similarly, the use of a creativity training program in the NPD enhances the significant improvements of creative abilities and outcomes of those who participated the program (Woodman et al., 1993; Burroughs, Dahl, Moreau, Chattopadhyay & Gorn, 2011). Taken all together, the hypothesis is posited as follows:

H1a: Customer co-creation activities in the fuzzy front end of new product development are positively associated with the creativity of product concept.

Early Performance

Next, prior NPD research argues that allowing customers to be actively involved in the FFE activities enables firms to gather useful information on their customers' current and future needs; thereby it enhances the firm's performance and subsequent profit (Witell et al., 2011). This is not only because firms can directly experiment and adjust their products due to customer's sharing of user knowledge, but also because customers are not constrained by firm-specific restrictions (Magnusson, 2009; Poetz & Schreier, 2012). For example, firms working with lead users (Lilien et al., 2002) generate ideas with greater strategic importance and sales potential. Firms that can assimilate and apply knowledge from their customers enhance their ability to attract new customers and to attract capital (Brettel et al., 2012). Moreover, prior empirical research on customer participation shows the positive relationship with financial NPD performance (Chang and Taylor, 2016). Therefore, the hypothesis is posited as follows;

H1b: Customer co-creation activities in the fuzzy front end of new product development are positively associated with early performance.

3.2.2 Comparison with Traditional Customer Facing Activities in the FFE

In the previous chapter, the characteristics of customer co-creation activities and traditional customer facing activities were highlighted.

Examining the differences between two approaches, traditional customer facing activities are characterized by unidirectional communication between firms and customers, as well as "asking for" and "listening into" customers' input (Griffin & Hauser, 1993). However, these traditional approaches can be "reactive," mainly because they only capture customer's spoken needs, which limit firm's ability to obtain insights outside their pre-determined questions (Witell, Kristensson, Gustafsson & Löfgren, 2011).

On the other hand, customer co-creation activities can be characterized as bi-directional interaction and communication (Prahalad & Ramaswamy, 2000). It is also considered as a "proactive approach" (Witell et al., 2011). That is, companies can have better understanding of customer's hidden needs by bi-directionally interacting with them (Prahalad & Ramaswamy, 2000). To find out what customers value and to actively engage with them, it would be necessary for firms to communicate with customers and actively involve them in activities during the NPD process (Witell et al., 2011). By working with customers and co-creation activities, firms can capture their unspoken latent needs. Furthermore, customers who actively participates co-creation activities are regarded as a source of creativity and additional skills (Kristensson et al., 2004).

Creativity of the Product Concept

Firstly, involvement in customer co-creation activities has proven to be a motivating factor for customers (Woodman et al., 1993; Roberts, Hughes & Kertbo, 2014). Roberts et al. (2014) specify different motivations of customers who participate in the various types of co-creation activities. They argue that customer's motivation in directly collaborating with firms is more likely to be opportunity-based, which participants

expect to gain attention or even an opportunity for working with firms in the future. Therefore, customers enthusiastically inform and share their knowledge for the new product ideas (Füller, 2010; Roberts et al., 2014).

Next, developing highly creative concepts results from openness and flexibility during the FFE of NPD, because openness and flexibility allow for different perspectives as well as new insights to be integrated and implemented (Song & Chen, 2014; Cui & Wu, 2017). Moreover, customer co-creation activities let participants have more opportunities to ensure that their creative inputs are discussed and applied in NPD (Cui & Wu, 2017). Cui & Wu (2017) assert that an NPD process without much chance of experimentation might prevent NPD practitioners from finding novel meanings and uses of customer information by sticking to existing knowledge. In line with this, Kristensson et al. (2004) empirically show that user generated ideas are more original and valuable. Therefore, it is hypothesized as follows:

H2a: In comparison with traditional activities in the FFE, customer co-creation activities are positively associated with higher creativity of product concept.

Early Performance

Based on argument from H1b, it is expected that customer co-creation activities are positively related to early performance. In comparison with traditional customer facing activities, "activeness" of customer co-creation activities would outperform "reactive" traditional customer facing activities in the FFE of NPD (e.g., Narver, Slater & MacLachlan, 2004). That is, utilizing customer co-creation activities in the FFE might be more efficient for firms to identify customer needs, which in turn bring more value to NPD performance (Narver et al., 2004). On the other hand, traditional customer facing activities such as focus groups and surveys have limitations of getting closely and

directly engaged with customers in asking their input for NPD (Sawhney et al., 2005). Therefore, the hypothesis is suggested as follows:

H2b: In comparison with traditional activities in the FFE, customer co-creation activities are positively associated with higher early performance.

3.2.3 Creativity of Product Concept and Early Performance

On hypothesizing the association between the creativity of product concept and early performance, the research posits that achieving high levels of creativity of product concept through co-creation activities leads to early performance. A firm that can offer unique and meaningful products will meet the changing needs of consumers by generating highly innovative and superior products in the market (Cooper 1979; Deshpandé et al., 1993). Thus, new product creativity is one of the strong strategic determinants of new product success (Griffin & Page, 1996). Moreover, prior literature on new product creativity asserts that new product creativity influences product competitive advantage (PCA) as well as financial and market performance (Kleinschmidt & Cooper, 1991; Song & Montoya-Weiss, 2001; Im & Workman, 2004; Im et al., 2013; Kim, Im & Slater, 2013).

Firstly, PCA has been recognized as an especially important outcome variable of new product creativity (Montoya-Weiss & Calantone, 1994; Henard & Szymanski, 2001). PCA is referred to product's perceived superiority over competing products (Kim et al., 2013). Novel and meaningful products out of NPD processes entail highly differentiated ones, which characterise degrees of distinctiveness in terms of product images and strategic positioning relative to competing products (Kim et al., 2013). Therefore, creativity is highly related with the product differentiation, which is one critical aspect of PCA

(Andrews & Smith, 1996; Song & Parry, 1997; Song & Montoya-Weiss, 2001). Furthermore, achieving highly creative product ideas and concepts during the NPD enables firms to accumulate organizational intelligence, which makes it hard for competitors to imitate and duplicate (Barney, 1991; Hunt & Morgan, 1995; Kim et al., 2013). Therefore, it is also applicable to the FFE context in developing creative product concepts, rephrasing that highly creative product concepts (both novel and meaningful) enhances the competitive advantage potential of concept.

Secondly, creativity of product concept contributes to enhancing early performance in financially beneficial ways to the firm. That is based on the notion that higher creativity of a new product eventually leads to relatively higher financial profitability by better satisfying customer needs (Calantone, Chan & Cui, 2006; Huang & Tsai, 2014; Cui & Wu, 2017). Thus, a highly creative new product is more likely to gain market demand, which in turn benefit firms with higher sales, market share, and profit (Song & Parry, 1997; Li & Calantone, 1998; Im et al., 2013).

However, it is difficult to quantify the profitability of concepts, because traditional objective outcome measures, such as market share or revenue, cannot be directly assessed at the end of the FFE (O'Connor, 1998). After the new product concept is developed, funds for further development may be allocated by senior management or the firm can get outside investment. Particularly, the ability to attract capital captures financial performance of the FFE as a proxy. Thus, it is also expected that a highly creative product concept would be attractive enough to get more invested for the further development and commercialization after the FFE. Therefore, the hypothesis is suggested as follows:

H3: Creativity of product concept is positively associated with early performance.

3.2.4 Mediation of Creativity of Product Concept

As discussed in the literature review chapter, prior research on creativity of NPD has shown creativity either (1) as one of the performance variables in NPD (e.g., Moorman 1995; Rindfleisch & Moorman 2001), or (2) as a core construct with antecedents and NPD success or new product advantage (Im & Workman, 2004; Im et al., 2013; Kim et al., 2013). Most prior literature on new product creativity has investigated the relationship between (1) antecedents and new product creativity or (2) new product creativity and performance as a separate path in the framework of NPD. If there are significant relationships from these paths, it is reasonable to assume that the creativity of product concept might play a mediating role between customer co-creation activities and early performance in this conceptual framework.

There appears to be no research investigating the mediating role of the creativity of product concept between customer co-creation activities and early performance in the FFE of NPD; this is despite most recently, Cui & Wu (2017) examine the mediating role of new product innovativeness (same as novelty dimension of creativity) on the relationship between customer involvement and new product advantage. The results verify the mediation role of new product innovativeness. Therefore, this research is not just limited to investigate the direct effect between customer co-creation activities and creativity of product concept, as well as creativity of product concept and early performance respectively, but also examine the mediating role of creativity of product concept in between customer co-creation activities and early performance. Thus, the author hypothesize as follows:

H4: Creativity of product concept mediates the relationship between customer co-creation activities and early performance.

3.2.5 Moderation of Effectuation

A further question arises regarding role of effectuation logic in conjunction with co-creation activities in the NPD of FFE. Prior research asserts that since competitive advantage may be achieved through a firm's strategic orientation in utilizing distinctive innovation capabilities, thereby a strategic orientation may moderate the relationship between open innovation and innovation performance (Cheng & Huizingh, 2014). Similarly, applying effectuation in the NPD in the FFE will moderate the relationship between customer co-creation activities and the creativity of product concept mainly because developing creative product concepts may rely on effectuation in implementing co-creation activities. More specifically, most dimensions of effectuation can contribute to leveraging customer co-creation activities in developing a creative concept.

Firstly, means-driven firms are able to advance from opportunity recognition to ongoing co-creation based on their internal knowledge (Coviello & Joseph, 2012). Given this, they can more easily explore external resources and reach out to customers who can fill gaps and create value (Mahr et al., 2014). Next, it furthers the notion that a means-driven approach increases the perceived existence of available resources (Blauth et al., 2014). Similar to the work by Cohen & Levinthal (1990) on absorptive capacity, it is important for firms to utilize existing resources when faced with high environmental uncertainty (Brettel et al., 2012). Also, Cheng & Huizingh (2014) argue that resource orientation, which is concerned with deploying firms' internal resources, positively drives open innovation activities and innovation performance. By focusing on means that firms have already accumulated, firms are able to assimilate and apply expertise and knowledge from existing knowledge stocks to develop their new competences in co-creation (Brettel et al., 2012).

Secondly, it is expected that partnership dimension contributes to leveraging customer co-creation activities in developing a creative product concept. First of all, prior NPD creativity research shows that collaboration has a significant impact on new product

creativity (e.g., Sethi et al., 2001; Im & Workman, 2004; Im et al., 2013). A partnership oriented perspective of firm leads to the firms being able to collaborate with customers during the FFE, based on the evidence that a personal tendency to share knowledge and collaborate leads to creativity (Hoegl & Gemuenden, 2001).

Thirdly, agility plays an important role in leveraging customer co-creation activities in developing a creative concept. As discussed in the section 2.4.3, the concept of agility is concerned with processing newly coming information from customers and integrating it with new product ideas, which requires an analogical thinking process. Creativity and NPD research supports the fact that analogical thinking enhances creativity (e.g., Dahl & Moreau, 2002; Read et al., 2009a). Analogical thinking is a key element for generating ideas for new products by transferring existing knowledge to construct new ideas (Finke et al., 1992; Dahl & Moreau, 2002). In other words, new product practitioners can facilitate knowledge exchanges during co-creation activities with analogical thinking. Moreover, agility enables them to be open to alternatives (such as those suggested by customers) during co-creation activities, which can lead to more creative outcomes (Sternberg et al., 1997).

Finally, the control dimension is expected to contribute to developing a creative product concept in conjunction with customer co-creation activities. As discussed in the previous chapter, “control” is related to the mind-set of dealing with the uncertain future in the current situation, which is focusing on the controllable aspects of an unpredictable future (Sarasvathy, 2001). That is, NPD practitioners with effectuation logic tend to gather information through experimental and trial-and-error learning techniques aimed at first speculating about the unknown environment (Sarasvathy, 2001). Particularly, it is encouraged that mindful trial-and-error improves options for new products whilst also reducing uncertainty during NPD (Coviello & Joseph, 2012). Moreover, attempts of experimentation as early as possible enable NPD practitioners to converge into the

more relevant options for the new product concepts by removing unfeasibility (Chandler et al., 2011). Based on the discussion above, the thesis posits the hypothesis as follows:

H5a: The relationship between customer co-creation activities and the creativity of product concept will be stronger when effectuation in the FFE of NPD is higher.

3.2.6 Moderated Mediation of Effectuation

Within the theoretical framework, the question is whether customer co-creation activities in high/low levels of effectuation enhances early performance when they develop higher/lower creative concepts. To answer the question, one should include the co-creation and effectuation literature to support their impacts on performance (e.g., Brettel et al., 2012; Mahr et al., 2014). It is the extension of the moderating role of effectuation, investigating whether its impact would enhance early performance or not. Accordingly, firms with higher effectuation should develop higher creative concepts and firms developing higher creative concepts, in turn, enhance early performance.

Firstly, the reason why effectuation logic is also related to early performance is concerned with the notion that collaborating with customers during the FFE of NPD enables firms to reduce uncertainty and ambiguity (Griffin, 2002). Moreover, the reduced uncertainty attracts customers and gains their commitment, which enhances NPD performance (Brettel et al., 2012). For example, firms can test newly developed concepts with their pre-committed customers, rather than spending on more expensive, open market tests (Chandler et al., 2011). Coviello & Joseph's (2012) study shows early success outcomes of close and frequent relationships with users, such as a university laboratory in their study. The study also shows that selling early ideas to customers is beneficial in acquiring their pre-commitment (Coviello & Joseph, 2012).

Secondly, agile firms can recognize patterns from external resources, which, in turn, lead to enhance FFE effectiveness (O'Connor & Rice, 2001; de Brentani & Reid, 2012). Pattern recognition refers to perceiving "complex and seemingly unrelated events as constituting identifiable patterns" (Baron 2006: 106). During the FFE, it is important that a new product developer, as a boundary-spanning individual, receives external information during co-creation activities, and then can align to similar patterns within their recognizable prior knowledge (de Brentani & Reid, 2012). On the other hand, agility also means that new product developers rapidly adapt to emerging customer input by embracing the unexpected circumstances during co-creation activities (Biazzo, 2009). For example, during the FFE, flexibility enables firms to have customers explore the implication of product concepts early enough to adjust and meet customers' requirement, as well as to easily converge experienced knowledge from different product generations into the current NPD context (Thomke, 1997; Biazzo, 2009).

In sum, the author expects that the indirect effect of customer co-creation activities on early performance, through the creativity of product concept, will be contingent on a firm's effectuation. Therefore, H5b is hypothesized as follows:

H5b: Firms with higher effectuation, when they co-create with customers in the FFE of NPD, early performance is enhanced through the creativity of product concept.

Chapter 4 Methodology

4.1 Introduction

In the previous chapter, the conceptual framework and hypotheses were developed to address the research questions in the thesis. In response to these questions, the thesis takes a quantitative approach underpinned by a positivist philosophy. In such a philosophy, the nature of the research question considers investigating the theory applied in the model to establish scientific truth (Trochim, 2006). More specifically, a large scale cross-sectional survey is conducted to collect the data in order to analyse the conceptual framework and test the hypotheses. Basically, the approach resembles the suggestion from Creswell (2003) to set up research framework.

Next, the chapter elaborates on research design process, the specific procedures of survey development, data collection, and the analysis process. Particularly, the first section briefly compares various research philosophies to justify the choice of research methodology for this thesis, followed by further elaborations of quantitative research and survey method.

in the second section, it describes how to develop the survey questionnaire for the data collection, prepare for measures to operationalize constructs for the analysis, and lastly it discusses how to ensure the survey is ready for the administration and distribution.

The third section explains the data collection process including targeting the sample and getting the research ethics approval. Furthermore, it describes the process for obtaining good quality of data as well as examining outliers and distribution of the raw dataset.

The last section provides the data analysis procedure for the hypotheses testing before presenting specific findings. Moreover, it explains terminologies as well as elaborates the underlying mechanisms of the analysis procedure. Specifically, for the hypotheses test, the research mainly conducted PLS-SEM, as well as PROCESS Macro.

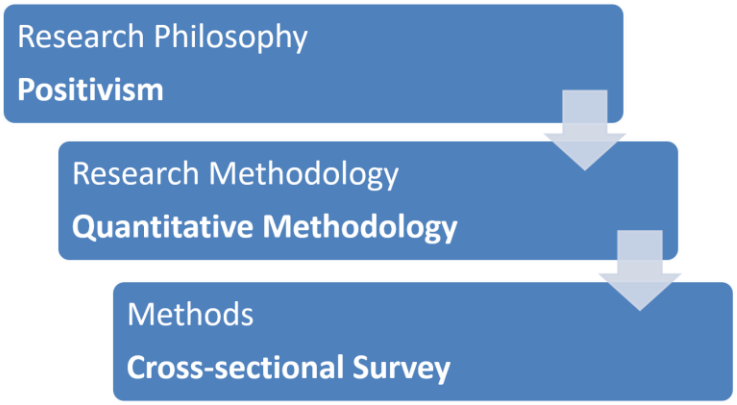


Figure 4.1 Choice of Methodology in the Thesis

4.2 Research Design

4.2.1 Research Philosophy

Once research questions have been set up, then research procedure to answer these questions needs to be designed to answer these questions. This process of research design embeds underlying assumptions on the nature of the phenomenon examined (ontology) and methods for understanding it (epistemology) (Van de Ven, 2007). Whether explicit or implicit, research philosophy, also called research worldview (Creswell, 2003) which relates to underlying view of development and nature of knowledge (Saunders, Lewis & Thornhill, 2011), needs to be identified and justified for the choice of methodology.

Ontology, which refers to the view of world as being, concerns with the issue that objectivism versus subjectivism (constructionism) (Saunders et al., 2011). Objectivism concerns that realities exist outside of mind, while subjectivism (constructionism) relates to a view that reality as individually constructed (Crotty, 1998).

Epistemology concerns with perspectives on methodology, also relates to providing philosophical foundation of possible knowledge and justification for its legitimization (Crotty, 1998). Like ontology, epistemology ranges from objectivism, which assumes an objective knowledge is a possibility, to subjectivism, which asserts the knower and known are interactive and inseparable (Crotty, 1998).

In this section, four research philosophies are listed with different combinations of ontology and epistemology. In this section, four research philosophies are briefly addressed, including pragmatism, interpretivism, critical realism, and positivism. Summary is also provided in Table 4.1. Discussing research philosophies clearly contributes to choosing an appropriate methodology in answering research questions of this research.

Pragmatism

In philosophy of science, pragmatism was regarded as an alternative to positivism and was aligned with instrumentalism[5] (Van de Ven, 2007). However, this view is free from choosing a certain perspective of philosophy and reality (Creswell, 2013). That is, researchers can explain what the reality is like according to their own value systems, allowing pluralistic ontological perspective. Moreover, pragmatists argue that the social world is constantly changing, but causal relations can be found through a snapshot of a moment (Johnson & Onwuegbuzie, 2004). Therefore, researchers who take pragmatism

[5] the view that scientific theories should be thought of primarily as tools for solving practical problems rather than as meaningful descriptions of the natural world. (de Neufville, 2017)

are free to choose the research methods, techniques, and procedures that best meet their research purposes (Creswell, 2003).

Pragmatists argue that the most important determinant of the epistemology and ontology is the research question (Creswell, 2003). Specifically, pragmatists focus on the "what" and "how" of the research questions, and any relevant data collection and methods can be used if they are likely to provide better insights to the questions (Creswell, 2003; Saunders et al., 2011). Therefore, pragmatists are more likely to adopt mixed methods approach, which combines or integrates qualitative and quantitative methodology (Creswell, 2003).

Pragmatism research is conducted in social, historical, political and other contexts, which mainly involves a human activity (Creswell, 2003). And mixed methods research might be able to provide the best understanding of a research problem under pragmatism. However, critiques of pragmatism argue that it is also important for researchers to be consistent in one paradigm throughout the study, unless it might affect the quality of research (Crotty, 1998). Furthermore, since pragmatism allows researchers to interpret their data analysis based on their own value system, it would not be able to present a clear posture for the discussion of generalisations of knowledge (Tashakkori & Teddlie, 2010).

Constructionism (Interpretivism)

Constructionism (social constructionism), which is often combined with interpretivism, is paradigmatic opposite of positivism (Creswell, 2003). Constructionism takes subjectivism ontology and epistemology (Denzin & Lincoln, 2005). Constructionists view reality as socially constructed, and the goal of social science as that of understanding what meanings individuals give to reality, not only to determine how reality works (Van de Ven, 2007). Specifically, constructivism researchers seek to the complexity of views

rather than narrowing meanings into a few categories (Creswell, 2003). Therefore, the goal of the research is to rely on the participants' views of phenomenon (Creswell, 2003).

Qualitative methodology is adopted to investigating constructivist research. Broad and general open-ended questions are asked to participants about their interactions with other persons or specific contexts. Researchers need to carefully involve in participants' narrative on their historical and cultural settings. It enables researchers to interpret and understand their interaction with participants based on their own backgrounds and experiences. The constructivism researchers intend to make sense of the meanings of others out of the data collected in the field. This procedure is suitable to inductively generate or develop a theory or pattern of meaning (Creswell, 2003).

Critical realism (Post-positivism)

Critical realism, which is ontology of post-positivism, argues that there is an external reality or the "real" world, but scientists are just able to understand, and imperfectly discover it (Bryman & Bell, 2015). That is, this view takes an objective ontology and a subjective epistemology (Van de Ven, 2007). Critical realism is rooted from both positivism and constructivism (Denzin & Lincoln, 2005). It assumes that knowledge is fallible and theory-laden, while the world exists independently (Sayer, 1992). Contrary to positivism, critical realists are satisfied with including theoretical terms that are not directly amenable to observation, so as seek regularities at the level of objects and structures, not in the empirical data (Bryman & Bell, 2015).

The goal of research based on post-positivism is to develop multiple answers of phenomena that is examined (Pawson & Tilley, 1997). Critical realists argue that researchers might be able to understand the flow of phenomena that they try to understand, but it is imperfect (Saunders et al., 2011). Their focus is to understand the meaning of social phenomena that is examined after measuring it (Sayer, 2000).

Therefore, researchers can identify what they do not see through the practical and theoretical processes of the social sciences (Bhaskar, 1989).

With this, post-positivism is flexible on the use of research methods. Research based on the post-positivism is more likely to focus on theory-building, even though research on theory testing is possible under the assumption that the applied theory is fallible (Healy & Perry, 2000). Furthermore, critical realists are more likely to do multi-level study. With critical realism perspective, researchers study changes of phenomena when structures, procedures and processes of social organizations across levels (e.g., individual, group, and organization level) interact with each other (Saunders et al., 2011).

Positivism

The present thesis adopts a *positivistic* epistemology to position the nature of research. That is, it stems from the research philosophy of *positivism*, which maintains that the social world can be studied based on procedures as a natural science (Bryman & Bell, 2015). The research of positivism can entail a process of deductive research described in Figure 4.2. Particularly, by following the process of deduction, positivistic research is to test the theory of interest to obtain generalizations about the relationships drawn from the theory. Moreover, in order to do this, the research task is to collect data so that generalizable hypotheses can be tested (Bryman & Bell, 2015). These hypothesized relationships, which are developed based on the "conceptual framework" consisting of "analytical constructs[6]," are examined using the collected data. After the analysis, conclusions can be drawn by explaining and confirming these hypothesized relationships. This will give insights and implications for answering research questions for the phenomena (Bryman & Bell, 2015).

[6] Also referred to as latent variables, which are not directly measured.

Similarly, in this thesis, it uses the co-creation paradigm and effectuation theory to examine their effectiveness in NPD. After developing the conceptual framework and hypotheses, data will be collected from NPD practitioners and analysed to test these hypotheses. At the end of the research, it aims to accumulate theoretical knowledge on the co-creation paradigm and effectuation theory, as well as to provide managerial implications to firms working with customers in the FFE of NPD. Therefore, the philosophy underpinning the present research is embedded in positivism that follows the deductive process. In the next sub-section, it details more on the methodological choice of this research under positivistic position.

Table 4.1 Comparisons of Research Philosophies

Dimensions	Positivism	Constructivism (Interpretivism)	Pragmatism	Critical realism
Background	Inspired by Empiricism, Instrumentalism	Scepticism about foundation of Western philosophy (post modernism)	The relation of theory and praxis and specifically in the predetermined outcomes of an inquiry	Existent of a mind-independent reality and the ability of a theory to capture partial aspect of reality (conjecture realism etc)
Ontology	External, objective and independent of social actors	Socially constructed, subjective, may change, multiple	External, multiple, view chosen to best enable answering of research question	Is objective. Exists independently of human thoughts and beliefs or knowledge of their existence (realist), but is interpreted through social conditioning (critical realist)
Epistemology	Only observable phenomena can provide credible data, facts. Focus on causality and law like generalisations, reducing phenomena to simplest elements	Subjective meanings and social phenomena. Focus upon the details of situation, a reality behind these details, subjective meanings motivating actions	Either or both observable phenomena and subjective meanings can provide acceptable knowledge dependent upon the research question. Focus on practical applied research, integrating different perspectives to help	Observable phenomena provide credible data, facts. Insufficient data means inaccuracies in sensations (direct realism). Alternatively, phenomena create sensations which are open to misinterpretation (critical realism). Focus on explaining within a context or

			interpret the data	contexts
Approach	Deduction	Induction	Mixed	Abduction, Retroduction
Methodology	Quantitative	Qualitative	Mixed	Quantitative, Mixed
Methods	Survey, Experiment, Quasi-experiment	In-depth Interview, Focus group, Ethnography, Case study,	Case study (interview and survey) triangulation, Ground theory	Action research, case study

Sources: Creswell (2003); Van de Ven (2007); Saunders et al. (2011: 119)

4.2.2 Research Methodology

The present thesis chooses a quantitative approach for its methodology. Researchers need to choose a proper methodology in order to solve research questions. *Methodology* is mainly related to the research philosophy that a researcher chooses. In particular, the *quantitative* methodology is suitable for the deductive approach with a positivistic point of view, while the qualitative methodology can be adopted to the inductive approach with interpretivism (Bryman & Bell, 2015). Furthermore, the quantitative approach will be suitable to adopt if research questions concern (1) the identification of factors that affect an outcome, (2) the utility of an intervention, and (3) understanding the best predictors of outcomes (Creswell, 2003).

The research questions which this research is interested in answering are concerned with investigating whether the currently growing paradigm, which is customer co-creation, empirically improves firms' outcomes, as well as testing effectuation theory on leveraging of customer co-creation in the FFE of NPD. The nature of the research questions of the present research justifies the adoption of a philosophical point of view and methodology as discussed above.

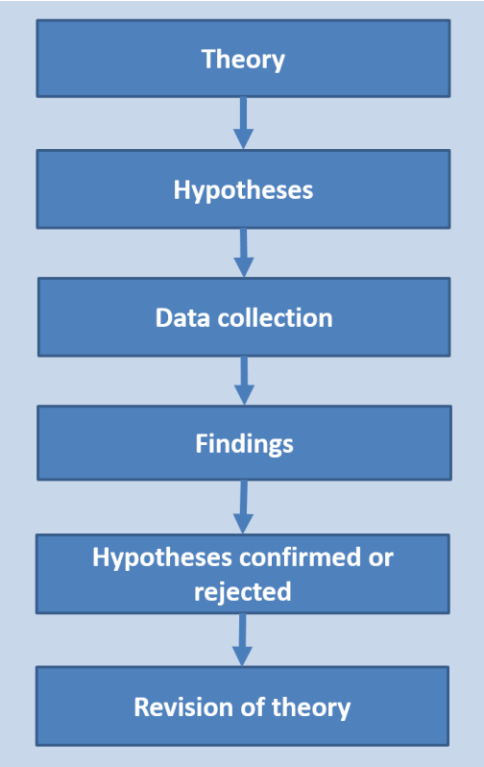


Figure 4.2 The Process of Deduction

Source: Bryman & Bell (2015)

Therefore, with a positivistic approach following a deductive process for this research, adopting the quantitative approach is appropriate to resolve research questions and to examine the conceptual framework developed through the literature review. Quantitative research focuses on quantification in the collection and analysis of data (Bryman & Bell, 2015). Specifically, the research process in this thesis entails a deductive approach, which examines research questions based on the theory. Moreover, quantitative research tends to incorporate practices and a conceptual framework based on theory. That is, since the research is interested in investigating whether co-creation activities that firms utilize would contribute to developing successful concepts in the FFE of NPD, actual cases are gathered as data, then analysed to test the conceptual

framework and hypotheses. Finally, the quantitative research views social reality as an external, objective reality (Bryman & Bell, 2015). In this regard, this research measures each construct to quantify and analyse within the conceptual framework and link to outcome variables to be able to explain the relationships among constructs. The process of quantitative research (as can be seen Figure 4.3) follows and details the basis of the deductive process (Figure 4.2).

Moreover, since the conceptual framework consists of latent constructs, researchers should carefully consider the issue of how these constructs are measured throughout the methodology of the research. Usually, once researchers figure out proper methods under methodological approach for their issues, important steps need to be taken that to choose appropriate indicators[7] to measure the constructs. This is referred to as *operationalization*. Because, specifically in social sciences, a *construct* represents a certain concept that explains an aspect of the social world or phenomenon of interest. That is (also known as a *latent variable* in social science) focal constructs in the conceptual framework are usually unobservable, nor a directly quantifiable concept in the real world. Therefore, the process of operationalization should be carefully implemented in the research design phase of the research.

The next section further elaborates the development of the research method- a large scale cross-sectional survey method.

[7] Also called items or manifest variables, which are the directly measured proxy variables (Hair et al., 2015).

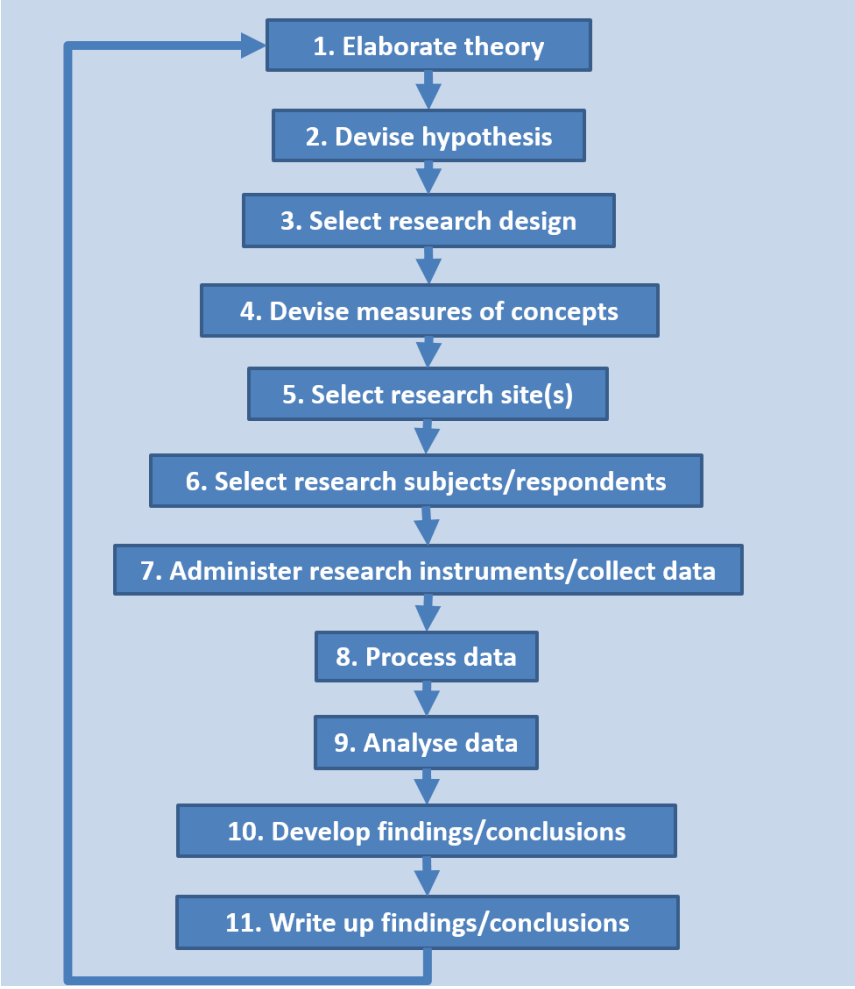


Figure 4.3 The Process of Quantitative Research

Source: Bryman & Bell (2015)

4.2.3 Research Method: Cross-sectional Survey

This research uses a cross-sectional survey design as the *method* for the data collection. Methods refer to techniques for collecting and analysing data for investigating research questions of interest under the certain methodological perspective (Creswell, 2003).

A cross-sectional survey design is the method for the collection of quantitative data at a certain point in time with questionnaire using more than one case (Bryman & Bell, 2015).

In a quantitative methodology approach, the cross-sectional survey is developed with a systematic and structured procedure. Thus, it provides a quantitative or numeric description of a population by analysing the sample of the population (Creswell, 2003). Questions in the structured questionnaire are the operationalized measures of constructs in the research model. When respondents answer the same set of questions (mostly multiple choices type of questions: e.g., Likert scaled questions) in questionnaires, then each response of survey can be coded and aggregated as quantifiable data to test relationships among variables in the analysis (Bryman & Bell, 2015).

Therefore, the survey is a useful method to collect data for the quantitative research approach for the following reasons. Firstly, sample results from survey may provide the researcher with statistical evidence to generalize or draw inferences about the population (Creswell, 2003). Recalling that the main purpose of this thesis is to examine the growing customer co-creation paradigm in NPD in firms, research gaps found based on the literature review suggest to use a large-scale survey method to generalize the co-creation paradigm (Hoyer et al., 2010; O'Hern & Rindfliesch, 2010), as well as test the predictability and capability of effectuation theory in the NPD context (Read et al., 2009a; Perry et al., 2012). In fact, the survey method enables researchers to provide a quantified structure to measure relationships around constructs in the research model as the scientific evidence once the data analysis is done. As a result, generalizability of the paradigm and theory can be gained convincingly.

Secondly, the survey method is beneficial when researchers try to quantify latent variables of their interests. In order to be operationalized in the context of research, once the concept is defined, a survey is carefully developed based on a scientific guidance from social science scholars e.g., survey method literature on developing survey research (Dillman, 2000; Creswell, 2003). Usually, these latent variables are asked as a form of questions through the operationalization (Babbie, 2015). Specifically,

these questions are a measure of concept, in other words *proxies/indicators*, which measure the concept (latent construct), in a way asking the degree to which the concept in the certain context and letting respondents answering choosing one point ranged between a continuum from the least to the most, which is known as the Likert scale.

Most questions in the survey used for this research adopt the Likert scale type of questions to measure key latent constructs. The thesis also takes careful approach in adopting measures of constructs in the survey as more details are presented in the latter section of this chapter. After choosing methodology and a method for the data collection as well as setting the framework with construct definition with theoretical background, a survey questionnaire is carefully designed and developed by following a scientific procedure to minimize potential method bias/measurement error (Hair, Celsi, Money, Samouel & Page, 2015). Next section discusses more details on the procedure of the survey development.

4.3 Survey Development

This section elaborates the survey development procedure for the data collection. Mostly, this procedure includes the issues on measuring constructs of interests and collecting data for analysis (step 3-7 in the Figure 4.3). After deciding to adopt the survey method for the data collection and analysis for answering the research questions, given that conceptual framework and hypotheses have been set up, the next thing to do is to develop and identify appropriate measures of focal constructs in this research framework. That is, researchers need to figure out how they measure the concept, specifically in the given context of study, which is called *operationalization* (Babbie, 2015; Bryman & Bell, 2015).

With a quantitative approach, the construct needs to be properly measured. The process of assigning numbers to a variable according to a set of rules is referred to as *measurement* (Hair et al., 2015). In the survey, indicator is presented in order to measure a certain latent construct. Usually, multiple indicators form a scale (e.g., Likert scale) and are used to measure it mainly because using multiple indicators is anticipated to afford improved accuracy in the analysis. It is also assumed that using multiple indicators is more likely to capture all the different aspects of a concept (Hair, Hult, Ringle & Sarstedt, 2016). The author will go further in this sub-section about the issue how and why these measures used in this thesis are categorised.

4.3.1 Measures

The section specifies the procedure and use of multiple indicators in each focal construct. Specifically, in use of multi-item indicators to measure a certain construct, it is important to distinguish if the latent construct is either a formative or reflective construct (Diamantopoulos & Winklhofer, 2001; Jarvis, MacKenzie & Podsakoff, 2003). If a latent construct uses reflective indicators to measure it, all possible indicators which represent the domain of the construct can be used to measure it (Nunnally & Bernstein, 1994). That is, these indicators show high internal correlation in the construct. Therefore, these indicators are interchangeable, and removing a certain indicator based on measurement model analysis does not affect the meaning of the construct (Hair et al., 2016). In contrast, in using formative indicators to measure the construct, each indicator influences to form a construct by means of linear combination (Hair et al., 2016). Unlikely with reflective indicators, formative indicators are not interchangeable. Thus, the notion that each indicator for a formative construct contains a specific aspect of the domain of construct makes it possible to imply that omitting an indicator possibly changes the nature of the construct (Hair et al. 2016). Therefore, in order to precisely capture the content of the construct, it is important to include all the potential indicators of the formative constructs (Diamantopoulos & Winklhofer, 2001).

Both reflective and formative multi-item measures are adapted for measuring key constructs from the survey. In developing the measurement instrument, scale development procedures, such as expert review and pre-test for scale refinement were carefully followed. Well-defined and validated scales were utilized from existing literature. Details on specific refinement procedures and scale development are elaborated below. The key constructs (customer co-creation activities and effectuation) were considered as either 2nd order formative or reflective constructs based on criteria from previous research (Diamantopoulos & Winklhofer, 2001; Jarvis et al., 2003).

Traditional Customer Facing Activities:

The construct measures the use of a traditional type of customer facing activities. Based on the conceptualization in the literature review chapter, traditional customer facing activities are characterized as "passive" and "reactive" methods of getting information from customers (Witell et al., 2011; Cui & Wu, 2017). Traditional customer facing activities are identified through prior literature (Griffin & Hauser, 1993; Urban & Hauser, 1993; Witell et al., 2011) and include observation, survey, focus group interview, in-depth interview, netnography, and concept testing methods. Measures use a 5-point Likert scale ranging from 0% to 100% asking percentage of the time spent on all customer facing activities during the FFE of the recent NPD. These items in traditional customer facing activities measures are first order formative indicators.

Table 4.2 Selected Measure of Traditional Customer Facing Activities

Please indicate what % of the time you spent on the following customer facing activities in the NPD project (items collected from Griffin & Hauser, 1993; Urban & Hauser, 1993; Witell et al., 2011).
Observation of customers
Customer Surveys
Focus Groups
In-depth Interviews
Netnography
Concept testing
Others

Customer Co-creation Activities:

The construct measures the use of customer co-creation activities in terms of generation and evaluation activities in the FFE. Measures, which are a 5-point Likert scale, the same as those of traditional customer facing activities, were developed by adopting definitions from the prior literature on co-creation activities (e.g., O'Hern & Rindfleisch, 2010; Piller et al., 2010) as seen in the literature review chapter. Then these customer co-creation activities are categorized based on whether their characteristics could be either generation or evaluation activities. In the first stage, 15 items of co-creation activity measures were developed. As can be seen in table below, 8 items of co-creation activities were those in generation, and 7 items in co-creation activities were those in evaluation. For example, idea contests are categorized as a generation activity where customers submit their ideas for new products, while idea screening is considered as an evaluation activity by customers in NPD. Even though most activities can include both generation and evaluation activities, these also can be categorized by either generation or evaluation activities based on the focus on these activities. Once these measure items were developed, then six co-creation scholars were contacted. Detailed feedback on these scale items as to whether the included items (co-creation activities) make sense was then received (DeVellis, 2003). Specifically, each item was evaluated by evaluators based on criteria regarding wording, timing, and logic of indicators as well as maximizing content validity. The construct is treated as the second order formative-formative one, since the measure with each customer co-creation activity forms the construct (Diamantopoulos & Winklhofer, 2001).

Table 4.3 Selected Scale Items of Customer Co-creation Activities

Customer Co-creation activities (items adapted from O'Hern & Rindfleisch, 2010; Piller et al., 2010)
Generation (formative measures, 8 items, 5-point Likert scale) Please indicate what % of all the time you spent on the following customer co-creation

activities in generation phase in the new product development project

1) We arranged idea contests drawing on the general public or a specific target customer group to make use of their expertise, skills or creativity.
2) We arranged crowdsourcing (outsourcing to the crowd by using online platform such as Innocentive) to develop ideas for new products with customers.
3) We engaged in customer communities focusing on generating novel ideas and concepts.
4) We held co-creation workshops with customers to develop ideas for new products.
5) We applied creative problem-solving techniques to develop ideas for new products with customers.
6) We connected product-related discussion customer forums to gather customers' usage experiences in using the product.
7) We utilized idea generation toolkits to let customers participate.
8) We held lead users meetings to develop ideas for new products.

