

To what extent can Lean Startup improve performance of servitizing manufacturing firms?

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ABSTRACT,

In the past decade, servitization received much attention among scholars and practitioners as an effective way for manufacturers to achieve superior performance. However, the servitization-performance relationship is still debated by many empirical studies, due to the mixed results that they provided. Therefore, this paper conducted a quantitative study to investigate whether manufacturing firms that use lean startup principles when servitizing achieve higher performance outcomes. Hence, it analysed the moderating effect of lean startup methodology on the servitization-performance relationship. This study found statistically significant results that when manufacturing firms used lean start-up methodologies, servitization-performance relationship was improved. Thus, we urge manufacturing firms to use lean startup methodologies when undergoing the servitization journey and co-create value together with their customers. This way, manufacturing firms will be able respond to the challenging competition and achieve higher performance outcomes.

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Servitization, Lean Startup, Firm Performance, Service Offering, Customer Value

1. INTRODUCTION

To overcome the challenges of increasing competition, many traditional manufacturing firms are moving from industrial goods toward the provision of services and solutions (Antiooco et al., 2008; Helander and Möller, 2008; Windahl, 2007; Brady et al., 2005). Academic research argues that in order to compete in the future, firms must shift from a “goods-centered paradigm” to a “service-centered view” (Vargo and Lusch 2004, p. 12). A good example of this transition is the case of IBM where their core business has gradually shifted to provide solutions for customers, and Rolls-Royce’s annual report in 2015 revealed that more than half of its total revenues were generated from maintenance on its engine products (Wang et al., 2017).

Since the term “servitization” was first coined by Vandermerwe and Rada (1988) to delineate the process of creating value by adding services to products, there have been growing studies in this field. Many manufacturing enterprises regard servitization as an important route to acquire growth, profitability, and economic stability (Spohrer and Maglio, 2008; Bandinelli and Gamberi, 2011). Neely (2008) reports that globally over a third of manufacturing firms have servitized, with regard to these trends. Based on the works of Wang et al. (2018), Visnjic et al. (2016), Fang et al. (2008) and Kohtamäki et al. (2015), we can say that it isn’t clear whether industrial services create profits (or increase performance in general for that matter). The studies of Wang et al. (2018) confirmed the impact of performance operationalization on the observed servitization-performance relationship. More precisely, servitization has a stronger positive effect on firms’ non-financial performance than financial performance. Furthermore, the studies of Wang et al. (2018) only proved the linear positive relationship between servitization and firm performance, urging other practitioners to study the non-linear effects of servitization on firm performance.

Other researchers have found non-linear effects of servitization on firm performance. The findings by Fang et al. (2008) and Kohtamäki, Partanen, Parida and Wincent (2013) reveal a U-shaped relationship between servitization and firm performance. This effect can be due to initial learning effects and missing economies of scope, that is, missing synergies between products and services businesses.

While structure and frameworks might be appealing, these have to be created in a way that recognizes and allows for an emergent servitization journey and provides scope to respond to opportunities and challenges that arise (Martinez et al., 2017). Thus, exploring possibilities that could improve the way manufacturing firms deal with uncertainties and opportunities (i.e. reducing costs of initial learning effects) throughout the servitization process can further improve the relationship between servitization and firm performance.

Startups are well known to be able to cope with uncertainties and explore new opportunities many of which use the Lean Startup (LS). Hence, LS is a toolset for opportunity exploration (Bakker & Shepherd, 2017) that emphasizes iterative experimentation and early customer insight. This iterative process of LS consists of the cycle (1) customer orientation, (2) hypothesizing, (3) experimentation, (4) validation and (5) learning. This way, entrepreneurs use validated evidence to learn, and in doing so, they can meet time and budget requirements in order to avoid costly failures through early intervention (Hayes, Wheelwright, & Clark, 1988), hence, having a direct impact on performance.