Evaluation/selection (formative measures, 7 items, 5-point Likert scale)
Please indicate what % of all the time you spent on the following customer co-creation activities in evaluation/selection phase in the new product development project

1) We arranged on-line voting/ratings to allow customers to cast a vote or rate for selecting new product ideas.
2) We applied idea screening, which let customers evaluate ideas.
3) We arranged crowdsourcing to evaluate ideas/concepts for new products with customers.
4) We held co-creation workshops with customers to evaluate ideas/concepts for new products.
5) We applied creative problem-solving techniques to prioritize developed new ideas/concepts for new products with customers.
6) We provided customer toolkits to let customers evaluate new products ideas/concepts.
7) We held lead users meetings to evaluate developed ideas/concepts for new products.

Effectuation Logic

The construct measures the degree of each dimension of effectuation (means driven, affordable loss, partnerships, agility, and control) and is the second order reflective-formative construct (Perry et al., 2012). Measures in each dimension are a 7-point Likert scale ranging from 1 (Strongly disagree) to 7 (Strongly agree). The author mainly adapted newly developed measures from recent research (i.e., Chandler et al., 2011; Brettel et al., 2012; Werhahn et al., 2015). However, during the first scale refinement

procedure, each item was carefully adapted to accommodate within the research context (FFE of NPD), by changing the wording and consideration of concept delineation from theory. Thus, a total of 47 indicators of effectuation with five dimensions were initially prepared.

Six effectuation theory researchers were contacted to review these adapted items to assess if they are conceptually matched with the underlying dimension and to assess the content validity of fitting with the research context following the recommendation of scale development literature (Rossiter, 2002; DeVellis, 2003). Furthermore, each item was refined and revised by these experts based on criteria regarding wording and logic of indicators, specifically avoiding redundancy, multiple negatives, or double barrelled meaning. As a result of the assessors' evaluation of the item's relevance to the construct, a total of 12 indicators were removed due to the lack of their relevance. Then the author refined these indicators following their feedback, and finalized the total of 35 items with five dimensions to include the survey. Details of selected indicators are listed in the following table.

Table 4.4 Selected Scale Items of Effectuation

Effectuation (2nd order formative construct, 7-point Likert scale)
Partnerships (adapted from Chandler et al., 2011; Brettel et al., 2012) As we worked with any external parties (industrial customers, end consumers, suppliers, competitors, and/or universities during the front end/early stages of the new product development project, Please indicate the extent to which you agree or disagree with the following statement 1) we tried to manage the uncertainty of the new product development project (NPD) through external partnerships. 2) we worked with potential partners to jointly shape the future. 3) we jointly developed new product ideas with our partners. 4) our focus on the reduction of uncertainty led us to approach potential partners. 5) before implementing the project, we received commitments from our partners. 6) in order to reduce uncertainties, we started partnerships. 7) we used agreements with partners to reduce uncertainty. 8) commitments from our partners guided the direction of the project. 9) we actively combined resources with our partners.

Means-driven (adapted from Chandler et al., 2011; Brettel et al., 2012)
During the front end/early stages of the new product development project,

1) our NPD project was specified on the basis of the resources that we already have.
2) the goal of our NPD project was vaguely defined in the beginning.
3) existing resources formed the starting point for the project.
4) the process converged towards a project goal on the basis of existing resources.
5) the project outline was predominantly based on existing resources.
6) existing resources significantly impacted on the framework of our NPD project.

Affordable loss (adapted from Chandler et al., 2011; Brettel et al., 2012)
During the front end/early stages of the new product development project,

1) considerations about minimizing potential losses were decisive for the selection of the new product concept
2) preliminary project budgets were approved on the basis of considerations about minimizing acceptable losses.
3) the selection of the new product concept was mostly based on a minimization of the downside consequences in the event of project failure
4) we compared different NPD concepts on the basis of what we were willing to lose
5) early decisions on capital expenditures were primarily based on potential losses
6) we were careful not to commit more resources than we could afford to lose.
7) we were careful not to invest more money than we were willing to lose.
8) we were careful not to make so many financial commitments that if our NPD project didn't work out, the organization would be in trouble financially

Agility (adapted from Chandler et al., 2011; Brettel et al., 2012)
During the front end/early stages of the new product development project,

1) we always reacted on surprise findings – if necessary the project goal was then adjusted.
2) we always tried to integrate surprising results and findings – even though this was not necessarily in line with the original project goal.
3) we were open to new information that emerged during the process.
4) we took advantage of new opportunities as they arose.
5) we tried to look at setbacks as potential sources of new opportunity.
6) we revised what we were doing as new information emerged.
7) we were willing to make use of new information.

Control (adapted from Werhahn et al., 2015)
During the front end of the NPD project, please indicate to what extent you agree or disagree with the following statements.

1) We consider it important that we attempt to influence trends.
2) We consider it important that we attempt to shape the environment we operate in.
3) We consider it important that we attempt to co-create future markets.
4) We consider it important that we attempt to proactively design our environment with others.
5) We consider it important that we are always looking for new opportunities.

Creativity of Product Concept

The construct measures the degree of creativity of product concept as a result of NPD during the FFE, and it is the second order reflective-formative construct. Measuring the creativity of product concept has previously been shown to be one way of assessing FFE performance (Eling et al., 2014), mainly because new product creativity is typically assessed as a major NPD performance metric (Moorman, 1995; Im & Workman, 2004; Im et al., 2013). Therefore, the study adapted an eight 7-point Likert scales assessing the creativity of product concept (4 items for Novelty and 4 items for Meaningfulness) from prior research measuring NPD creativity (Im & Workman, 2004).

Table 4.5 Adapted Measure of Creativity of Product Concept

Creativity of Product Concept (2nd order reflective construct, adapted from Im et al., 2013)
Novelty (4 items, 7-point Likert scale)
After the concept evaluation stage, the selected new product concepts
1) was really "out of the ordinary."
2) could be considered as revolutionary.
3) were stimulating.
4) showed an unconventional way of solving problems.
Meaningfulness (4 items, 7-point Likert scale)
After the concept evaluation stage, the selected new product concepts
1) were relevant to customers' needs and expectations.
2) were considered suitable for customers' desires.
3) were appropriate for customers' needs and expectations.
4) were useful for customers.

Early Performance

The construct measures the degree of potential of developed concepts from the FFE as a result of activities in the FFE. It is also the second order reflective-formative construct

with two dimensions which are concept competitiveness potential and ability to attract capital. Considering the notion that it is inappropriate to use most traditional standard measures in the FFE, following O'Connor's (1998) argument that assessments of market potential, size, and growth are not relevant factors during early stages of NPD. Prior research has already developed appropriate measure to assess FFE performance (e.g., Martinsuo & Poskela, 2011; Reid et al., 2015). Specifically, it is important for firms to measure how the developed concepts are potentially competitive (concept competitive potential: Martinsuo & Poskela, 2011) as well as if these concepts are given future fund allocation for further NPD as a proxy to measure financial performance of FFE activities (ability to attract capital: Reid et al., 2015). Therefore, concept competitive potential was adopted as one of the early performance measures. Concepts might be sufficiently mature and provide reasonable references for firms to envision their product advantage later on (Martinsuo & Poskela, 2011). Furthermore, the ability to attract capital was measured with a 5-item Likert scale (Reid et al., 2015). Reid et al. (2015) used this construct as a proxy to capture early success of NPD. This construct stems from notions around venture capital where entrepreneurs try to obtain funding for their early ideas (Zider, 1998; Timmons & Spinelli, 2004). Similarly, product managers might be able to acquire some investment from stakeholders or senior management with product concepts emanating from the FFE of NPD.

Table 4.6 Adapted Measures of Early Performance

Early performance (2nd order reflective construct) Competitive potential of new product concepts (5 items, 7 point Likert scale, adapted from Martinsuo & Poskela, 2011) Please indicate the degree in which you expected from the concepts. 1) The product will generate a sustainable competitive advantage for our organization 2) The product will offer unique features to customers, compared to competing products. 3) The product will solve important customer problems. 4) The product will boost superior price/performance features, compared to competing products. 5) The product will reach high customer satisfaction.

Ability to attract capital (5 items, 7 point Likert scale, adapted from Reid et al., 2015)
The new product concepts contributed to

1) ability to be more attractive to potential alliance partners has been (will be) enhanced.
2) average growth in company employment stemming from involvement.
3) cash flow.
4) ability to attract capital.
5) amount of funding (internal and external) compared to initial request.

Control Variables:

To control for the effects of other variables on creativity of product concept and early performance in the conceptual model, several control variables are included. They include (1) firm size, (2) project innovation type (Radical vs. Incremental project), (3) customer base (industrial customer, end consumer, and both), and (4) industries (manufacturing vs. non-manufacturing sector).

Firstly, firm size measures the number of employees ranging from 50 to over 1000 (medium and large sized firms) (Mahr et al., 2014). Even though this research focuses more on medium and large sized firms, different firm size might influence the conceptual model in this study. Specifically, since this research is interested in applying effectuation theory to medium and large sized firms, controlling firm size would be necessary to focus on the role of effectuation in the model.

Secondly, project innovation type relates to whether the nature of project is a radical innovation project or an incremental innovation project. Radical innovation relates to developing really new or new-to-the-world type of product, while incremental innovation focuses on refining or enhancing the existing products (Song & Montoya-Weiss, 1998; Crawford & Di Benedetto, 2008; Obal, Kannan-Narasimhan & Ko, 2016). Prior research has shown the difference between radical and incremental innovation processes in many circumstances (e.g., Dewar & Dutton, 1986; Subramaniam & Youndt, 2005). Therefore, project innovation type needs to be controlled in this research context.

Thirdly, this study controlled the customer base, which is measured by firms' target of their NPD (1 = industrial customers, 2 = end user consumers, 3 = both industrial customers and end consumers). The customer base needs to be controlled, because it might be reasonable to contemplate that NPD for industrial customers and NPD for end user consumers might be different (e.g., Bonner & Walker, 2004).

Lastly, industry type is categorized by either manufacturing or service industry. Mostly, prior literature considers co-creation in manufacturing sectors (e.g., Gruner & Homburg, 2000; Al-Zu'bi & Tsinopoulos, 2012), while other research has also discussed co-creation in new service development (e.g., Alam, 2006; Perks et al., 2012). Therefore, it needs to be controlled in this model.

Table 4.7 Measures of Control Variables

Control variables
Firm size: Number of company employees (approximate)? (e.g., Mahr et al., 2014; Candi et al., 2016) Below 50, 51 – 250, 251- 500, 501-1000, Over 1000
Innovation type (e.g., Song & Montoya-Weiss, 1998): Radical NPD project, Incremental NPD project
Customer base (e.g., Mahr et al., 2014): Industrial customers, End consumers, Both Industrial customers and end consumers
Industry (e.g., Mahr et al., 2014): Manufacturing, Non-manufacturing (Service and others)

4.3.2 Confirmation of Survey

Once all measures of constructs are confirmed for use in the survey, a questionnaire is developed throughout the online survey tool, "Qualtrics" website. Employing an online

survey tool is becoming a common practice in research for the survey method (Sue & Ritter, 2011; Engel et al., 2014). Specifically, Qualtrics provides a convenient platform to design a questionnaire in a way that it enables respondents to easily answer all questions without missing any or exiting the survey if a respondent has not properly answered qualification questions. In addition, it can manage the responses and simultaneously put the data into a dataset file after the data collection is done (e.g., csv format file). Therefore, researchers can save time on data collection and management.

Once a questionnaire is developed through Qualtrics, it is reviewed through colleagues who have experiences on survey research as well as NPD practitioners on its (1) logical flow, (2) easiness on understanding questions, and (3) time to finish.

4.3.3 Research Ethics

Prior to distributing the questionnaire to the target respondents, it is required to gain approval from the ethics committee of University of Nottingham, Business School. Following the Data Protection Act (1998), the research ethics mainly focus on the issues that the questionnaire in use for the data collection contains the consent that respondents agree with the form and voluntarily participate in answering the questions. Moreover, the questionnaire includes the information sheet inside of it containing all relevant information about the data collection procedure, such as (1) the research objectives, (2) the identity of the researcher with contact details, (3) a statement that ensures the security of collected data and anonymity of participants, (4) and that of potential harms/risks or benefits to participants by answering it. The research ethics committee carefully reviewed the questionnaire with the filled out research ethics form together and granted the approval of data collection to the researcher in February 2016[8].

[8] The approval document is presented in Appendix 2.

4.4 Sampling and Data Collection

This section describes data collection procedure with descriptive statistics from the collected sample. First part focuses on the sampling procedure for the data collection, followed by the second part which presents demographic statistics of the sample used in the analysis.

4.4.1 Target Sample

In order to answer the research questions, this research chooses a large scale cross-sectional survey for the research method. It is expected to gather data from each NPD project in each firm, therefore it becomes the unit of analysis. Again, the research intends to take a large-scale survey in order to obtain the generalizability of the customer co-creation paradigm, as well as to test whether employing effectuation theory in a NPD context is beneficial for firms. Therefore, the survey can be given to firms that collaborate with customers in the FFE of NPD. However, not every firm adopts customer co-creation activities in their NPD. However, the European Community Innovation study estimated that about 27% of firms work with customers in their innovation process (Eurostat, 2013). Therefore, it collects as many cases of customer co-creation as possible by controlling firm specific factors such as innovation type, project type, target customer, and firm size. Then, it is analysed in the results chapter.

Furthermore, the survey is launched targeting medium and large firms (more than 50 employees) as firm size is used as one of control variables, because it is assumed that a NPD project is well established as a project by project operation in the medium and large firms rather than in small firms (O'Connor & Rice, 2001). Moreover, it is another aim of this research to expand effectuation theory in the FFE of NPD context in medium and large firms, since the theory is well applied in early stage of developing small and start-up businesses, but not yet tested in the medium and large firms. In addition, the survey is distributed to firms in the USA and the UK as these countries represent a

growing paradigm of customer co-creation (e.g., Payne et al., 2008) and a convenient way to collect data in countries where the questionnaire is in English. In sum, therefore, the sample domain ranges from medium and large firms with experiences of customer co-creation in the FFE of NPD (Mahr et al., 2014) and located in the UK and the US.

The survey is distributed to new product managers/professionals in medium and large size firms of a wide range of industry sectors in UK and the US by working with Qualtrics. Qualtrics offer not only an online survey tool in their website, but they also have panels of firms so that they help researchers to collect the data from the target sample. They are capable of distributing the survey and contacting new product professionals via their panels which meet the criteria for this study.

Specifically, the qualification questions are included in the survey to screen out firms that do not satisfy the following criteria for sample selection. Firstly, managers/ professionals must have experience working on a NPD in the past 2 years. Secondly, they are asked if they have worked on the FFE. And last, but the most important question, is whether they have worked with customers in the FFE of NPD.

Table 4.8 Qualification Questions within the Questionnaire

Qualification Questions
• Where is your company located? (marking neither UK nor USA makes out of survey) • Number of company employees (approximate)? (choosing Below 50 makes out of survey) • Have you worked on NPD project for the last 2 years? • Were you involved in the front end of the project? • Did you work with customers (e.g., industrial customers, end consumers) in the NPD project? (Marking No makes out of survey)

4.4.2 Data Examination

After the data collection process was finalized, collected data was managed in order to prepare for the path analysis for the testing of the hypotheses. Specifically, during this data management procedure, issues including missing data, suspicious response patterns, outliers and sample distribution need to be examined (Hair, Black, Babin & Anderson, 2010; Hair et al., 2016).

Firstly, missing data can be managed by asking study participants to answer all questions in the survey. Secondly, suspicious response patterns are determined by checking response time answering the questionnaire. Cases were screened out from the final data set if the respondent is finished within 3 minutes and 20 seconds (200 seconds) given that the average response time is about 9 minutes. In addition to this, an attention filter was inserted in the questionnaire to prevent straight lining of answers. Also, a visual inspection of the responses with the raw dataset was carefully done to detect any suspicious response patterns.

After the data collection, outliers and sample distribution usually need to be examined in order to prepare the data set for the analysis with CB-SEM method. However, these procedures are not seriously considered with the collected dataset for this study, because PLS-SEM is nonparametric statistical method, which doesn't assume that the data distribution needs to be normal (Hair et al., 2016). Particularly, the author identified outliers in the sample by measuring Mahalanobis distance[9], and then analysed the structural model after removing them. The results were consistent with the data analysis including outliers. Therefore, the author decided to keep these outliers in the dataset based on the notion that the consistency of data analysis with and without

[9] This is the one of popular techniques of multivariate outlier detection (Rousseeuw & Van Zomeren, 1990).

outliers should not be the reason to remove the outliers (Sarstedt & Mooi, 2014; Hair et al., 2016).

Throughout the careful data examination procedure, a total of four cases were removed from the original 209 responses mainly due to the lack of variability of these responses. Therefore, 205 usable responses were finally prepared for further data analysis (out of 3,619 surveys sent out: response rate: 17.65%).

4.4.3 Sample Demographics

After the data collection and management procedure, 205 usable responses were prepared for the data analysis. Firstly, a sample size of 205 is sufficient sample size for using PLS-SEM (Hair et al., 2016). Even though the PLS-SEM method is advantageous in requiring a relatively small sample size versus other methods such as CB-SEM, experts recommend obtaining a sufficient sample size that ensures the results are robust, as well as the model being generalizable (Reinartz, Haenlein & Henseler, 2009; Hair et al., 2016). According to the ten times rule, the general rule of thumb for determining the sample size when using PLS-SEM is that the sample size should be equal to the larger of either (1) 10 times the largest number of formative indicators used to measure a single construct or (2) 10 times the largest number of structural paths directed at a particular construct (Barclay, Higgins & Thompson, 1995; Hair et al., 2016). In this regard, the sample size of this study is sufficient enough to satisfy this 10 times rule, given that customer co-creation in generation, a formative construct, has 8 indicators, requiring at least an 80 sample size for this study. Or applying the second condition requires about a 100 sample size, given that about 10 paths direct at one of early performance (e.g., ability to attract capital).

Next, the sample demographics are identified. About half of responses are from firms located in the UK (50.2%). The sample contains firms of different sizes (51-250: 26.3%, 251-500: 24.4%, 501-1000: 22.9%, over 1000: 26.3%), showing firms are quite evenly

distributed in terms of size. Also, the sample includes 74.6% of firms in manufacturing industry, 25.4% from services and other sectors. 57.6% of firms deal with both industrial customers and end consumers, while 17.1% of firms and 25.4% of firms only deal with industrial customers and end consumers respectively. 42% of the sample focuses on radical innovation projects, while 58% on incremental innovation projects.

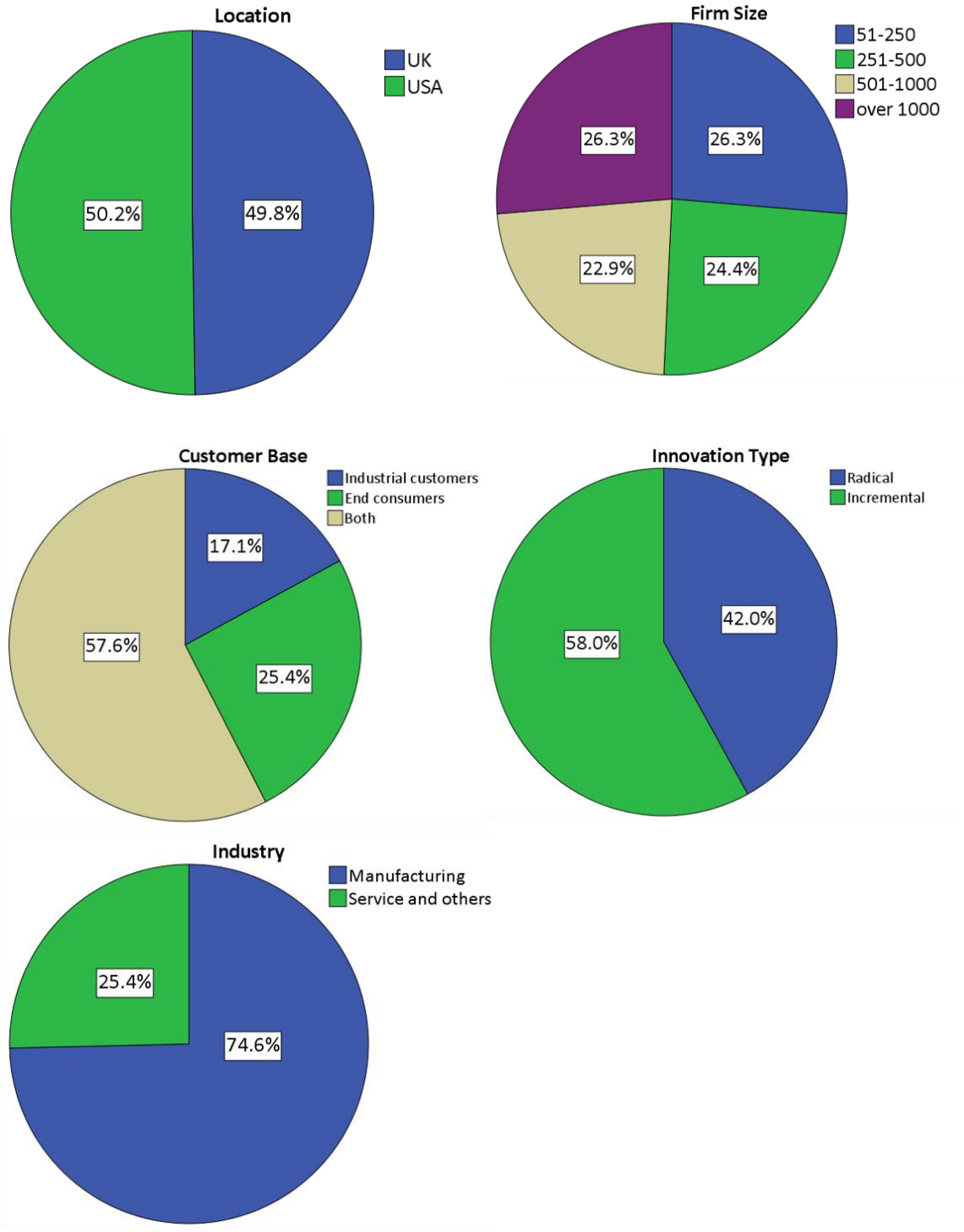


Figure 4.4 Demographics of Sample

4.5 Analysis Procedure

Before showing the results from the analysis, the author explains what analysis procedures are used with the collected data. As listed in Table 4.9 below, 6 different analyses are applied to validate the collected data and examine hypotheses. The following sub-sections detail more on each task with the rationale of using that particular method.

The present thesis uses the partial least square structural equation model (PLS-SEM) approach (Hair et al., 2016) and regression based approach (Hayes, 2013) to test the hypotheses. Mainly because our theoretical framework contains focal constructs with both formative and reflective measurement scales, it is reasonable to use the PLS-SEM approach (Hair et al., 2016) rather than the covariance based SEM (CB-SEM). Moreover, they are all second-order constructs, so a hierarchical component model (HCM) approach is applied to get path coefficients (Ringle, Sarstedt & Straub, 2012). Then to confirm the hypothesized relationships, the model is also investigated through conditional process analysis to verify the mediation, moderation and moderated mediation effects (Hayes, 2013) after applying latent value scores obtained from PLS-SEM.

Table 4.9 Analysis Procedure

Step	Task	Purpose	Method
1	Measurement model	To assess reliability and validity, To obtain 1st order latent value score	PLS-SEM
2	Common method bias	To examine common method variance bias	Herman's one factor test, Lindell and Whitney's test
3	Hierarchical component model	To develop a path model with 2nd order constructs	2-stage approach

4	Path analysis	To test hypotheses 1 to 3	PLS-SEM
5	Mediation	To test hypothesis 4	PLS-SEM, PROCESS Macro
6	Moderation	To test hypothesis 5a	PLS-SEM, PROCESS Macro
7	Moderated mediation	To test Hypothesis 5b	PROCESS Macro
8	Multigroup analysis	To show differences when including controls	PLS-MGA

4.5.1 Path Model

In this research, hypothesized relationships in the model (conceptual framework) are examined through the structural equation model (SEM). As can be seen in Figure 4.5, path models can be visually displayed as the hypotheses and variable relationships that are examined (Hair, Ringle & Sarstedt, 2011; Hair et al., 2016). Ovals (Y_1 to Y_4) represent constructs, while small rectangles (x_1-x_{10}) represent indicators. Arrows show relationships between constructs as well as between their assigned indicators and constructs; they are always single headed, which signifies directional relationships (Hair et al., 2016).

Furthermore, the path model consists of a measurement model and a structural model. On the one hand, the structural model (inner model with red-dot rectangle) denotes the relationships between constructs (i.e. hypothesized relationships). Specifically, in Figure 4.5, Y_1 and Y_2 (exogenous latent variables) are posited to be associated with Y_3, and Y_3 to be associated with Y_4 (i.e., Y_3 and Y_4 are endogenous latent variables). On the other hand, the measurement model (outer model with violet-dashed line rectangle) shows relationships between indicators and their assigned latent variables. Error terms are displayed as z_3-z_4 and e_7-e_9, and they are connected to endogenous (z_3 and z_4) and reflective variables (e_7-e_9).

Latent variables Y_1, Y_2 and Y_3 use multi-item indicators, while Y_4 only uses a single-item indicator. Further, Y_1 and Y_2 denote formative constructs in that directional arrows are pointing from the indicator to constructs, while Y_3 is a reflective construct in that directional arrows are from the construct to the indicator. For the measurement model analysis, it is important to specify which construct is either formative or reflective because it needs to use a different measurement model analysis approach. Further details will be explained in the next section.

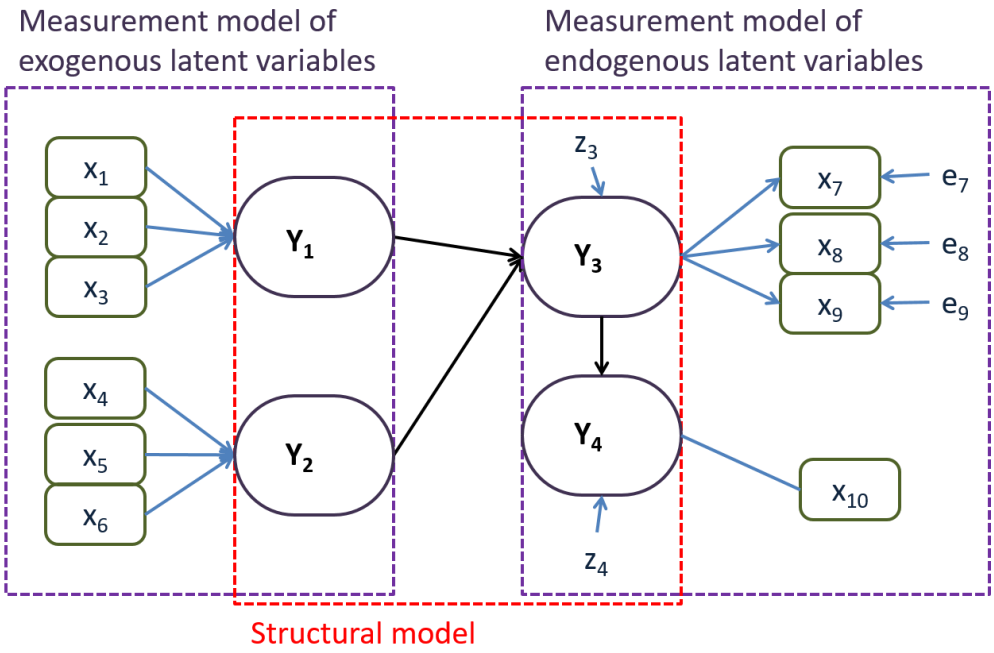


Figure 4.5 A Simple Path Model: Measurement Model vs. Structural Model

Source: Hair et al. (2016)

In the thesis, the conceptual framework can be described as in Figure 4.6 in p. 114[10]. In considering adopting structural equation modelling (SEM) with the collected data set, the partial least square (PLS) approach is chosen for assessing the SEM (i.e., PLS-SEM). PLS-SEM is based on regression analysis, which focuses on minimizing residual variances of endogenous constructs (Hair et al., 2011). This compared to co-variance based SEM (CB-SEM: Jöreskog, 1978), which is the method that is much more established in social science. Specifically, CB-SEM is widely used in estimating a set of model parameters to see the difference between the theoretical covariance matrix and the estimated covariance matrix (Rigdon, 1998; Hair et al., 2011).

The reasons why the thesis uses PLS-SEM in order to investigate hypotheses are explained as follows (see Table 4.10). Firstly, the conceptual model in the thesis contains both reflective and formative constructs (Hair, Sarstedt, Ringle & Mena, 2012). Specifically, customer co-creation activities are a formative construct in the first level. Secondly, the purpose of this research lies in exploring the implementation of customer co-creation activities in the FFE, as well as applying an emerging theoretical perspective to the growing paradigm. Therefore, it is more suitable to use PLS-SEM for the data analysis rather than CB-SEM. Thirdly, PLS-SEM enables the production of the unique latent score values based on its algorithm, which makes them useful in applying them in hierarchical component modelling analysis, the main approach to testing hypotheses in this research (Hair et al., 2016).

[10] Note that error terms are not described in the figure.

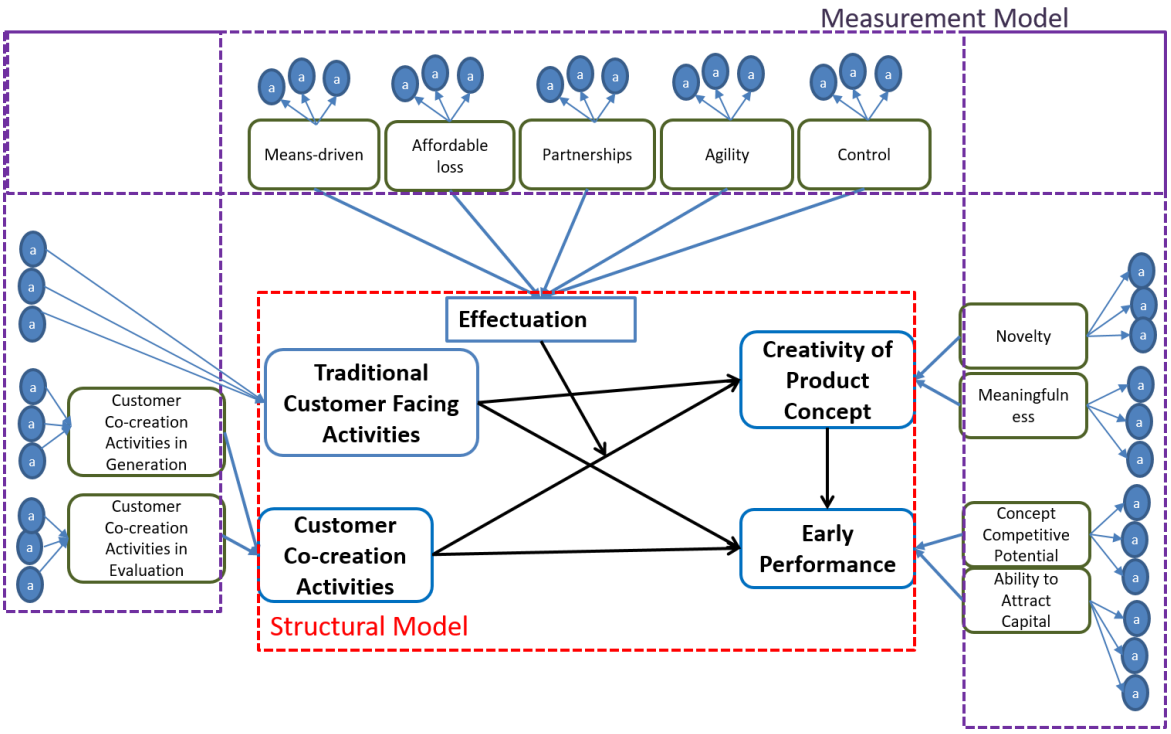


Figure 4.6 Path Models of Conceptual Framework

Table 4.10 Difference of PLS-SEM or CB-SEM

	PLS-SEM	CB-SEM
Research Goals	The goal is predicting key target constructs or identifying key "driver" constructs.	The goal is theory testing, theory confirmation, or the comparison of alternative theories.
Measurement Model Specification	Formatively measured constructs are part of the structural model. Note that formative measures can also be used with CB-SEM, but doing so requires construct specification modifications (e.g., the construct must include both formative and reflective indicators to meet identification requirements).	Error terms require additional specification, such as the covariation.

Structural Model	The structural model is complex (many constructs and many indicators).	The structural model has circular relationships.
Model Evaluation	The plan is to use latent variable scores in subsequent analyses.	The research requires a global goodness-of-fit criterion.

Source: Hair et al. (2011); Hair et al. (2016)

4.5.2 Measurement Model

The first step of analysis, following all data cleaning procedures such as managing missing data, examining suspicious and inconsistent response patterns as well as looking at raw data distribution and outliers throughout SPSS version 21, measurement model analysis is assessed via PLS-SEM. The main purpose of assessing the measurement model is to verify the relationships between constructs and their corresponding indicators, as well as minimizing the measurement error[11] as much as possible during this procedure. It is necessary to conduct a rigorous measurement model analysis to move on to the next step- hypothesis testing involving the structural relationships among constructs. That is, obtaining a reliable and valid measurement model result justifies the fact that the constructs are measured in a reliable and valid way (Hair et al., 2016).

In order to do it in PLS-SEM, measurement model analysis verifies reliability, convergent validity, and discriminant validity. Firstly, use of multiple indicators for measuring a latent variable requires showing internal consistency reliability. To obtain internal consistency reliability, respondents need to consistently answer each indicator within the construct. Therefore, the scores for the individual questions (indicators) making up the measure need to be correlated if the construct is to be reliable in the measurement

[11] Measurement error refers to the difference between the true value of a variable and the value obtained by a measurement (Hair et al., 2016).

model (Hair et al., 2015). Next, validity concerns the extent to which a construct measures what it is intended to measure (Hair et al., 2015). Specifically, convergent and discriminant validity needs to be ensured throughout the measurement model analysis. Convergent validity is the extent to which a construct is positively correlated with other measures of the same construct, while discriminant validity is the extent to which the construct is significantly distinct from other measures in different constructs (Hair et al., 2015; Hair et al., 2016).

In this research, measurement models are tested by applying two different approaches since the conceptual framework contains both formative and reflective constructs with a PLS-SEM algorithm (Hair et al., 2016) (Table 4.10). First of all, for the reflective measures, the measurement model is assessed on its internal consistency reliability and validity. Internal consistency reliability can be assessed by checking the value of either Cronbach Alpha or its composite reliability. Next, evaluating the convergent validity of reflective constructs can be done by assessing the outer loadings of the indicators and the average variance extracted (AVE). Then, discriminant validity is assessed by using Fornell-Larker criterion or the heterotrait-monotrait ratio (HTMT) of the correlations.

On the other hand, for the formative measures, the measurement model is assessed by checking convergent validity and collinearity issues. Different from the reflective measurement model, it skips examination of internal consistency reliability because it is expected that the formative indicators in the construct are not highly correlated (Hair et al., 2016). Rather, content validity needs to be established before empirically evaluating formative constructs. That is, a formative construct includes a comprehensive set of indicators in the construct domain (Hair et al., 2016). In the formative measurement model analysis, convergent validity is evaluated by testing whether the formative construct is highly correlated with reflective measure of the same construct, which is

called redundancy analysis[12] (Chin, 1998; Hair et al., 2016). Secondly, in the formative measurement model managing collinearity among indicators in the formative construct is pertinent, because the formative construct is not expected to show high correlations of indicators of the construct. To assess collinearity among indicators, tolerance (TOL) or variance inflation factor (VIF) is measured. TOL represents the amount of variance of one formative indicator not explained by the other indicators in the same block. A TOL value of 0.20 or lower indicates a potential collinearity issue (Hair et al., 2011; Hair et al., 2016). Next, it is important to evaluate the contribution of formative indicators by focusing on their outer weights. Since formative indicators lead to the production of the latent variable score of the construct based on multiple regression analysis, the outer weights of formative indicators express their relative contribution to the construct (Hair et al., 2016). Therefore, these estimated outer weights are statistically tested via the bootstrapping[13] procedure.

Table 4.11 Reflective vs. Formative Measurement Model Assessment

Reflective Measurement Models	Formative Measurement Models
• Internal consistency (Cronbach's alpha, composite reliability) • Convergent validity (indicator reliability, average variance extracted) • Discriminant validity • HTMT criterion	• Convergent validity • Collinearity between indicators • Significance and relevance of outer weights

Source: Hair et al. (2016)

[12] To execute it, a reflective measure or a global indicator of the construct also needs to be included along with the formative measure in the survey (Hair et al., 2016). However, this thesis didn't include it since the survey needs to be shorten. Therefore, this step was not analysed as Hair et al., (2016) instructed, but it briefly checked as Ringle (2015) suggested.

[13] A more detail of bootstrap technique is explained in p. 129 in "Test of Path Coefficient" sub-section.

4.5.3 Common Method Bias Check

Once all validities are checked from the measurement model, common method bias (CMB) needs to be evaluated. Common method variance is mainly occurred by the measurement method in a structural equation model study, not by the constructs the measures represent (Podsakoff, MacKenzie, Lee & Podsakoff, 2003). Bias from common method variance may potentially increase when the data collection procedure is implemented with a single survey that contains all the questions (Podsakoff et al., 2003). Since it may cause a measurement error, which threatens the validity of the conclusion of the relationships between constructs, common method bias should be minimized throughout the data collection procedure (Podsakoff et al., 2003). There are two approaches for avoiding or correcting common method bias in social science research. These are (1) *ex ante* and (2) *ex post* approaches (Chang, van Witteloostuijn & Eden, 2010).

Firstly, the *ex ante* approach is more concerned with survey design and development. For example, it would be best to design research in a way that collects data from different sources. And, during answering the questionnaire, a respondent doesn't recognize any intention of the researcher in mixing or changing the order of questions (Chang et al., 2010). Moreover, Chang et al. (2010) urges the use of a complicated specification of regression models which may reduce the possibility of common method variance.

However, even if these are considered before and during the data collection process, if the study could not completely avoid common method bias, it would be necessary to take *ex post* approach to detect common method bias (Podsakoff & Organ, 1986; Chang et al., 2010). Many studies take this approach (e.g., Cheng & Huizingh 2014; Mahr et al., 2014; Cui & Wu, 2017), particularly in those cases where data is collected via survey from a single informant of a company. This is due to cost and time matters of data collection.

There are several techniques of *ex post* approaches that check common method bias (Table 4.12) (Rönkkö & Ylitalo, 2011; Chin, Thatcher & Wright, 2012). Since most techniques controlling for common method bias are adopted from ones widely used in CB-SEM, applying them to research models based on PLS-SEM needs to be adjusted. Therefore, how to improve these techniques in PLS-SEM is still ongoing topic among researchers (e.g., Liang, Saraf, Hu & Xue, 2007; Rönkkö & Ylitalo, 2011; Chin et al., 2012). Moreover, use of multiple techniques to ease a concern about common method bias is recommended (Chang et al., 2010).

Firstly, Harman's single-factor method loads all items of constructs into an exploratory factor analysis to see if one single factor accounts for a majority of the covariance between the measures (Chang et al., 2010). Even though this is one of most commonly used techniques assessing the extent of method variance, it is insensitive and these results do not guarantee removing a concern for common method bias (Podsakoff et al., 2003; Rönkkö & Ylitalo, 2011). Therefore, if possible, this technique can be used with other available techniques.

Second, a partial correlation method can be used (Podsakoff et al., 2003). This involves partialing out a measured method effect such as a social desirability. That is, the detection of method variance can be measured by partialing out a method variance by comparing the results of the marker correlation from all other correlations after adding a method variable in the model and calculating a correlation matrix from the data (Rönkkö & Ylitalo, 2011). However, it assumes common method bias is only shared with the predictor and the dependent variable (endogenous variable), but it prevents examining the relative impact of antecedents (Chin et al., 2012).

Third, similar to the partial correlation method, Lindell & Whitney's (2001) marker variable test adds another factor, which is expected to not be significantly correlated to other latent variables to the model. This is based on the notion from Lindell & Whitney (2001) that if the marker variable, which is not theoretically related in the model, is

significantly correlated with at least one other factor in the model, then there may exist a common method variance in any observed relationships between a marker and any other variables (Podsakoff et al., 2003). Although this approach can detect common method bias, it has been criticized that it can also falsely detect common method bias where none exists in the data (Richardson, Simmering & Sturman, 2009).

Fourth, also adapted from correlation marker technique, CFA Marker techniques is to include one or more method factors, which is theoretically unrelated, in the analysis to model to examine the systematic measurement error (Williams, Hartman & Cavazotte, 2010; Chin et al., 2012). This method is specifically applied to CB-SEM analysis by examining shared variance between the marker and the other constructs in the marker included CB-SEM model for detecting and controlling for common method bias. However, Rönkkö & Ylitalo (2011) argue that it might not be applicable to structural model based on PLS-SEM because the underlying mechanism in model estimation of PLS-SEM is different from that of CB-SEM. Instead, Rönkkö & Ylitalo (2011) suggest "PLS Marker variable" modelling approach[14], which is to include a method factor as a predictor for all endogenous constructs in the model.