This effect is backed up by the studies of Harms and Schwery (2020), they found out that Lean Startup Capability (LSC) contributes to performance, finding a moderately strong, positive and significant relationship between them. Their analysis, done on startup companies, suggests that more mature ventures performed better (performance was not related to the degree of market uncertainty or business type), opening the doors for manufacturing firms to capitalize on this opportunity. Early customer engagement and the use of hypotheses facilitate early interventions, which enables experimentation to create data that can be used to counteract decision-making biases (Eisenmann et al., 2011; York & Danes, 2014), hence, updating their theory on how to create value. By using these (LS) capabilities, manufacturing firms can get early customer insights in order to mitigate initial learning effects and further improve their opportunities for economies of scope.

Given the limited frameworks for managing the illogical and unstructured character of the servitization process, this paper aims to fill this research gap by investigating if the Lean Startup method can contribute to servitization performance. For investigating how the Lean Startup method can improve servitization outcomes, in terms of performance, and to analyze to what extent Lean Startup methodologies are already being used within manufacturing firms, and what impact it has on servitization outcomes, this paper will respond to the following research question:

“ To what extent can Lean Startup improve performance of servitizing manufacturing firms? ”

2. THEORETICAL FRAMEWORK

2.1.1 Servitization

The term “Servitization”, coined by Vandermerwe and Rada (1988), is now widely recognised as the process of creating value by adding services to products. In this respect, many leading firms have added services to their existing product offerings in an attempt to provide total customer solutions, and, thus, to improve their competitiveness and performance (Lusch, Vargo, and O’Brien 2007; Sawhney 2006; Wise and Baumgartner 1999).

Earlier studies of Lutjen et al. (2017) identified three steps in the servitization process that manufacturing companies undergo: service orientation, service anchoring and service extension. More recent studies of Baines et al. (2020) confirm that these steps align with the Exploration, Engagement and Expansion stages, and added an additional stage of Exploitation, together they comprise the servitization progression model. The Exploration stage is characterized by “searching and finding out about the concept and the implications of competing through advanced services, until they are confident that the opportunity exists”. The Engagement stage is characterized by “seeking to evaluate and demonstrate advanced services, until the potential is accepted within the organization”. The Expansion stage is characterized by “increasing the scale and speed at which advanced services are innovated and implemented, until significant value is demonstrated within the organization”. The last stage is called Exploitation, which is characterized by “seeking to optimise innovation and delivery of advanced services portfolio, unless business is adversely disrupted”.

The servitization transformation process model, described by the studies of Baines et al. 2020, sees the progression as a timeline, arguing that in order to transition effectively from one stage to the next, manufacturers have to look at contextual factors that affect progression through the transformation process. By linking events associated with each category to a well-delimited time period, different stages of maturity can be constituted, hence performance can be tracked down. This argumentation implies that if manufacturing firms are “stuck” in one of these stages for too long, the costs outweigh the benefits. Furthermore, their findings suggest that most contextual factors affect each stage of the process. These factors include: customer pull (refers to the external contextual factors about the market environment), technology push (refers to the external contextual factors about digital technologies), value network positioning (refers to the external contextual factors about the value network structure), organisational readiness (refers to the internal contextual factors about the organization that affect whether or not the process starts), and organisational commitment (refers to the common internal factors that across all stages and focuses on the key capabilities that enable or inhibit the progression). Therefore, this model explains how the servitization journey unfolds through four distinct stages of organisational maturity, in accordance with five sets of internal and external forces; yet, within each stage, activities to progress servitization are organic, intuitive and repetitive (Baines et al., 2020): “if the outcome of Exploration is positive, the organisation moves to Expansion” (i.e. pilots are translated into commercial offerings and increase in the scale and speed at which advanced services are innovated and implemented) and afterwards “if Expansion is successful, attention switches to Exploitation”. In the last stage the organisation continues to develop new offerings and scale these, but also improve the reliability and efficiency of the delivery of services at scale. Within the servitization progression model described above, the term advanced services is described as complex value propositions whereby the manufacturer focuses on providing performance outcomes to customers, and can be thought of as substituting services (Cusumano et al., 2015) that replace the purchase of the product (Paiola et al., 2013). Furthermore, the studies of Sousa and Silveira (2017) contend that advanced services affect firms’ sales and profitability while basic services negatively affect firms’ profitability. There are multiple categories of services (with regard to service offering), they can be either base services (warranties and spare parts), intermediate services (maintenance, repair, overhaul) and advanced services (Baines and Lightfoot, 2013), jointly they encompass the service offering. Moreover, service offering is closely related with the extent of service provisions from manufacturing firms, which implies the efforts in service business made by manufacturing firms (Kohtamäki, Partanen, Parida and Wincent, 2013; Sousa and Silveira, 2017). However, service offering by itself may be easily copied and generates neither economic rents (Amit and Schoemaker, 1993; Hoskisson et al., 1999) nor added value (Lepak et al., 2007). Thus, an active service offering joined with service-oriented organizational structure and culture creates the capability to deliver customer value effectively and transforms service strategies into valuable resources (Brax, 2005; Long and Vickers-Koch, 1995). Developing extended product-service offerings may yield performance benefits as long as solution providers are truly interested in value co-creation, this way, manufacturing firms can improve their customer value experience that results in higher prices and lower delivery costs (Kohtamäki et al. 2015).

The findings by Fang et al. (2008) and Kohtamäki, Partanen, Parida and Wincent (2013) reveal a U-shaped relationship between servitization and firm performance, whereas Visnjic and van Looy (2013) find a positive S-shaped association between the scale of service activities and profit margin.

The studies of Szász et al. (2017) confirm that service paradox (e.g. overestimating revenue streams and unexpected increase in delivery costs) occurs more frequently in less-developed economic contexts, few studies have explored the moderating effect of external environmental factors (e.g. industry and region) on the servitization-performance relationship. Moreover, a positive impact on performance only seems to (re)appear when a critical mass of services (minimum amount of services to start or maintain the new venture) is achieved (Fang et al., 2008; Suarez et al., 2013; Visnjic Kastalli and Van Looy, 2013). While the traditional resource-based view (Barney, 1991) has struggled to show how servitization creates value, the so-called demand-based view (Priem, 2007; Ye et al., 2012) may offer additional insights (Visnjic Kastalli and Van Looy, 2013). This view argues that companies can create value by saving time, effort, and/or investments in learning for their customers and, thereby, generate “economies of scope in use” (Ye et al., 2012). The negative side of the U-shape relationship can be tied down to initial learning costs that are needed in developing new services to their product offering. After these costs are absorbed, customers start utilizing these services (and firms gain know-how in developing services), contributing to the “positive side” of the U-shape, increasing firm’s performance. Therefore, we hypothesize that:

H1: Servitization has a U-shaped relationship with firm performance.

2.1.2 The Lean Startup approach

Lean Startup is a methodology used for opportunity exploration that emphasizes iterative experimentation and early customer insight (Bakker & Shepherd, 2017). This way, entrepreneurs can avoid costly mistakes early on and increase likelihood of success.

Harms & Schwery (2020) managed to conceptualize lean startup capability (LSC) as the realized capability to perform activities related to LS, which implies that it is not a single capability but the integrated bundle of LSC dimensions that are related to performance. We define Lean Startup Capability as the LS-based cross-functional capability bundle (Grant, 1996) that the venture performs when it engages in opportunity incubation (Vogel, 2016). Activities such as experimentation, generating early customer insights, learning and iteration form the bundle of activities of LS. In this context, the opportunity incubation cycle can be viewed as an entrepreneurial learning process, for accumulating missing information about the venture idea; for engaging in experiments (e.g., testing different pricing strategies); or for adapting, shaping, and refining the venture concept (Alvarez, Barney, & Anderson, 2013; Corbett, 2005; Garud & Gehman, 2012).