Fifth, unmeasured latent marker construct (ULMC) is a technique similar with CFA Marker technique. This approach in PLS-SEM is proposed by Liang et al. (2007), which is to create a method factor, which is a latent construct with no unique observed indicators. After all indicators for each construct are treated as a single indicator construct, they can be linked to the original constructs. Once the method construct is linked to these single indicator constructs, a model can be estimated (Liang et al., 2007; Chin et al., 2012). However, this approach has been criticized by Chin et al. (2012) that this technique does not accurately detect common method bias in PLS based on their

[14] Please refer to Rönkkö & Ylitalo (2011) for the further information.

simulation study. Instead, Chin, Thatcher, Wright & Steel (2013) recently suggest that measured latent marker variable (MLMV) technique[15].

Although these common method bias techniques have their own limitations, they have been widely used in PLS-SEM studies (Chin et al., 2012). However, published research in high level journals cannot be underestimated by the fact that it applies these common method bias techniques. What is more important is that researchers should acknowledge any possibility of common method bias throughout the data collection procedure. More specifically, it would be advantageous for researchers to include one or more potential method factors in the survey for the efficient implementations of *ex post* common method bias techniques in case of collecting the survey from a single data source[16].

Table 4.12 ex post Techniques to Check Common Method Bias (CMB) in PLS-SEM

Technique	Descriptions	Limitations	Literature
Harman's	Load all the items into an exploratory factor analysis and examines the unrotated solution. If CMB is present a single-factor will emerge from the factor analysis.	Does not control form method effects. It is unlikely single factor will emerge from the data.	Podsakoff et al. 2003

[15] Please refer to Chin et al. (2013) for further information.
[16] This discussion links to limitations of this research since the study didn't include these potential method factors in the survey in order to keep it as short as possible.

Partial Correlation Technique	Technique used to control for effects of method variance. There are several variations but typically a factor with a specific meaning (e.g., social desirability) is used to partial CMB	Assume the CMB is only shared with the predictor factor and the dependent factor. Also, prevents examining the effects of the relative impact distinct antecedents.	Podsakoff et al. 2003; Williams et al. 1996
Correlation Marker Technique	Controlling for CMB by partialing out the shared variance in correlations. A marker variable is best chosen a priori based on it being theoretically unrelated to the nomological network. Similar to other variables this marker variable may be contaminated by CMB.	Typically used post hoc and often concludes no CMB.	Lindell & Whitney 2001; Richardson et al. 2009; Williams et al. 2010
CFA Marker Technique	Adapted from the correlation marker technique form use in covariance based SEM whereby a theoretically unrelated marker construct is used to model CMB with paths to each of its own unique indicators as well as paths to the other constructs in the nomological network. The shared variance between the marker and the other constructs is representative of CMB.	Relatively underutilized and unproven	Lindell & Whitney2001; Richardson et al. 2009; Williams et al. 2010
Unmeasured Latent Marker Construct (ULMC)	A latent variable used to represent and partial out the CMB. This variable is an aggregate of all manifest variables used in the study with no unique observed indicators.	Debatable and unproven	Liang et al. 2007; Podsakoff et al. 2003; Richardson et al. 2009

Source: Chin, Thatcher & Wright (2012: A2)

4.5.4 Structural Model

As can be seen in Figure 4.5, a structural model (inner model) deals with hypothesized relationships after all measurement model analyses confirms that the constructs measures are reliable and valid (Hair et al., 2016). The usual steps for assessing the structural model procedures are shown in Figure 4.9. However, in this thesis, specifically, the structural model not only includes path coefficients analysis based on PLS-SEM, but also includes a hierarchical component model analysis as well as the PROCESS Macro procedure for hypotheses testing (Table 4.9). The following sub-sections elaborate on the entire structural model analysis process.

Hierarchical Component Model Analysis

This thesis further considers using a hierarchical component model (HCM) mainly because most key constructs in the present framework are second-order latent variables. HCMs are "explicit representations of multidimensional constructs that exist at a higher level of abstraction and are related to other constructs at a similar level of abstraction completely mediating the influence from or to their underlying dimensions" (Becker et al., 2012: 362). Specifically, in the context of PLS-SEM, HCM suggests the PLS path model to be more parsimonious as well as valuable where indicators in the first order might be highly correlated (Hair et al., 2016). Figure 4.7 describes four main types of HCMs presented in the prior literature (e.g., Jarvis et al., 2003; Wetzels, Odekerken-Schröder & van Oppen, 2009). HCMs includes a higher-order component (HOC) and lower-order components (LOCs). In this study, as discussed in the earlier section, most constructs are second order constructs; LOCs capture the first order dimension with indicators (*x*), while HOC captures the second order construct. For example, "customer co-creation activities" as a HOC includes customer co-creation activities in generation (LOC1) and customer co-creation activities in evaluation (LOC2). Moreover, both LOC1 and LOC2 are formative constructs, having a formative relationship with the HOC construct. Therefore, "customer co-creation activities" is the formative-formative HCM

type. On the other hand, effectuation, creativity of product concept, and early performance all indicate a formative relationship between LOCs and HOC. Since all first-order constructs are measured by reflective indicators, they are reflective-formative HCM type.

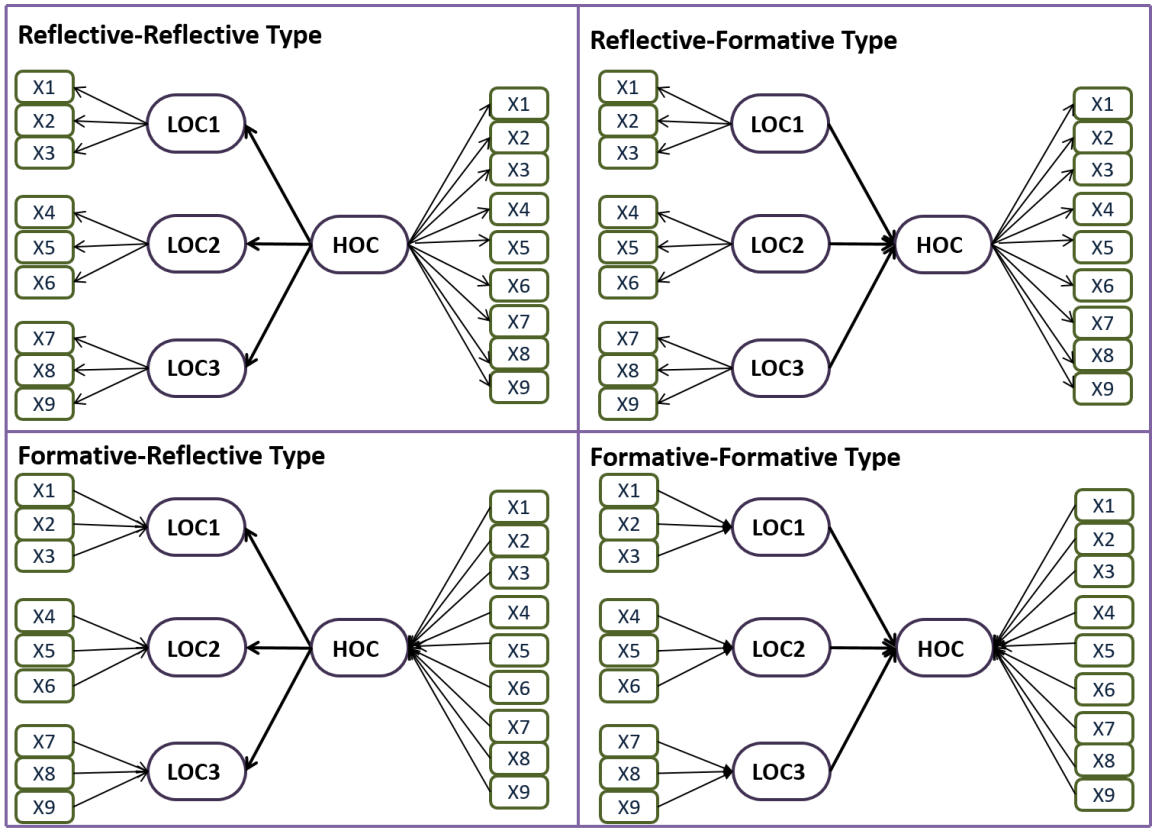


Figure 4.7 Types of Hierarchical Component Model

Source: Ringle et al. (2012); Hair et al. (2016)
Note: LOC= lower-order component; HOC= higher order component;
x_1-x_9= indicators

Firstly, to carry out the HCM analysis in the PLS-SEM, HOC latent construct scores, which represent the main construct of interest, need to be obtained in the path model (Becker et al., 2012; Ringle et al., 2012). There are three approaches to estimate HCM: (1) the

repeated indicator approach (Wold, 1982; Lohmoller, 1988), (2) the two-stage approach[17] (Wetzels et al., 2009; Ringle et al., 2012), and (3) the hybrid approach[18] (Wilson & Henseler, 2007). Firstly, to represent the HOC's measurement model, what can be done is to assign all the indicators from LOCs to the HOC in the form of a repeated indicators approach. For example, as can be seen Figure 4.7 above, the HOC uses the indicators x_1 to x_9 of its underlying components LOC1, LOC2, and LOC3 in the measurement model (Hair et al., 2016). Therefore, path coefficients between the LOCs and HOC represent the loadings/weights of the HOC (Becker et al., 2012).

However, by applying it to the formative-formative model and reflective-formative HCMs, the issue could arise that R^2 value of HOC which is explained by LOCs becomes (close to) 1.0 (Figure 4.8). Therefore, in this case, what can be done is to take the second step after applying the repeated indicators approach, which is referred to as the two-stage approach. Overall, the first stage estimates the latent variable scores of the LOCs in a measurement model without considering the HOC. In the second stage, once LOC scores are estimated out of PLS-SEM, these scores serve as indicators for the structural model analysis (Becker et al., 2012; Hair et al., 2016).

[17] Also referred to "the sequential latent variable score method" in Becker et al. (2012)

[18] Similar to the repeated indicator approach but it splits indicators only applying one half indicators to estimate LOC and the other half to HOC (Becker et al., 2012). The thesis does not go further discussing this approach because it is not applied to this study.

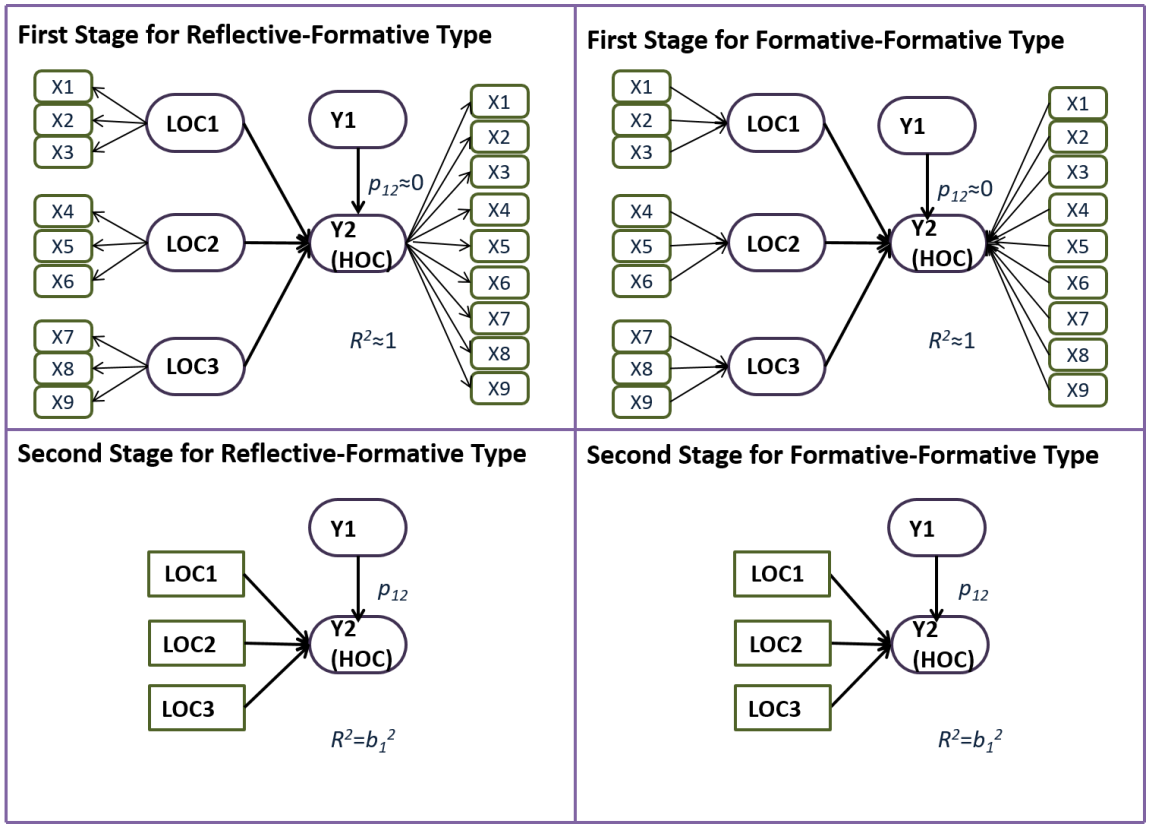


Figure 4.8 Two-stage Approach for HCM Analysis

Source: Ringle et al. (2012); Hair et al. (2016)
Note: LOC= Lower-order component; HOC= higher-order component; Y_1=exogenous latent variable in the structural; Y_2= endogenous latent variable in the structural model; p_{12}= standardized path coefficient for the structural model relationship between the latent variables Y_1 and Y_2.

Structural Model Assessment

Then after estimating all latent variable scores through the HCM analysis, the structural model that contains hypothesized relationships is assessed. To examine hypothesized relationships in the conceptual framework, the structural model assessment procedure suggested by Hair et al. (2016) is utilized. Figure 4.9 shows a systemic approach to assess the structural model results adopted from Hair et al. (2016).

The PLS-SEM structural model is assessed in terms of how well the model with the sample data predicts the dependent (endogenous) constructs (Sarstedt, Ringle, Henseler & Hair, 2014). That is, PLS-SEM estimates the parameters so that the explained variance of the dependent (endogenous) construct(s) is minimized (Hair et al., 2016). As can be seen in Figure 4.9 below, the main criteria of assessing PLS-SEM structural model includes the significance of the path coefficients, the level of the R^2 values, the f^2effect size, the predictive relevance Q^2, and the q^2 effect size (Hair et al., 2016).

Before examining the hypothesized relationships through assessing path coefficients, Hair et al. (2016) recommend assessing collinearity issues of the structural model. Because the structural model is based on regression analysis, the path coefficients might be biased if there are critical levels of collinearity between each set of predictor variables (Hair et al., 2016).

Path coefficients represent the hypothesized relationships among constructs obtained from PLS-SEM algorithm. They have standardized values approximately ranging between -1 to 1. The closer the estimated coefficients are to 0, the weaker are the relationships. The bootstrapping technique is applied to check whether the estimated path coefficients are significantly different from 0, which means that there exists an established hypothesized relationship between constructs. Based on the bootstrapping procedure, computed empirical *t* values and *p* values for all structural path coefficients determine whether the relationships are statistically significant at a certain error probability (i.e. significance level). For example, commonly used critical values for two-tailed tests are 1.65 at a 10% significance level.

Thereafter the predictive power of the PLS-SEM model can be examined by looking at the coefficient of determination R^2, f^2 effect size, Q^2, and q^2 effect size. Firstly, R^2 value represents the amount of variance in the endogenous constructs explained by the exogenous constructs that are connected to it (Hair et al., 2016). That is, it ranges from 0 to 1, with higher R^2 values indicating the contribution of exogenous constructs on

endogenous constructs. Even though there is no proper rule of acceptable levels of R^2 values, on marketing issues, R^2 values of 0.75, 0.50, or 0.25 for endogenous constructs can be respectively regarded as substantial, moderate, or weak respectively (Henseler, Ringle & Sinkovics, 2009; Hair et al., 2011; Hair et al., 2016).

Secondly, f^2 also needs to be reported along with R^2 values. It explains the change in the R^2 value when a certain exogenous construct is omitted from the model. In other words, f^2 indicates the effect size of omitted constructs in the model[19] (Hair et al., 2016).

Thirdly, Q^2 value measures the model's out-of-sample predictive power or predictive relevance (Hair et al., 2016). The Q^2 value can be obtained by the blindfolding procedure. Blindfolding is "a sample reuse technique that omits every *d*th data point in the endogenous construct's indicators and estimates the parameters with the remaining data points" (Hair et al., 2016: 202). In the structural model, Q^2 values larger than zero suggest that there is predictive relevance for a certain endogenous construct (Hair et al., 2016).

Finally, q^2 effect size can be obtained by a procedure similar to f^2 effect size, as q^2 refers to the relative impact of predictive relevance[20]. Therefore, q^2 values of 0.02, 0.15, and 0.35 specify that an exogenous construct has a small, medium, or large predictive relevance, respectively, for a certain endogenous construct (Hair et al., 2016).

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[19] It can be calculated as $f^2 = \frac{R^2_{included} - R^2_{excluded}}{1 - R^2_{included}}$, where $R^2_{included}$ and $R^2_{excluded}$ are R^2 values of the endogenous constructs when a selected exogenous construct is included in or excluded from the model (Hair et al., 2016).

[20] It can be calculated as $q^2 = \frac{Q^2_{included} - Q^2_{excluded}}{1 - Q^2_{included}}$ (Hair et al., 2016).

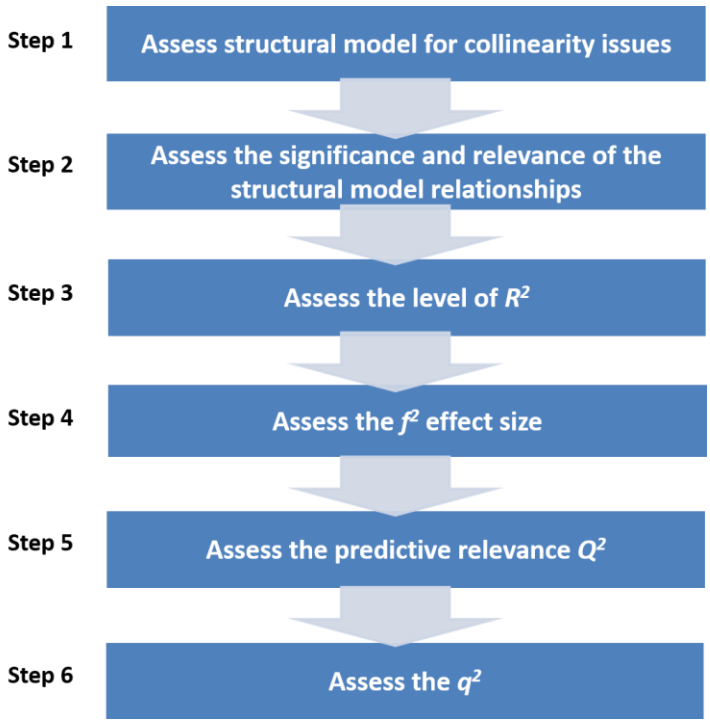


Figure 4.9 Structural Model Assessment Procedure

Source: Hair et al. (2016)

Test of Path Coefficient

Once a structural model is assessed, the significance of path coefficient is tested by applying bootstrapping technique for hypothesis test. Bootstrapping is a technique based on resampling with replacement (Efron & Tibshirani, 1993). It allows estimation of test statistics, confidence interval, and enable hypothesis test from any kind of sample. PLS-SEM basically adopt bootstrapping technique, because it doesn't strictly assume the sample to follow normal distribution (Hair et al., 2011). In bootstrapping, random samples (bootstrap samples) are drawn out of the original sample with replacement (Hair et al., 2016). Each bootstrap sample should have same number of cases as the original sample. The bootstrap samples are used to estimate the PLS-SEM models. That is, 5000 PLS-SEM models can be estimated by 5000 bootstrap samples. Then these estimates of the path coefficients form a bootstrap distribution, and this enables one to

determine the standard error and the standard deviation of the estimated coefficients. With this information, a sample t-test can be conducted to investigate the significance of path coefficients (Hair et al., 2011).

In this study, this technique is applied not only to test H1a, H1b and H3, which examine path coefficients, but also examining significance of formative indicators. In addition to it, it is used to examine other hypothesized relationships including mediation, moderation, moderated mediation, and multi-group analysis.

In comparing path coefficients (H2a, H2b), this study applies the asymptotic z-test suggested by Steiger (1980) through a web calculator designed by Lee & Preacher (2013). This test allows one to compare two path coefficients from the same sample, which shares one common variable.

Mediation

H4 in this conceptual framework is concerned with testing a mediation effect. Mediation occurs when a mediator variable intervenes the relationship between an exogenous construct and an endogenous construct (Baron & Kenny, 1986; Hayes, 2013; Hair et al., 2016). That is, as can be seen in Figure 4.10 below, changes of *X* (Customer Co-creation Activities in this research) results in a change of *M* (Creativity of product concept), which, in turn changes *Y* (Early Performance). Specifically, the existence of the mediation can be determined through examining the indirect effect (*ab*) and the direct effect (c'). The indirect effect represents the mediating effect of *M* on the relationship between *X* and *Y*, while the direct effect stands for *c'*, which is the path coefficient of *X* on *Y*. Firstly, the author tested the mediation effect of *M* through the SmartPLS 3.0 (Ringle, Wende & Becker, 2015) as well as PROCESS macro (Preacher & Hayes, 2008; Hayes, 2013). Based on bootstrapping analysis to test for an indirect and direct effect, there exists a full mediation effect if only the indirect effect (*ab*) is significant and the direct effect (c') is

not significant, while a partial mediation of *M* would occur if both the indirect effect and direct effect are significant (Hair et al., 2016).

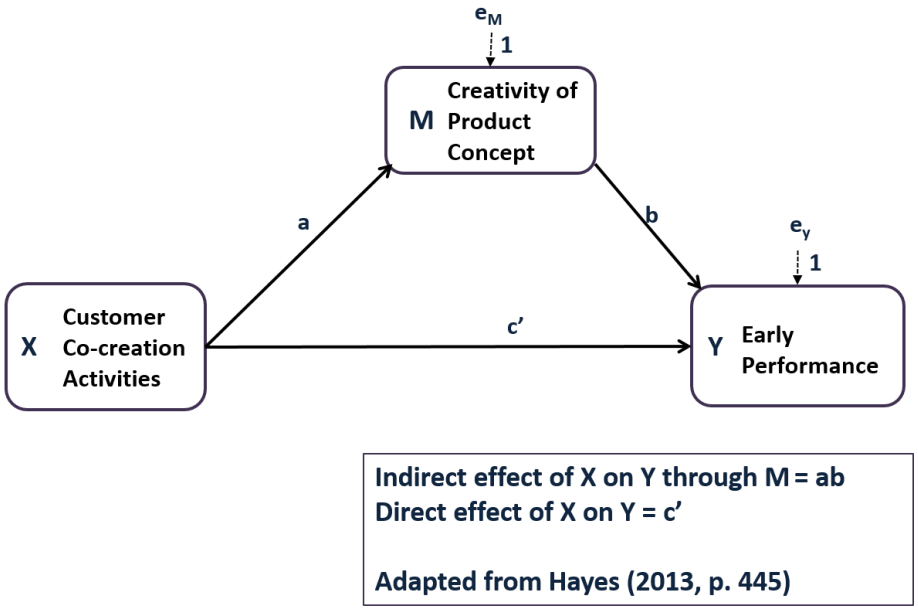


Figure 4.10 Mediation Diagram

Moderation

Since H5a of this thesis is concerned with moderation, this part briefly discusses the concept of the moderation effect and its test procedure. Moderation explains a situation in which the relationship between two constructs is not constant when a third variable (moderator) comes into the relationship (Hair et al., 2016). As can be seen in Figure 4.11 below, in this research the author is interested in inclusion of effectuation in the relationship between the customer co-creation activities and creativity of product concept. Statistically, moderation effect is identified as the interaction effect of *X* and *M* (e.g., Hayes, 2013), and tested by examining if the coefficient of interaction term (b_3) is statistically significantly or not. Both SmartPLS 3.0 and PROCESS macro provide the test result, which is presented in detail in the next chapter.

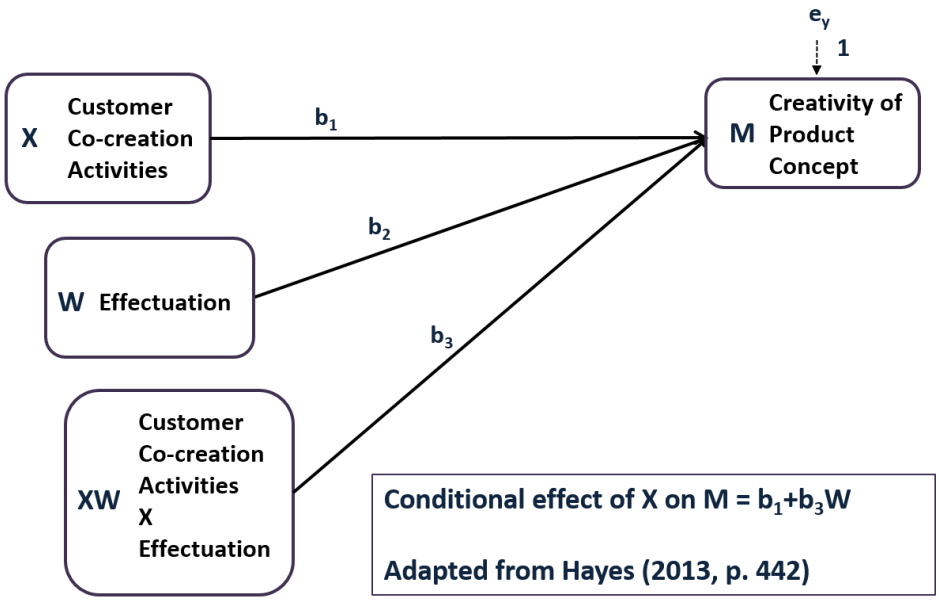


Figure 4.11 Moderation Diagram

Moderated Mediation

H5b in this research framework is related to the *moderated mediation*. Moderated mediation, as can be seen in Figure 4.12 below, occurs when a moderator variable interacts with an exogenous construct on a mediator, then its impact also results in *Y* (Hayes, 2013; Hair et al., 2016). In other words, it is also referred to a *conditional indirect effect*, the value of the indirect effect is conditional on the moderator (Hair et al., 2016). More specifically, the exogenous construct *X* (customer co-creation activities) and a mediator *M* (creativity of product concept) are posited to be moderated by *W* (effectuation) as H5a. Furthermore, to claim the mediation is moderated, Hayes (2013) recommends to see if the linear function of *W* (index *w*) would be significantly different from zero. If the function is significantly different in a certain area, it can be concluded that the indirect effect of *X* on *Y* through *M* depends on *W*. Unlike most hypotheses in this research framework, to confirm H5b, utilizing the PLS-SEM method in SmartPLS 3.0, the model is investigated through the PROCESS Macro to verify moderated mediation

and indirect effect (Hayes, 2013) by applying latent value scores obtained from the PLS-SEM.

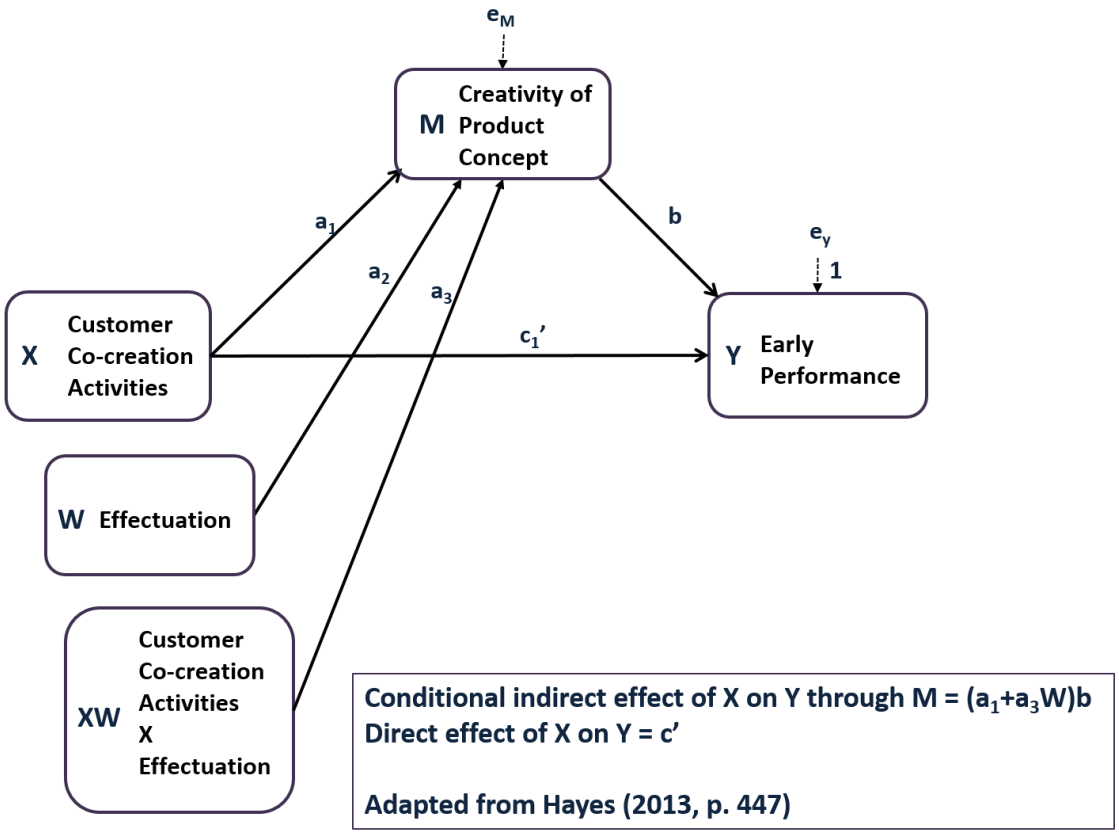


Figure 4.12 Moderated Mediation Diagram

4.5.5 Multi-group Analysis for Control Variables

In the final step of the analysis after investigating all hypotheses, multi-group analysis in PLS-SEM is conducted with control variables, since these control variables are all discrete variables. In these cases, PLS multi-group analysis (PLS-MGA) compares the difference between path coefficients of a certain path in terms of control groups (null hypothesis is that the path coefficients are not significantly different) (Hair et al. 2016). Specifically, in SmartPLS 3.0, PLS-MGA estimates parameters in each group as a result of

the bootstrapping technique. Then it counts the number of occurrences where the bootstrap estimate of the one group is larger than those of the other group, which results in a probability value for a one tailed test (Hair et al., 2016). Based on the bootstrapping technique, the PLS-MGA result is robust and reliable in testing the coefficient difference (Sarstedt et al., 2011). For example, this research considers the innovation type (radical vs. incremental innovation) as one control group (variable) so that it provides the path model with two different path coefficients in terms of innovation types. These are path coefficients from customer co-creation activities to creativity of product concept in radical innovation group (a_r) and incremental innovation group (a_i). Then PLS-MGA compares each bootstrap estimate (a_r) with all of the other bootstrap estimates (a_i), and counts the number of occurrences where a_r is larger than a_i. This results in the probability value for a one tailed test[21]. Specific results on PLS-MGA with control variables will be presented in the following chapter.

[21] In a case of 5000 bootstrap samples, there are 25,000,000 comparisons for each parameter

Chapter 5 Results

5.1 Introduction

Following data collection, the analysis procedures were performed as described in the previous chapter (section 4.5, Figure 4.9). The data analysis consisted of two stages as follows; the measurement model stage and the structural model stage. Firstly, in the measurement model stage, validity issues between measures and corresponding indicators are verified in order to minimize the measurement error. Also, common method variance was checked after this stage. Secondly, in the structural model stage, hypothesized relationships between constructs are investigated. Specifically, this study took more steps within the structural model stage to test hypotheses, which involve in (1) obtaining latent variable scores through the hierarchical component model (HCM), then (2) obtaining path coefficients of the structural model from PLS-SEM, and (3) then verifying further relationships such as mediation, moderation, and moderated mediation through PROCESS Macro. Lastly, PLS-MGA was conducted for the control variables.

5.2 Measurement Model

Since the conceptual model consists of both reflective and formative measure constructs, the measurement model is tested through SmartPLS 3.0 (Ringle et al., 2015) in terms of validities focusing on first order constructs in the conceptual framework (Hair et al., 2016). By ensuring the measurement model verification procedure discussed in the previous chapter, the following sections provide detailed results from the analysis.

5.2.1 Measurement Model Verification

Firstly, internal consistency reliability on all first order reflective constructs is evaluated via Cronbach's alpha and composite reliability (CR) to show consistency within each construct. As can be seen in Table 5.1 below, Cronbach's alpha and composite reliability values of each construct are over the threshold, indicating items within each construct are internally consistent.

Secondly, convergent validity is also assessed with outer loadings and average variance extracted (AVE) scores for the constructs. Initially, when all indicators in the model are included, four items did not meet the criteria on outer loadings of reflective constructs, which means that their factor loadings are less than 0.7 (means-driven_2, affordableloss_6, 7, 8). Therefore, these items are removed from the model as recommended (Hair et al., 2010; Hair et al., 2016). When the model was rerun after removing these items, all outer loadings show above the threshold value of 0.7. Also, they exceed the recommended minimum of 0.5 on AVE scores (Bagozzi & Yi, 1988; Hair et al., 2016). Therefore, these items of reflective constructs have a large enough variability within each construct (Kline, 2010; Hair et al., 2016). Note that a table of outer loadings of the measurement model is located in Appendix 4 (Table A.4.1).

Thirdly, discriminant validity is assessed using the Fornell-Larcker criterion (Anderson & Gerbing, 1988). It also provides the confidence interval of Heterotrait-Monotrait Ratio (HTMT). As can be seen in Table 5.2, the Fornell-Larcker criterion (the square root of AVE shown as bold values in diagonal cells) shows that they are greater than other correlations. Also, note that the confidence interval of the HTMT statistic should not include the value 1 for all combinations of constructs as indicated in the tables of HTMT and outer loading- as shown Table 5.4. Furthermore, the outer loading of an item for its related construct should be higher than all other constructs (Hair et al., 2011). Therefore,

according to the examination, the reflective measurement model has shown discriminant validity.

Table 5.1 Criteria for the Evaluation of Reflective Measurement Model

Test	Rule of Thumbs/Criterion
Reliability	• Internal consistency reliability: composite reliability should be higher than 0.70. • Cronbach Alpha should be greater than 0.70 • Indicator reliability can be examined by checking its outer loadings, which should be higher than 0.70
Convergent Validity	• Average Value Extracted (AVE) should be higher than 0.50
Discriminant Validity	• Indicator's outer loadings on a construct should be higher than all its cross-loadings with other constructs. • The square root of the AVE of each construct should be higher than its highest correlation with any other construct (Fornell-Larcker criterion) • HTMT test: check the confidence interval of the HTMT whether it includes the value 1 for all combinations of constructs.

Source: Hair et al. (2016)

Table 5.2 Reliability and Convergent Validity Test of Measurement Model

	Cronbach's Alpha	Composite Reliability	Average Variance Extracted (AVE)
ABILITY TO ATTRACT CAPITAL	0.922	0.942	0.765
AFFORDABLE LOSS	0.868	0.905	0.655
AGILITY	0.877	0.904	0.575
CONCEPT COMPETITIVE POTENTIAL	0.84	0.887	0.611
CONTROL	0.852	0.894	0.628
MEANINGFULNESS	0.878	0.916	0.733
MEANS-DRIVEN	0.837	0.884	0.604
NOVELTY	0.77	0.853	0.592
PARTNERSHIPS	0.951	0.958	0.719

Table 5.3 Discriminant Validity Test of Measurement Model

	1	2	3	4	5	6	7	8	9	10	11	12
1. ABILITY TO ATTRACT CAPITAL	**0.875**											
2. AFFORDABLE LOSS	0.312	**0.81**										
3. AGILITY	0.269	0.53	**0.758**									
4. CONCEPT COMPETITIVE POTENTIAL	0.287	0.395	0.612	**0.782**								
5. CONTROL	0.347	0.53	0.724	0.71	**0.792**							
6. CO-CREATION EVALUATION	0.469	0.61	0.426	0.365	0.456	**N/A**						
7. CO-CREATION GENERATION	0.496	0.563	0.437	0.373	0.49	0.812	**N/A**					
8. MEANINGFULNESS	0.148	0.263	0.492	0.69	0.57	0.173	0.219	**0.856**				
9. MEANS-DRIVEN	0.175	0.491	0.485	0.459	0.497	0.407	0.419	0.42	**0.777**			
10. NOVELTY	0.372	0.491	0.498	0.622	0.554	0.57	0.565	0.446	0.413	**0.769**		
11. PARTNERSHIPS	0.401	0.669	0.529	0.38	0.462	0.619	0.585	0.225	0.399	0.461	**0.848**	
12. TRADITIONAL CUSTOMER FACING ACTIVITIES	0.459	0.583	0.427	0.354	0.455	0.731	0.755	0.201	0.42	0.513	0.561	**N/A**

Note: Bold numbers in diagonal are square root of AVE

Table 5.4 Significance and Confidence Interval of HTMT

	HTMT	T Statistics (|O/STDEV|)	P Values	Confidence Interval [2.5%, 97.5%]
AFFORDABLE LOSS -> AAC	0.339	4.959	0.000	[0.207, 0.478]
AGILITY -> AAC	0.295	4.517	0.000	[0.174, 0.427]
AGILITY -> AFFORDABLE LOSS	0.596	8.140	0.000	[0.454, 0.738]
CCP -> AAC	0.330	4.489	0.000	[0.189, 0.472]
CCP -> AFFORDABLE LOSS	0.458	5.543	0.000	[0.297, 0.620]
CCP -> AGILITY	0.710	11.103	0.000	[0.581, 0.831]
CONTROL -> AAC	0.395	5.911	0.000	[0.255, 0.522]
CONTROL -> AFFORDABLE LOSS	0.618	8.334	0.000	[0.470, 0.758]
CONTROL -> AGILITY	0.832	16.928	0.000	[0.738, 0.930]
CONTROL -> CCP	0.830	19.181	0.000	[0.746, 0.914]
MEANINGFULNESS -> AAC	0.175	2.953	0.003	[0.088, 0.313]

MEANINGFULNESS -> AFFORDABLE LOSS	0.298	4.163	0.000	[0.167, 0.446]
MEANINGFULNESS -> AGILITY	0.560	8.636	0.000	[0.433, 0.685]
MEANINGFULNESS -> CCP	0.799	18.648	0.000	[0.712, 0.881]
MEANINGFULNESS -> CONTROL	0.652	12.142	0.000	[0.547, 0.760]
MEANS-DRIVEN -> AAC	0.199	2.844	0.004	[0.086, 0.356]
MEANS-DRIVEN -> AFFORDABLE LOSS	0.576	6.579	0.000	[0.396, 0.740]
MEANS-DRIVEN -> AGILITY	0.555	6.320	0.000	[0.384, 0.730]
MEANS-DRIVEN -> CCP	0.542	6.141	0.000	[0.366, 0.714]
MEANS-DRIVEN -> CONTROL	0.584	7.287	0.000	[0.425, 0.745]
MEANS-DRIVEN -> MEANINGFULNESS	0.480	6.221	0.000	[0.323, 0.628]
NOVELTY -> AAC	0.444	6.156	0.000	[0.299, 0.580]
NOVELTY -> AFFORDABLE LOSS	0.589	8.110	0.000	[0.447, 0.728]
NOVELTY -> AGILITY	0.598	10.717	0.000	[0.485, 0.704]
NOVELTY -> CCP	0.764	15.095	0.000	[0.660, 0.860]
NOVELTY -> CONTROL	0.675	12.722	0.000	[0.564, 0.774]
NOVELTY -> MEANINGFULNESS	0.532	9.846	0.000	[0.424, 0.636]
NOVELTY -> MEANS-DRIVEN	0.503	5.716	0.000	[0.331, 0.678]
PARTNERSHIPS -> AAC	0.415	6.508	0.000	[0.283, 0.536]
PARTNERSHIPS -> AFFORDABLE LOSS	0.737	14.459	0.000	[0.633, 0.834]
PARTNERSHIPS -> AGILITY	0.571	8.684	0.000	[0.442, 0.696]
PARTNERSHIPS -> CCP	0.422	5.136	0.000	[0.267, 0.587]
PARTNERSHIPS -> CONTROL	0.514	7.057	0.000	[0.377, 0.664]
PARTNERSHIPS -> MEANINGFULNESS	0.245	3.365	0.001	[0.111, 0.393]
PARTNERSHIPS -> MEANS-DRIVEN	0.443	4.949	0.000	[0.274, 0.625]
PARTNERSHIPS -> NOVELTY	0.527	6.706	0.000	[0.373, 0.683]

Next, in order to evaluate formative first order constructs in the measurement model (traditional customer facing activities, customer co-creation activities in generation, and customer co-creation activities in evaluation), different approaches are applied for validity confirmation (Diamantopoulos & Winklhofer, 2001). First of all, in the formative measurement model, convergent validity is briefly considered on formative measures in

the model (Figure 5.1), since global items for each formative construct are not included in the survey[22] (Ringle, 2015; Hair et al., 2016).