According to the studies of Harms et al. (2020), the dimensions of LSC consist of the following capabilities: customer insight, hypothesis testing, iterative experimentation and learning.

Customer insight is the capability to understand customers and users deeply. It is built on a market-oriented philosophy (Slater & Narver, 1998) that puts potential customers’ latent needs central in solution development. Activities include

market research that focuses on latent rather than expressed needs (Slater & Narver, 1998) and conscious use of identified needs in opportunity exploration.

According to Rainer Harms & Mario Schwery (2020) *hypothesis testing* is the capability to formulate and test explicit hypotheses about the venture and its environment; activities include the explication of implicit hypotheses that feed into iterative experimentation to generate cognitive and behavioral learning.

Iterative experimentation is the capability to run several experiments on all elements of a business (Rainer Harms & Mario Schwery, 2020). Iterative experimentation addresses the continuous, rather than sporadic, nature of experimentation (Block & MacMillan, 1985; Lynn et al., 1996; Sull, 2004).

Validation refers to the use of data to monitor the impact of decisions based on the results of iterative experiments (Harms & Schwery, 2020). Data helps entrepreneurs to cancel out human decision-making biases (Eisenmann et al., 2011; York & Danes, 2014).

Learning is the capability to use new information to update beliefs and actions (Harms & Schwery, 2020). Learning aims to understand better (cognitive learning) the value generating potential of the opportunity (Felin & Zenger, 2017). It is also aimed to inform action ("pivot or persevere"; behavioral learning). The literature proposes a positive relationship between learning and performance (Baker & Sinkula, 1999; Calantone et al., 2002; Real, Roldán, & Leal, 2014; Wang, 2008). Activities include, for example, the accumulation of experiences, the articulation, and codification of knowledge (Zollo & Winter, 2002).

Recent empirical studies (Harms & Schwery, 2020) have found that there is a strong and robust LSC-performance relationship. By making early interventions, costly failures can be avoided through early customer engagement and the use of hypotheses. Experimentation creates data that can be used to counteract decision-making biases (Eisenmann et al., 2011; York & Danes, 2014). With this data, entrepreneurs enable experimental learning in order to update their theory of how to create value (Harms et al., 2020), consequently increasing performance. That is why we expect the following hypotheses:

H2: Lean Startup has a positive impact on firm performance.

2.1.3 LS implications on servitization

In the context of servitization, there can be seen similarities between the LS methods and the agile co-creation process for digital servitization (i.e. the micro-service innovation approach) described by the studies of Sjödin et al. (2020). The studies of Baines et al. 2020 and Lutjen et al. 2017 overcame challenges such as creating a framework for the servitization process, which prescribe characteristics and priorities for each stage. While these stages do not deal with all the challenges involved in servitizing companies, they further indicate the need for understanding the rate of progression along these stages or the efficiency and effectiveness with which advanced services are provided. Hence, LS has the potential to mitigate these risks by improving the rate of progression along these stages, and by creating more customer oriented solutions, with regard to their advanced services.

While undertaking the servitization journey three main barriers were categorized: (1) strategy-related barriers, (2) implementation related barriers and (3) market related barriers (Lutjen et al., 2017). Strategy fit-related barriers concern the ambiguity of a broad service portfolio

(Benedettini et al., 2017; Nordin et al., 2011) and the cannibalisation of the established product-oriented business (Greenstein, 2010; Vendrell-Herrero, in press). Implementation-related barriers range from a lack of innovation capabilities and necessary resources (Kindström and Kowalkowski, 2014; Tietze et al., 2013; Wang et al., 2016), to missing service and innovation cultures (Gebauer et al., 2012; Neely, 2008; Oliva and Kallenberg, 2003), to problems in establishing service-specific innovation processes (Chen et al., 2016; Dörner et al., 2011; Kindström and Kowalkowski, 2014). Market-related barriers inhibit customer acceptance (Ulaga and Loveland, 2014; Wang et al., 2016) and network configurations (Story et al., 2017; Zhang et al., 2016).

Empirical studies suggest that firms fail to successfully create new services due to their lack of specific capabilities, and commitment to the front-end, development or launch phase of the innovation (Kindström and Kowalkowski, 2014). Further, customers are becoming more integrated in the innovation process with their knowledge, skills and resources which consequently leads to a higher share of value being added by customers and to increasing demands on employee know-how and skills (Vargo and Lusch, 2008). We expect LSC to help with these shortcomings when undergoing servitization, which focuses on validated learning through gaining early customer insight and performing iterative experimentation (continuous rather than sporadic). Specifically, by possessing the required skills, LSC helps retaining customer needs, without the excess use of resources, thus improving the launch phase of the innovation. This translates into the possibility of creating new customer-oriented services, which we expect to lower the ambiguity of a broad service portfolio (by focusing on customer needs) hence, preventing the widely documented servitization failure. Performance studies on servitization have shown that investments and higher costs for developing and offering services often do not generate the expected returns, often resulting in widely documented servitization failure (Fang et al., 2008; Gebauer et al., 2005; Suarez et al., 2013; Visnjic Kastalli and Van Looy, 2013). Thus, by lowering experimentation costs in early stages (which is a consequence of using LSC) servitizing companies can avoid doing high investments when developing new services, and take an iterative approach where customer involvement is the main source of knowledge.

While traditional new product and service development processes no longer work (Cooper & Sommer, 2018; Paluch et al., 2019), for reasons that it discourages experimentation; they are too rigid, planned, and linear to handle dynamic and innovative projects (Cooper & Sommer, 2018) that are prevalent in the context of servitization. In contrast, many studies argue that the new digital landscape requires a more agile and co-creative innovation process because companies need to cope with a constantly evolving digital landscape (Cooper & Sommer, 2018; Parida et al., 2019; Sjödin et al., 2018). Being agile means applying previous knowledge while continuing to learn from current experience to deliver high-quality products or services under budget constraints and in short timeframes (Sjödin et al., 2020), and, it has been shown that it can augment product and service performance (Barrett, Davidson, Prabhu, & Vargo, 2015; Hasselblatt, Huikkola, Kohtamäki, & Nickell, 2018; Iansiti & Lakhani, 2014). This approach is very similar to the LS approach, where focus is put on validated learning through gaining early customer insight and performing iterative experimentation (continuous rather than sporadic). Thus, we propose the following hypotheses:

H3: Lean Startup Capability negatively moderates the U-shaped servitization-performance relationship.

3. METHODOLOGY

3.1.1 Research Design and sample

In the following section the methodology is described in how this paper tries to answer the research question “To what extent can Lean Startup improve performance of servitizing manufacturing firms?”. There are several dimensions to this research setting. The aim of this paper is to investigate the infusion of services into a product-business model and the moderating effect of Lean Startup on the servitization-performance relationship of small to medium sized Dutch manufacturing firms, with the infusion of some large manufacturing firms. In doing so, the primary data collected for this research is quantitative, gathered through surveys that employees from the sampled companies answered. This way, we were able to measure the provision of services that these firms offer, and consequently, servitization and lean startup methodologies could be measured. Whereas, a qualitative study would have not been able to measure how many services these firms offer, thus, we chose quantitative over qualitative studies. Moreover, this research used the deductive approach. A deductive approach is concerned with developing a hypothesis (or hypotheses) based on existing theory, and then designing a research strategy to test the hypothesis. ‘In this type of research, theory, and hypotheses built on it, come first and influence the rest of the research process – this type of research is often associated with the quantitative type of research’ (Ghauri and Grøhaug, 2005: 15).