Next, collinearity issues need to be assessed by checking the variance inflation factor (VIF) with outer of measurement model. As indicated in Table 5.6, no VIF value is over 5 in this measurement model (Hair et al., 2016).

Then, significance of each item of the formative measures are examined as can be seen in Table 5.7 (Hair et al., 2016). It shows the significance of the indicator's outer weight, explaining its contribution to the construct domain (*t* value greater than 1.64 or 1.96 for 10% and 5% significance levels respectively)[23]. If the outer weight of an indicator was not significant (not enough to show its absolute significance), it is alternatively recommended to check whether the outer loading of an indicator is above 0.5 or not. If the relative importance of an indicator (outer loading of an item) is greater than 0.5, a decision to retain an item depends on the careful consideration of its theoretical importance (Hair et al., 2016). Therefore, based on the formative measurement model analysis, all formative indicators are kept for the further analysis.

Before moving forward, multicollinearity of inner model is once again checked, in case this influences the generation of inaccurate estimates of path coefficients of structural model (Grewal, Cote & Baumgartner, 2004). Firstly, multicollinearity is checked by looking at the correlation table (Table 5.3), and it shows that the highest correlation is shown between customer co-creation activities in generation and that in evaluation (0.812). In addition, the second highest correlation is shown between traditional

[22] In this study, global measures for these formative constructs were not included in the survey. In this case, Ringle, who is one of developers of SmartPLS and co-author of Hair et al. (2016), suggests using a single indicator which is close to the formative construct, then to check if the sign of the relationship is as expected with a strong relationship in the SmartPLS forum (Ringle, 2015). Based on his suggestion, an item of 'effectiveness of co-creation activities' measure was used for this convergent validity examination. Detailed results are shown in Figure 5.1.

[23] Bootstrapping technique (5000 samples) is applied to test significance of outer loadings and outer weights as PLS-SEM is based on nonparametric analysis (Hair et al., 2016).

customer facing and customer co-creation in generation (0.755). Grewal et al. (2004) warn that high chance of type II error[24] results from high level of multicollinearity, which deeply depends on high correlation (correlations among the exogenous variables greater than 0.9), low measure reliability (composite reliability smaller than 0.7), low R^2, and low sample size. Based on simulation results from Grewal et al. (2004), this study has rather lower chance to cause type II error from multicollinearity problem, given that the dataset has enough sample size (n=205), R^2 range (0.5-0.6), and composite reliability (over 0.7). Moreover, VIF of inner model (Table 5.8) shows none is over 5, which indicate little concern for collinearity issue.

Table 5.5 Criteria for the Evaluation of Formative Measurement Model

Test	Rule of Thumbs
Convergent Validity	Applying Redundancy analysis (Hair et al., 2016), correlation between the constructs (or path coefficient) should be 0.70 or higher.
Collinearity Check	Each indicator's VIF value should be lower than 5 (or Tolerance should be greater than 0.20).
Indicator's Importance	Whether each indicator's outer weight and outer loading are significant or not based on bootstrapping analysis. When an indicator's weight is significant, there is empirical support to retain it. When an indicator's weight is not significant but the corresponding item loading is relatively high (i.e., ≥0.5), or statistically significant, the indicator should generally be retained. If the outer weight is non-significant and the outer loading relatively low (i.e., <0.5), strongly consider to remove the indicator from the model.

Source: Hair et al. (2016)

[24] It refers to failing to reject the null hypothesis when it is not true.

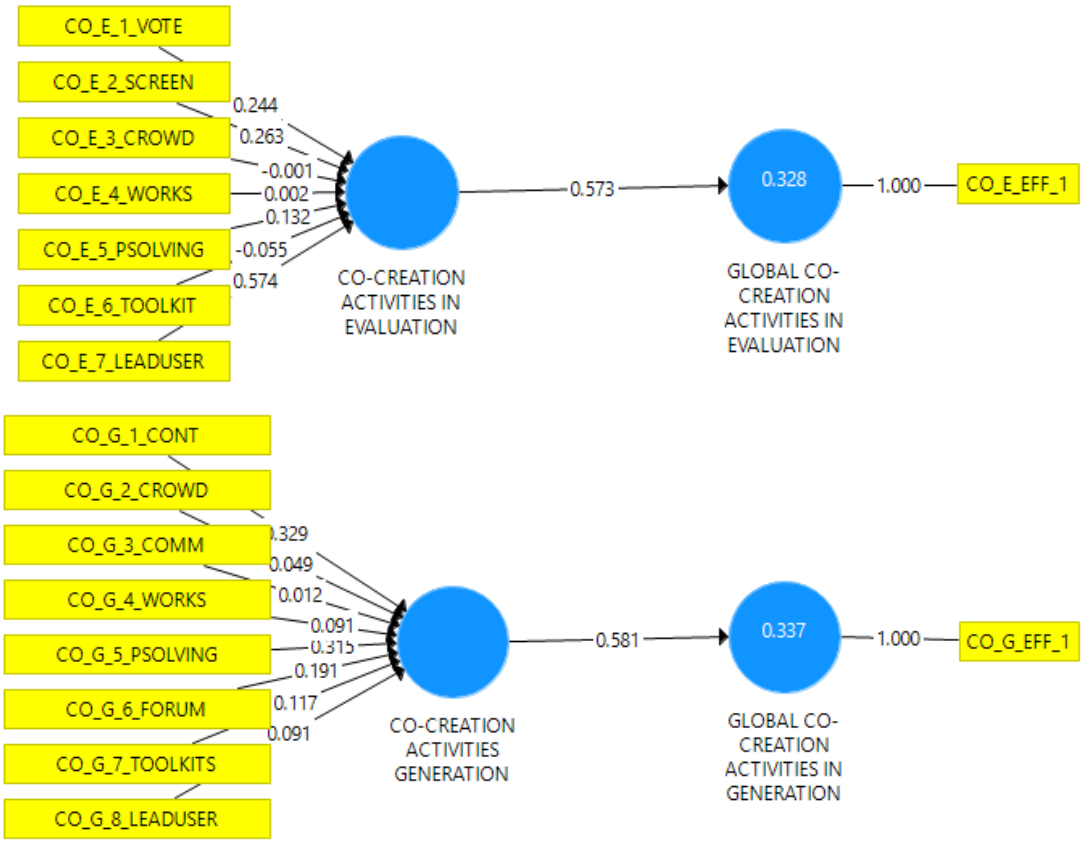


Figure 5.1 Relevance Test Result

Table 5.6 VIF of Outer Model

Construct	Item	VIF
CUSTOMER CO-CREATION IN EVALUATION	CO_E_1_VOTE	2.616
	CO_E_2_SCREEN	3
	CO_E_3_CROWD	2.906
	CO_E_4_WORKS	3.27
	CO_E_5_PSOLVING	2.595
	CO_E_6_TOOLKIT	2.839
	CO_E_7_LEADUSER	2.136
CUSTOMER CO-CREAITON IN GENERATION	CO_G_1_CONT	2.626
	CO_G_2_CROWD	2.305
	CO_G_3_COMM	2.922
	CO_G_4_WORKS	2.919

	CO_G_5_PSOLVING	2.187
	CO_G_6_FORUM	2.9
	CO_G_7_TOOLKITS	3.623
	CO_G_8_LEADUSER	2.574
TRADITIONAL CUSTOMER FACING ACTIVITIES	TM_1_OBS	1.806
	TM_2_SURV	2.166
	TM_3_FOCUS	2.495
	TM_4_INT	2.415
	TM_5_NETNO	2.334
	TM_6_CONC	1.349

Table 5.7 Assessment Results of Importance of the Formative Indicators

Construct	Item	Outer Weight	T Statistics (|O/STDEV|)	P Values	Loading
CO-CREATION EVALUATION	CO_E_1_VOTE	0.249	1.762	0.078	0.839
	CO_E_2_SCREEN	0.212	1.157	0.247	0.857
	CO_E_3_CROWD	0.069	0.38	0.704	0.798
	CO_E_4_WORKS	0.329	1.858	0.063	0.89
	CO_E_5_PSOLVING	0.329	2.276	0.023	0.865
	CO_E_6_TOOLKIT	-0.173	0.888	0.374	0.727
	CO_E_7_LEADUSER	0.137	0.826	0.409	0.752
CO-CREATION GENERATION	CO_G_1_CONT	0.377	2.689	0.007	0.873
	CO_G_2_CROWD	0.357	2.39	0.017	0.833
	CO_G_3_COMM	-0.08	0.482	0.63	0.711
	CO_G_4_WORKS	-0.141	0.97	0.332	0.676
	CO_G_5_PSOLVING	0.398	2.852	0.004	0.818
	CO_G_6_FORUM	0.082	0.498	0.618	0.729
	CO_G_7_TOOLKITS	0.116	0.602	0.547	0.811
	CO_G_8_LEADUSER	0.063	0.368	0.713	0.726
TRADITIONAL CUSTOMER FACING ACTIVITIES	TM_1_OBS	0.499	3.381	0.001	0.846
	TM_2_SURV	-0.04	0.242	0.809	0.672
	TM_3_FOCUS	-0.039	0.199	0.843	0.688
	TM_4_INT	0.268	1.703	0.089	0.783
	TM_5_NETNO	0.351	2.164	0.03	0.848
	TM_6_CONC	0.199	1.483	0.138	0.627

Table 5.8 VIF of Inner Model

	AAC	CCP	MEANINGFULNESS	NOVELTY
ABILITY TO ATTRACT CAPITAL (AAC)				
AFFORDABLE LOSS	2.371	2.371	2.357	2.357
AGILITY	2.458	2.458	2.405	2.405
CONCEPT COMPETITIVE POTENCIAL (CCP)				
CONTROL	2.764	2.764	2.394	2.394
CUSTOMER CO-CREATION IN EVALUATION	3.695	3.695	3.554	3.554
CUSTOMER CO-CREAITON IN GENERATION	3.688	3.688	3.646	3.646
MEANINGFULNESS	1.732	1.732		
MEANS-DRIVEN	1.602	1.602	1.527	1.527
NOVELTY	1.964	1.964		
PARTNERSHIPS	2.241	2.241	2.239	2.239
TRADITIONAL CUSTOMER FACING ACTIVITIES	2.728	2.728	2.721	2.721

5.2.2 Common Method Bias Check

As discussed in the previous chapter (at section 4.5.3), after all validities of measurement model are identified, common method variance bias is checked to avoid systematic bias which could occur during the survey procedure, mainly because the study is designed with a single survey design for each firm (Podsakoff et al., 2003).

This section explains *ex post* approaches on diagnosing common method bias once data collection is done, even though *ex ante* approaches that avoid common method bias were implemented during the survey development procedure. As far as *ex ante* approaches, after the survey design was carefully reviewed by survey experts and new product professionals through pre-study to refine and revise to improve readability, flow, and time involved, questions to improve respondents' quality of answers such as

(1) an attention filter during the questionnaire and (2) forcing the respondents to answer options for all questions to reduce missing questions were utilized.

As recommended by social science researchers, *ex post* approaches to diagnose common method bias after the data collection were attempted[25] (e.g., Podsakoff et al., 2003; Chang et al., 2010). Harman's one factor test was performed by including all first order constructs with principal component analysis (no rotation). The main reason for this test was to determine whether a single factor accounts for the majority of the variance in the model. The result of the one factor analysis test shows that the largest factor accounts for only 33.22% of the variance of the model (Podsakoff & Organ, 1986; Lowry & Gaskin, 2014).

5.3 Structural Models for Path Analysis: Hypothesis Test

Above all, the structural model analysis (refer to Figure 4.6) divides into two structural models and is similar with the hierarchical regression approach (Hair et al., 2010). Two structural models are well represented in terms of answering two different research questions posed in this study. The first structural model helps to answer the first research question, which is about examining and comparing co-creation activities with traditional customer facing activities. It tests H1 to H4. Moreover, the second structural model deals with the second research question, which focuses on the role of effectuation. It mainly tests H5a and H5b through PROCESS Macro procedure.

[25] In order to minimize the length of survey and reduce time to finish the survey, possible method factors were not included in the survey. This limitation will be further discussed in limitation section of chapter 6.

5.3.1 Assessment of the Structural Model 1

In this section, the structural model 1 is analysed for its answers to the first research question. After the measurement model is carefully assessed, the next step is to examine the structural model. Based on the guideline discussed in the previous chapter (Figure 4.9), this section briefly addresses whether the structural model 1 is well fitted and provides the empirical evidence to support H1 to H4.

Again, before testing H1 to H4, the structural model 1 is constructed by following a two-stage approach hierarchical component model, because all focal hypothesized constructs, except traditional customer facing activities, are 2nd order constructs (Ringle, Sarstedt, & Straub, 2012; Hair et al., 2016). After constructing HCM to fit the conceptual framework, PLS-SEM is used to check the path coefficients of the hypothesized relationships as well as assess the overall how well the model predicts results.

To assess PLS-SEM with HCM, the first structural model assessed the collinearity of the model, because the estimation of path coefficients is based on ordinary least square (OLS) regression of each endogenous latent variable. All VIF values of the inner model are clearly below the threshold of 5, as can be seen in Table 5.9. The R^2 values of the endogenous latent variables are then examined. The R^2 values of creativity of product concept (0.305) and early performance (0.568) can be considered high (Henseler, Ringle & Sarstedt, 2012; Hair et al., 2016).

Next, the effect sizes f^2 for all paths are examined. f^2 effect size refers to evaluating changes in R^2 when a specified exogenous variable is omitted (Hair et al., 2016). Notably, the f^2 of customer co-creation activities on creativity of product concept (0.108) shows a medium effect size, while creativity of product concept on early performance (0.755) shows quite a large effect size in the path model. Furthermore, the f^2 of traditional customer facing activities on creativity of product concept (0.012) is rather small. However, the f^2 of customer co-creation activities on early performance (0.003) and traditional customer facing activities on early performance (0.004) shows no effect size.

The result can be seen in Table 5.10. Note that f^2 at or approximately 0.02=small, f^2 up to 0.15=medium and f^2 around 0.35=large (Henseler & Fassott, 2010; Hair et al., 2016). Therefore, it is interpreted that customer co-creation activities are relatively more important than traditional customer facing activities on the creativity of product concept. However, neither customer co-creation activities nor traditional customer facing activities show a significant path coefficient for early performance. Additionally, creativity of product concept turned out to be the primary driver for early performance.

Then, the blindfolding procedure to assess the predictive relevance of the structural model 1 shows interesting results (Chin, 1998; Henseler et al., 2009). As can be seen in Table 5.11, the Q^2 values of creativity for product concept (0.172) and early performance (0.319) are considerably above zero. These results suggest support for the structural model 1's predictive relevance regarding the endogenous latent variables.

The results of the blindfolding procedure lead to the assessment of the q^2 effect sizes. As can be seen in Table 5.12, the q^2 values are presented with a manual calculation to explain all the relationships in the structural model 1 (Hair et al., 2016). Consistent with f^2 effect sizes of this model, q^2 values of endogenous latent variables (customer co-creation activities on creativity of product concept: 0.066, creativity of product concept on early performance: 0.188) are considered to be small and medium respectively when applying the same thresholds as with f^2 effects size (Chin, 1998; Hair et al., 2016).

Table 5.9 VIF Values of the Structural Model 1

	CO-CREATION ACTIVITIES	CREATIVITY OF PRODUCT CONCEPT	EARLY PERFORMANCE
CO-CREATION ACTIVITIES		2.511	2.782
CREATIVITY OF PRODUCT CONCEPT			1.439
EARLY PERFORMANCE			
TRADITIONAL CUSTOMER FACING ACTIVITIES		2.511	2.54

Table 5.10 f^2 Effect Sizes of Structural Model 1

	CO-CREATION ACTIVITIES	CREATIVITY OF PRODUCT CONCEPT	EARLY PERFORMANCE
CO-CREATION ACTIVITIES		0.108	0.003
CREATIVITY OF PRODUCT CONCEPT			0.755
EARLY PERFORMANCE			
TRADITIONAL CUSTOMER FACING ACTIVITIES		0.012	0.004

Table 5.11 Q^2 Values of Structural Model 1

	SSO	SSE	Q^2 (=1-SSE/SSO)
CO-CREATION ACTIVITIES	410	410	
CREATIVITY OF PRODUCT CONCEPT	410	339.673	0.172
EARLY PERFORMANCE	410	279.253	0.319
TRADITIONAL CUSTOMER FACING ACTIVITIES	1,230.00	1,230.00	

SSO: the sum of the squared observations, SSE: the sum of the squared prediction errors

Table 5.12 q^2 Effects Sizes of Structural Model 1

	CREATIVITY OF PRODUCT CONCEPT	EARLY PERFORMANCE
CO-CREATION ACTIVITIES	0.066	-0.019
CREATIVITY OF PRODUCT CONCEPT		0.188
TRADITIONAL CUSTOMER FACING ACTIVITIES	-0.001	-0.009

Test of H1a, H1b & H3

After assessing structural model 1, path coefficients (*β*) of the model are carefully examined to assess the hypothesized relationships by running the bootstrapping procedure (5000 bootstrap samples). As can be seen in Figure 5.2 and Table 5.13, as a result of PLS-SEM, hypothesized relationships (customer co-creation activities→ creativity of product concept, creativity of product concept→ early performance) are presented to be significant. According to the results, H1a, which is addressing the impact of customer co-creation activities on the creativity of product concept, is supported at a 5 % significance level in the model 1 (*β*=0.434, *t*=4.111, *p*=0.000). On the other hand, H1b, which is about the relationship between customer co-creation activities and early performance, is not supported at a 5% significance level in the model 1 (*β*=0.055, *t*=0.563, *p*=0.573).

More specifically, according to the results from the structural model 1, both customer co-creation generation and evaluation activities relate to creativity of the product concept, and have similar outer weights (outer weight: 0.595, 0.454 respectively in Figure 5.2). As indicated in Table 5.7, particularly among generation of customer co-creation activities, idea contests (0.377), crowdsourcing (0.357), and problem-solving techniques with customers (0.398) indicate significant outer weight. Whereas, voting (0.249), workshop (0.329), and problem-solving techniques (0.329) show significant outer weight in customer co-creation activities in evaluation.

Furthermore, H3, which is proposing a positive relationship between creativity of product concept and early performance, is supported in the structural model 1 (*β*=0.685, *t*=8.751, *p*=0.000).

Test of H2a and H2b

On the other hand, H2a and H2b are about comparing the effect of customer co-creation activities with traditional customer facing activities. These hypotheses are

examined by comparing path coefficients of customer co-creation activities with those of traditional customer facing activities. More specifically, H2a compares the effect of customer co-creation activities with that of traditional customer facing activities on creativity of product concept. The path coefficient between customer co-creation activities and creativity of product concept was significant as already verified in the H1a, (*β*=0.434, *t*=4.111, *p*=0.000), while the path coefficient between traditional customer facing activities and creativity of product concept was not significant (*β*=0.143, *t*=1.375, *p*=0.169). In order to confirm the difference between customer co-creation activities and traditional customer facing activities on the creativity of product concept, the comparison of coefficients can be done via the asymptotic z-test suggested by Steiger (1980). The calculation is done by a web calculator for the coefficient comparison which is developed by Lee & Preacher (2013). Based on the result, H2a is supported with significant evidence (z-score = 6.616, p = 0.000). That is, the evidence confirms that the effect of customer co-creation activities has relatively positive effect compared to that of traditional customer facing activities on creativity of product concept.

However, H2b, which compares the effect of customer co-creation activities with traditional customer facing activities on early performance, was not clearly supported in this structural model 1. That is mainly because both path coefficients toward early performance are not significant (customer co-creation activities→ early performance: *β*=0.055, *t*=0.563, *p*=0.573, traditional customer facing activities→ early performance: *β*=0.067, *t*=0.795, *p*=0.426). To confirm the comparison, the asymptotic z-test is also used. The result shows there is no significant difference between these two path coefficients on early performance (z-score = -0.254, p = 0.39). Therefore, H2b is not supported.

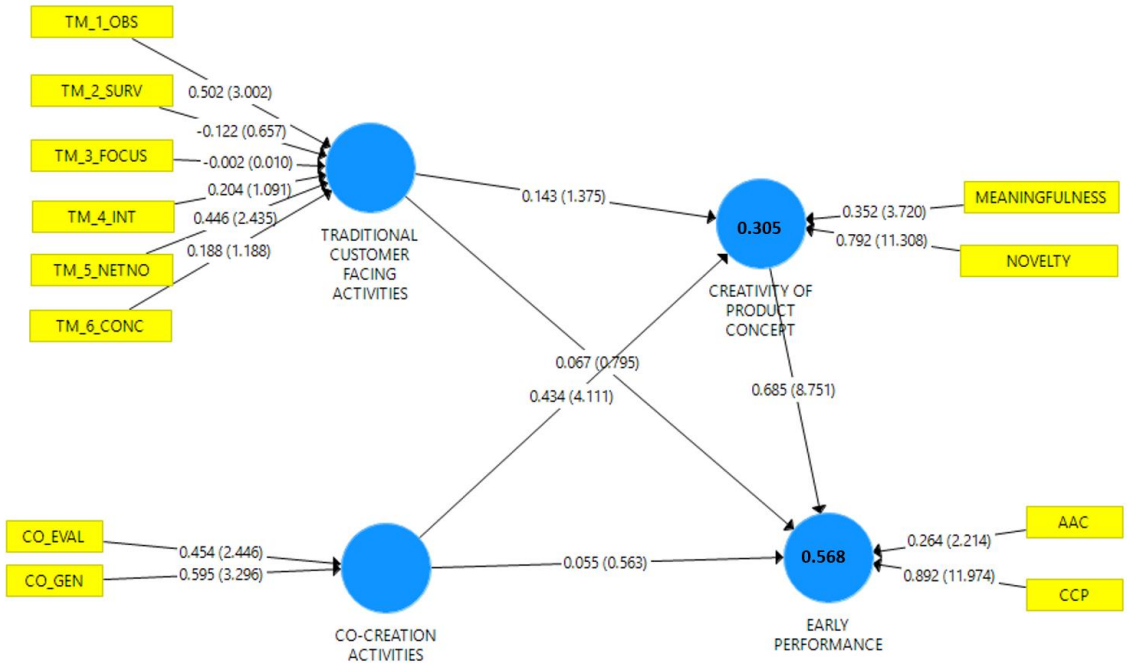


Figure 5.2 PLS-SEM Results in Structural Model 1 Path Coefficient & t-value

Note: path coefficient (*t*-value) is significant with 10 % significance level if *t*-value is greater than 1.64. R^2 to creativity of product concept is 0.305, and R^2 to early performance is 0.568.

Table 5.13 Path Coefficients with Significance of Model 1

	Path Coefficient	T Statistics (|O/STDEV|)	P Values	Confidence Interval [2.50%, 7.50%]	Hypothesis Test
CO-CREATION ACTIVITIES -> CREATIVITY OF PRODUCT CONCEPT	0.434	4.111	0	[0.209, 0.623]	H1a: Supported
CO-CREATION ACTIVITIES -> EARLY PERFORMANCE	0.055	0.563	0.573	[-0.119, 0.267]	H1b: not supported, Direct effect for H4
CREATIVITY OF PRODUCT CONCEPT -> EARLY PERFORMANCE	0.685	8.751	0	[0.493, 0.797]	H3: Supported
TRADITIONAL	0.143	1.375	0.169	[-0.018, 0.390]	

CUSTOMER FACING ACTIVITIES -> CREATIVITY OF PRODUCT CONCEPT					
TRADITIONAL CUSTOMER FACING ACTIVITIES -> EARLY PERFORMANCE	0.067	0.795	0.426	[-0.078, 0.247]	

Result of Mediation of Creativity of Product Concept (H4)

H4 concerns predicting the mediation effect of creativity of product concept with customer co-creation activities and early performance. To verify the mediation effect, firstly, the indirect effect from customer co-creation activities via creativity of product concept to early performance was calculated. To do, the product of the path coefficients from customer co-creation activities to creativity of product concept and from creativity of product concept to early performance were calculated as discussed in the previous chapter (Figure 4.10, *ab*). The bootstrapping result supported the fact that there is significant indirect effect, as can be seen in Table 5.14 (*ab*=0.298, *t*=4.087, *p*=0.000). Then, the direct effect (Figure 4.10, *c'*) from customer co-creation activities to early performance was checked. As it was already determined as a result of H1b in the structural model 1 (Table 5.13), the path coefficient showed that the relationship between customer co-creation activities and early performance is weak (0.055) and statistically non-significant (*t*=0.901, *p*=0.563).

Table 5.14 Indirect Effect of Model 1 from PLS-SEM

	Indirect Effect	T Statistics (|O/STDEV|)	P Values	Confidence Interval [2.50%, 97.50%]
CO-CREATION ACTIVITIES -> EARLY PERFORMANCE	0.298	4.087	0	[0.136, 0.422]
TRADITIONAL CUSTOMER FACING ACTIVITIES -> EARLY PERFORMANCE	0.098	1.363	0.173	[-0.012, 0.271]

Next, the PROCESS Macro procedure (Preacher & Hayes, 2008; Hayes, 2013) was conducted to test H4 in order to confirm the PLS-SEM result above. The PROCESS Macro result confirms H4 by showing the significant indirect effect of customer co-creation activities on early performance as a result of the bootstrapping procedure. Moreover, it shows an insignificant direct relationship between customer co-creation activities and early performance (refer to the details in Table 5.15). Therefore, based on the criteria for the mediation analysis procedure (Hair et al., 2016), it can be concluded that creativity of product concept fully mediates the path customer co-creation activities and early performance.

Table 5.15 Results from PROCESS Macro of Mediation Test

```
****************** TOTAL, DIRECT, AND INDIRECT EFFECTS ********************

Total effect of X on Y
     Effect         SE          t          p       LLCI       ULCI
      .4345      .0632     6.8744      .0000      .3099      .5591

Direct effect of X on Y
     Effect         SE          t          p       LLCI       ULCI
      .0802      .0503     1.5931      .1127     -.0191      .1794

Indirect effect of X on Y
            Effect    Boot SE   BootLLCI   BootULCI
CREATIV      .3543      .0500      .2628      .4590

Normal theory tests for indirect effect
     Effect         se          Z          p
      .3543      .0515     6.8801      .0000
```

Note: X: Customer co-creation activities, Y: Early performance, CREATIV: Creativity of product concept, full result detail is located in Table A.4.5 in Appendix 4

5.3.2 Assessment of the Structural Model 2

Before examining the moderating role of the effectuation, the structural model 2 is carefully examined. Effectuation and its interaction with customer co-creation activities are included in the structural model 2, while traditional customer facing activities are removed from the model 1 as can be seen in Figure 5.3.

Initially, the structural model 2 assessed the collinearity of the model. As can be seen in Table 5.16, all VIF values of the inner model are clearly below the threshold of 5. Then the R^2 values of the endogenous latent variables were examined. The R^2 values of creativity of product concept (0.516) and early performance (0.602) were reported to be high (Henseler et al., 2012; Hair et al., 2016).

Next, the effect sizes f^2 for all paths are examined. Notably, f^2 of effectuation on creativity of product concept (0.581) as well as creativity of product concept on early performance (1.511) show a quite large effect size in the structural model 2, while f^2 of moderation is small (0.041) as can be seen in Table 5.17.

Then, the blindfolding procedure was conducted in order to assess the predictive relevance of the structural model 2 (Chin, 1998; Henseler et al., 2009). The Q^2 values of creativity of product concept (0.341) and early performance (0.338) are considerably above zero, as can be seen in Table 5.18. These results suggest support for the predictive relevance of the endogenous latent variables for the structural model 2.

The results of the blindfolding procedure lead to assessment of the q^2 effect sizes. The q^2 values are presented with respect to all the relationships in the structural model 2, as can be seen in Table 5.19 (Hair et al., 2016). Only the q^2 value of effectuation (on creativity of product concept: 0.27) is considered large, according to Cohen's criteria (Hair et al., 2016).

Table 5.16 VIF Values in the Structural Model 2

	CREATIVITY OF PRODUCT CONCEPT	CUSTOMER CO-CREATION ACTIVITIES	EARLY PERFORMANCE	EFFECTUATION	EFFECTUATION * CO-CREATION
CREATIVITY OF PRODUCT CONCEPT			1		
CUSTOMER CO-CREATION ACTIVITIES	1.526				
EARLY PERFORMANCE					

EFFECTUATION	1.534				
EFFECTUATION * CO-CREATION	1.029				

Table 5.17* f^2 *Effect Sizes of Structural Model 2

	CREATIVITY OF PRODUCT CONCEPT	CUSTOMER CO-CREATION ACTIVITIES	EARLY PERFORMANCE	EFFECTUATION	EFFECTUATION * CO-CREATION
CREATIVITY OF PRODUCT CONCEPT			1.511		
CUSTOMER CO-CREATION ACTIVITIES	0.012				
EARLY PERFORMANCE					
EFFECTUATION	0.581				
EFFECTUATION * CO-CREATION	0.041				

Table 5.18* Q^2 *Values Structural Model 2

	SSO	SSE	Q^2 (=1-SSE/SSO)
CREATIVITY OF PRODUCT CONCEPT	410	270.325	0.341
CUSTOMER CO-CREATION ACTIVITIES	410	410	
EARLY PERFORMANCE	410	271.250	0.338
EFFECTUATION	1,025.00	1,025.00	
EFFECTUATION * CO-CREATION	205	205	

Table 5.19* q^2 *Effects Sizes of Structural Model 2

	CREATIVITY OF PRODUCT CONCEPT	EARLY PERFORMANCE
CREATIVITY OF PRODUCT CONCEPT		0.006
CUSTOMER CO-CREATION ACTIVITIES	0.023	
EFFECTUATION	0.27	
EFFECTUATION * CO-CREATION	0.017	

Result of Moderation of Effectuation (H5a)

As discussed in the previous chapter, the examination of the moderation effect of effectuation is examined by PLS-SEM, following the guided procedure (Hair et al., 2016), as well as confirmed by the PROCESS Macro procedure (Hayes, 2013).

In order to assess the H5a, which predicts a moderating role of effectuation in the relationship between customer co-creation activities and creativity of product concept the bootstrapping procedure was also applied to the structural model 2. According to the bootstrapping results, the path coefficient of the moderation variable to creativity of product concept is significant (β=0.139, t=2.787, p=0.005), which is supportive of H5a.

Table 5.20 Significance Testing Results of the Structural Model Path Coefficients Model 2

	Path Coefficients	T Statistics (|O/STDEV|)	P Values	Confidence Interval [2.50%, 97.50%]	Hypothesis Test
CREATIVITY OF PRODUCT CONCEPT -> EARLY PERFORMANCE	0.776	27.591	0	[0.719, 0.830]	
CUSTOMER CO-CREATION ACTIVITIES -> CREATIVITY OF PRODUCT CONCEPT	0.094	1.454	0.146	[-0.022, 0.234]	
EFFECTUATION -> CREATIVITY OF PRODUCT CONCEPT	0.657	11.828	0	[0.547, 0.767]	
EFFECTUATION * CO-CREATION -> CREATIVITY OF PRODUCT CONCEPT	0.139	2.797	0.005	[0.029, 0.230]	H5a: Support

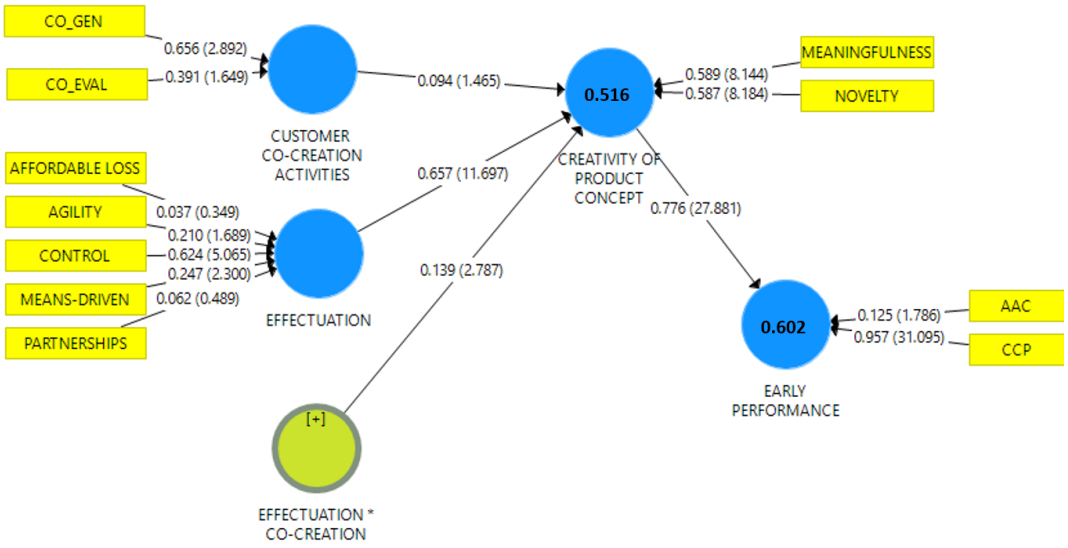


Figure 5.3 PLS-SEM Path Model Results of Structural Model 2

Next, the PROCESS Macro procedure is utilized in order to test H5a. Results indicate that the interaction of customer co-creation activities and effectuation is significant (β=0.139, t=2.876, p=0.005) (see the details in Table 5.22). This PROCESS Macro result of the moderation effect of effectuation confirms H5a. The significance of interaction term (Int_1) represents the product of customer co-creation activities and effectuation. The result suggests that the effect of customer co-creation activities on the creativity of product concept is stronger with higher effectuation.

Furthermore, Figure 5.4 provides the visual presentation of the moderation effect of effectuation. Specifically, the figure is depicted by the "Pick-a-Point" approach (Rogosa, 1980; Hayes, 2013), similar to the simple slopes approach (Aiken, West & Reno, 1991). As recommended by Hayes (2013), five percentile values of effectuation were chosen (10% = -1.38, 25% = -0.73, 50% = 0.02, 75% = 0.77, and 90% = 1.26). Figure 5.4 plots the simple slope of customer co-creation activities at various values of effectuation by using the estimated coefficients from the model (b_1+b_3*$Effectuation$, Figure 4.11). As can be

seen in Figure 5.4, when firms have high effectuation in the FFE of NPD, the relationship between customer co-creation activities and creativity of product concept gets more positive. Overall, the slope of conditional effects changes from negative to positive as the level of effectuation increases.

Table 5.21 Results from PROCESS Macro of Moderation Test

```
Outcome: CREATIV

Model Summary
          R       R-sq        MSE          F        df1        df2          p
      .7182      .5158      .4938    71.3767     3.0000   201.0000      .0000

Model
             coeff         se          t          p       LLCI       ULCI
constant     -.0801      .0564    -1.4198      .1572     -.1914      .0312
EFFECTUA      .6570      .0608    10.8066      .0000      .5371      .7768
COCRE         .0941      .0606     1.5527      .1221     -.0254      .2136
int_1         .1392      .0484     2.8758      .0045      .0438      .2347

Product terms key:

 int_1    COCRE       X     EFFECTUA

R-square increase due to interaction(s):
         R2-chng          F        df1        df2          p
int_1      .0199     8.2704     1.0000   201.0000      .0045
```

Note: COCRE: Customer co-creation activities, EFFECTUA: Effectuation, CREATIV: Creativity of product concept, full result detail is located in Table A.4.6 in Appendix 4

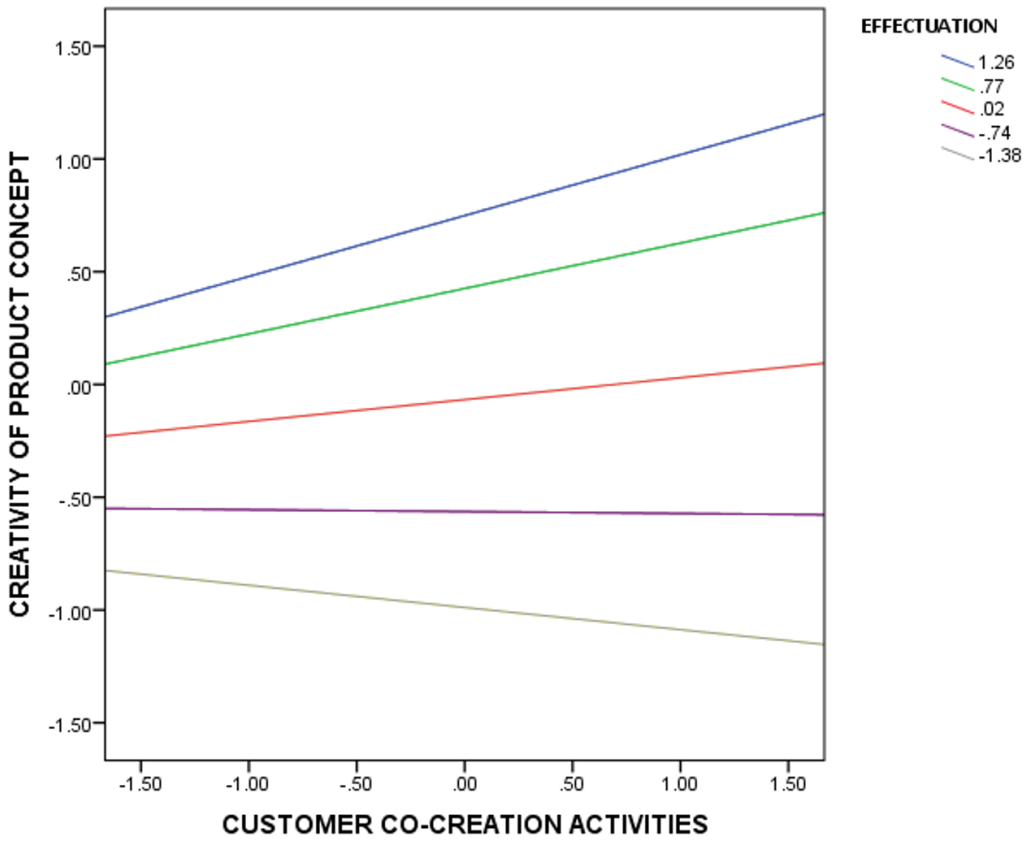


Figure 5.4 A Visual Representation of the Moderation Effect of Effectuation

Then the Johnson-Neyman technique was used to probe the "regions of significance" for the conditional effect of customer co-creation. That is, the values within the range of the moderator in which the association between customer co-creation activities and creativity of product concept is statistically different from zero (e.g., Hayes & Matthes, 2009; Pollack, Vanepps & Hayes, 2012). Figure 5.5 plots the conditional effect of customer co-creation activities on the creativity of product concept across the distribution of effectuation, with the upper and lower bounds of a 95 percent confidence interval (Aiken et al., 1991; Hayes & Matthes, 2009). As can be seen in Figure 5.5, when effectuation is less than -3.03, the effect of customer co-creation activities is significantly negative, but only about 0.5% is affected. However, when effectuation is

greater than 0.174, the effect of customer co-creation activities is significantly positive. Therefore, the results from Johnson-Neyman analysis suggest that firms with high effectuation (over 0.1742) can develop a highly creative concept when they co-create with customers in the FFE of NPD.

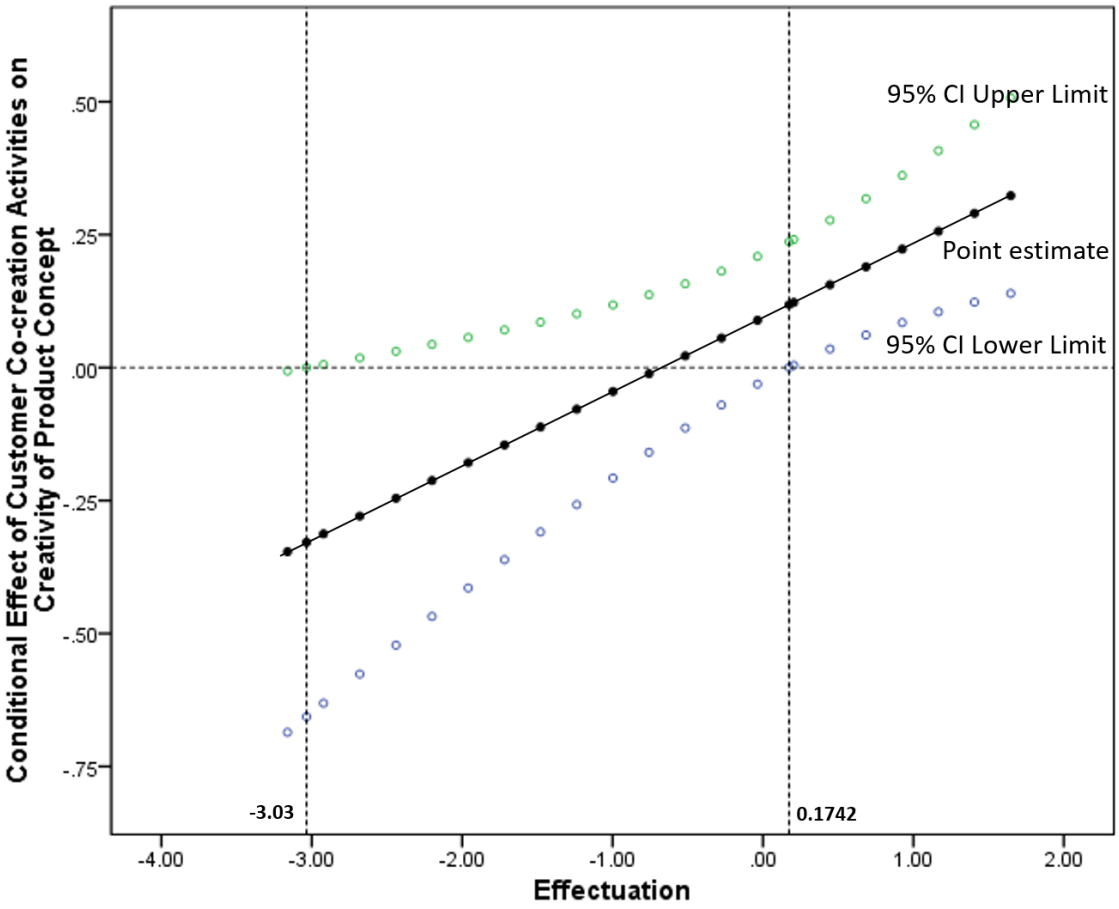


Figure 5.5 The Conditional Effect of Customer Co-creation Activities on Creativity of Product Concept as a function of Effectuation

Result of Moderated Mediation of Effectuation (H5b)

H5b posits that the effect of customer co-creation activities on early performance is influenced indirectly through creativity of product concept, being moderated by effectuation. To test H5b, PROCESS Macro analysis (Hayes, 2013) is conducted. As suggested in Figure 4.12, it can be verified as a method to check the significance of the conditional indirect effect (a_1*b+a_3*b**Effectuation*). Generally, the function of conditional indirect effect could be understood as the combination of the moderation effect of effectuation and mediation effect of creativity of product concept (e.g., Pollack et al., 2012; Hayes, 2013). As already examined in the H5a, the effect of customer co-creation activities can be linked with the creativity of product concept depending on effectuation. In H5b, the effect of customer co-creation activities associated with effectuation eventually reaches early performance with the mediation effect of the creativity of product concept. Specifically, according to the result in Table 5.23, as the percentile of effectuation increases from 75% to 90%, the conditional indirect effect gets stronger going from 0.148 to 0.199.

It can be checked through Figure 5.6, which depicts both the conditional indirect effect and the direct effect. The PROCESS Macro results of the conditional indirect effect suggest its estimate at the five percentile values of effectuation with a 95% bootstrap confidence interval, similar with the “Pick-a-Point” approach as shown in Table 5.23. The linear function slope of conditional indirect effect goes upward, meaning that it increases as effectuation increases. Specifically, the 95% confidence interval for the conditional indirect effect is entirely above zero when effectuation is more than 0.17, meaning that with high effectuation, customer co-creation activities lead to higher creativity of product concept, which in turn enhances early performance. However, the results do not support the notion that lower effectuation contributes to the opposite result.

Table 5.22 Result from PROCESS Macro, Providing Evidence of Moderation and Moderated Mediation

	Consequent						
	M (Creativity of Product Concept)				Y (Early Performance)		
Antecedent		Coeff	SE	p		Coeff	SE	p
X (Co-creation Activities)	a_1	0.0941	0.0606	0.1221	c_1'	0.0802	0.0503	0.1127
M					b	0.7371	0.0503	0
W (Effectuation)	a_2	0.6570	0.0608	0				
X * W	a_3	0.1392	0.0484	0.0045				
Constant	i_1	-0.0801	0.0564	0.1572	i_2	0	0.0441	0.9996
		R^2=.5158				R^2=.6066		
		F(3,201)	71.376			F(2,202)	155.73	

Table 5.23 Results from PROCESS Macro of Moderated Mediation Test

```
********************* DIRECT AND INDIRECT EFFECTS *************************

Direct effect of X on Y
     Effect         SE          t          p       LLCI       ULCI
      .0802      .0503     1.5931      .1127     -.0191      .1794

Conditional indirect effect(s) of X on Y at values of the moderator(s):

Mediator
          EFFECTUA     Effect    Boot SE   BootLLCI   BootULCI
CREATIV    -1.3830     -.0726      .0782     -.2298      .0803
CREATIV     -.7360     -.0062      .0615     -.1270      .1145
CREATIV      .0200      .0714      .0476     -.0204      .1671
CREATIV      .7700      .1484      .0451      .0614      .2405
CREATIV     1.2620      .1989      .0507      .1011      .3014

Values for quantitative moderators are 10th, 25th, 50th, 75th, and 90th
percentiles
Values for dichotomous moderators are the two values of the moderator.

********************* INDEX OF MODERATED MEDIATION ************************

Mediator
             Index   SE(Boot)   BootLLCI   BootULCI
CREATIV      .1026      .0336      .0388      .1698
```

Note: X: Customer co-creation activities, Y: Early performance, COCRE: Customer co-creation activities, EFFECTUA: Effectuation, CREATIV: Creativity of product concept, full result detail is located in Table A.4.7 in Appendix 4

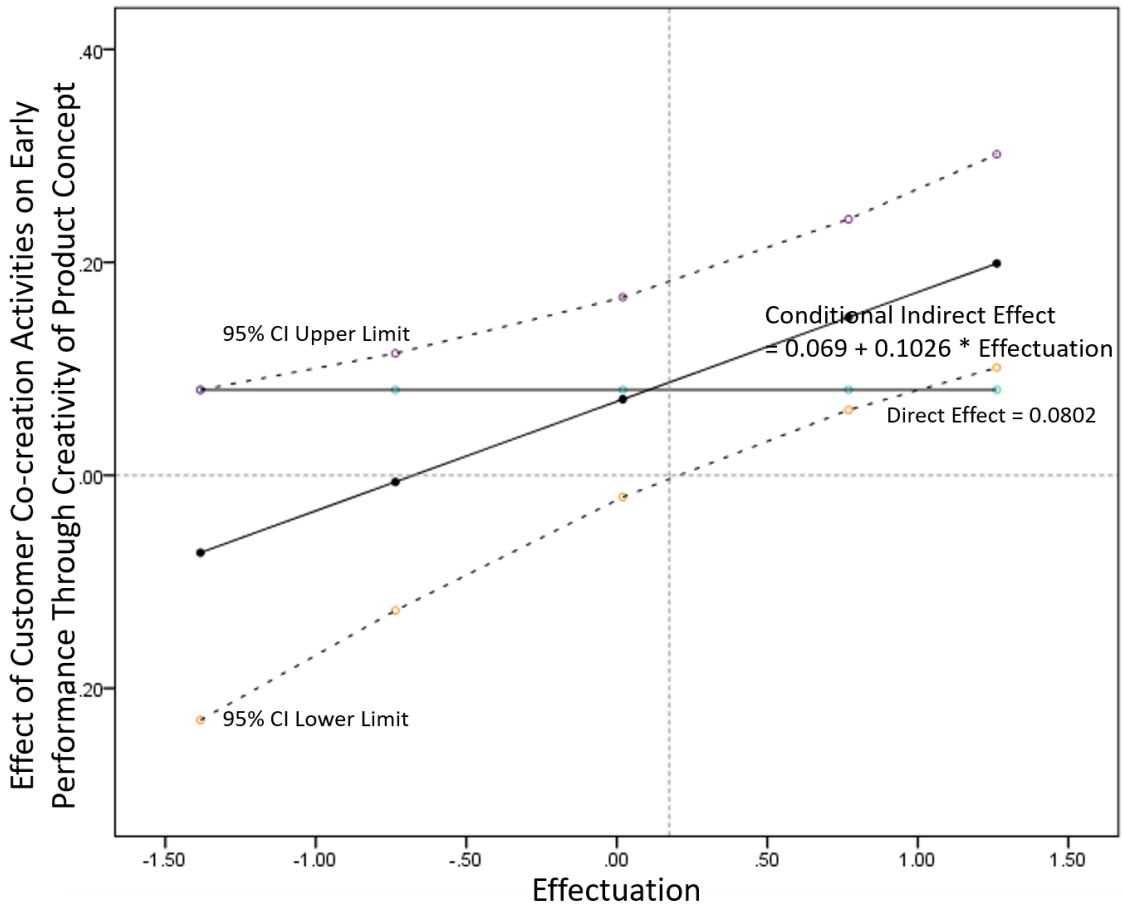


Figure 5.6 A Visual Representation of the Moderated Mediation

5.3.3 Result of Multi Group Comparisons

Finally, the path model was once again examined with control variables. Particularly, PLS multigroup analysis (PLS-MGA) was conducted with control variables (Sarstedt et al., 2011; Hair et al., 2016) for both the structural model 1 and 2, since they were all categorical variables.

Mostly, results of PLS-MGA with control variables were consistent with the overall results. Results of PLS-MGA which were shown significant group differences are

discussed in this section in Table 5.24, while detail results are presented in Appendix 4 (Table A.4.8 through A.4.25).

Firstly, by groups of industry (manufacturing vs. non-manufacturing) in the structural model 1, it appears that the relationship between creativity of product concept and early performance of the non-manufacturing group is significant, while that of manufacturing group is not so.

Secondly, with innovation group types (radical vs. incremental) in structural model 2, the PLS-MGA results showed that the difference of moderation role of effectuation with incremental innovation and radical innovation was reported to be significant.

There were few notable results in terms of types of customer base (B2B, B2C, or both). Through PLS-MGA, customer co-creation activities on creativity of product concept turned out to be significant in firms which is B2C base or firms which deal with both business customers and end consumers, while the relationship was not significant in firms which deal with B2B customers. Rather, B2B firms show the significant relationship while using traditional customer facing activities on developing highly creative concept. In particular, there are significant group differences between B2B firms and firms dealing with both B2B and B2C.

Lastly, there were some significant group differences in terms of firm size (50-250, 251-500, 501-1000 or over 1000 employees). For example, the effect of customer co-creation activities in large firms (over 1000) were not significant, but their use of traditional customer facing activities showed a significant relationship with developing a highly creative concept. However, medium sized firms showed a use of customer co-creation activities to develop highly creative concepts. Moreover, there were significant differences of the moderation role of effectuation between medium and large sized firms, where the former showed a significant moderating role of effectuation compared to the latter. Even though specific results will be discussed in the next chapter, briefly

firm size needs to be considered in adopting customer co-creation activities and effectuation.

Table 5.24 Summary of Significant Group Difference of Control Variables

Control variable	Significant Path	P-Value of significant Group difference	Comparison
Industry	CUSTOMER _CO-CREATION ACTIVITIES -> CREATIVITY OF PRODUCT CONCEPT	(MFG) vs (NON_MFG): **0.073**	NON-MFG > MFG
Industry	CUSTOMER _CO-CREATION ACTIVITIES -> EARLY PERFORMANCE	(MFG) vs (NON_MFG): **0.017**	NON_MFG > MFG
Innovation Type^	EFFECTUATION*_CO-CREATION -> CREATIVITY OF PRODUCT CONCEPT	(INCREMENT) vs (RADICAL): **0.045**	INCREMENT > RADICAL
Customer Base	TRADITIONAL_CUSTOMER FACING ACTIVITIES -> CREATIVITY OF PRODUCT CONCEPT	(B2B) vs (BOTH): **0.069**	B2B > BOTH
Customer Base^	CUSTOMER _CO-CREATION ACTIVITIES -> CREATIVITY OF PRODUCT CONCEPT	(B2B) vs (B2C): **0.049**	B2C > B2B
Firm Size	CREATIVITY OF PRODUCT CONCEPT -> EARLY PERFORMANCE	(1001-) vs (51-250): **0.091** (501-1000) vs (251-500): **0.044** (251-500) vs (51-250): **0.039**	(51-250) > (1001-) (501-1000) > (251-500) (51-250)> (251-500)
Firm Size	CUSTOMER _CO-CREATION ACTIVITIES -> CREATIVITY OF PRODUCT CONCEPT	(1001-) vs (251-500): **0.046** (1001-) vs (51-250): **0.085**	(251-500) > (1001-) (51-250) > (1001-)
Firm Size	TRADITIONAL_CUSTOMER FACING ACTIVITIES -> CREATIVITY OF PRODUCT CONCEPT	(1001-) vs (251-500): **0.077** (1001-) vs (51-250): **0.065**	(1001-) > (251-500) (1001-) > (51-250)
Firm Size^	EFFECTUATION*_CO-CREATION -> CREATIVITY OF PRODUCT CONCEPT	(1001-) vs (501-1000): **0.071** (1001-) vs (51-250): **0.08** (501-1000) vs (251-500): **0.01** (501-1000) vs (51-250): **0.006**	(1001-) > (501-1000) (51-250) > (1001-) (251-500) > (501-1000) (51-250) > (501-1000)

Note: ^ PLS-MGA results from the structural model 2

5.3.4 Summary of Results

The section elaborates the results of data analysis. Table 5.25 summarizes the hypothesis testing results from the data analysis. In conclusion, the data analysis responds to the research questions by showing whether or not the hypothesized relationships are supported. Firstly, the results confirm that customer co-creation activities are significantly related to the creativity of product concept (H1a), while customer co-creation activities aren't significantly associated with early performance (H1b). Secondly, when comparing the effect of customer co-creation activities with the effect of traditional customer facing activities on the creativity of product concept (H2a) as well as early performance (H2b), only the effect of customer co-creation activities is significant on the creativity of product concept, which supports H2a. Thirdly, the effect of creativity of product concept is positively related to early performance, as hypothesized in H3. Fourthly, the effect of creativity of product concept mediates the path of customer co-creation activities and early performance, which supports H4. Fifthly, in relation to the second research question of the thesis, the role of effectuation empirically moderates the relationship between the customer co-creation activities and creativity of product concept, supporting H5a. Furthermore, its moderating role extends toward enhancing early performance via creativity of product concept, which supports H5b.

Therefore, in answering the first research question, which is testing the impact of customer co-creation activities, the data analysis confirms that the use of customer co-creation activities has a positive influence on developing highly creative concept at the FFE of NPD. Moreover, regarding the second question, effectuation plays an important role when firms use customer co-creation activities by enhancing the creativity of product concept, and its impact also increases early performance via the creativity of product concept.

Table 5.25 Hypotheses Test Summary

Hypothesis	Relationship	Test Result in the first structural model	Test Results in the second structural model	Implications (Including Controls)
H1a	CO-CREATION ACTIVITIES -> CREATIVITY OF PRODUCT CONCEPT	Supported	Not supported	Use of co-creation activities is effective on developing creative new concepts. In the structural model 2, the relationship is not significant as the model 1.
H1b	CO-CREATION ACTIVITIES -> EARLY PERFORMANCE	Not Supported	Not tested	This result hints the role of creativity of product concept.
H2a	Comparison CUSTOMER CO-CREATION ACTIVITIES with TRADITIONAL CUSTOMER FACING ACTIVITIES -> CREATIVITY OF PRODUCT CONCEPT	Supported Only CUSTOMER CO-CREATION ACTIVITIES significant	Not tested	Characteristics of co-creation (drawing active and high collaboration from customers) are more beneficial for firms than traditional customer facing activities in developing higher creative concepts in the FFE of NPD. Medium-sized firm: significance of customer co-creation activities on creativity of product concept, Large firm (over 1000): significance of traditional co-creation activities on creativity of product concept.
H2b	Comparison CUSTOMER CO-CREATION ACTIVITIES with TRADITIONAL CUSTOMER FACING ACTIVITIES -> EARLY PERFORMANCE	Not supported	Not tested	Both customer co-creation activities and traditional customer facing activities did not significantly enhance early performance.
H3	CREATIVITY OF PRODUCT CONCEPT -> EARLY PERFORMANCE	Supported	Supported	Higher creativity of product concept enhances early performance.
H4	Mediation of CREATIVITY OF PRODUCT CONCEPT between CUSTOMER CO-CREATION	Supported	Not tested	Results showed the significant mediation of creativity of product concept in between customer co-creation activities and early performance. Medium sized firms (51-250) showed the significant mediation of creativity of

	ACTIVITIES AND EARLY PERFORMANCE			product concept.
H5a	EFFECTUATION * CO-CREATION -> CREATIVITY OF PRODUCT CONCEPT	Not Tested	Supported	Agility, Control, and Means-driven dimensions of effectuation significantly contribute to constructing the effectuation. Firms in the manufacturing industry, incremental innovation, and medium sized firms showed a significant moderation role of effectuation.
H5b	Moderated mediation of EFFECTUATION	Not Tested	Supported	Firms in incremental innovation and medium sized firms showed significant moderation role of effectuation.

Chapter 6 Discussion and Contribution

This chapter presents the results of the study and highlights its contribution to theory and practice. This is followed by a discussion of the limitations of the study and opportunities for future research.

Two main research questions are investigated as follows: (1) how do customer co-creation activities relate to creativity of the product concept, compared to traditional customer facing ones? (2) does effectuation logic leverage the co-creation-early performance relationship? The findings of the study give clear answers to these research questions, which are discussed in the following sections. What follows, not only summarizes the empirical results, but also interprets the specific results in the context of the FFE and NPD to present theoretical contributions and managerial implications.

6.1 Discussion of Results

6.1.1 Customer Co-creation Activities

In terms of the relationship between customer co-creation activities and creativity of the product concept, it was posited in H1a that customer co-creation activities in the FFE of NPD are positively associated with creativity of the product concept. The results suggest that utilizing customer co-creation activities enhances creativity of the product concept in the FFE of NPD.

Based on these specific results, it can be implied that, in generation, co-creation activities which gather ideas through contests or crowdsourcing, are more likely to be adopted, with the exception of problem solving techniques. But, in evaluation, firms are

more likely to work with customers in a close setting through a workshop and problem solving session, even though firms might also adopt voting in order to screen the information of customers.

Therefore, firstly, it is reasonable to conclude that firms utilize the customer co-creation activities in generation phases by gathering as much as information or ideas from customers in the FFE of NPD (Poetz & Schreier, 2012). On the other hand, firms might work closely with customers in evaluating ideas or concepts for screening and moving forward. In particular, Cui & Wu (2017) discussed that considering customers' participation as co-developers would help firms in making decisions together with customers by closely working with them.

Even though the results provide insights on the use of specific customer co-creation activities, it may be concluded that these specific activities are effective ways to develop creative product concepts. However, the results do provide straightforward insights into the impact of specific co-creation activities on the development of highly creative product concepts in the FFE of NPD.

Above all, the result showed a linear positive relationship between customer co-creation activities and creativity of the product concept. This result is consistent with the effect of activities of open innovation on product portfolio innovativeness (Cheng & Huizingh, 2014), as well as the impact of customer involvement in design on new product performance (Menguc, Auh & Yannopoulos, 2014). Although the result supports the positive linear relationship between the use of customer co-creation activities and creativity of the product concept, it is important to consider prior research which asserts the "dark side" of customer co-creation (e.g., Hoyer et al., 2010; Storey & Larbig, 2017). Specifically, Hoyer et al., (2010) was concerned that "information overload" from customer co-creation activities might prevent firms from effectively responding to all customers' input. In order to resolve this issue, they suggest collaborating with

customers in the evaluation of ideas (Hoyer et al., 2010), which is reflected in the result of H1a.

However, H1b. which concerns the direct relationship between customer co-creation and early performance, is not supported in this data analysis. This result is inconsistent with previous research, for example, Chang & Talyor (2016). This might be because the effect of customer co-creation activities is indirectly related to early performance via the creativity of product concept. In other words, the direct impact of the use of customer co-creation activities can be measured by assessing its creativity at the FFE (Eling et al., 2014). This result implies that co-creating with customers in the FFE would not guarantee developing highly competitive concept nor attractive further investment. However, once they are able to co-create highly creative concept with customers, chances for enhancing early performance will significantly increase. Moreover, this result echoes prior FFE literature which argues that product concepts need to be clearly defined at the front end of NPD (Cooper, 1996; Florén & Frishammar, 2012). Therefore, the results hint that creativity of the product concept might mediate the relationship between customer co-creation activities and early performance, which was examined in H4.

6.1.2 Comparison between Customer Co-creation Activities and Traditional Customer Facing Activities

In H2a, this research proposed that customer co-creation activities in the FFE of NPD were positively associated with the creativity of the product concept compared to utilizing traditional customer facing methods. Moreover, in H2b, the research proposed that customer co-creation activities in the FFE of NPD were more positively associated with early performance than traditional customer facing activities. The results suggest that only co-creation activities were significantly associated with the creativity of the

product concept. However, traditional customer facing activities are not significantly associated with the creativity of the product concept nor early performance.

This overall result might be because, in the FFE, firms do not effectively adopt customers input through traditional activities in order to develop a highly creative concept. On the other hand, customer co-creation activities play a significant role in enhancing creativity of the product concept in the FFE of NPD. This is consistent with prior research (Gruner & Homburg, 2000; Lilien et al., 2002; Witell et al., 2011). Moreover, the result might be explained by motivation factors of customer co-creation (e.g., Hoyer et al., 2010; Roberts et al, 2014). That is, customers who are involved in co-creation activities are more motivated by various types of benefits (e.g., financial reward, social benefit, or opportunity-related motives) than those who partake in traditional activities.

However, looking at group differences, it showed somewhat interesting results. In fact, size of firm (notably, firm size over 1000 vs. 51-250) clearly distinguishes that firms over 1000 employees showed that their use of traditional methods was positively associated with developing higher creative concepts versus those firms with 51-250 employees. However, firms with 51-250 employees (medium sized firm[26]) utilized customer co-creation activities in developing higher creative concepts in the FFE of NPD. This result implies that, in practice, it might be advantageous for medium sized firms to utilize customer co-creation activities, while relatively large firms still are familiar with using traditional customer facing activities in the FFE of NPD. Moreover, medium sized firms might be able to more effectively co-create with customers in the FFE than large firms. This result reflects a similar finding from a meta-analysis (Chang & Taylor, 2016) who found that the effect of customer participation for small firms is better than for large firms.

[26] OECD defines medium sized firm with 50-249 employees (OECD, 2005)

The reason for this might be because, firstly, medium sized firms are more flexible in working with customers in the FFE of NPD than larger firms. That is, since medium sized firms, like small firms, are less bureaucratic, they can efficiently communicate and collaborate with customers, which in turn build strong relationships with them (Berends et al., 2014). Secondly, medium sized firms have relatively low NPD knowhow and experiences so that they might be eager to co-create with customers rather than just gathering their input (Moultrie, Clarkson & Probert, 2007; Berends et al., 2014). On the other hand, larger firms have structured NPD procedures so they are able to develop efficient innovation projects of their own, thereby they are accustomed to utilizing traditional market research activities in their formalized NPD process (Cooper & Kleinschmidt, 1986; March-Chordà, Gunasekaran & Lloria-Aramburo, 2002; Scozzi, Garavelli & Crowston, 2005; Berends et al., 2014).

The control variable analysis highlighted another interesting finding. Firstly, there were significant group differences between B2B firms and firms who are both B2B and B2C. That is, B2B firms are more likely to keep using traditional customer facing activities in the FFE of NPD. This is probably because B2B firms manage a handful of customers, thereby they might not value adopting new co-creation techniques such as crowdsourcing or an idea contest (Bonner & Walker, 2004).

6.1.3 Creativity of the Product Concept and Early Performance

It is hypothesized in H3 that achieving high levels of creativity of the product concept through customer co-creation activities is highly associated with higher early performance enhancement. Results from both structural model 1 and 2 indicate that higher creativity of the product concept relates to higher early performance. That is, once a firm develops creative product concepts at the FFE, it would enhance both their competitive advantage potential and the ability to attract capital, which are dimensions of early performance. Therefore, the result is consistent with prior research in NPD and

the innovation discipline which has shown that there is a positive effect of product creativity on NPD success, confirming that product creativity is one of the key success factors of new product development (Cooper & Kleinschmidt, 1987; Song & Parry, 1997; Im et al., 2013).

6.1.4 Mediation of Creativity of the Product Concept in Between Customer Co-creation Activities and Early Performance

In H4, this research examined the mediating role of creativity of the product concept between customer co-creation activities and early performance. The results of PLS-SEM and PROCESS Macro confirmed the indirect effect of customer co-creation activities to early performance through the mediator of the creativity of the product concept. In other words, this result suggests that the use of customer co-creation activities enhances early performance through developing a highly creative product concept. This result implies that, in the FFE of NPD, creativity of the product concept plays a crucial role in transforming output from the customer co-creation activities to competitive and attractive product concepts (Cui & Wu, 2017). Therefore, enhancing creativity of the product concept should be considered one of main focuses in the FFE of NPD.

Consistent with previous hypotheses, it also shows a significant difference among firm sizes and the indirect effect of customer co-creation activities on early performance through creativity of the product concept. That is, specifically, the mediation role of creativity of the product concept is significant in medium sized firms (51-250), while is not significant in large firms (over 1000). This is rather expected because the results of previous hypotheses have shown the group difference in firm size. Therefore, developing a highly creative product concept is a crucial path to enhancing early performance when medium sized firms co-create with customers.

6.1.5 Moderation of Effectuation

In H5a, it was proposed that the positive relationship between customer co-creation activities and the creativity of the product concept would be stronger for firms with a higher effectuation in the context of FFE. The result from PLS-SEM and PROCESS Macro showed a moderation effect of effectuation in the relationship between customer co-creation activities and creativity of the product concept. This overall result supports the notion that firms with higher effectuation would be able to develop higher creative concepts when they co-create with customers in the FFE of NPD. This is because effectuation contributes to stimulating the creativity of each individual who is involved in the FFE of NPD by applying an experimentation or trial-and-error approach (Chandler et al., 2011; Fisher, 2012; Coviello & Joseph, 2012). Furthermore, firms with effectuation are playing as enablers who quickly recognize similar patterns of information input from customers and match them with their existing knowledge (Read et al., 2009a).

Even though H5a focused on the overall moderating role of effectuation in the FFE, it is also important to point out how each dimension of effectuation contributes to forming the effectuation construct. Specifically, when examining the outer weights of dimensions of effectuation shown in Figure 5.3, means-driven (0.210), agility (0.624), and control dimension (0.247) showed significant outer weights.

The results may show that these three dimensions of effectuation are mainly related to the development of highly creative concepts in the FFE of NPD. Firstly, the results are consistent with the notion from prior literature, suggesting that identifying available resources enables firms to perceive their resources, which in turn give insights to firms to expand their resources and to combine even unrelated resources (Blauth et al., 2014).

Secondly, the results suggest that agility, which is characterized as a flexible and nimble approach under uncertainty, contributes to developing highly creative concepts during the FFE (Coviello & Joseph, 2012; Blauth et al., 2014). Effectual reasoning emphasizes recognizing contingencies as valuable sources for opportunities; thereby it is associated

with activating analogical reasoning in ideas flowing from customers and matching them with their existing competencies to develop creative concepts in the FFE (Sternberg et al., 1997; Moreau & Dahl, 2002).

Thirdly, in effectuation, control relates to the notion that firms transform and reshape their existing competence into extending artefacts (Sarasvathy et al., 2014). In NPD, the control aspect of effectuation relates to deciding which allows ideas or concepts to move forward. Particularly, once firms with control identify their available means, as well as access their environment, they mindfully converge into more relevant options as they do experiments by reducing unfeasible ones (Chandler et al., 2011; Coviello & Joseph, 2012). With that, firms with effectuation are able to leverage the use of co-creation activities during the FFE of NPD.

Furthermore, PLS-MGA results showed that there was a significant difference in the path coefficient between the moderating role of effectuation in incremental innovation and radical innovation projects. Interestingly, in an incremental innovation project, firms with high effectuation leverage their customer co-creation activities to develop a higher creative concept more than those with low effectuation; even though this finding was not initially expected versus the prior literature that proposed the effectual capabilities in radical innovation[27] (Coviello & Joseph, 2012). However, it may be reasonable to argue that high uncertainty might reduce the chance that firms work on radical innovation projects that go beyond their current competences. That is, firms with high effectuation tend to rather focus on expanding their available means by developing new concepts in the FFE of NPD, than taking risk by predicting a long-term trajectory. On the other hand, causal reasoning, which is also related to planning, is useful for incremental improvement of NPD (Brown & Eisenhardt, 1995).

[27] Coviello & Joseph (2012) use the terminology “major innovation.”

Lastly, it was also unexpected that firms with 501-1000 employees were very unique, resulting from their negatively significant moderating effect of effectuation, while firms with over 1000 employees showed an insignificant moderating role of effectuation. Based on this result, it could be assumed that, in reality, large sized firms (firms with more than 500 employees) are still accustomed to applying causal reasoning to NPD (e.g., Read et al., 2009a). That is, NPD professionals in large firms are trained for applying causal reasoning, which relates to set up goals and calculated expected returns (Read et al., 2009a; Fisher, 2012). Moreover, large firms are used to perceiving the future as measurable and predictable with their existing competences, which leads them to do their systematic information gathering and analysis in pursuing their goals (Sarasvathy, 2001).

6.1.6 Moderated Mediation of Effectuation

In H5b, it was expected that the indirect effect of customer co-creation activities on early performance, through creativity of the product concept, would be contingent on a firm's effectuation. In other words, H5b investigated whether the moderated mediation role of effectuation enhanced early performance throughout creativity of the product concept. As hypothesized, the conditional indirect effect increases when firms with higher effectuation use customer co-creation activities, enabling them to enhance early performance through developing highly creative product concepts. The main insight is that firms with effectuation are able to develop concepts with a competitive advantage as well as to be attractive to investors by developing highly creative concepts when they co-create with customers.

A conditional indirect effect in terms of control groups was also calculated based on path coefficients from a PLS-SEM structural model of each control group. These results were consistent with those of H5a.

Similar to the above discussion, the results summarize a couple of insights on why effectuation is effective in the FFE of NPD. Firstly, in a highly uncertain situation like FFE, the reason may relate to the notion that effectuation is designed for embracing such high uncertainty (Read et al., 2009a). In higher uncertainty, firms should implement their strategy in a way that minimizes uncertainty (O'Conner & Rice, 2011). Effectuation guides firms in exploiting potential contingencies. The results show that having "agility" is helpful for firms in dealing with unexpected events, and even transforming them into opportunities. Overall, effectuation theory generally suggests how firms can make decisions under high uncertainty (Sarasvathy, 2001; Fisher, 2012). Specifically, if decision makers in firms believe that they are under unpredictable phenomena, they might prefer doing experimental and trial-and-error learning throughout NPD (Fisher, 2012).

Next, principles of effectuation (Sarasvathy, 2001) assert that they encourage involving co-creation in the process to develop new artefacts. Particularly, "partnership," which is deeply related to "willing to co-create" (Read & Sarasvathy, 2012), suggests that the effectuation process enables firms to induce commitment of participants (customers), leading to improved outcomes (Read et al., 2009a; Brettel et al., 2012). Similar cases were shown (Fisher, 2012) in which those entrepreneurs who actively engage with customers in communities are able to improve their product over time.

6.2 Theoretical Contributions

6.2.1 Effectuation Theory Applied to the FFE of NPD

The present research uses a unique framing, effectuation theory, in the context of the FFE of NPD (Dew et al., 2008; Read et al., 2009a; Coviello & Joseph, 2012). Furthermore, this research has shown how effectual reasoning at a micro level explains firm level

behaviour when managing customer co-creation activities in the FFE of NPD (Dew et al., 2008; Brettel et al., 2012; Blauth et al., 2014). It challenges the traditional view of the innovation process as one based upon causation logic where firms start with predetermined goals and means, and try to identify the optimal route to meet those goals (Gartner, 1985). Instead, using effectuation logic, firms will identify a set of means in the FFE as given and then focus on selecting the possible effects created by those means (Read et al., 2009a; Brettel et al., 2012).

The results confirm the applicability of effectuation in the FFE of NPD as discussed in the literature review, thus enhancing the generalizability of the theory (Read et al., 2009a). With regard to the role of effectuation during the FFE of NPD, results show that effectuation leverages the use of customer co-creation activities, providing a boundary condition for its effective use (e.g., Hoyer et al., 2010). More specifically, results are shown as expected that effectuation is the crucial moderator in stimulating the creativity of product concept when firms co-create with customers. Furthermore, the results highlight the linkage between effectuation theory and co-creation activities (Coviello & Joseph, 2012; Fisher, 2012; Read & Sarasvathy, 2012; Vargo & Lusch, 2017). That is, one of the crucial aspects of effectuation, denoted as "need to co-create," clearly supports the research and provides common ground with the co-creation paradigm (Read & Sarasvathy, 2012). Therefore, results suggest that having high effectuation would be a way to overcome one of impediments of customer co-creation in developing creative concepts in the FFE of NPD (Hoyer et al., 2010). For example, effectuation enables firms to screen out infeasible ideas suggested by co-creation activities by keeping experimenting or trial-and-error (Chandler et al., 2011; Coviello and Joseph, 2012).

Moreover, results show how dimensions of effectuation relate to the effectuation construct, which eventually explain reasons why it leverages the use of customer co-creation activities. Specifically, these results relate to responding propositions from the

previous studies (Read et al., 2009; Coviello & Joseph, 2012; Fisher, 2012). Firstly, it responds to a proposition from Fisher (2012), which relates to engaging with communities of customers in order to create more appealing products. In this research, results hold that applying this notion to the context of FFE of NPD and not simply engaging customer communities, but also other activities such as idea contest and problem-solving workshop with customers. Furthermore, this research replies a proposition suggested by Coviello & Joseph (2012), which concerns agile and flexible aspect of effectuation enhances early performance of NPD. It also provides clear results consistent with propositions by Read et al. (2009a), which relate to the usefulness of adopting analogical thinking, as well as a co-creational approach in highly uncertain situation in order to efficiently make decisions on NPD.

Therefore, consistent with these propositions, results provide insights of effectuation that they leverage the use of co-creation activities not only developing highly creative concepts but also drawing early performance in the FFE of NPD. Particularly, the thesis clarifies each dimension (all five as updated) with a firm's point of view, and resonates with a firm's strategic direction under a highly uncertain environment, especially in the FFE of NPD context.

In order to measure effectuation, the thesis carefully adopts the suggestion of Perry et al. (2012), which recommend applying the measure of effectuation as second order reflective-formative measure. Moreover, this research measures all five dimensions under the effectuation construct by adapting all developed measures by previous literature (e.g., Chandler et al., 2011; Brettel et al., 2012; Werhahn et al., 2015).

Furthermore, the control group analysis provides more insights on conditions of applying the theory to the NPD setting (Dew et al., 2009). Particularly, it showed that effectuation logic might play a different role contingent on the innovation type of NPD, as well as firm size. In terms of firm size, this research expects no differences as Brettel et al. (2012) examined. First, findings imply that effectuation facilitates the use of

customer co-creation activities in medium sized firms, because effectuation logic is easier to apply under a more flexible and unstructured NPD process (Berends et al., 2014). Even though this result is shown as expected, which is consistent with Berends et al. (2014), the role of effectuation had not been fully explored in large sized firms as this research has done with expected results. As briefly explained in earlier section, this is because large firms might be familiar to follow causation logic in the FFE of NPD by their formalized systems and experiences (Berends et al., 2014).

Interestingly, the results indicate that firms with effectuation were better at developing highly creative concepts when they co-created with customers within an incremental innovation project versus a radical innovation project. This result contrasts with Coviello & Joseph (2012)'s study, whereby they proposed effectual capability to be effective in radical innovation context. This may be because the effectual reasoning starts identifying existing means, which connects with the nature of incremental innovation, developing existing products by making incremental changes under the highly uncertain environment like FFE.

As called for in previous literature (Read et al., 2009a; Coviello & Joseph, 2012; Fisher, 2012; Perry et al., 2012), taken together, the testing of effectuation in the FFE of the NPD setting expands the applicability of the theory.

6.2.2 Co-creation Paradigm

The thesis touches on both the user innovation perspective and relationship strategy perspective in identifying and characterizing customer co-creation activities. Firstly, the research combines customer co-creation activities from user innovation literature (e.g., Ogawa & Piller, 2006; Piller & Walcher, 2006; Mahr et al., 2015), and challenges customer co-creation based on the relationship strategy perspective by suggesting new measure of the use of customer co-creation activities (e.g., Read & Ranjan, 2014; Chang & Taylor, 2016; Cui & Wu, 2017). Moreover, the construct with generation and

evaluation dimension is adopted by applying creativity perspective (Lubart, 2001; Eling et al., 2014). The creativity perspective explains how people can cognitively develop creative outcomes (Finke et al., 1992; Ward, 2001).

Above all, the research answers the calls for research on examining the effectiveness of co-creation activities in the FFE of NPD (Hoyer et al., 2010), because customer co-creation is strongly recommended in order to improve product acceptance by having a better fit to customer needs (Mahr et al., 2014) and by minimizing uncertainty of the FFE of NPD (Alam, 2006). In fact, this research suggests that the effectiveness of co-creation activities can be investigated through measuring the creativity of the outcome at the FFE. Thus, this study sheds light from both user innovation and firm-driven strategy perspective by synthesizing these two perspectives in the customer co-creation activities construct (e.g., O'Hern & Rindfleisch, 2010; Mahr et al., 2014).

Firstly, the present research theoretically contributes to strengthening the customer co-creation paradigm by conceptualizing customer co-creation activities as well as examining their impact on early performance. Customer co-creation activities were identified through the literature review, followed by the conceptualization of customer co-creation activities measurements. Unlike previous measures of co-creation (e.g., Gruner & Homburg, 2000; Fang, 2008; Candi et al., 2016), customer co-creation activities are straightforwardly measured with formative measures.

Secondly, the research characterized customer co-creation activities in terms of generation and evaluation by adopting the creativity processes (Finke et al., 1992; Ward, 2001; Eling et al., 2014). This is because, in the FFE, the creativity process explains different thinking involved in the generation (diverging) and evaluation (converging) phase, which is used to narrow down new product concepts (Eling et al., 2014). This contributes to the development of the customer co-creation activities construct that is a multi-dimensional construct that includes generation and evaluation.

Therefore, the results of the study reveal what kind of specific customer co-creation activities can be effectively adapted in either the generation or evaluation phases of FFE. Particularly, co-creation via crowd inputs such as idea contests or crowdsourcing are strongly associated with customer co-creation activities in the generation phase, while close co-creation activities such as involving customers in workshops or problem-solving techniques would be more effective for narrowing down ideas or concepts. Hence, the results of this study provide a clear understanding of customer co-creation activities in the FFE of NPD.

6.2.3 Front End of NPD and Innovation Literature

As discussed in the previous section, the research contributes to the literature on the FFE and innovation literature on (1) its relationship with effectuation theory (Brettel et al., 2012) and (2) the use of customer co-creation activities in reducing fuzziness in the front end of NPD (Zhang & Doll, 2001; Kim & Wilemon, 2002; Chang et al., 2007). The thesis discussed the research stream of FFE, which focuses on conceptualization and theorization, followed by its integration with customer co-creation, demonstrating how and when customers can be involved in the FFE. Moreover, as discussed in section (6.1.1), the results provided insights into what kind of customer co-creation activities in terms of generation and evaluation are more effective in the front end of NPD.

At the same time, the thesis contributes to the NPD and innovation literature by examining the role of outcome measures of the conceptual framework, such as creativity of the product concept and early performance. Specifically, the results suggest that the creativity of the product concept is one of the core factors for measuring the outcome of customer co-creation activities by confirming its mediation role on early performance in the FFE (e.g., Cui & Wu, 2017). Then it also carefully measured its potential (both competitive advantage and attractiveness of further capital investment) which was specifically developed to measure FFE performance (Poskela & Martinsuo,

2010; Reid et al., 2014). Therefore, this research clarifies the outcome measures of the FFE by specifying its role, that is, positioning creativity of the product concept as a mediator, followed by measuring its competitive potential, as well as its attractiveness for the further investment.

6.3 Managerial Implications

In practice, this research provides NPD professionals with valuable insights in terms of adopting effectuation in the FFE of NPD, the type of specific customer co-creation activities that may be utilised, as well as adopting and developing effectuation logic in the FFE of NPD. Specifically, the results provide insights for NPD professionals: (1) on when to use specific type of customer co-creation activities in the FFE of NPD, (2) the importance on focusing on measuring creativity of the product concept at the FFE of NPD, and (3) the advantages of adopting effectuation logic for firms in developing highly creative concepts during the FFE of NPD.

Managers first need to consider which phase of the co-creation process (generation or evaluation) they are working in and then choose the appropriate co-creation activities. For instance, in the ideation stage, the findings show that crowdsourced participation such as idea contests may be more useful. Whereas in the evaluation stage it may be more beneficial to choose activities working in close settings such as workshops.

Secondly, NPD professionals are advised to develop and thoroughly assess the creativity of the new product concept during the FFE (e.g., Eling et al., 2014). The findings suggest that developing highly creative concepts (both novel and meaningful) in the FFE is a crucial activity. That is because the results imply that achieving a competitive advantage is facilitated by developing highly creative concepts. Once firms develop highly creative

concepts, the higher chance that they will be able to attract resources for further development based on the results.