To explore our research question, a representative sample of 51 Dutch manufacturing firms with a service orientation was compiled through distributing survey questionnaires. The final sample size was 37, as respondents who did not finish the surveys were removed. Furthermore, 4 companies were removed due to not offering any services, resulting in a 33 sample size. Respondents were contacted (via phone, email) from representative B2B manufacturing companies and asked to fill in the survey. Contacts were selected as respondents for the “Organizing for servitization Survey”. Respondents were filtered based on their role within the companies, requiring a role of seniority (e.g. CEO, director, project manager) involved in the service business. In figure 1 below you can find descriptive statistics of the sample.

Descriptive Statistics					
	N	Minimum	Maximum	Mean	Std. Deviation
Firm_performance	37	3.70	8.00	6.0522	.96736
Service_offering	33	63.00	182.00	114.8182	35.71804
Lean_Startup_use_AVG	37	1.00	6.20	4.7438	1.20098
Valid N (listwise)	33				

Figure 1

3.1.2 Measures

According to (Wang et al., 2018), there are 4 validated measures for the servitization process, namely, service orientation, service offering, service revenue and service breath. This research specifically tries to explore further the “service offering” concept as the operationalization of the servitization. This relates to the extent of service provisions from manufacturing firms, which implies the efforts in service business made by manufacturing firms (Kohtamäki, Partanen, Parida and Wincent, 2013; Sousa and Silveira,

2017). When measured with service offering, respondents to the survey should first select the used services from the service list and assess the extent of selected services offered by firms to customers (Kohtamäki et al., 2015; Szász et al., 2017). Moreover, the degree of servitization was measured through the service offering construct as the activeness in service provision of manufacturing firms based on a likert scale (from very unimportant to very important and/or not at all applicable to very applicable, with their associated scores from 1 to 7) and a standardized service list (hence, number of services offered with associated scores). For some of the questions respondents had the option to leave additional comments in order to elaborate on set questions. The service list provided to respondents consists of six dimensions: design and development services, systems and solutions, retail and distribution services, maintenance and support services, installation and implementation services and financial services. Each dimension had subsequent questions, which afterwards were averaged out to represent the constructs of the service offering. In doing so, service offering represents the operationalization of the servitization construct. For measurement, service offering can be seen as “the extent of selected services offered by firms to customers” (Wang et al., 2018).

For performance measures, subjective performance measures were used as described by the studies of Kohtamäki et al. (2015). Due to anonymity concerns of respondents, subjective performance measures were preferable, instead of using financial measures like EBIT.

To assess the validity and reliability of the sampled data, multiple steps were conducted prior to analysis. Cronbach’s alpha was used in SPSS to test the reliability of each construct and to assess whether there is a need to remove variables. Their respective scores can be found in the operationalization table in the appendix (Appendix 1.1).

Further, we tested for normality of residuals, the Shapiro-Wilk test showed the same values ($P=.868 > .05$) for both unstandardized and standardized residuals, suggesting a normal distribution of residuals (See Figure 2, below). Finally, a multicollinearity test was made, which showed that no variables were too highly correlated. However, some variables had a moderate level of correlation, which can be tied down to the way the hypothesis were formulated in this paper. No multicollinearity was present, except when moderating variables were used. This effect was due to using service offering and service offering squared in the model, in order to capture moderating effects.

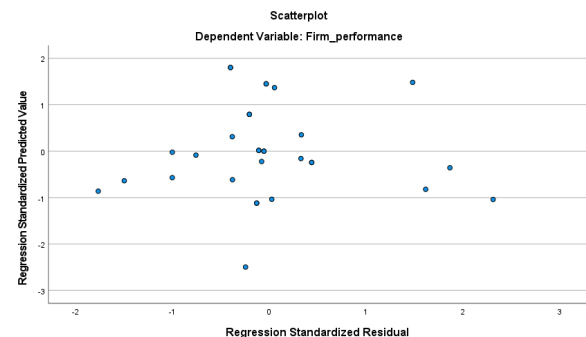


Figure 2

3.1.3 Control variables

In this study, control variables were used in order to see their influence on firm performance. The first control variable used in this analysis was firm size, as larger companies benefit of

higher available resources when they undergo the servitization process.