The findings demonstrate the importance of effectuation logic and how it can support the development of highly creative concepts. To adopt effectuation logic, NPD professionals need to identify and mobilize their competencies, resources, and networks and focus on a set of means before embarking on NPD projects. They need to take a particular effect and focus on what means they have to create that effect.

Also, NPD professionals would be advised to develop the agility aspect of effectuation. The findings demonstrate the importance of effectuation logic and how it can support the development of highly creative concepts. This would also help NPD professionals in managing and sorting out co-created new product ideas with customers using their agility and control aspects of effectuation. Moreover, NPD professionals need to direct where their NPD is going, which would enable them to know that their actions will result in the desired outcomes (Sarasvathy et al., 2014). Hence, based on the findings, developing effectuation using available means is strongly recommended to NPD professionals.

Aligned with the above, effectuation needs to develop an entrepreneurial mindset in order to build up a co-creation ecosystem (Hienerth et al., 2014). Business ecosystems describe the dynamic value co-creation by all involved actors (Moore, 1993; Adner & Kapoor, 2010) who develop synergies by focusing on customer co-creation enabling to transform the customer's input into a "continuous stream" of successful NPD (Hienerth et al., 2014: 849). Based on the results that effectuation supports the leveraging of co-creation, firms pursuing co-creation are advised to leverage their entrepreneurial traits. By adopting effectuation, firms may be able to reduce the risks involved in the FFE of NPD, because it proactively encourages to expand their existing means to co-create with their customers. In addition, they may also build stronger relationships with customers who they involve in their co-creation activities in NPD. Effectuation logic enables firms

to be more active in engaging with customers and motivates them to commit in the FFE. For example, LEGO encourages and facilitates their customers in their communities to start their own ventures, as well as they play an active role raising customers (Hienerth et al., 2014). Above all, these results can not only aid managerial decision-making within the FFE, it can also support firm-level investments.

6.4 Limitations and Future Research Directions

The present thesis opens up opportunities and interests for future research. This section points out some limitations of this study and suggests new opportunities for further research.

The simplified conceptual framework tested in this study could be extended into the future. For example, even though the overall results from effectuation supported the notion of its role in the FFE of NPD, control group analysis added specific conditions about the roles of effectuation. Particularly, firm size and innovation type might be key factors associated with the role of effectuation. Future research needs to provide further evidence to show how the relationship between a firm's size and other organizational factors (e.g., organizational culture, vision) might be related to applying effectuation in the FFE of NPD.

Moreover, this research examined the effectuation as the second order construct with five dimensions. However, these five dimensions, which stemmed from five principles of effectuation theory, might have dynamic relationships within, as depicted in the effectual process model (Sarasvathy & Dew, 2005; Read et al., 2009a).

Secondly, in relation to examining the impact of customer co-creation activities in the FFE of NPD, it might be insightful to explore qualities of firms' use of these activities

from both NPD professionals and customers who are involved. The dyadic match of NPD professionals and customers will certainly strengthen the quality of data. Furthermore, although the research augments the present knowledge of customer co-creation by showing boundary conditions of utilizing customer co-creation activities, it needs to be clearly understood how different phases of customer co-creation (either generation or evaluation) are related to each dimension of creativity of the product concept and early performance. For example, the empirical results briefly showed that in the generation phase firms used idea contests or crowdsourcing, whereas in the evaluation phase, firms used customer workshops or creative problem-solving activities. Certainly, future studies should not only confirm and clarify characteristics of customer co-creation activities in each phase, but also investigate the use and the quality of these activities from multiple participants (both NPD professionals and customers). Furthermore, the present study is limited to mostly investigating a firm's relation to the use of customer co-creation activities. In designing future research with a dyadic approach, customer characteristics such as customer knowledge (Schreier & Prügl, 2008) or motivational factors (Burroughs et al., 2011; Hoyer et al., 2010; Roberts et al., 2014) would be studied.

This research adopts a quantitative methodology with a positivistic approach. Specifically, a large scale cross-sectional survey was conducted to test hypotheses. Although the present research presented rigorous methodological procedures to answer research questions and test hypotheses, a large scale cross-sectional survey has its own constraints (Hayes, 2013). Firstly, data analyses did not clearly diagnose the concern for common method bias. If data are collected from single informants per unit of analysis, even if researchers carefully apply *ex ante* procedures to avoid common method bias, a couple of *ex post* techniques should typically be conducted to control for common method bias. In the future research, it is expected to include a couple of measures of method factors in the survey, which might be helpful to apply *ex post* techniques during data analysis, though there have been ongoing debates around appropriate techniques of common method bias in the PLS-SEM context (e.g., Chin et al.,

2012). Furthermore, it would be ideal to collect data from multiple responses per firm with different sets of questionnaires for measuring independent and dependant variables, provided the best remedy to avoid common method bias is to collect multiple responses per firms to enhance the quality of the cross-sectional survey, (e.g., Im et al., 2013; Kim et al., 2013). In addition, multiple responses per firms would enable the future research to do a multi-level study with firm level factors included in the survey (e.g., Frambach & Schillewaert, 2002).

Secondly, large scale cross-sectional approach is limited to verify causality issue. Even though this research provides significant paths, mediation, moderation, and moderated mediation in the research framework, it is not enough to assert causal relationships between constructs. In the future, in order to overcome this limitation, researchers might conduct necessary condition analysis (NCA) as a complement analysis alongside multiple regression and SEM (Dul, 2016). Applying NCA is straightforward. Once NCA verifies necessary conditions on determinants, researchers are able to state that these determinants are necessary but not sufficient to achieve a desired outcome, which increase chances to draw causal inferences (Dul, 2016).

On the other hand, in order to cautiously ensure causality, researchers might attempt to do longitudinal research, which collecting survey data from the same respondents repeatedly over a period of time (e.g., 1 year) (Perks & Roberts, 2013). Given that longitudinal study is concerned with sequential events and flow of activities within process, it can illustrate changes of phenomena over time and explain the cause of the process (Perks & Roberts, 2013). Conducting longitudinal research will demonstrate causal relationships whether customer co-creation activities influence developing highly creative concepts during FFE of NPD.

Furthermore, future research might consider applying process research methods to examine the customer co-creation activities in the FFE of NPD. For example, Berends et al. (2014) applied process research methods to uncover small firms with effectuation

and causation logic in their NPD. As the empirical results demonstrated, this approach would be appropriate for confirming and unveiling the applicability and dynamics of effectuation in medium and large sized firms.

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Appendix 1: Literature Review Summary Tables

Table A.1.1 Research on Conceptualizing the Fuzzy Front End

Research	Research objectives/questions	FFE Definition	Main Arguments
Cooper (1988, 1994, 1996)	What are the secrets to a winning new product process, one that consistently delivers a steady stream of successful and significant new products, and in a timely fashion?	Up front homework: Homework includes many activities that occur before development begins: initial screening; market, user, and competitive studies; technical and manufacturing appraisals; and financial analysis	Three cornerstones of performance in NPD are resources, strategy, and high quality process. A total overhaul of the new product process is necessary in order to realize real improvements in this critical function of the firm.
Khurana & Rosenthal (1997, 1998)	To examine front end activity with a systematic view in incremental innovations	FFE includes product strategy formulation and communication, opportunity identification, and assessment, idea generation, product definition, project planning, and early executive reviews which typically precedes detailed design and development of a new product.	Classifying successful factors for the front end success. Also emphasizing balancing front-end explicitness and flexibility. Providing cases evidence of three stages of evolution, and conclude that integrated capability (stage three) companies execute NPD projects better and faster.
Zhang & Doll (2001)	A framework for defining 'front-end fuzziness'	The front-end activities include pre-phase zero (idea generation), phase zero (assessment of market, technology and competition) and phase one (product definition, project justification and action plan) of phase review or stage-gate system (Cooper, 1997; Khurana and Rosenthal, 1998; Moenaert et al., 1995).	Authors explain front-end fuzziness in terms of *environmental uncertainties*. Front-end fuzziness has consequences for a project's team vision. It reduces the team's sense of shared purpose and causes unclear project targets and priorities.

Kim & Wilemon (2002)	To define the fuzzy front end of NPD, and suggests several strategies	"The period between when an opportunity is first considered and when an idea is judged ready for development."	The FFE phase is intrinsically non-routine, dynamic, and uncertain. Suggestions: A. Appoint knowledgeable individual or team to lead the FFE B. Providing organizational support for FFE activities C. Understanding the sources of FFE ambiguity D. Building an information system E. Developing relationships with supporters, partners, and alliances
Koen et al. (2002)	To provide the most effective methods, tools, and techniques for managing the FFE	The first part. Activities including opportunity identification, opportunity analysis, idea generation& enrichment.	Suggesting the new concept development (NCD) model: non-sequential model
Reid & de Brentani (2004)	To develop propositions about the nature of the fuzzy front end at the discontinuous end of the innovation spectrum.	"The earliest stage of NPD process and roughly is meant to denote all time and activity spent on an idea prior to the official group meeting to discuss it, or what they call "the start day of team alignment"" (171).	Three key roles at three decision-making interfaces: (1) the boundary spanner, (2) the gatekeeper, and (3) project broker. Authors propose boundary spanners identify and understand emerging patterns in the environment. Also, gatekeepers decide on the value to the organization of externally derived information, and share it within organization after decision making.
Kijkuit & van den Ende (2007)	Developing a dynamic framework for the role of social networks from idea generation to selection.	Following conceptualization by Khurana & Rosenthal (1998): All activities from idea generation until the go/no-go to execute an NPD project. Then they develop a dynamic framework for the role of social networks from idea generation to selection.	Suggest to have strong ties and prior related knowledge, to incorporate decision makers, and to move over time from a large, non-redundant and heterogeneous to a smaller and more cohesive network structure.
Florén & Frishammar, (2012)	The differences between incremental and radical front-end development and to the front end in the light of increasingly open innovation processes.	Comprising three key core activities: idea/concept development, idea/concept alignment, and idea/ concept legitimization, which allows firms to create corroborated product definitions.	Provided a comprehensive framework of the front end of new product development. Suggested outcomes of FFE are corroborated product concepts, Compared and contrasted FFE in terms of radical

			and incremental innovation context.
Eling, Griffin, & Langerak (2014)	To develop a conceptual framework theorizing why and under which conditions the use of intuition in FFE execution decision-making may or may not be (as) beneficial for the creativity of the resulting new product concept.	"The FFE is the dynamic getting-started stage of the NPD process that ends when a new product concept has been defined that is ready to proceed to development" (957) Three main tasks in the FFE include (1) problem definition, idea generation, and concept development.	Authors offer conceptual framework with 6 propositions. They propose a direct effect of intuition use in FFE execution decision-making on new product concept creativity that is based on the benefits of intuition use. In individual level Incremental nature of the project, FFE team member inexperience, and the existence of multiple goals may lead to less successful FFE outcomes, and rational decision culture, and hierarchical or democratic decision-making rules in team level may weaken FFE execution decision making.

Table A.1.2 Selected Empirical Research on FFE

Authors	Focus	Methodology	Main conclusion	Key perspective	Performance measure
Moenaert, De Meyer, Souder & Deschoolmeester (1995)	The integration of R&D and marketing activities during innovation process	Survey from 40 technologically innovative Belgian companies, expost facto research design	"[S]uccessful project teams are characterized by a maximum uncertainty reduction during planning, i.e., by a maximum decrease of R&D and marketing task variability, and a maximum increase of R&D and marketing task analyzability. Information flows between these functions help them to achieve this efficient uncertainty reduction. While project centralization has a negative effect on efficient uncertainty reduction, project formalization is curvilinearly related to the amount of uncertainty reduced during planning."	Uncertainty reduction perspective: Information transfer model (Moenaert & Souder, 1990)	The commercial success of the innovation project
Murphy & Kumar (1997)	Activities in each stage of FFE	Survey of 53 individuals from fifteen high technology firms in the integrated circuit board industry.	Support for Cooper's (1988) three stage model of predevelopment, including idea generation, product definition and project evaluation stages.	Cooper's (1988) 'predevelopment' model	The commercial success of the innovation project
Montoya-Weiss & O'Driscoll (2000)	Idea-development and subsequent idea-selection stages	Case study, Nortel	Nortel developed a way to implement idea-development and selection processes using electronic performance support system technology	Galieo process model	Four sets of criteria: marketing, technology, business, human factors
Thomke & Fujimoto (2000)	How shifting the identification and solving of problems—a concept that they define as front-loading—can reduce development time and cost and thus free up resources to be more innovative in the marketplace.	A field study of front-loading at Toyota	Systematic effort to front-load its development process has, in effect, shifted problem-identification and problem-solving to earlier stages of product development.	Problem-solving perspective	Product development performance: Development time and cost

Joshi & Sharma, (2004)	To set a nomological framework examining antecedents and impact of customer knowledge development on the new product performance	Survey of 165 marketing managers	(1) the organizational actions that enable effective implementation of the customer knowledge development process, (2) the characteristics of new product development projects that moderate the effects of these actions, and (3) the outcomes that are generated by the process.	Prelaunch process, customer interaction, trial-and-error	The new product's profitability, market share, and growth compared with that of its main competitor
Langerak, Hultink, & Robben (2004b)	Structural relationships among market orientation, the proficiency in predevelopment activities, new product performance, and organizational performance.	Data from 126 firms in The Netherlands	Market orientation is positively related to the proficiency in strategic planning, idea generation and idea screening. Strategic planning and idea generation are positively related to new product performance, which in itself is positively related to organizational performance.	Strategic orientation	New product performance, Organizational performance
Gassmann, Sandmeier & Wecht (2005)	New ways to integrate customers' knowledge into the innovation front-end	Case studies from interviews with R&D directors of 20 technology-intensive companies	Four determinants for front-end management that reside between creativity and resource efficiency: customer need, steering/project planning, product system architecture, NPD organization	New open innovation paradigm	Front-end effectiveness: creativity and resource efficiency
Alam (2006)	The fuzzy front-end of service innovations through customer interactions	Qualitative field research involving 26 financial services firms	The fuzzy front-end can be much less 'fuzzy' if customers are involved in the front-end stages of new service development.	Customer interaction	Reducing fuzziness
Griffiths-Hermans & Grover (2006)	To understand the idea fruition process, or the fuzzy front-end set of activities that an organization	Mixed approach: Case, Depth Interview, and survey	The idea fruition process consists of three subprocesses: idea creation, idea concretization, and idea commitment.	Idea fruition process	Degree of creativity of the generated idea. the degree of concretization of the generated idea. The degree of organizational commitment to formally develop the product
Rosenthal & Capper (2006)	Ethnographic research in the fuzzy front end to extend	In-depth case descriptions of two projects, a review of twelve other projects	Successful planning for ethnographies calls for an open mind coupled with explicit procedures for screening for diversity in respondents, gaining access to the desired range of respondents, and selecting a suitable ethnography team	Ethnographic approaches	Front-end product choices

Schulze & Hoegl (2008)	Relationships between the four knowledge creation modes and an organization's ability to create novel product ideas.	Survey of multiple responses from 33 companies	Positive relationships between socialization as well as internalization and the novelty of product ideas, negative relationships for externalization as well as combination.	Knowledge creation model from Nonaka et al (1994)	Novelty of product ideas
Verwon, Herstatt, & Nagahira (2008)	The fuzzy front end of Japanese new product development projects: impact on success and differences between incremental and radical projects	Data from 497 NPD projects in Japanese manufacturing firms, structural equation model	Results suggest that an early reduction of market and technical uncertainty as well as an initial planning before development have a positive impact on NPD project success. Also they find that the difficulty of estimating the market size and price sensitivity of the customers in radical innovation context.	Information processing approach	Efficiency, effectiveness, subjective success measures
Poskela & Martinsuo (2009)	Management Control and Strategic Renewal in the Front End of Innovation	Survey of 133 new product development projects from different large and medium-sized companies	Input control is positively associated with achieving strategic renewal in the front-end phase. The results also confirm the importance of intrinsic task motivation of the front-end group. Under high technology uncertainty, the use of outcome based rewarding or front-end process formalization has a negative influence on strategic renewal.	Management controls (Simons, 1995)	Strategic renewal: the ability of the front-end phase to create an opportunity window for new market entries or NPD activities (Cooper & Kleinschmidt, 1987; Kleinschmidt et al., 2005).
Verwon (2009)	A direct and indirect impact of fuzzy front end on the success	144 projects completed by German measurement and control technique firms	The results offer strong support for the importance of the early involvement of all departments in new product development to enhance communication and, ultimately, project success. This process can be advanced by initial planning prior to development.	Contingency theory	Efficiency, Satisfaction
Reid & de Brentani (2010, 2012)	Market vision (MV) and its precursor, market visioning competence (MVC), for radically new, high-tech products	2 studies (109 responses for study 1, 117 for study 2) for measurement development: High-tech firms involved in early technology developments	To develop a comprehensive set of scales to measure these constructs and then to combine them in a model by which to examine their interrelationships.	Resource based view	Early performance: Ability to attract capital, Early success with customer

Bertels, Kleinschmidt, & Koen (2011)	Dispersed collaboration, moderating role of mechanisms believed to enable tacit knowledge transfer in the front end of innovation	Survey 116 business units	Encouragement of communities of practice is found to moderate the relationship between proficiency of dispersed collaboration and front end of innovation performance on the business unit level.	Learning theory	Front end of innovation performance: advantage, and portfolio
Frishammar, Floren, & Wincent (2011)	Equivocality in the Fuzzy Front End of Product and Process Innovation Projects	A longitudinal, multiple case study of four large companies	Both uncertainty and equivocality is more effectively reduced in successful front-end projects than in unsuccessful ones. Negative consequences of equivocality appear more critical to front-end performance than the consequences following uncertainty. Uncertainty and equivocality are reduced sequentially in successful projects and simultaneously in unsuccessful projects, uncertainty and equivocality takes longer time to reduce in process innovation projects than in product innovation projects	Uncertainty in front end	Consequences of the project: Increases risk in development
Martinsuo & Poskela (2011)	How the use of evaluation criteria is associated with innovation performance in the front end of innovation.	Cross-sectional survey of 107 usable responses from product development and experts.	"[a]ssessment formality is negatively but nonsignificantly associated with innovation performance, whereas the use of evaluation criteria has a significant role in promoting competitive and business potential in the front end of innovation. None of the moderating effects of product complexity are significant, but **the use of evaluation systems** and criteria mediate the link between product complexity and strategic opportunity."	NA	Strategic opportunity in the front end of innovation: Competitive potential, Future business potential,
Markham (2013)	Tests a model of the impact of front-end innovation activities on product performance	Survey data from 272 companies	Empirically demonstrates the distinction between the front-end and formal stages and gates types of systems.	NA	Front end performance, product performance
Kock, Heising, & Gemunden (2014)	How ideation portfolio management affects the performance of the front end and of the eventual project portfolio.	Cross-industry investigation of 175 medium-sized and large firms in Germany	Ideation portfolio management are complementary and should be balanced to maximize the performance of the front end and the eventual innovation project portfolio.	Ideation portfolio management	Front-end success: front-end effectiveness, front-end speed, and front-end cost efficiency Project portfolio success: overall business success, average

					economic success of products and project results, strategic fit, portfolio balance, and preparing for the future
Reid, Roberts, & Moore (2014)	Role of "technology visions," toward project-level and organizational-level involvement with a given technology.	A large sample of firms engaged in radical innovation in North America and the United Kingdom	Technology vision is found to have a significant positive impact on technical competitive advantage, early success with customers, and ability to attract capital, as measures of early success.	Organizational vision	Early success: Early success with customers, Technical competitive advantage, Ability to attract capital
Eling, Langerak, & Griffin (2014)	The use of both rational and intuitive approaches to decision-making in the fuzzy front end	An experiment with product development practitioners	Intuitively analysing the ideas and then rationally considering the resulting intuition in making the final decision, leads to both the highest quality and speed.	Decision making	Performance measures: creativity
Christiansen & Gasparin (2016)	The behavior in ambiguous situations in the fuzzy-front	Qualitative, 4 cases	The ambiguous situations which were successfully black-boxed required experimental behavior, rather than uncertainty reducing analytical behavior. This might indicate that experiments and the use if intuition might be a better suggestion for the complex challenges in the FFE, rather than to rely on uncertainty reduction and information collection	Actor Network Theory (ANT) (Latour, 1987), Blackboxing	Reduction of ambiguity

Table A.1.3 Literature Theorizing and Developing Customer Co-creation Paradigm

Authors	Focus	Main conclusion	Perspective
von Hippel (1976, 1986)	Importance of Lead Users' for NPD market in industrial markets.	Shows dominant roles of lead users in research, product design and development challenging the conventional view that products are designed by manufacturers.	Lead user
von Hippel (1978)	Presentation of a new customer active paradigm	Describes and compares the manufacturer-active paradigm (MAP) and customer-active paradigm (CAP), and propose how well each paradigm fits actual conditions in the industrial market.	Customer-active paradigm
Ramirez (1999)	History of an alternative view of value creation	Technical breakthroughs and social innovations in actual value creation render the alternative—a value co-production framework	Value co-production framework based on history
Prahalad & Ramaswamy, (2000, 2004)	Recognises the active role of consumers in an increasingly networked society and calls into question our basic conception of value and the processes that lead to its creation.	Suggest companies can achieve a competitive advantage by co-opting customer competence. Innovation will focus on experiences supported by networks of companies and consumer communities.	Value co-creation, present DART model
Thomke & von Hippel, (2002)	Using Customers as Innovators as a new way to create value.	Discuss the basic principles for turning 'customers into innovators' and provides 5 key learning points. Suggests consumers can be innovators.	Get customer involved in the user-friendly toolkits
von Hippel & Katz (2002)	Shifting the locus of innovation to users via toolkits in high-tech industries.	Manufacturers can overcome problems of traditional MR methodologies and NPD process by outsourcing key need related innovation tasks, e.g. design and prototyping to users- by equipping them with 'user friendly' toolkits.	Lead user
Veryzer & Borja de Mozota, (2005)	How User-oriented design (UOD) can enhance collaborative NPD, improve ideation and improve product/ service solutions.	Presents four research propositions relating to the impact of UOD on the NPD process.	User-oriented design (UOD)
Vargo & Lusch (2004, 2008)	S-D Logic continuing the evolution	Offers revisions to the foundational premises of SD logic published in 2004, e.g., FP6 now states that 'the customer is always a co-creator of value'.	Service-dominant (S-D) logic
Etgar (2008)	A model of consumer engagement in co-production.	Five distinct phases of the production activity chain where consumers can become involved in co-production: (1) development of antecedent	S-D logic

		conditions, (2) development of motivations which prompt consumers to engage in co-production, (3) calculation of the co-production cost-benefits, (4) activation when consumers become engaged in the actual performance of the co-producing activities, (5) generation of outputs and evaluation of the results of the process.	
Payne, Storbacka, & Frow (2008)	To develop a process-based conceptual framework for understanding and improving value co-creation within the context of S-D logic.	Provide a structure for customer involvement that takes account of key foundational propositions of S-D logic and places the customer explicitly at the same level of importance as the company as co-creators of value.	S-D logic
Fuller (2010)	Explore what consumers expect from virtual co-creation and how consumers' motivations and personalities influence those expectations.	"[c]onsumers' motives in contributing to co-creation projects may be heterogeneous and depend on their personality. Further, differently motivated consumer groups may have different expectations towards cocreation— the process, the co-creation content, as well as co-creation partners."	Social exchange theory, virtual co-creation
Hoyer, Chandy, Dorotic, Krafft, & Singh (2010)	The area of consumer cocreation	Outline and discuss a conceptual framework that focuses on the degree of consumer cocreation in new product development (NPD) (a) the major stimulators and impediments to this process, (b) the impact of cocreation at each stage of the NPD process, and (c) the various firm-related and consumer-related outcomes.	Consume co-creation framework with impediments
O'Hern & Rindflesch (2010)	New perspective in which customers are active co-creators of the products they buy and use	A conceptual typology of four different types of co-creation activity, and offers an agenda for future research of this emerging paradigm.	Typology, creativity process
Rawaswamy & Gouillart (2010)	To propose customer co-creation process of strategy	Presenting four principles of co-creation with stakeholders	Co-creation, stakeholers
Piller, Ihl, & Vossen (2011)	A typology of customer co-creation in the innovation process	A review of the evolution of customer co-creation and related forms of customer participation and suggest a typology of recent methods of co-creation (open innovation with customers).	Co-creation typology based on open innovation
Coviello & Joseph (2012)	Creating Major Innovations with Customers	The firms with MI success are distinguished by a nonconventional new product development process that includes five iterative and overlapping activities and up to ten different customer roles. These activities and roles are captured in a multifaceted taxonomy of customer participation. Uncover three capabilities relevant to the development of successful MI—capabilities that are effectual rather than adaptive in nature.	Effectuation, B2B SME
Greer & Lei (2012)	A review of the literature, placing	"[d]evelop a synthesized conceptual framework from three existing models,	Present collaborative

	emphasis on how firms engage in collaborative innovation with individual and business customers.	and other streams of research, to organize this diverse body of literature: based on Ojanen & Hallikas (2009) CIC framework, the Etgar (2008) model of co-production, and the Payne et al. (2008) framework for co-creation of value.	innovation with customer (CIC) framework
Gronroos (2012)	Conceptualising value co-creation	Value co-creation can be defined as the joint actions by a customer (or another beneficiary) and a service provider during their direct interactions.	Servuction model and the interactive marketing model
Lee, Olson & Trimi (2012)	Co-innovation and organisational value creation	"The core of co-innovation includes engagement, co-creation, and compelling experience for value creation. Thus, the practices of co-innovative organizations are difficult to imitate by competition."	Co-innovation as next version of innovation, Macro view
Jimenez, Voss, & Frankwick (2013)	Classification schema of customer co-production of goods based on general systems theory (GST)	Six sub-areas of co-production of goods: restricted co-manufacturing, unrestricted co-manufacturing, co-ideation, co-design, mass customization, and participation loop.	General systems theory Tangible goods, Customer tacitility, autonomy
Frow, Nenonen, Payne, & Storbacka (2015)	Developing a structured framework that enables managers to identify and evaluate co-creation opportunities	Offering a detailed and granular approach to co-creation design. Extending the application of a design approach within the context of co-creation activities.	Co-creation with design perspective
Gemser & Perks (2015)	Selecting customer co-creation literature in JPIM	Providing criterion for distinguishing customer cocreation literature in NPD/Innovation	Criteria systematic review on co-creation in Innovation discipline
Ranjan & Read (2014)	Core conceptual elements of Value co-creation	Expose co-production and value-in-use (ViU) as the two peer, core conceptual dimensions of Value Co-creation (VCC). derive an integrated conceptual model of VCC and employ it in the development and testing of a measurement index for VCC	Value co-creation
Kohtamaki & Rajala, (2016)	The co-creation of value and the coproduction of value proposition	Authors demonstrate research of value co-creation and the coproduction of value proposition covers a myriad of viewpoints to the economic and social exchange among actors in multi-actor service ecosystems. and They show various definitions and meanings associated with value co-creation, and provide insight into theories and methods used in the area.	Practice theory

Table A.1.4 Selected Empirical Literature on Co-creation in NPD/ Innovation Focus

Authors	Focus	Methodology/ Context	Main conclusion	Theory, Perspective	Dependent variable
Gruner & Homburg (2000)	The customer as a co- creator in NPD. Intensity of customer interaction in terms of different stages of NPD	Cross-sectional Survey of 310 responses from firms in Machinery industry more than 250 employees	Collaborating with financially attractive customers or those exhibiting Lead User Characteristics influences product success; as does customer involvement in the early and late stages of NPD.	Resource dependence theory, Lead-user perspective	Quality of new product
Lilien, Morrison, Searls, Sonnack, & von Hippel (2002)	Performance assessment of the lead user idea generation process for NPD.	Case Study 3M with observation, surveys and interview	Lead User process improved innovation capabilities and increased sales forecasts.	Lead-user	Innovation capabilities Sales forecasts
Franke & Shah (2003)	How user innovators gather the information and assistance they need to develop and how they share and diffuse the resulting innovations	Exploratory study, investigating four sports communities	Individuals who are involved in voluntary special interest community often prototype novel sports-related products and that they receive assistance in developing their innovations from fellow community members. Also, innovation-related information and assistance, as well as the innovations themselves, are freely shared within these communities	User innovators in communities	Knowledge sharing within communities
Franke & Piller (2004)	To examine values created by Toolkits	Four experiments with total of 717 participants	findings suggest that the toolkit's ability to allow customers to customize products to suit their individual preferences creates value for them in a business-to-consumer (B2C) setting even when only a simple toolkit is employed.	Lead-user	Willingness to pay
Kristensson, Gustafsson & Archer (2004)	The benefits of user involvement in idea generation for NPD	Experimental research on mobile Phone industry.	Ideas developed by 'ordinary users' were found to be more original and more valuable than those generated by professional developers.	Lead users, divergent thinking	Creative output: original, valuable, and realizable merit
Lüthje (2004)	The innovation activities of end users in the field of consumer goods	Empirical/ survey of 153 users of outdoor-related consumer products	innovating users can be reliably distinguished from non-innovating ones by characteristics such as the benefit they expect from using their innovations and the level of expertise they have in the use of the products.	Lead-user	Expected financial benefit

Moreau & Dahl (2005)	How input and time constraints influence the way in which consumers process information during a creative task and how those processes, in turn, influence the creativity of the solution	Experiments from undergraduate students	Input constraints encourage more creative processing, provided the individual is not under significant time constraints	Creative cognition	Judged Creativity of the Outcome
Roberts, Walker & Baker (2005)	Consumers as “co developers for innovation”. Examines consumers and manufacturers perceptions of the process (creativity workshop)	Qualitative approach, workshop, in Fast moving consumer goods industry.	Consumers are willing and able to contribute more to the innovation process than traditional methods permit. This requires creativity, dialogue and a re-definition of the producer-consumer relationship.	Creative problem solving model	Consumers as co-developers, innovators
Jeppesen & Frederiksen (2006)	Users in online firm-hosted user communities	Analyzing data derived from multiple sources (interviews, a Web-log, and questionnaires),	"innovative users are likely to be (i) hobbyists, an attribute that can be assumed to (positively) affect innovators' willingness to share innovations, and (ii) responsive to “firm recognition” as a motivating factor for undertaking innovation, which explains their decision to join the firm's domain."	User innovation	Innovative users
Knudsen (2007)	Exploring the nature and relative importance of different types of interfirm relationships for new product development (NPD) success	Survey of European manufacturing and service industries (764 responses)	Relationships with customers are used most frequently at both early and late stages of the product development process, with a second and more contradictory finding that at the same time customer relationships have a negative impact on innovative success.	Interorganizational relationship, knowledge transfer	Innovation performance
Blazevic & Lievens (2008)	Customers of electronic services coproduce knowledge in varying degrees (e.g., passive user, active informer, and bidirectional creator).	Data from three electronic service interaction channels, involving managers, engineers, and customers; case study findings; and an extensive literature review	The results show three different roles of customers (passive user, active informer, and bidirectional creator) in knowledge coproduction and explain comprehensively how each role impacts various innovation tasks (detection, development, and deployment).	Customer collaboration	Innovation tasks: detection, development, deployment

Fang (2008)	Trade-off between new product innovativeness and speed to market caused by customer participation activities,	Empirical/ Matched data collected from 143 customer–component manufacturer dyads	Customer participation as an information resource (CPI) has a negative influence on innovativeness when downstream customer network connectivity is high but a positive effect when it is low. In contrast, CPI has a positive effect on speed to market when downstream customer network connectivity is high and no significant effect when it is low. In addition, customer participation as a codeveloper (CPC) undermines new product speed to market when process interdependence is high. In contrast, CPC can improve new product speed to market but hurt new product innovativeness when process interdependence is low.	Network connectivity	New product innovativeness, speed to market
Schreier & Prugl (2008)	Antecedents and consequences of consumers' Lead userness	Three experiments in consumer sports field	Field-related variables (consumer knowledge and use experience) as well as field-independent personality variables (locus of control and innovativeness) help explain an individual's lead userness. Lead users demonstrate innovative behavior not only by creating new product ideas but also by adopting new commercial products more heavily and faster than ordinary users.	lead user, Rogers's (2003) innovation-decision process theory,	new product adoption behavior
Carbonell, Rodriguez-Escudero, & Pujari (2009)	Customer Involvement in New Service Development: An Examination of Antecedents and Outcomes (Technological novelty as antecedent of customer involvement)	Survey from 102 Spanish service firms	Whereas customer involvement has a positive direct effect on technical quality and innovation speed, it has an indirect effect on competitive superiority and sales performance through both technical quality and innovation speed. The study also finds a positive effect of technological novelty as well as technological turbulence on customer involvement.	Resource dependence theory	New service performance (1) operational outcomes: innovation speed, technical quality, (2) Market outcomes: Competitive superiority, sales performance
Magnusson (2009)	(1) What contributions do ordinary users make when involved in the FFE for ideation of new technology-based services;	A comparative quasi-experimental design with three scenarios of mobile service	Ordinary users should not be expected to contribute ideas that can be directly put into the new product development process; rather, ordinary user involvement should be regarded as a process whereby a company learns about users'	Lead user, creative process	Originality, user value, and producibility

	(2) how is the contribution of the users affected by their knowledge of the underlying technology?		needs and is inspired to innovate.		
Nambisan & Baron, (2009)	Investigating the reason why customer participate voluntarily in value co-creation activities in such virtual customer environments (VCE).	Survey, collected from customer participants of the VCEs of two firms, Microsoft and IBM.	"customers' participation in product support activities in a VCE is motivated not just by their ''citizenship'' or norm-related behavior but stems primarily from their beliefs concerning the benefits of engaging in such activities."	Uses and Gratifications Framework (Katz et al., 1974)	Customer Participation in Value Creation (Product Support)
Fuchs & Schreier (2011)	How customers from the ''periphery'' (i.e., the mass that does not participate) perceive customer empowerment strategies.	Two experiments using three different product categories (T-shirts, furniture, and bicycles)	Both customer empowerment dimensions (as well as its interaction) are found to lead to (1) increased levels of perceived customer orientation, (2) more favorable corporate attitudes, (3) and stronger behavioral intentions.	Empowerment	Customer orientation, Behaviorial intention
Al-Zu'bi & Tsinopoulos (2012)	Examining impact of suppliers and Lead Users on Product variety	Hierarchical regression analysis of survey data collected from 313 U.K. manufacturers	The key findings are that increasing the extent of collaboration with lead users and with suppliers during the NPD process will increase the variety of products offered to customers, and that lead users have a higher impact on product variety to suppliers.	Lead user	Product variety
Mahr & Lievens (2012)	"creation of innovation-related knowledge in virtual communities visited mainly by lead users"	Netnography from Nokia BetaLabs (community)	The value of lead users in digital networks stems from their skills, not only in terms of describing needs and preferences but also for developing solutions to these needs.	Lead user	Subjective ratings by individuals or small groups to assess the novelty and relevance of information
Poetz & Schreier (2012)	Comparison of ideas actually generated by a firm's professionals with those generated by users in the course of an idea generation contest	Field experiment held via Bamed/MAM group, recruited 70 users in the idea generation project.	Crowdsourcing process generated user ideas that score significantly higher in terms of novelty and customer benefit, and somewhat lower in terms of feasibility	Crowdsourcing	Quality of ideas
Mahr, Lievens, & Blazevic (2014)	Impact of customer cocreated knowledge on innovation outcomes	Survey from 126 customer cocreation projects	"The data analysis indicates that customer cocreation is most successful for the creation of highly relevant but moderately novel knowledge. Cocreation with customers who are closely related to the innovating firm results in more highly relevant knowledge at a low cost. Yet, cocreation	Customer knowledge management, Lead-user	Innovation outcomes

			with lead users produces novel and relevant knowledge."		
Roberts, Hughes, & Kertbo (2014)	To explore what factors motivate consumers to engage in co-creation innovation activities.	Qualitative approach with in-depth interview with 17 from online gaming community	"Innovating independently of the firm appears to be driven by egocentric motives; innovating as part of a community appears to be driven by altruistic motives; and innovating directly in collaboration with the firm appears to be driven by opportunity- (or goal-related motives."	Goal-based theory, social exchange theory, motivation theory	Participating innovation activity to create value
Mahr, Rindfleisch, & Slotegraaf (2015)	Exploring why some external solvers are more successful than others: The impact of creative versus deliberate problem-solving styles on solving success.	Survey and archival data from solvers in InnoCentive	Creative (deliberate) styles are more effective under conditions of high (low) contextual familiarity and shorter (longer) time investments. When solvers employ both styles, overall problem-solving success declines.	Dual-processing theory	Solving success
Candi, van den Ende, & Gemser (2016)	Moderating effects of utilitarian and hedonic radicalness with customer codevelopment	Survey in Innovation projects from 132 firms in the Netherlands	The findings suggest that the contribution of customer codevelopment to market success is positively moderated by utilitarian radicalness and negatively moderated by hedonic radicalness.	The theory of the experiential view of consumption	New product market success
Chang & Taylor (2016)	Authors present a conceptual framework that synthesizes a variety of contingency factors. A meta-analysis empirically examines the moderating effects of contextual factors between customer participation and NPD performance.	Meta-analysis with 35 empirical studies of customer participation and NPD performance.	The analysis reveals that involving customers in the ideation and launch stages of NPD improves new product financial performance directly as well as indirectly through acceleration of time to market, whereas customer participation in the development phase slows down time to market, deteriorating new product financial performance.	Knowledge management theory	New product development performance: Operational, financial, and marketing performance
Cui & Wu (2017)	The effects of two forms of customer involvement on new product outcomes: the traditional form of customer involvement as an information source (CIS) and the more active form of customer involvement as co-developers (CIC)	Survey from 264 new product professionals	When a firm uses CIC, highly experimental learning in NPD may compromise product outcomes. CIS also substitutes for the effect of CIC such that CIC has a positive effect on product outcomes when the level of CIS is low but its effect is not significant when CIS is high.	Experimental learning approach	New product advantage, New product innovativeness

Table A.1.5 Concept Comparison of Customer Related Constructs

Construct	Definition	Literature	Note
Customer orientation	Customer orientation centers on an organization-wide generation and dissemination of, and responsiveness to, market intelligence (Kohli & Jaworski, 1990) the set of beliefs that puts the customer's interest first, while not excluding those of all other stakeholders such as owners, managers, and employees, in order to develop a long-term profitable enterprise (Deshpande, Farley, & Webster, 1993)	Deshpande, Farley, & Webster (1993); Kohli & Jaworski (1990); Narver & Slater (1990); Gatignon & Xuereb (1997)	Kohli & Jaworski (1990) used it as same construct as 'market orientation' it is subdimension of market orientation (Narver & Slater, 1990) Deshpande et al. (1993) consider it as being a part of an overall, but much more fundamental, corporate culture. Proactive market orientation: a business attempts to discover, to understand, and to satisfy the latent needs of customers (Narver, Slater, & MacLachlan, 2004) Perceived customer orientation (Fuchs & Schreier, 2011) a customer-oriented firm "with the ability and the will to identify, analyze, understand, and answer user needs." (Gatignon & Xuereb, 1997: 78)
Mass customization	The ability to provide customized products or services through flexible processes in high volumes and at reasonably low costs (Da Silveira, Borenstein, & Fogliatto, 2001).	Wind & Rawaswamy (2001); Berger & Piller (2004); Franke, Keinz, & Schreier, (2008); Kaplan & Haenlein (2006); Franke & Piller (2003)	"Mass customization (MC) toolkits are defined as a set of user friendly design tools that allow trial-and-error experimentation processes and deliver immediate simulated feedback on the outcome of design ideas." (Franke et al., 2008)
Coupled process	Co-creation with (mainly) complementary partners through alliances, cooperation, and joint ventures during which give and take are crucial for success (Enkel, Gassman, & Chesbrough, 2009)	Enkel, Gassman, & Chesbrough, (2009); West & Bogers (2014); Cheng & Huizingh (2014)	Not limited to work with customers in this concept.