The second control variable that was used was the number of customers, hence customer heterogeneity. By assessing both independent variables in the model, biases such as the implication of higher level of resources and other business model variants could be avoided.

3.1.4 Analysis

After validating the data two models were created in order to capture the U-shaped relationship between servitization and firm performance. In doing so, the first model includes the first two hypothesis; servitization and lean start-up, coupled with the control variables discussed above. For the second model a multiple linear regression was made, using servitization, LSC, control variables and moderator variables. The importance of including moderating variables in our model was to capture the moderating effect of LSC on the servitization-performance relationship. The moderator variable was created by using z-scores of LSC and servitization. The first moderator variable was computed by multiplying lean startup capability with servitization, whereas, the second moderator by multiplying the square root of servitization with lean startup capability. In doing so, the U-shape relationship could be measured.

Dimensionality was tested using principal-axis factoring and the Varimax Rotation method, as this method of rotation assumes factors are not correlated (the Direct Oblimin rotation method showed all coefficients $<.32$). Further, the Kaiser-Meyer-Olkin measure of sampling adequacy showed a score of .74 and therefore our sample was adequate for Factor Analysis. Bartlett's test of sphericity was significant ($P=.001$), and therefore suggests that our data are normally distributed. The Factor Analysis extracted three components, the first component having 6 items, the second component with 3 items and the third with 2 components having the highest coefficient and consequently the strongest relationship with the factor. The highest factor loadings for the items 1 till 6 were in Factor 1. Looking at the theoretical similarities between these items, they measured the respondents activeness in offering services, hence, it comprises the service offering construct. The Factor Loadings for items 7, 9 and 11 were in Factor 2. Looking at the theoretical similarities between these items, it could be argued that they measure respondents activeness in experimentation, hence, it forms the LSC construct. The Factor Loadings for items 8 and 10 were in Factor 3. Looking at the theoretical similarities between these items, it could be argued that they measure respondents activeness in learning from they customers. Although the Factor Analysis identified three separate factors, namely, service offering, experimentation and learning, in this paper experimentation and learning are taken as the same factor, which comprises the activeness in

using LS methodologies. Therefore, the Factor Analysis provides evidence to suggest that the eleven-item measure of overall activeness is in fact measuring the following two factors separately; activeness in service offering and activeness in using LS methodology (i.e. experimentation and learning).

4. RESULTS

In table 1 correlations between given constructs and the control variables are presented, and shows that when considering the correlations between independent and mediating variables, the highest correlation is between lean start-up capability and service offering being .528; excluding correlations between the service offering and the square root of it, and moderator variables. In the analysis, we tested two different models in order to be able to test direct and moderating effects on the full model of LSC on the servitization-performance relationship.

4.1.1 Hypothesis 1

The results of the full model can be seen in table 1. We found that there is a significant effect on firm performance when having a higher level of servitization. The quadratic term of service offering ($\beta=2.745$, $P=.019$) shows significant positive effect on firm performance. The linear result of Service Offering ($\beta=-2.286$, $P=.043$) shows a significant negative relationship with firm performance. Moreover, the sign of the standardized beta flipped proving the U-shaped relationship between servitization and performance. Thus proving H1 that there is significant evidence to accept the H1 which implies that there is a U-shaped significant positive relationship between service offering and firm performance.