Co-production	"direct or indirect "coworking with customers" or participation in the product/service design process" (Ranjan & Read, 2014)	Vargo (2008), Vargo & Lusch (2008, 2011), Kohtamaki & Rajala (2016), Auh, Bell, McLoed, & Shih (2007), Jimenez, Voss, & Frankwick (2011),	Co-production and co-creation of value are linked as “nested concepts with the co-production being a subordinate concept to that of co-creation of value” (Etgar, 2008)
Customer codevelopment	"actively involving customers in the development of new products" (Candi, van den Ende, & Gemser, 2016: 418)	Greer & Lei (2012); Candi et al. (2016)	Mostly overlap with co-production concept. However, the concept focuses more on
Customer participation/Involvement	The extent to which the customer is involved in the manufacturer's NPD process (Fang, 2008). The degree to which the customer is involved in producing and delivering the service (Dabholkar, 1990: 484)	Dahlsten (2004); Lagrosen (2005); Fang (2008); Fang et al. (2008); Cui & Wu (2015, 2017); Chang & Taylor (2016)	The construct can be specified into customer participation as an information resource and customer participation as a codeveloper (Fang, 2008) Including customer participation as a codelveloper in NPD process overlaps with the concept of customer co-development. Opportunities for customer involvement (Jeppesen, 2005)
Intensity of customer interaction	Interactions between producers and the representative(s) of one or more customer firms at various stages of a NPD process (Alam, 2006)	Gruner & Homburg (2000); Alam (2006)	Gruner & Homburg (2000) focus on B2B context by relying on relationship marketing literature and resource dependence theory in developing customer interaction construct. They also consider customer related factor from von Hippel's (1976, 1978) CAP. They tapped into paradigm shift.
Customer engagement	‘‘customers’ behavioral manifestations that have a brand- or firm-focus, beyond purchase, resulting from motivational drivers’’ (Van Doorn et al., 2010: 254).	Van Doorn et al. (2010), Brodie et al. (2011), Verhoef et al. (2010)	Relationship marketing

Customer co-creation	Customers coproduce knowledge that is valuable for the firm's innovation process. This occurs when customers actively engage in the development of new products and take over activities traditionally executed by the firm (Hoyer et al., 2010; Mahr et al., 2014) a collaborative NPD activity in which customers actively contribute and/or select the content of a new product offering (O'Hern & Rindfleisch, 2010)	Hoyer et al. (2010), O'Hern & Rindfleisch (2010), Mahr et al. (2014)	Two components: contribution and selection (O'Hern & Rindfleisch, 2010) Frow et al. (2015): Co-production and co-creation relating to value-in-use as dimension of co-creation.
Value co-creation	VCC is superordinate to elements of co-production and customization as it extends beyond the production chain to the consumption and value delivery chain (Ranjan & Read, 2014)	Ranjan & Read, (2014); Payne et al. (2009)	VCC consists of co-production and value in use (Ranjan & Read, 2014)
Value in use	"Value in Use is the customer's experiential evaluation of the product or service proposition beyond its functional attributes and in accordance with his/her individual motivation, specialized competences, actions, processes, and performances" (Ranjan & Read, 2014)	McColl-Kennedy et al.(2012); Vargo & Lusch (2008)	It consists of experience, personalization, and relationship as dimensions (Ranjan & Read, 2014)
Customer creativity	Customers contributes to creativity of products (Kristensson, Gustaffson, & Archer, 2004)	Kristensson et al., (2004); Moreau & Dahl, (2005); Magnusson (2009)	Comparison between expert and ordinary customers on product creativity (Kristensson et al., 2004)
Customer empowerment	Empowerment: "(co)creative force that structures the possible field of interaction and exchange of free agents" (Denegri-Knott, Zwick, & Schroeder 2006: 961) "as a strategy firms use to give customers a sense of control over its product selection process, allowing them to collectively select the final products the company will later sell to the broader market" (Fuchs, Prandelli, & Schreier, 2010: 66)	Empowerment: Denegri-Knott, Zwick, & Schroeder, (2006); Ramini & Kumar (2008); Fuller, Muhlbacher, Matzler, & Jawecki, (2009); Fuchs et al., (2010); Fuchs & Schreier (2011)	Customer empowerment strategies in NPD: who creates new design vs. who decides which designs will be produced (Fuchs & Schreier, 2011) Overlapped with customer co-creation (O'Hern & Rindfleisch, 2010) two sub-dimensions of empowerment: initiator and decision maker
Customer mobilization	Not only [to] assemble resources from customers, but also activating them through deliberate encouragement and being open to customer-initiated efforts (Coviello & Joseph, 2012)	Coviello & Joseph, (2012); Day (2011)	One component of effectual capabilities (Coviello & Joseph, 2012) Extended and adjusted to innovation context based on adaptive capabilities (Day 2011)

Table A.1.6 Selected Conceptual Research on Effectuation Theory

Authors	Focus	Main conclusion	Note
Sarasvathy (2001)	Comparing causation and effectuation	The author provides five principles of the logic of the effectuation.	Theory building
Sarasvathy, Dew, Velanuri, & Venkataraman (2003)	Reviewing three views of entrepreneurial opportunity: allocative, discover, and creative process view	The lags between invention and creation of new economic welfare require not only the ability and alertness to recognize, and the perception to discover opportunities for the achievement of pre-determined goals, but also necessitate decisions and actions based often only on human imagination and human aspirations, that may or may not in time lead to new products, firms, and markets.	Entrepreneurial opportunity
Sarasvathy & Dew (2005)	Entrepreneurial logics for a technology of foolishness	Propose three entrepreneurial logics: (1) the logic of identity, as opposed to the logic of preferences; (2) the logic of action, as opposed to the logic of belief; and (3) the logic of commitment, as opposed to the logic of transaction.	Transformation
Goel & Karri (2006)	Effectual logic and over-trust	Specific personality characteristics of the entrepreneur interact with effectual logic to make the entrepreneur more susceptible to over-trust	Trust of entrepreneur
Wiltbank, Dew, Read, & Sarasvathy (2006)	Independence of prediction and control	Providing 2 by 2 framework in terms of control and prediction, and positioning effectuation as a transformative approach with regard to low prediction and high control.	Control-oriented approach (transformaitve)
Chiles, Bluedorn, & Gupta (2007)	Alternative Austrian approach to entrepreneurship, based on Lachmann's work.	Introduced Lachmann's work and identified the direction in which a Lachmannian approach would lead the entrepreneurship field. Specifically, this approach suggests two central issues, (1) the creation of opportunities through human imagination directed toward an envisioned future, and (2) the exploitation of opportunities through continuous resource combination and recombination.	Entrepreneurial opportunity
Dew, Read, Sarasvathy, & Wiltbank (2008)	Outline a behavioral theory of entrepreneurial firm	Explicating three ideas (1) accumulating stakeholder commitments under goal ambiguity (in line with a political conception of goals), (2) achieving control (as opposed to managing expectations) through non-predictive strategies, and (3) predominately exaptive (rather than adaptive) orientation.	Effectual thinking
Sarasvathy, Dew, Read, & Wiltbank (2008)	Organization design strategy with effectuation	Use an 'alternate histories' method to trace four strategic options — namely, planning, adaptation, vision and transformation — for designing at the second interface. Applying transformational approach to organizational design also beneficial in designing the environments around organizations.	Designing organization

Dew, Sarasvathy, Read, & Wiltbank (2009)	Affordable loss on plunge decision	Develop propositions to explain how individuals: (1) decide what they can afford to lose; and (2) what they are willing to lose in order to plunge into entrepreneurship.	Affordable loss dimension
Harmeling & Sarasvathy (2011)	Educating entrepreneurs contingency as resource	Present an inductive conceptual framework of responses to contingency based on entrepreneurs' beliefs about agency and environment	Contingency
Harmeling (2011)	Contingency's role in the entrepreneurial process.	The entrepreneurial process as amechanism throughwhich "private obsession" fulfills "public need." A depiction of possible alternative responses (counterfactuals) for each narrative illustrates how entrepreneurs tend to take a resourceful, rather than an adaptive or a heroic stance toward contingency. A discussion of American Pragmatism provides theoretical support for contingency's role in the entrepreneurial process.	Contingency
Fisher (2012)	How different theoretical perspectives in entrepreneurship research translate into individual behavior, and whether such behavior is evident in the creation and development of new ventures.	Through case study, the author shows the behaviors associated with effectuation and bricolage appeared to be more representative what entrepreneurs do in building their business.	Comparing theories
Perry, Chandler, & Markova (2012)	Encouraging effectuation research	How to design and conduct empirically rigorous effectuation studies consistent with the developmental state of the research stream. Suggesting effectuation construct as multilevel constructs.	Developing effectuation as a multidimensional latent construct
Read & Sarasvathy (2012)	The intersection of service-dominant logic and effectuation	One of the clearest intersections of effectuation and S-D logic literatures is in interactions surrounding the activity of co-creation.	Effectuation as co-creative perspective.
Arend, Sarooghi, & Burkemper (2015)	Theory assessment of effectuation applying 3E theory-assessment framework	Assess the strength and weakness of effectuation theory.	Theory assessment criteria
Read, Sarasvath, Dew, & Wiltbank (2016)	Response to Arend et al. (2015)	Defending critics of Arend et al (2015) by pointing out their approach of assessing the effectuation theory, and present future research questions.	Effectuation as Pragmatist theory

Table A.1.7 Selected Empirical Research Using Effectuation Theory as Theoretical Underpinning

Authors	Focus	Methodology	Main conclusion	Context
Dew, Read, Sarasvathy, & Wiltbank (2009)	Entrepreneurial experts frame decisions using an "effectual" logic	Interview, verbal protocol	The expert entrepreneurs used analogical reasoning, were more likely to think holistically about business, weighed predictive information less, were more means-driven, were less concerned with expected return, and were more interested in developing partnerships than MBA students.	Expert Entrepreneurs vs MBA students (novices)
Read, Dew, Sarasvathy, Song & Wiltbank (2009)	Approach by expert entrepreneurs on uncertainty in marketing (focusing 4Ps)	Depth interview,	Expert entrepreneurs use an effectual or nonpredictive logic to tackle uncertain market elements and to coconstruct novel markets with committed stakeholders.	Marketing research, 4Ps
Read, Song, & Smit (2009)	Measure the relationship between effectual principles and new venture performance.	Meta-analysis of 35 studies	Results indicate that positive relationships between new venture performance and all the effectual constructs we were able to measure, except Affordable Loss.	Literature review
Wiltbank, Read, Dew, & Sarasvathy (2009)	Prediction and control under uncertainty: Outcomes in angel investing	121 angel investors	Angels who emphasize prediction make significantly larger venture investments, while those who emphasize nonpredictive control experience a reduction in investment failures without a reduction in their number of successes.	Angel investors
Andersson (2011)	The understanding of a born global firm's early internationalization process and the entrepreneur's decisions regarding internationalization	An explorative case study	The founders' prior knowledge and networks were important to understand the rapid international expansion. Effectuation theory focuses on the entrepreneurs' ability to create opportunities together with network partners and is a useful tool to understand the development in the born global firm.	International business
Chandler, DeTienne, McKelvie, & Mumford (2011)	Develop and validate measures of causation and effectuation approaches	Survey, scale development	Effectuation is a formative, multidimensional construct with three associated sub-dimensions (experimentation, affordable loss, and flexibility) and one dimension shared with the causation construct (pre-commitments).	New venture creation
Fischer & Reuber (2011)	How effectuation processes are impacted when entrepreneurs adopt Twitter	Theory building methodology, depth interview. Combined with Twitter data	Perceived time affordability predicts the level of social interaction in which an entrepreneur engages via Twitter. Community orientation and community norm adherence moderate the consequences of social interaction through Twitter.	Social interaction of entrepreneurs

Brettel, Mauer, Engelen, & Küpper (2012)	Applying effectuation theory in R&D project context, then develop measure scales	Using a thorough qualitative and quantitative scale-development process	After developing measure scales of effectuation and causation, then empirically examine their impact on effectiveness of R&D projects, which specifies that (a) effectuation is positively related to success in highly innovative contexts, (b) causation approaches are beneficial in projects with low levels of innovativeness.	R&D projects
Harms & Schiele (2012)	The antecedents and consequences of causation and effectuation in the entry mode selection	Regression with a sample of 65 gazelles	Experienced entrepreneurs tend to apply effectuation rather than causation, while uncertainty does not have a systematic influence. Entrepreneurs using causation-based international new venture creation processes tend to engage in export-type entry modes, while effectuation-based international new venture creation processes do not predetermine the entry mode.	Internationalization
Berends, Jelinek, Reymen & Stultiëns (2014)	Applying entrepreneurial effectuation and managerial Causation to theorize product innovation processes in small firms	Process research approach from 5 small firms across 352 events	Quantitative analyses confirmed the use of both logics, with effectual logic rendering product innovation resource-driven, stepwise, and open-ended, and with causal logic used especially in later stages to set objectives and to plan activities and invest resources to attain objectives.	New product development process of small firms
Blauth, Mauer, & Brettel (2014)	Entrepreneurial decision making and creativity in new product development	Survey from 219 employees of NPD team of German firms	The use of entrepreneurial decision making logic positively impacts practised creativity; comparably find indicators that the use of causal decision making logic negatively influences creativity.	New product development practitioners
Werhahn, Mauer, Flatten, & Brettel (2015)	Effectuation orientation as strategic direction	Survey, scale development	Describe, develop, and validate a multidimensional measure of effectual orientation.	Effectuation as organizational behavior
Jia (2016)	Effectuation and entrepreneurial orientation on venture performance	Survey of new ventures in China	Entrepreneur effectual logic is positively related to venture entrepreneurial orientation especially when venture is young, but not related to venture performance. However, the positive relationship between entrepreneur effectuation and venture performance would exist when environment is externally highly dynamic, when venture is internally highly innovative or when venture is in early stage.	Chinese ventures
Koepplin, Weiss, & Hoegl (2016)	Complex relationship between constraints, which are a function of the extremely constrained BOP market, and innovation processes innovators take to deal with	Interview, investigating 55 base of the pyramid (BOP) innovation projects	Develop a constraint typology of goal constraints (i.e., sociohuman, government-regulatory, and market requirements) and resource constraints (i.e., financial, material, knowledge, and institutional constraints) and explain how innovators deploy different innovation process	Bottom of Pyramid

	constraints		approaches depending on which type of constraints they have to deal with.	
Kristinsson, Candi, & Sæmundsson (2016)	The contribution of founder team informational diversity to innovation performance as well as the moderating effect of the degree of causation logic used in decision making	Survey of 157 new technology based ventures in northern European firms	The relationships between founder diversity and both idea generation and realized innovation are moderated by the logic of entrepreneurial decision making. The relationship between founder team informational diversity and idea generation is stronger when decision making is based on strong causation logic, while the relationship between founder team informational diversity and realized innovation is stronger when decision making is based to a lesser degree on causation logic.	New ventures

Appendix 2: Research Ethics

Nottingham University Business School
UNITED KINGDOM · CHINA · MALAYSIA

NOTTINGHAM UNIVERSITY BUSINESS SCHOOL
RESEARCH ETHICS REVIEW CHECKLIST – STAFF AND DOCTORAL RESEARCH

Research ethics approval is required for every research project that involves human participants or their data, whether that project is externally funded or not. Research projects may not start without ethical approval.

Please complete this form electronically and email it to Stella Fuller (stella.fuller@nottingham.ac.uk), along with any annexes, from your UoN email account.

Research Project Title:	Effectual Orientation and Customer Co-creation in the Fuzzy Front End of New Product Development

Doctoral students should name their supervisors under "co-investigator" and add [PhD] before the project title.

Principal Investigator	Guihan Ko
Co-Investigators (and affiliation)	Helen Perks, Ph.D. Professor of Marketing Deborah Roberts, Ph.D. Associate Professor of Marketing
Project Funder(s)	Self

Project start/finish dates	Oct. 2014/ Sep. 2017	**Date of Ethics Application**	Jan. 2016

Questions about the appropriate REC to review the application:		
Will the study involve recruitment of patients through the NHS or the use of NHS data or premises and/or equipment?	Y	N
Does the study involve participants age 16 or over who are unable to give informed consent? (e.g. people with learning disabilities)	Y	N

If the answer to either of these questions is 'yes', then you will need to seek approval through an NHS Research Ethics Committee – the School Committee cannot review your project. Please contact the University's Research Governance Officer, Angela Shone (Angela.Shone@nottingham.ac.uk) (and cc adam.golberg@nottingham.ac.uk).

NUBS LREC cannot approve projects which involve: the administration of drugs, placebos etc to research participants; tissue collection; the infliction of pain; or invasive, intrusive or harmful procedures. Please contact Angela/Adam as above.

Questions about involvement of researchers from outside NUBS:		
Are colleagues from another school or institution involved in the research?	Y	N
If you are leading the project, does this application cover their involvement?	Y	N
If they are leading, have they obtained ethical approval for your involvement?	Y	N

If a project is led from outside NUBS, ethical approval by her institution will normally be accepted in lieu of a NUBS REC review. In such cases, please complete this page only and attach a letter confirming ethical review. Similarly, NUBS REC will normally be willing to write to external project partners to confirm that we have reviewed the project. It would be up to their respective institutions to decide whether to accept our review or to carry out their own – you should not assume agreement.

Please note that it is your responsibility to follow the University of Nottingham's Code of Practice on Ethical Standards and any relevant academic or professional guidelines in the conduct of your study. **This includes providing appropriate information sheets and consent forms, and ensuring confidentiality in the**

storage and use of data.

Any significant change in the question, design or conduct over the course of the research should be notified to the School Research Ethics Officer (adam.golberg@nottingham.ac.uk) and may require a new application.

Brief summary of project goals:

The study aims to examine whether and how effectual orientation is related to performance in the FFE of NPD through co-creation activities. To achieve its aim the study seeks to address the following two research questions:

• What is the effect of customer co-creation activities (characterized as generation and evaluation activities), in comparison with traditional market research methods, on FFE performance of NPD?
• What is the moderating role of an effectual orientation on the relationship between customer co-creation activities and FFE performance?

For more details on research context, firstly, customer co-creation activities are defined as "a collaborative new product activity in which customers actively contribute and select various elements of a new product offering" (O'Hern and Rindfleisch, 2010, p. 4). Specifically, customer co-creation activities are determined by two sub dimensional characteristics which are developed from a number of previous studies: (1) customer co-creation activities in generation and (2) customer co-creation activities in evaluation (O'Hern and Rindfleisch, 2010; Piller et al., 2010).

Secondly, the fuzzy front end, a term initially coined by Smith and Reinertsen (1991), concerns the early stages of NPD. In other words, it is the "up-front homework" of NPD (Cooper, 1990), encompassing problem/opportunity structuring and identification/recognition, idea generation, and concept development (Cooper, 1990; Eling, Griffin, and Langerak 2014). The core FFE phases of generation and evaluation/selection are well aligned with recognized customer co-creation activities (Eling et al., 2014; O'Hern and Rindfleisch, 2010). The FFE is important for firms because they can achieve high innovation impact, in terms of quality and creativity, by putting more efforts in the FFE (Smith and Reinertsen, 1991; Magnusson, 2009) and by gaining customers' early involvement in the NPD process (Coviello and Joseph, 2012; Magnusson, 2009).

Lastly, this research draws from effectuation theory to help address such questions. Effectuation refers to "a logic of entrepreneurial expertise, a dynamic and interactive process of creating new artefacts in the world" (Fisher, 2012, p. 1024; Sarasvathy, 2008). Effectuation has its roots in entrepreneurship and can be encapsulated as 'muddling through' for contexts where NPD decision-makers face high levels of uncertainty. In this study, we conceptualize and develop four dimensions of an effectual orientation and hypothesize and empirically test their associations with co-creation. The dimensions of an effectual orientation are (1) means driven, whereby organizations seek to build on existing resources, rather than put effort towards investing in new ones; (2) affordable loss, whereby organizations are oriented towards controlled risk-taking, or mindful trial and error; (3) partnerships, whereby organizations tend to develop deliberate engagement with stakeholders; and (4) agility, whereby organizations easily move across and integrate diverse knowledge bases.

Brief description of research methods to be employed:

We aim to collect a cross-sectional survey data from NPD developers based in the USA and Europe. In developing the survey we have adapted and utilized reliable measures

from the literature for effectual capabilities, co-creation activities and performance measures. These have been sent to academic experts for initial comments and feedback.

We plan to have a pilot test first, and then to conduct a main study with updated survey based on the pilot test result. From the pilot test, we expect to see preliminary empirical results as well as to refine our measurement scales for the main study. We are developing the survey through online platform 'Qualtrics' which many researchers have used for the data collection, and we will recruit respondents who had new product development experiences through professional associations such as PDMA and Front End Innovation group.

For the main survey, we will refine and revise our survey based on the pilot test result. To recruit respondents, we are going to compile contact list from the data base, as well as reach out professional association to get company contact points.

Questions about consent	**Y**	**N**
Does the research involve vulnerable groups: children, those with cognitive impairment, or those in unequal power relationships (e.g. students)	Y	**N**
Will the study require the co-operation of a gatekeeper for initial access to the groups or individuals to be recruited? (e.g. students at school, members of self-help group, residents of nursing home, employees)	**Y**	N
Will it be necessary for participants to take part in the study without their knowledge and/or full informed consent at the time? (e.g. covert observation)?	Y	**N**
Questions about confidentiality		
Will research involve the sharing of data or confidential information beyond the initial consent given? Will data collected be (or potentially be) used for any other purpose?	Y	**N**
Will the research involve administrative or secure data that requires permission from the appropriate authorities before use?	Y	**N**
Will any payments, compensation, expenses, or incentives be offered to participants?	**Y**	N
Questions about the potential for harm		
Will the study involve discussion of personal or sensitive topics (e.g. sexual activity, drug use, commercially or legally sensitive topics)?	Y	**N**
Could the study induce psychological stress or anxiety or cause harm or negative consequences beyond the risks encountered in normal life?	Y	**N**
Will the study involve prolonged or repetitive testing?	Y	**N**
Is there a possibility that the safety of the researcher may be in question beyond everyday risks (e.g. in some international research in trouble spots)?	Y	**N**
Location of the research		
Will any of the research take place outside the UK?	**Y**	N

If you have answered 'yes' to any of the questions above, please explain your reasons below, and any steps you will take to deal with the ethical issues raised. Please note that answering 'yes' will not in itself adversely affect the chances of approval. For guidance on completing this section of the form, please contact adam.golberg@nottingham.ac.uk

On the second question of "Question of consent"
For the main study, we might need to contact research agency and research institute which can provide contacts (email addresses) of appropriate respondents in companies to distribute our survey.

On the third question of "Questions about confidentiality"
We plan to give respondents incentives (e.g. Amazon gift card) to encourage their

participation as a gift draw.

"Location of the research"
We are interested in collecting surveys from companies in North America as well as EU (including UK), because (1) the investigator is also familiar with companies in that area, and (2) it is to increase the generalisability of the study to gather as many companies as possible.

To what degree will individual research participants and organisations be anonymised in the research outputs? Please list any potentially-identifying characteristics that you may wish to use. Please attach a copy of your participant information sheet and/or consent form (where appropriate) as annexes.

The research is firm level quantitative study. Also we are using psychometric measurement for the analysis. Therefore responses from participants will be aggregately quantified for the analyses. Moreover, respondents will answer questions on company size (number of employees), and an industry sector. These firm characteristics would be coded for the quantitative analysis as control variables. We only report descriptive statistics in terms of company characteristics in the research.
We also attach a copy of consent form (online survey welcome screen notifying participation is voluntary) following this form.

Useful links:

A link to the University of Nottingham Code of Research Conduct and Research Ethics can be found on Nexus at http://www.nottingham.ac.uk/business/nexus/index.phtml?anml=-1&sid=4149

ESRC Framework for Research Ethics
http://www.esrc.ac.uk/about-esrc/information/research-ethics.aspx

UK Research Integrity Office Code of Practice for Research
http://asset.ukrio.org/ukR10htre/UKRIO-Recommended-Checklist-for-Researchers.pdf

Appendix 3: Survey

Welcome screen

Nottingham University Business School
UNITED KINGDOM · CHINA · MALAYSIA

Dear participant,

Greetings!
Thank you for agreeing to participate in this study, which is part of my doctoral research. The purpose of the survey is to examine activities and factors for developing successful new product concepts during front end stages of new product development.

We are looking for people who have been recently involved in new product development projects in your company. We are particularly interested in hearing from you if you have worked with customers in early stages of new product development.

Completing the survey will take no more than 15 minutes. Your participation in this research is voluntary, and you have a right to stop answering questions at any time you want.

Your individual responses will be kept confidential and analysed with aggregate data. The findings will only be used for academic research purposes; my doctoral thesis and journal papers. The research is funded by Nottingham University Business School.

Again, we appreciate your contribution and participation in this study.

Kind regards,
Guihan Ko, PhD candidate, Nottingham University Business School
Prof Helen Perks, supervisor, Nottingham University Business School
Associate Prof Deborah Roberts, supervisor, Nottingham University Business School

Company background and NPD project

We are focusing on the front end of the new product development (NPD) projects, including opportunity identification, idea generation, and concept development.
Note, "products" in this survey refers to both physical goods and services.

Where is your company located?

- United Kingdom
- United States of America
- Others

Number of company employees (approximate)?

- Below 50
- 51 – 250
- 251- 500
- 501-1000
- Over 1000

Please select the industry category that best describes your company.

- Food and kindred products
- Textile, Apparel, Leather
- Chemicals and Pharmaceutical Products
- Rubber and Plastic products
- Metals and Metal products
- Computer equipment
- Electrical equipment
- Machinery
- Transportation equipment
- Furniture
- Others

Who is your main customer base?

Industrial customers

End consumers

Both Industrial customers and end consumers

We would like to know more about your recent NPD project. Please answer following questions.

Have you worked on NPD project for the last 2 years?

Yes

No

What NPD project have you been involved?

Was the project launched?

Yes

No

What was your role in the project?

Were you involved in the front end of the project?

Yes

No

Please indicate the NPD project which you involved.

Note, a radical NPD project relates to developing a new-to-the world and breakthrough

product, while an incremental NPD project involves the adaptation, refinement, and enhancement of existing products and/or production.

Radical NPD project

Incremental NPD project

Did you work with customers (e.g., industrial customers, end consumers) in the NPD project?

Yes

No

Front end performance

Front End performance

Now, we would like to talk about concepts you developed from the front end of the NPD project.

Firstly, please indicate the degree of creativity by answering following questions.

After the concept evaluation stage, the selected new product concepts

	Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree
was really "out of the ordinary."	O	O	O	O	O	O
could be considered as revolutionary.	O	O	O	O	O	O
were stimulating.	O	O	O	O	O	O
showed an unconventional way of solving problems.	O	O	O	O	O	O

After the concept evaluation stage, the selected new product concepts

	Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree
were relevant to customers' needs and expectations.	O	O	O	O	O	O

were considered suitable for customers' desires.	O	O	O	O	O	O
were appropriate for customers' needs and expectations.	O	O	O	O	O	O
were useful for customers.	O	O	O	O	O	O

Please indicate the degree of success, which you felt your company achieved in each of the following indicators after the front end of the NPD project.

The new product concepts contributed to

	0-14%	15-29%	30-44%	45-54%	55-69%	70-84%	85-100%
ability to be more attractive to potential alliance partners has been (will be) enhanced.	O	O	O	O	O	O	O
average growth in company employment stemming from involvement.	O	O	O	O	O	O	O
cash flow.	O	O	O	O	O	O	O
ability to attract capital.	O	O	O	O	O	O	O
amount of funding (internal and external) compared to initial request.	O	O	O	O	O	O	O

Now we want to know about the **competitive potential** of new product concepts.

Please indicate the degree to which you felt the concepts achieved.

	Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree
The product would generate a sustainable competitive advantage for our organization	O	O	O	O	O	O
The product would offer unique features to customers, compared to competing products.	O	O	O	O	O	O
The product would solve important customer problems.	O	O	O	O	O	O
The product would enable superior price/performance features, compared to competing products.	O	O	O	O	O	O

The product would enable high customer satisfaction.	○	○	○	○	○	○

Effectual orientation

Now, we would like to talk about your company's mind-set/behavioural directions when you worked on the NPD project.

When working with external parties (industrial customers, end consumers, suppliers, competitors, and/or universities) during the front end of the NPD project, please indicate the extent to which you agree or disagree with the following statements.

	Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree
We tried to manage the uncertainty of the new product development (NPD) project through external partnerships.	○	○	○	○	○	○
We worked with potential partners to jointly shape the future.	○	○	○	○	○	○
We jointly developed new product ideas with our partners.	○	○	○	○	○	○
Our focus on the reduction of uncertainty led us to approach potential partners.	○	○	○	○	○	○
Before implementing the project, we received commitments from our partners.	○	○	○	○	○	○
In order to reduce uncertainties, we started partnerships.	○	○	○	○	○	○
We used agreements with partners to reduce uncertainty.	○	○	○	○	○	○
Commitments from our partners guided the direction of the project.	○	○	○	○	○	○
We actively combined resources with our partners.	○	○	○	○	○	○

When starting the NPD project, please indicate the extent to which you agree or disagree with the following statements.

	Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree
Our NPD project was specified on the basis of the resources that we already have.	O	O	O	O	O	O
The goal of our NPD project was vaguely defined in the beginning.	O	O	O	O	O	O
Existing resources formed the starting point for the project.	O	O	O	O	O	O
The process converged towards a project goal on the basis of existing resources.	O	O	O	O	O	O
This is an attention filter. Please select 'Strongly Agree' for this statement.	O	O	O	O	O	O
The project outline was predominantly based on existing resources.	O	O	O	O	O	O
Existing resources significantly impacted on the framework of our NPD project.	O	O	O	O	O	O

Thinking about the decisions you have to make during the front end of the NPD project, please indicate the extent to which you agree or disagree with the following statements.

	Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree
Considerations about minimizing potential losses were decisive for the selection of the new product concept.	O	O	O	O	O	O
Preliminary project budgets were approved on the basis of considerations about minimizing acceptable losses.	O	O	O	O	O	O
The selection of the new product concept was mostly based on a minimization of the downside consequences in the event of project failure.	O	O	O	O	O	O
We compared different NPD concepts on the basis of what we were willing to lose.	O	O	O	O	O	O
Early decisions on capital expenditures were primarily based on potential losses.	O	O	O	O	O	O

We were careful not to commit more resources than we could afford to lose.	○	○	○	○	○	○
We were careful not to invest more money than we were willing to lose.	○	○	○	○	○	○
We were careful not to make so many financial commitments that if our NPD project didn't work out, the organization would be in trouble financially.	○	○	○	○	○	○

During the front end of the NPD project, please indicate to what extent you agree or disagree with the following statements.

	Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree
We always reacted on surprise findings – if necessary the project goal was then adjusted.	○	○	○	○	○	○
We always tried to integrate surprising results and findings – even though this was not necessarily in line with the original project goal.	○	○	○	○	○	○
We were open to new information that emerged during the process.	○	○	○	○	○	○
We took advantage of new opportunities as they arose.	○	○	○	○	○	○
We tried to look at setbacks as potential sources of new opportunity.	○	○	○	○	○	○
We revised what we were doing as new information emerged.	○	○	○	○	○	○
We were willing to make use of new information.	○	○	○	○	○	○

During the front end of the NPD project, please indicate to what extent you agree or disagree with the following statements.

	Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree
We consider it important that we attempt to influence trends.	○	○	○	○	○	○
We consider it important that we						

attempt to shape the environment we operate in.	O	O	O	O	O	O
We consider it important that we attempt to co-create future markets.	O	O	O	O	O	O
We consider it important that we attempt to proactively design our environment with others.	O	O	O	O	O	O
We consider it important that we are always looking for new opportunities.	O	O	O	O	O	O

Front end activities

Continuing to focus on the recent NPD project, now we will talk about customer facing front end activities.
Please indicate the amount of time spent on the following customer facing activities. Note, you may use a combination of customer facing activities for the NPD project, so your selections may add to more than 100 percent.

Please indicate what % of the time you spent on the following customer facing activities in the NPD project.

	Never	Sometimes (25%)	About half the time (50%)	Most of the time (75%)	Always
Observation of customers	O	O	O	O	O
Customer Surveys	O	O	O	O	O
Focus Groups	O	O	O	O	O
In-depth Interviews	O	O	O	O	O
Netnography	O	O	O	O	O
Concept testing	O	O	O	O	O
Others	O	O	O	O	O

We are now separating each front end (opportunity identification, idea generation, and concept development) into generation phase and evaluation/selection phase.

That is, **generation phase** involves activities working with customers to ***identify/generate/develop*** new product opportunity/ideas/concepts, while **evaluation/selection phase** involves activities working with customers to ***evaluate/select*** new product opportunity/ideas/concepts.

Please indicate what % of the time you spent on the following customer co-creation activities in generation phase in the NPD project

Note, *lead users: lead users are capable of sensing needs for marketplace ahead of time, and they can benefit by obtaining a solution to their needs.

	Never	Sometimes (25%)	About half the time (50%)	Most of the time (75%)	Always
We arranged **idea contests** drawing on the general public or a specific target customer group to make use of their expertise, skills or creativity.	O	O	O	O	O
We arranged **crowdsourcing** (outsourcing to the crowd by using online platform such as Innocentive) to develop ideas for new products with customers.	O	O	O	O	O
We engaged in **customer communities** focusing on generating novel ideas and concepts.	O	O	O	O	O
We held **co-creation workshops** with customers to develop ideas for new products.	O	O	O	O	O
We applied **creative problem-solving techniques** to develop ideas for new products with customers.	O	O	O	O	O
We connected **product-related discussion customer forums** to gather customers' usage experiences in using the product.	O	O	O	O	O
We utilized **idea generation toolkits** to let customers participate.	O	O	O	O	O
We held **lead users* meetings** to develop ideas for new products.	O	O	O	O	O
Others:	O	O	O	O	O

Please rate the extent to which you benefited from these activities, in case that you didn't mark "Never" in **all** the previous question.

	Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree
We benefited significantly from these activities.	O	O	O	O	O	O
We thought they were effective.	O	O	O	O	O	O
We were satisfied with these activities	O	O	O	O	O	O
We were willing to use them later again.	O	O	O	O	O	O

Please indicate what % of the time you spent on the following customer co-creation activities in **evaluation/selection phase** in the NPD project

	Never	Sometimes (25%)	About half the time (50%)	Most of the time (75%)	Always
We arranged **on-line voting/ratings** to allow customers to cast a vote or rate for selecting new product ideas.	O	O	O	O	O
We applied **idea screening**, which let customers evaluate ideas.	O	O	O	O	O
We arranged crowdsourcing to evaluate ideas/concepts for new products with customers.	O	O	O	O	O
We held **co-creation workshops** with customers to evaluate ideas/concepts for new products.	O	O	O	O	O
We applied **creative problem-solving techniques** to prioritize developed new ideas/concepts for new products with customers.	O	O	O	O	O
We provided **customer toolkits** to let customers evaluate new products ideas/concepts.	O	O	O	O	O
We held **lead users* meetings** to evaluate developed ideas/concepts for new products.	O	O	O	O	O
Others:	O	O	O	O	O

Please rate the extent to which you benefited from these activities, in case that you didn't mark "Never" in **all** the previous question.

	Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree
We benefited significantly from these activities.	O	O	O	O	O	O
We thought they were effective.	O	O	O	O	O	O
We were satisfied with these activities	O	O	O	O	O	O
We were willing to use them later again.	O	O	O	O	O	O

Thank you screen

Nottingham University Business School
UNITED KINGDOM · CHINA · MALAYSIA

Thank you very much for your time and valuable inputs!
If you have any questions, please do not hesitate to contact us.

Kind regards,
Guihan Ko, PhD candidate,
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Appendix 4: Results

This appendix includes tables and figures from data analysis, which support the results. But they are located in here because they take up quite a lot of space.

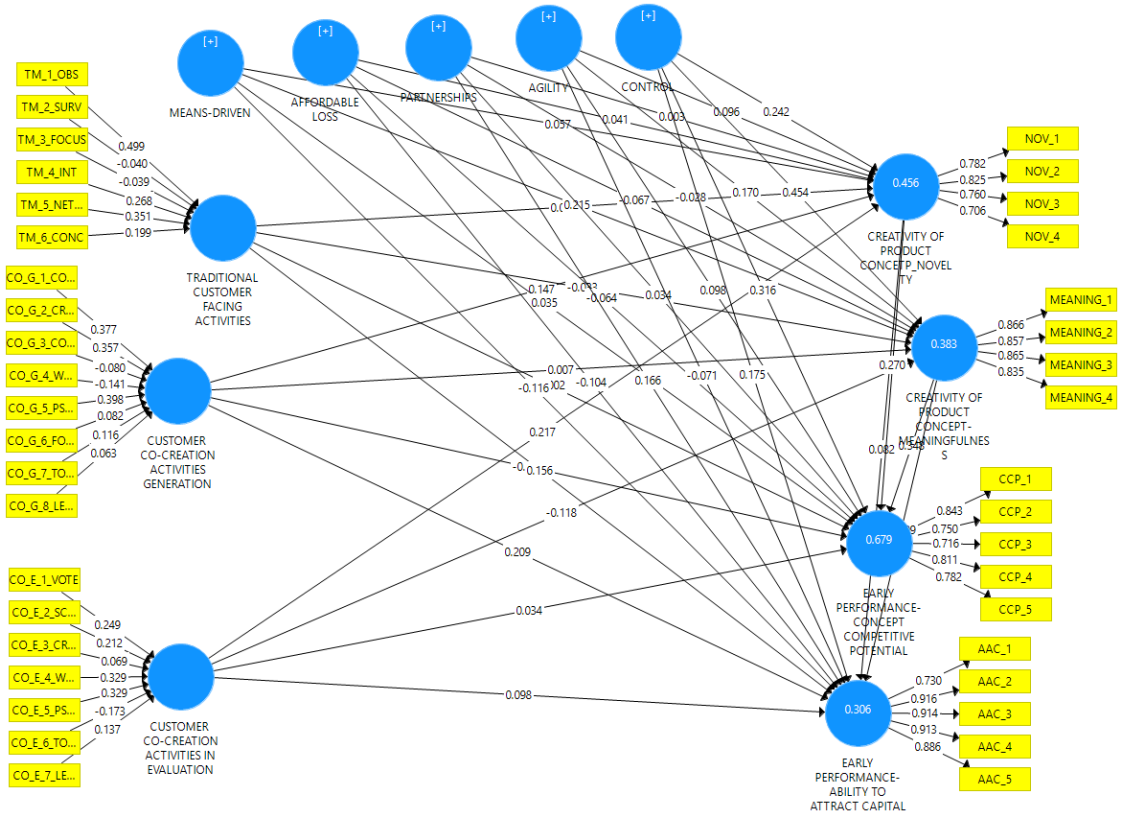


Figure A.4.1 Graphical Demonstration of Measurement Model

Table A.4.1 Cross Loadings of Measurement Model

	AAC	AFFORDABLE LOSS	AGILITY	CCP	CONTROL	CO_EVAL	CO_GEN	MEANING FULNESS	MEANS-DRIVEN	NOVELTY	PARTNER SHIPS	TRADITIONAL
AAC_1	**0.73**	0.095	0.227	0.303	0.291	0.265	0.253	0.229	0.13	0.311	0.183	0.293
AAC_2	**0.916**	0.286	0.257	0.242	0.308	0.422	0.478	0.097	0.156	0.338	0.364	0.4
AAC_3	**0.914**	0.332	0.232	0.208	0.277	0.472	0.5	0.071	0.139	0.304	0.415	0.439
AAC_4	**0.913**	0.279	0.222	0.288	0.358	0.402	0.456	0.173	0.18	0.356	0.322	0.412
AAC_5	**0.886**	0.323	0.246	0.245	0.293	0.455	0.436	0.12	0.16	0.325	0.422	0.444
AFFLOSS_1	0.241	**0.817**	0.481	0.373	0.422	0.48	0.433	0.251	0.343	0.376	0.495	0.448
AFFLOSS_2	0.204	**0.793**	0.418	0.36	0.427	0.47	0.453	0.287	0.396	0.406	0.524	0.455
AFFLOSS_3	0.218	**0.864**	0.41	0.302	0.431	0.485	0.446	0.256	0.45	0.382	0.592	0.436
AFFLOSS_4	0.295	**0.824**	0.455	0.268	0.483	0.584	0.499	0.156	0.374	0.45	0.591	0.538
AFFLOSS_5	0.312	**0.746**	0.373	0.288	0.377	0.447	0.446	0.102	0.431	0.37	0.508	0.484
AGILITY_1	0.25	0.562	**0.745**	0.493	0.577	0.47	0.467	0.329	0.481	0.504	0.489	0.433
AGILITY_2	0.26	0.514	**0.711**	0.456	0.532	0.401	0.393	0.332	0.457	0.448	0.485	0.352
AGILITY_3	0.137	0.331	**0.794**	0.461	0.554	0.215	0.237	0.444	0.369	0.337	0.342	0.266
AGILITY_4	0.1	0.293	**0.705**	0.396	0.487	0.247	0.237	0.338	0.261	0.303	0.285	0.238
AGILITY_5	0.3	0.432	**0.791**	0.446	0.563	0.331	0.332	0.412	0.351	0.381	0.458	0.355
AGILITY_6	0.148	0.291	**0.77**	0.455	0.563	0.229	0.289	0.354	0.261	0.316	0.347	0.3
AGILITY_7	0.2	0.341	**0.787**	0.528	0.555	0.328	0.332	0.397	0.355	0.322	0.362	0.296
CCP_1	0.27	0.348	0.526	**0.843**	0.658	0.328	0.328	0.644	0.399	0.524	0.308	0.311
CCP_2	0.255	0.336	0.467	**0.75**	0.559	0.318	0.261	0.52	0.257	0.476	0.313	0.273
CCP_3	0.182	0.269	0.463	**0.716**	0.462	0.273	0.26	0.452	0.355	0.463	0.273	0.248
CCP_4	0.264	0.346	0.483	**0.811**	0.562	0.316	0.363	0.53	0.432	0.554	0.359	0.344
CCP_5	0.137	0.233	0.45	**0.782**	0.515	0.181	0.236	0.533	0.346	0.403	0.227	0.198

CONTROL_1	0.317	0.404	0.475	0.506	**0.757**	0.326	0.408	0.349	0.4	0.415	0.328	0.384
CONTROL_2	0.26	0.444	0.523	0.515	**0.775**	0.392	0.375	0.362	0.324	0.431	0.416	0.347
CONTROL_3	0.336	0.436	0.571	0.609	**0.833**	0.427	0.504	0.463	0.424	0.509	0.378	0.407
CONTROL_4	0.23	0.488	0.656	0.573	**0.821**	0.396	0.403	0.493	0.434	0.42	0.45	0.372
CONTROL_5	0.232	0.333	0.628	0.598	**0.773**	0.265	0.25	0.568	0.38	0.414	0.268	0.296
CO_E_1_VOTE	0.366	0.57	0.337	0.289	0.357	**0.839**	0.701	0.132	0.352	0.516	0.483	0.618
CO_E_2_SCREEN	0.38	0.563	0.38	0.287	0.423	**0.857**	0.702	0.151	0.379	0.523	0.523	0.593
CO_E_3_CROWD	0.409	0.553	0.32	0.224	0.36	**0.798**	0.768	0.045	0.373	0.497	0.529	0.681
CO_E_4_WORKS	0.418	0.512	0.359	0.32	0.389	**0.89**	0.737	0.103	0.374	0.525	0.595	0.671
CO_E_5_PSOLVING	0.472	0.509	0.37	0.324	0.391	**0.865**	0.7	0.14	0.354	0.436	0.513	0.615
CO_E_6_TOOLKIT	0.391	0.505	0.335	0.218	0.335	**0.727**	0.713	0.012	0.387	0.437	0.506	0.601
CO_E_7_LEADUSER	0.323	0.458	0.423	0.314	0.393	**0.752**	0.632	0.195	0.304	0.407	0.546	0.624
CO_G_1_CONT	0.37	0.467	0.407	0.335	0.419	0.726	**0.873**	0.223	0.404	0.531	0.497	0.678
CO_G_2_CROWD	0.447	0.511	0.26	0.247	0.334	0.668	**0.833**	0.144	0.345	0.499	0.513	0.683
CO_G_3_COMM	0.396	0.428	0.267	0.213	0.287	0.696	**0.711**	0.118	0.22	0.414	0.512	0.62
CO_G_4_WORKS	0.304	0.488	0.296	0.244	0.328	0.737	**0.676**	0.101	0.281	0.434	0.538	0.628
CO_G_5_PSOLVING	0.434	0.442	0.396	0.358	0.452	0.676	0.818	0.167	0.262	0.408	0.478	0.571
CO_G_6_FORUM	0.339	0.496	0.389	0.269	0.376	0.71	0.729	0.18	0.401	0.426	0.499	0.63
CO_G_7_TOOLKITS	0.393	0.535	0.356	0.265	0.41	0.766	0.811	0.143	0.371	0.505	0.559	0.65
CO_G_8_LEADUSER	0.395	0.457	0.374	0.233	0.373	0.682	0.726	0.153	0.33	0.406	0.552	0.625
MEANING_1	0.106	0.248	0.44	0.578	0.5	0.179	0.209	**0.866**	0.384	0.392	0.215	0.179
MEANING_2	0.089	0.213	0.445	0.575	0.478	0.117	0.177	**0.857**	0.364	0.314	0.145	0.146
MEANING_3	0.133	0.208	0.392	0.595	0.485	0.139	0.181	**0.865**	0.351	0.376	0.188	0.182
MEANING_4	0.178	0.231	0.405	0.614	0.489	0.155	0.184	**0.835**	0.338	0.442	0.222	0.18
MEANSD_1	0.104	0.38	0.415	0.332	0.398	0.331	0.334	0.344	**0.746**	0.302	0.23	0.334

MEANSD_3	0.118	0.384	0.387	0.4	0.405	0.271	0.267	0.385	**0.785**	0.355	0.295	0.312
MEANSD_4	0.158	0.33	0.315	0.35	0.375	0.337	0.311	0.252	**0.785**	0.317	0.301	0.327
MEANSD_6	0.161	0.422	0.385	0.366	0.387	0.326	0.404	0.379	**0.77**	0.35	0.378	0.327
MEANSD_7	0.139	0.383	0.375	0.323	0.356	0.326	0.308	0.238	**0.799**	0.264	0.34	0.334
NOV_1	0.282	0.358	0.367	0.431	0.369	0.513	0.478	0.258	0.298	**0.782**	0.365	0.391
NOV_2	0.363	0.503	0.371	0.471	0.442	0.538	0.519	0.308	0.278	**0.825**	0.476	0.453
NOV_3	0.227	0.375	0.44	0.595	0.526	0.349	0.391	0.519	0.439	**0.76**	0.308	0.367
NOV_4	0.269	0.248	0.35	0.399	0.349	0.342	0.339	0.264	0.242	**0.706**	0.25	0.366
PARTNER_1	0.359	0.634	0.45	0.338	0.453	0.593	0.552	0.176	0.331	0.478	**0.803**	0.543
PARTNER_2	0.312	0.61	0.457	0.306	0.404	0.486	0.482	0.172	0.304	0.373	**0.848**	0.476
PARTNER_3	0.341	0.554	0.453	0.314	0.376	0.482	0.485	0.227	0.409	0.343	**0.853**	0.453
PARTNER_4	0.364	0.538	0.416	0.318	0.364	0.54	0.52	0.192	0.331	0.46	**0.858**	0.487
PARTNER_5	0.331	0.539	0.471	0.325	0.387	0.471	0.442	0.159	0.268	0.326	**0.83**	0.449
PARTNER_6	0.358	0.529	0.415	0.308	0.405	0.509	0.495	0.2	0.332	0.382	**0.849**	0.467
PARTNER_7	0.386	0.543	0.476	0.366	0.416	0.56	0.522	0.233	0.393	0.405	**0.88**	0.491
PARTNER_8	0.284	0.58	0.458	0.34	0.321	0.514	0.505	0.203	0.337	0.363	**0.847**	0.446
PARTNER_9	0.3	0.577	0.438	0.272	0.39	0.551	0.433	0.147	0.322	0.357	**0.862**	0.452
TM_1_OBS	0.392	0.477	0.38	0.284	0.421	0.555	0.574	0.164	0.366	0.445	0.479	**0.846**
TM_2_SURV	0.341	0.415	0.305	0.172	0.313	0.605	0.587	0.116	0.24	0.369	0.484	**0.672**
TM_3_FOCUS	0.301	0.398	0.295	0.227	0.309	0.603	0.6	0.082	0.311	0.401	0.438	**0.688**
TM_4_INT	0.389	0.466	0.312	0.276	0.344	0.674	0.658	0.094	0.34	0.401	0.447	**0.783**
TM_5_NETNO	0.344	0.538	0.37	0.309	0.384	0.689	0.709	0.171	0.413	0.47	0.5	**0.848**
TM_6_CONC	0.325	0.319	0.241	0.232	0.215	0.397	0.454	0.209	0.116	0.249	0.318	**0.627**

Table A.4.2 HTMT of Measurement Model

	AAC	AFFORDABLE LOSS	AGILITY	CCP	CONTROL	MEANINGFULNESS	MEANS-DRIVEN	NOVELTY	PARTNERSHIPS
AAC									
AFFORDABLE LOSS	0.339								
AGILITY	0.295	0.596							
CCP	0.33	0.458	0.71						
CONTROL	0.395	0.618	0.832	0.83					
MEANINGFULNESS	0.175	0.298	0.56	0.799	0.652				
MEANS-DRIVEN	0.199	0.576	0.555	0.542	0.584	0.48			
NOVELTY	0.444	0.589	0.598	0.764	0.675	0.532	0.503		
PARTNERSHIPS	0.415	0.737	0.571	0.422	0.514	0.245	0.443	0.527	

Table A.4.3 Significance Testing Results of the Total Effects of Structural Model 1

	Total Effect	T Statistics (|O/STDEV|)	P Values	Confidence Interval [2.50%, 97.50%]
CO-CREATION ACTIVITIES -> CREATIVITY OF PRODUCT CONCEPT	0.434	4.111	0	[0.209, 0.623]
CO-CREATION ACTIVITIES -> EARLY PERFORMANCE	0.353	2.979	0.003	[0.105, 0.569]
CREATIVITY OF PRODUCT CONCEPT -> EARLY PERFORMANCE	0.685	8.751	0	[0.493, 0.797]
TRADITIONAL CUSTOMER FACING ACTIVITIES -> CREATIVITY OF PRODUCT CONCEPT	0.143	1.375	0.169	[0.018, 0.390]
TRADITIONAL CUSTOMER FACING ACTIVITIES -> EARLY PERFORMANCE	0.165	1.416	0.157	[-0.021, 0.437]

Table A.4.4 Significance Testing Results of the Total Effects Model 2

	Total Effect	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (|O/STDEV|)	P Values	Confidence Interval [2.50%, 7.50%]
CREATIVITY OF PRODUCT CONCEPT -> EARLY PERFORMANCE	0.776	0.778	0.028	27.591	0	[0.719, 0.830]
CUSTOMER CO-CREATION ACTIVITIES -> CREATIVITY OF PRODUCT CONCEPT	0.094	0.102	0.065	1.454	0.146	[-0.022, 0.234]
CUSTOMER CO-CREATION ACTIVITIES -> EARLY PERFORMANCE	0.073	0.079	0.05	1.45	0.147	[-0.017, 0.182]
EFFECTUATION -> CREATIVITY OF PRODUCT CONCEPT	0.657	0.662	0.056	11.828	0	[0.547, 0.767]
EFFECTUATION -> EARLY PERFORMANCE	0.51	0.516	0.05	10.092	0	[0.412, 0.613]
EFFECTUATION * CO-CREATION -> CREATIVITY OF PRODUCT CONCEPT	0.139	0.131	0.05	2.797	0.005	[0.029, 0.230]
EFFECTUATION * CO-CREATION -> EARLY PERFORMANCE	0.108	0.102	0.038	2.807	0.005	[0.023, 0.177]

Table A.4.5 PROCESS Results (H4)

```
************** PROCESS Procedure for SPSS Release 2.16.1 *****************

          Written by Andrew F. Hayes, Ph.D.       www.afhayes.com
    Documentation available in Hayes (2013). www.guilford.com/p/hayes3

**************************************************************************
Model = 4
    Y = EARLYP
    X = COCRE
    M = CREATIV

Sample size
        205

**************************************************************************
Outcome: CREATIV

Model Summary
          R       R-sq        MSE          F        df1        df2          p
      .4808      .2311      .7764    61.0225     1.0000   203.0000      .0000

Model
             coeff         se          t          p       LLCI       ULCI
constant      .0000      .0615      .0007      .9995     -.1213      .1214
COCRE         .4807      .0615     7.8117      .0000      .3594      .6021

**************************************************************************
Outcome: EARLYP

Model Summary
          R       R-sq        MSE          F        df1        df2          p
      .7788      .6066      .3992   155.7315     2.0000   202.0000      .0000

Model
             coeff         se          t          p       LLCI       ULCI
constant      .0000      .0441     -.0005      .9996     -.0870      .0870
CREATIV       .7371      .0503    14.6459      .0000      .6379      .8363
COCRE         .0802      .0503     1.5931      .1127     -.0191      .1794

************************** TOTAL EFFECT MODEL ****************************
Outcome: EARLYP

Model Summary
          R       R-sq        MSE          F        df1        df2          p
      .4346      .1888      .8191    47.2570     1.0000   203.0000      .0000

Model
             coeff         se          t          p       LLCI       ULCI
constant      .0000      .0632      .0001      .9999     -.1246      .1246
COCRE         .4345      .0632     6.8744      .0000      .3099      .5591

***************** TOTAL, DIRECT, AND INDIRECT EFFECTS ********************

Total effect of X on Y
     Effect         SE          t          p       LLCI       ULCI
      .4345      .0632     6.8744      .0000      .3099      .5591

Direct effect of X on Y
     Effect         SE          t          p       LLCI       ULCI
      .0802      .0503     1.5931      .1127     -.0191      .1794

Indirect effect of X on Y
            Effect    Boot SE   BootLLCI   BootULCI
CREATIV      .3543      .0500      .2628      .4590

Normal theory tests for indirect effect
     Effect         se          Z          p
      .3543      .0515     6.8801      .0000

******************** ANALYSIS NOTES AND WARNINGS *************************

Number of bootstrap samples for bias corrected bootstrap confidence intervals:
     5000

Level of confidence for all confidence intervals in output:
    95.00

------ END MATRIX -----
```

Note: COCRE: Customer Co-creation Activities, creative: CREATIVITY OF PRODUCT CONCEPT, earlyp: Early Performance

Table A.4.6 PROCESS Results (H5a)

```
************** PROCESS Procedure for SPSS Release 2.16.1 *****************

          Written by Andrew F. Hayes, Ph.D.       www.afhayes.com
    Documentation available in Hayes (2013). www.guilford.com/p/hayes3

**************************************************************************
Model = 1
    Y = CREATIV
    X = COCRE
    M = EFFECTUA

Sample size
        205

**************************************************************************
Outcome: CREATIV

Model Summary
          R       R-sq        MSE          F        df1        df2          p
      .7182      .5158      .4938    71.3767     3.0000   201.0000      .0000

Model
             coeff         se          t          p       LLCI       ULCI
constant     -.0801      .0564    -1.4198      .1572     -.1914      .0312
EFFECTUA      .6570      .0608    10.8066      .0000      .5371      .7768
COCRE         .0941      .0606     1.5527      .1221     -.0254      .2136
int_1         .1392      .0484     2.8758      .0045      .0438      .2347

Product terms key:

 int_1    COCRE       X     EFFECTUA

R-square increase due to interaction(s):
         R2-chng          F        df1        df2          p
int_1      .0199     8.2704     1.0000   201.0000      .0045

**************************************************************************

Conditional effect of X on Y at values of the moderator(s):
   EFFECTUA     Effect         se          t          p       LLCI       ULCI
    -1.3830     -.0984      .0964    -1.0216      .3082     -.2885      .0916
     -.7360     -.0084      .0745     -.1123      .9107     -.1552      .1385
      .0200      .0969      .0605     1.6020      .1107     -.0224      .2162
      .7700      .2013      .0666     3.0227      .0028      .0700      .3327
     1.2620      .2698      .0799     3.3786      .0009      .1124      .4273

Values for quantitative moderators are 10th, 25th, 50th, 75th, and 90th percentiles
Values for dichotomous moderators are the two values of the moderator.

********************* JOHNSON-NEYMAN TECHNIQUE ***************************

Moderator value(s) defining Johnson-Neyman significance region(s)
      Value    % below    % above
    -3.0343      .4878    99.5122
      .1742    54.1463    45.8537

Conditional effect of X on Y at values of the moderator (M)
   EFFECTUA     Effect         se          t          p       LLCI       ULCI
    -3.1620     -.3461      .1723    -2.0089      .0459     -.6859     -.0064
    -3.0343     -.3284      .1665    -1.9718      .0500     -.6567      .0000
    -2.9216     -.3127      .1614    -1.9366      .0542     -.6310      .0057
    -2.6811     -.2792      .1507    -1.8526      .0654     -.5763      .0180
    -2.4407     -.2457      .1401    -1.7538      .0810     -.5220      .0305
    -2.2002     -.2122      .1297    -1.6366      .1033     -.4679      .0435
    -1.9598     -.1787      .1195    -1.4961      .1362     -.4143      .0568
    -1.7193     -.1453      .1096    -1.3258      .1864     -.3613      .0708
    -1.4789     -.1118      .1000    -1.1175      .2651     -.3090      .0855
    -1.2384     -.0783      .0910     -.8606      .3905     -.2577      .1011
     -.9980     -.0448      .0826     -.5427      .5879     -.2077      .1180
     -.7575     -.0114      .0751     -.1512      .8800     -.1594      .1367
     -.5171      .0221      .0687      .3220      .7478     -.1134      .1576
     -.2766      .0556      .0639      .8706      .3850     -.0703      .1815
```

```
      -.0362      .0891      .0609     1.4632      .1450     -.0310      .2091
       .1742      .1184      .0600     1.9718      .0500      .0000      .2367
       .2043      .1226      .0600     2.0411      .0425      .0042      .2410
       .4448      .1560      .0614     2.5396      .0119      .0349      .2772
       .6852      .1895      .0649     2.9188      .0039      .0615      .3176
       .9257      .2230      .0702     3.1767      .0017      .0846      .3614
      1.1661      .2565      .0769     3.3360      .0010      .1049      .4081
      1.4066      .2900      .0846     3.4256      .0007      .1231      .4569
      1.6470      .3234      .0932     3.4697      .0006      .1396      .5072

************************************************************************

Data for visualizing conditional effect of X on Y
Paste text below into a SPSS syntax window and execute to produce plot.

DATA LIST FREE/COCRE EFFECTUA CREATIV.
BEGIN DATA.

    -1.4260    -1.3830     -.8484
     -.7000    -1.3830     -.9198
     -.0280    -1.3830     -.9860
      .7400    -1.3830    -1.0616
     1.2940    -1.3830    -1.1161
    -1.4260     -.7360     -.5518
     -.7000     -.7360     -.5578
     -.0280     -.7360     -.5634
      .7400     -.7360     -.5699
     1.2940     -.7360     -.5745
    -1.4260      .0200     -.2052
     -.7000      .0200     -.1348
     -.0280      .0200     -.0697
      .7400      .0200      .0047
     1.2940      .0200      .0584
    -1.4260      .7700      .1386
     -.7000      .7700      .2848
     -.0280      .7700      .4201
      .7400      .7700      .5747
     1.2940      .7700      .6862
    -1.4260     1.2620      .3642
     -.7000     1.2620      .5601
     -.0280     1.2620      .7414
      .7400     1.2620      .9486
     1.2940     1.2620     1.0981

END DATA.
GRAPH/SCATTERPLOT=COCRE WITH CREATIV BY EFFECTUA.

****************** ANALYSIS NOTES AND WARNINGS *************************

Level of confidence for all confidence intervals in output:
    95.00

------ END MATRIX -----
```

Table A.4.7 PROCESS Results (H5b)

```
************** PROCESS Procedure for SPSS Release 2.16.1 *****************

          Written by Andrew F. Hayes, Ph.D.       www.afhayes.com
    Documentation available in Hayes (2013). www.guilford.com/p/hayes3

**************************************************************************
Model = 7
    Y = EARLYP
    X = COCRE
    M = CREATIV
    W = EFFECTUA

Sample size
        205

**************************************************************************
Outcome: CREATIV

Model Summary
          R       R-sq        MSE          F        df1        df2          p
      .7182      .5158      .4938    71.3767     3.0000   201.0000      .0000

Model
             coeff         se          t          p       LLCI       ULCI
constant     -.0801      .0564    -1.4198      .1572     -.1914      .0312
COCRE         .0941      .0606     1.5527      .1221     -.0254      .2136
EFFECTUA      .6570      .0608    10.8066      .0000      .5371      .7768
int_1         .1392      .0484     2.8758      .0045      .0438      .2347

Product terms key:

 int_1    COCRE       X     EFFECTUA

**************************************************************************
Outcome: EARLYP

Model Summary
          R       R-sq        MSE          F        df1        df2          p
      .7788      .6066      .3992   155.7315     2.0000   202.0000      .0000

Model
             coeff         se          t          p       LLCI       ULCI
constant      .0000      .0441     -.0005      .9996     -.0870      .0870
CREATIV       .7371      .0503    14.6459      .0000      .6379      .8363
COCRE         .0802      .0503     1.5931      .1127     -.0191      .1794

****************** DIRECT AND INDIRECT EFFECTS *************************

Direct effect of X on Y
     Effect         SE          t          p       LLCI       ULCI
      .0802      .0503     1.5931      .1127     -.0191      .1794

Conditional indirect effect(s) of X on Y at values of the moderator(s):

Mediator
          EFFECTUA     Effect    Boot SE   BootLLCI   BootULCI
CREATIV    -1.3830     -.0726      .0782     -.2298      .0803
CREATIV     -.7360     -.0062      .0615     -.1270      .1145
CREATIV      .0200      .0714      .0476     -.0204      .1671
CREATIV      .7700      .1484      .0451      .0614      .2405
CREATIV     1.2620      .1989      .0507      .1011      .3014

Values for quantitative moderators are 10th, 25th, 50th, 75th, and 90th percentiles
Values for dichotomous moderators are the two values of the moderator.

****************** INDEX OF MODERATED MEDIATION ************************

Mediator
             Index   SE(Boot)   BootLLCI   BootULCI
CREATIV      .1026      .0336      .0388      .1698

****************** ANALYSIS NOTES AND WARNINGS *************************

Number of bootstrap samples for bias corrected bootstrap confidence intervals:
     5000

Level of confidence for all confidence intervals in output:
```

```
    95.00
------ END MATRIX -----
```

Table A.4.8 PLS-MGA Result of Industry, Path Coefficients of Each Group in Structural Model 1

	Path Coefficients (MFG)	Path Coefficients (NON_MFG)	t-Values (MFG)	t-Values (NON_MFG)	p-Values (MFG)	p-Values (NON_MFG)
CREATIVITY OF PRODUCT CONCEPT -> EARLY PERFORMANCE	0.722	0.492	10.588	2.271	0	0.023
CUSTOMER _CO-CREATION ACTIVITIES -> CREATIVITY OF PRODUCT CONCEPT	0.317	0.682	3.213	3.134	**0.001**	**0.002**
CUSTOMER _CO-CREATION ACTIVITIES -> EARLY PERFORMANCE	-0.044	0.421	0.485	2.081	0.628	**0.038**
TRADITIONAL_CUSTOMER FACING ACTIVITIES -> CREATIVITY OF PRODUCT CONCEPT	0.241	-0.042	2.311	0.18	**0.021**	0.857
TRADITIONAL_CUSTOMER FACING ACTIVITIES -> EARLY PERFORMANCE	0.124	-0.069	1.456	0.361	0.146	0.718

Table A.4.9 PLS-MGA Result of Industry, Comparisons of Path Coefficients, Structural Model 1

	Path Coefficients-diff (MFG) - (NON_MFG)	p-Value (MFG) vs (NON_MFG)
CREATIVITY OF PRODUCT CONCEPT -> EARLY PERFORMANCE	0.229	0.161
CUSTOMER _CO-CREATION ACTIVITIES -> CREATIVITY OF PRODUCT CONCEPT	0.366	**0.932**
CUSTOMER _CO-CREATION ACTIVITIES -> EARLY PERFORMANCE	0.465	**0.984**
TRADITIONAL_CUSTOMER FACING ACTIVITIES -> CREATIVITY OF PRODUCT CONCEPT	0.283	0.134
TRADITIONAL_CUSTOMER FACING ACTIVITIES -> EARLY PERFORMANCE	0.194	0.171

Note: Group difference is significant either p-value is less then 0.1 or greater than 0.9. For example, in this table, p-value 0.932 means that path coefficient of 0.366 is significant enough to say that that of NON-MFG group is greater than that of MFG.

Table A.4.10 PLS-MGA Result of Industry, Path Coefficients of Each Group in Structural Model 2

	Path Coefficients (MFG)	Path Coefficients (NON_MFG)	t-Values (MFG)	t-Values (NON_MFG)	p-Values (MFG)	p-Values (NON_MFG)
CREATIVITY OF PRODUCT CONCEPT -> EARLY PERFORMANCE	0.776	0.779	23.539	14.57	0	0
CUSTOMER _CO-CREATION ACTIVITIES -> CREATIVITY OF PRODUCT CONCEPT	0.064	0.121	0.995	0.71	0.32	0.478
EFFECTUATION -> CREATIVITY OF PRODUCT CONCEPT	0.672	0.651	11.183	4.575	0	0
EFFECTUATION*_CO-CREATION -> CREATIVITY OF PRODUCT CONCEPT	**0.16**	**0.116**	**2.243**	**1.142**	**0.025**	**0.254**

Table A.4.11 PLS-MGA Result of Industry, Comparisons of Path Coefficients, Structural Model 2

	Path Coefficients-diff (MFG) - (NON_MFG)	p-Value (MFG) vs (NON_MFG)
CREATIVITY OF PRODUCT CONCEPT -> EARLY PERFORMANCE	0.002	0.532
CUSTOMER _CO-CREATION ACTIVITIES -> CREATIVITY OF PRODUCT CONCEPT	0.056	0.62
EFFECTUATION -> CREATIVITY OF PRODUCT CONCEPT	0.021	0.466
EFFECTUATION*_CO-CREATION -> CREATIVITY OF PRODUCT CONCEPT	0.044	0.348

Table A.4.12 PLS-MGA Result of Innovation Type, Path Coefficients in Structural Model 1

	Path Coefficients (INCREMENT)	Path Coefficients (RADICAL)	t-Values (INCREMENT)	t-Values (RADICAL)	p-Values (INCREMENT)	p-Values (RADICAL)
CREATIVITY OF PRODUCT CONCEPT -> EARLY PERFORMANCE	0.596	0.724	5.645	4.179	0	0
CUSTOMER _CO-CREATION ACTIVITIES -> CREATIVITY OF PRODUCT CONCEPT	0.366	0.323	2.571	2.785	0.01	0.005
CUSTOMER _CO-CREATION ACTIVITIES -> EARLY PERFORMANCE	0.153	-0.054	1.36	0.446	0.174	0.655
TRADITIONAL_CUSTOMER FACING ACTIVITIES -> CREATIVITY OF PRODUCT CONCEPT	0.271	0.178	2.053	1.352	0.04	0.177
TRADITIONAL_CUSTOMER FACING ACTIVITIES -> EARLY PERFORMANCE	0.075	0.207	0.747	1.331	0.455	0.183

Table A.4.13 PLS-MGA Result of Innovation Type, Comparisons of Path Coefficients in Structural Model 1

	Path Coefficients-diff (INCREMENT) - (RADICAL)	p-Value (INCREMENT) vs (RADICAL)
CREATIVITY OF PRODUCT CONCEPT -> EARLY PERFORMANCE	0.128	0.798
CUSTOMER _CO-CREATION ACTIVITIES -> CREATIVITY OF PRODUCT CONCEPT	0.042	0.403
CUSTOMER _CO-CREATION ACTIVITIES -> EARLY PERFORMANCE	0.207	0.104
TRADITIONAL_CUSTOMER FACING ACTIVITIES -> CREATIVITY OF PRODUCT CONCEPT	0.093	0.312
TRADITIONAL_CUSTOMER FACING ACTIVITIES -> EARLY PERFORMANCE	0.133	0.763

Table A.4.14 PLS-MGA Result of Innovation Type, Path Coefficients in Structural Model 2

	Path Coefficients (INCREMENT)	Path Coefficients (RADICAL)	t-Values (INCREMENT)	t-Values (RADICAL)	p-Values (INCREMENT)	p-Values (RADICAL)
CREATIVITY OF PRODUCT CONCEPT -> EARLY PERFORMANCE	0.752	0.804	18.087	21.871	0	0
CUSTOMER _CO-CREATION ACTIVITIES -> CREATIVITY OF PRODUCT CONCEPT	0.078	0.124	0.78	1.443	0.436	0.149
EFFECTUATION -> CREATIVITY OF PRODUCT CONCEPT	0.651	0.674	7.22	9.997	0	0
EFFECTUATION*_CO-CREATION -> CREATIVITY OF PRODUCT CONCEPT	**0.227**	**0.032**	**4.017**	**0.302**	**0**	**0.763**

Table A.4.15 PLS-MGA Result of Innovation Type, Comparisons of Path Coefficients in Structural Model 2

	Path Coefficients-diff (INCREMENT) – (RADICAL)	p-Value (INCREMENT) vs (RADICAL)
CREATIVITY OF PRODUCT CONCEPT -> EARLY PERFORMANCE	0.053	0.829
CUSTOMER _CO-CREATION ACTIVITIES -> CREATIVITY OF PRODUCT CONCEPT	0.046	0.644
EFFECTUATION -> CREATIVITY OF PRODUCT CONCEPT	0.023	0.579
EFFECTUATION*_CO-CREATION -> CREATIVITY OF PRODUCT CONCEPT	**0.195**	**0.045**

Table A.4.16 PLS-MGA Result of Customer Base, Path Coefficients in Structural Model 1

	Path Coefficients (B2B)	Path Coefficients (B2C)	Path Coefficients (BOTH)	t-Values (B2B)	t-Values (B2C)	t-Values (BOTH)	p-Values (B2B)	p-Values (B2C)	p-Values (BOTH)
CREATIVITY OF PRODUCT CONCEPT -> EARLY PERFORMANCE	0.806	0.509	0.751	2.109	2.531	8.896	0.035	0.011	0
CUSTOMER _CO-CREATION ACTIVITIES -> CREATIVITY OF PRODUCT CONCEPT	0.171	0.422	0.41	1.023	2.208	3.596	0.306	**0.027**	**0**
CUSTOMER _CO-CREATION ACTIVITIES -> EARLY PERFORMANCE	0.063	0.099	-0.049	0.315	0.672	0.413	0.753	0.502	0.68
TRADITIONAL_CUSTOMER FACING ACTIVITIES -> CREATIVITY OF PRODUCT CONCEPT	0.489	0.318	0.176	2.025	1.75	1.485	**0.043**	**0.08**	0.138
TRADITIONAL_CUSTOMER FACING ACTIVITIES -> EARLY PERFORMANCE	-0.208	0.258	0.129	0.533	1.427	1.274	0.594	0.154	0.203

Table A.4.17 PLS-MGA Result of Customer Base, Comparisons of Path Coefficients in Structural Model 1

	Path Coefficients-diff (B2B) - (B2C)	Path Coefficients-diff (B2B) - (BOTH)	Path Coefficients-diff (B2C) - (BOTH)	p-Value (B2B) vs (B2C)	p-Value (B2B) vs (BOTH)	p-Value (B2C) vs (BOTH)
CREATIVITY OF PRODUCT CONCEPT -> EARLY PERFORMANCE	0.297	0.054	0.243	0.202	0.301	0.883
CUSTOMER _CO-CREATION ACTIVITIES -> CREATIVITY OF PRODUCT CONCEPT	0.25	0.238	0.012	0.845	0.896	0.487
CUSTOMER _CO-CREATION ACTIVITIES -> EARLY PERFORMANCE	0.036	0.112	0.148	0.564	0.305	0.211
TRADITIONAL_CUSTOMER FACING ACTIVITIES -> CREATIVITY OF PRODUCT CONCEPT	0.171	0.313	0.142	0.211	**0.069**	0.253
TRADITIONAL_CUSTOMER FACING ACTIVITIES -> EARLY PERFORMANCE	0.465	0.337	0.128	0.851	0.81	0.265

Table A.4.18 PLS-MGA Result of Customer Base, Path Coefficients in Structural Model 2

	Path Coefficients (B2B)	Path Coefficients (B2C)	Path Coefficients (BOTH)	t-Values (B2B)	t-Values (B2C)	t-Values (BOTH)	p-Values (B2B)	p-Values (B2C)	p-Values (BOTH)
CREATIVITY OF PRODUCT CONCEPT -> EARLY PERFORMANCE	0.755	0.784	0.801	9.057	14.268	25.47	0	0	0
CUSTOMER _CO-CREATION ACTIVITIES -> CREATIVITY OF PRODUCT CONCEPT	-0.069	0.274	0.091	0.548	1.599	1.118	0.584	0.11	0.264
EFFECTUATION -> CREATIVITY OF PRODUCT CONCEPT	0.844	0.504	0.686	5.422	2.876	10.48	0	0.004	0
EFFECTUATION*_CO-CREATION -> CREATIVITY OF PRODUCT CONCEPT	0.191	0.163	0.141	1.429	1.628	1.75	0.153	0.104	0.08

Table A.4.19 PLS-MGA Result of Customer Base, Comparisons of Path Coefficients in Structural Model 2

	Path Coefficients-diff (B2B) – (B2C)	Path Coefficients-diff (B2B) - BOTH)	Path Coefficients-diff (B2C) - (BOTH)	p-Value (B2B) vs (B2C)	p-Value (B2B) vs (BOTH)	p-Value (B2C) vs (BOTH)
CREATIVITY OF PRODUCT CONCEPT -> EARLY PERFORMANCE	0.03	0.047	0.017	0.602	0.678	0.594
CUSTOMER _CO-CREATION ACTIVITIES -> CREATIVITY OF PRODUCT CONCEPT	0.343	0.16	0.183	**0.954**	0.862	0.168
EFFECTUATION -> CREATIVITY OF PRODUCT CONCEPT	0.339	0.157	0.182	**0.062**	0.169	0.838
EFFECTUATION*_CO-CREATION -> CREATIVITY OF PRODUCT CONCEPT	0.028	0.05	0.022	0.415	0.349	0.436

Table A.4.20 PLS-MGA Result of Firm Size, Path Coefficients in Structural Model 1

	Path Coefficients (1001-)	Path Coefficients (501-1000)	Path Coefficients (251-500)	Path Coefficients (51-250)	t-Values (1001-)	t-Values (501-1000)	t-Values (251-500)	t-Values (51-250)	p-Values (1001-)	p-Values (501-1000)	p-Values (251-500)	p-Values (51-250)
CREATIVITY OF PRODUCT CONCEPT -> EARLY PERFORMANCE	0.31	0.715	0.238	0.777	1.047	6.159	0.862	4.868	0.295	**0**	0.388	**0**
CUSTOMER _CO-CREATION ACTIVITIES -> CREATIVITY OF PRODUCT CONCEPT	0.097	0.321	0.555	0.436	0.529	1.764	2.961	2.565	0.597	0.078	0.003	0.01
CUSTOMER _CO-CREATION ACTIVITIES -> EARLY PERFORMANCE	0.269	0.017	0.149	0.006	1.405	0.152	0.589	0.032	0.16	0.879	0.556	0.975
TRADITIONAL_CUSTOMER FACING ACTIVITIES -> CREATIVITY OF PRODUCT CONCEPT	0.509	0.368	0.151	0.137	2.818	1.778	0.834	0.767	0.005	0.075	0.404	0.443
TRADITIONAL_CUSTOMER FACING ACTIVITIES -> EARLY PERFORMANCE	0.318	0.218	0.341	-0.055	1.427	1.554	1.295	0.297	0.154	0.12	0.195	0.767

Table A.4.21 PLS-MGA Result of Firm Size, Comparisons of Path Coefficients, in Structural Model 1

	Path Coefficients-diff (1001-) – (251-500)	Path Coefficients-diff (1001-) – (501-1000)	Path Coefficients-diff (1001-) – (51-250)	Path Coefficients-diff (501-1000) – (251-500)	Path Coefficients-diff (501-1000) – (51-250)	Path Coefficients-diff (251-500) – (51-250)	p-Value (1001-) vs (251-500))	p-Value (1001-) vs (501-1000))	p-Value (1001-) vs (51-250))	p-Value (501-1000) vs (251-500))	p-Value (501-1000) vs (51-250))	p-Value (251-500) vs (51-250))
CREATIVITY OF PRODUCT CONCEPT -> EARLY PERFORMANCE	0.072	0.406	0.468	0.478	0.062	0.54	0.441	0.878	**0.91**	**0.044**	0.671	**0.965**
CUSTOMER _CO-CREATION ACTIVITIES -> CREATIVITY OF PRODUCT CONCEPT	0.459	0.224	0.34	0.234	0.115	0.119	**0.953**	0.817	**0.915**	0.817	0.679	0.312
CUSTOMER _CO-CREATION ACTIVITIES -> EARLY PERFORMANCE	0.12	0.252	0.263	0.131	0.012	0.143	0.345	0.133	0.152	0.678	0.446	0.307
TRADITIONAL_CUSTOMER FACING ACTIVITIES -> CREATIVITY OF PRODUCT CONCEPT	0.359	0.141	0.372	0.218	0.231	0.013	**0.077**	0.299	**0.065**	0.213	0.196	0.487
TRADITIONAL_CUSTOMER FACING ACTIVITIES -> EARLY PERFORMANCE	0.023	0.1	0.374	0.123	0.274	0.397	0.527	0.331	0.103	0.672	0.116	0.113

Table A.4.22 PLS-MGA Result of Firm Size, Indirect Effects in Structural Model 1

	Indirect Effects (1001-)	Indirect Effects (501-1000)	Indirect Effects (251-500)	Indirect Effects (51-250)	t-Values (1001-)	t-Values (501-1000)	t-Values (251-500)	t-Values (51-250)	p-Values (1001-)	p-Values (501-1000)	p-Values (251-500)	p-Values (51-250)
CUSTOMER _CO-CREATION ACTIVITIES -> EARLY PERFORMANCE	0.030	0.229	0.132	0.339	0.399	1.780	1.038	2.598	0.690	0.075	0.299	0.009
TRADITIONAL_CUSTOMER FACING ACTIVITIES -> EARLY PERFORMANCE	0.158	0.263	0.036	0.107	0.940	1.847	0.317	0.731	0.347	0.065	0.751	0.465

Table A.4.23 PLS-MGA Result of Firm Size, Comparisons of Indirect Effects in Structural Model 1

	Indirect Effects-diff (1001-) - (501-1000)	Indirect Effects-Diff (1001-) - (251-500)	Indirect Effects-diff (1001-) - (51-250)	Indirect Effects-diff (501-1000) - (251-500)	Indirect Effects-diff (501-1000) - (51-250)	Indirect Effects-diff (251-500) - (51-250)	p-Value (1001-) vs (501-1000))	p-Value (1001-) vs (251-500)	p-Value (1001-) vs (51-250)	p-Value (501-1000) vs (251-500))	p-Value (501-1000) vs (51-250))	p-Value (251-500) vs (51-250)
CUSTOMER _CO-CREATION ACTIVITIES -> EARLY PERFORMANCE	0.200	0.102	0.309	0.098	0.110	0.207	0.918	0.761	**0.979**	0.300	0.728	0.879
TRADITIONAL_CUSTOMER FACING ACTIVITIES -> EARLY PERFORMANCE	0.106	0.122	0.051	0.228	0.157	0.071	0.686	0.282	0.428	0.109	0.218	0.676

Table A.4.24 PLS-MGA Result of Firm Size, Path Coefficients in Structural Model 2

	Path Coefficients (1001-)	Path Coefficients (501-1000)	Path Coefficients (251-500)	Path Coefficients (51-250)	t-Values (1001-)	t-Values (501-1000)	t-Values (251-500)	t-Values (51-250)	p-Values (1001-)	p-Values (501-1000)	p-Values (251-500)	p-Values (51-250)
CREATIVITY OF PRODUCT CONCEPT -> EARLY PERFORMANCE	0.797	0.86	0.661	0.787	15.646	19.914	7.742	13.327	**0**	**0**	**0**	**0**
CUSTOMER _CO-CREATION ACTIVITIES -> CREATIVITY OF PRODUCT CONCEPT	0.153	0.092	0.08	-0.007	1.289	0.885	0.357	0.044	0.197	0.376	0.721	0.965
EFFECTUATION -> CREATIVITY OF PRODUCT CONCEPT	0.673	0.666	0.655	0.691	7.65	6.321	3.617	4.885	0	0	0	0
EFFECTUATION*_CO-CREATION -> CREATIVITY OF PRODUCT CONCEPT	0.044	-0.181	0.218	0.264	0.353	1.856	1.634	2.761	0.724	0.063	0.102	0.006

Table A.4.25 PLS-MGA Result of Firm Size, Comparisons of Path Coefficients in Structural Model 2

	Path Coefficients-diff (1001-) - (501-1000)	Path Coefficients-diff (1001-) – (251-500)	Path Coefficients-diff (1001-) – (51-250)	Path Coefficients-diff (501-1000) – (251-500)	Path Coefficients-diff (501-1000) – (51-250)	Path Coefficients-diff (251-500) – (51-250)	p-Value (1001-) vs (501-1000)	p-Value (1001-) vs (251-500)	p-Value (1001-) vs (51-250)	p-Value (501-1000) vs (251-500)	p-Value (501-1000) vs (51-250)	p-Value (251-500) vs (51-250)
CREATIVITY OF PRODUCT CONCEPT -> EARLY PERFORMANCE	0.063	0.135	0.01	0.199	0.073	0.125	0.838	**0.072**	0.452	**0.01**	0.153	0.9
CUSTOMER _CO-CREATION ACTIVITIES -> CREATIVITY OF PRODUCT CONCEPT	0.061	0.073	0.159	0.012	0.099	0.086	0.33	0.363	0.191	0.451	0.277	0.383
EFFECTUATION -> CREATIVITY OF PRODUCT CONCEPT	0.007	0.018	0.017	0.011	0.024	0.036	0.473	0.502	0.572	0.51	0.583	0.551
EFFECTUATION*_CO-CREATION -> CREATIVITY OF PRODUCT CONCEPT	0.224	0.174	0.22	0.399	0.445	0.046	**0.071**	0.837	**0.92**	**0.991**	**0.996**	0.623