4.1.2 Hypothesis 2

The second hypothesis predicts that lean start-up capability has a positive effect on firm performance and showed a moderate positive non-significant effect on firm performance ($\beta=.232$, $P=.207$). Thus, showing that lean start-up has a moderately positive non-significant effect on firm performance, so we reject H2. However, by further investigating model 1 we see that it has an R-squared of .489 meaning it explains 48.9% of the variability in the model. Whereas, the control variables used in model 1 did not show a significant effect on the firm performance, with number of employees showing ($\beta=-0.99$, $P=.524$) and number of customers showing ($\beta=.148$, $P=.352$). Thus, while the moderating effect of lean startup on firm performance is not significant, it still contributes to the variation of the variables in model 1.

Correlation matrix								
Variables	1	2	3	4	5	6	7	8
1.Firm performance	1	0.109	0.107	0.509	0.571	0.524	0.376	0.352
2.Firm size	0.109	1	0.208	0.270	0.288	0.295	0.119	0.132
3.Customer heterogeneity	0.107	0.208	1	0.229	-0.021	0.007	-0.148	-0.102
4.Lean start-up capability	0.509	0.270	0.229	1	0.539	0.528	0.051	0.008
5.Service offering squared	0.571	0.288	-0.021	0.539	1	0.991	0.579	0.498
6.Service offering	0.524	0.295	0.007	0.528	0.991	1	0.506	0.428
7.Moderator variable squared	0.376	0.119	-0.148	0.051	0.579	0.506	1	0.989
8.Moderator variable	0.352	0.132	-0.102	0.008	0.498	0.428	0.989	1

Table 1

4.1.3 Hypothesis 3

The third hypothesis holds that lean start-up capability moderates the relationship between servitization and firm performance. The model shows that there is a significant positive effect on firm performance with ($\beta=3.681$, $P=.029$). Furthermore, the quadratic model of the moderating effect of lean startup on the U-shaped relationship between servitization and firm performance showed a negative significant effect ($\beta=-4.239$, $P=.027$), proving the U-shaped relationship. With both models showing significant effect, we accept H3. Moreover, control variables used in this model showed no significant effect, with customer heterogeneity showing ($\beta=.031$, $P=.844$) and number of employees showing ($\beta=-.199$, $P=.198$). The table below (table 2) summarizes all the aforementioned results for our hypothesis.

Variables	Hypothesis	Firm Performancee (Standardized β)	
		Model 1	Model2
Intercept		7.126 (1.707)**	10.150 (2.454)**
Service Offering	H1	-2.286 (.026)*	-4.417 (.037)*
Service Offering^2	H1	2.742 (.000)*	5.590 (.000)*
Lean startup	H2	.232 (.188)	.063 (.214)
Moderating effects			
Service Offering x Lean Startup	H3		3.681 (1.917)*
Service Offering^2x Lean Startup	H3		-4.239 (2.203)*
Control variables			
Customer heterogeneity		.148 (.000)	.031 (.000)
Firm Size		-.099 (.000)	-.199 (.000)
R squared		.489	.590
Adjusted R2		.387	.465
F-statistics		4.791	4.721

* $p < .05$.

** $p < .001$

SE=()

Table 2

5. DISCUSSION

While the competition for product-manufacturing firms is still increasing, solutions must be sought out in order to close the gap. While some manufacturing operations opt for lower-cost countries, it also sparked the development of service offerings and integrated solutions within the manufacturing industry (Davies et al., 2006; Helander and Möller, 2007; Windahl and Lakemond, 2010). While scholars have directed their attention towards the development of a strategy for industrial services, which can be seen as a service strategy (reflected in service offering), structure (service orientation) and performance factors (sales and profit performance) in manufacturing firms has not been well understood (Gebauer et al., 2012). This can be due to complex interactions that are needed for the ability to co-create value with customers (Davies and Brady, 2000; Storbacka, 2011; Windahl and Lakemond, 2006). Although other studies have found different dimensions of performance (sales and profit) are strongly correlated, the use of hybrid measures that capture several dimensions is not advisable (Combs et al., 2005), due to the nature of multidimensionality of performance (Hakala, 2013; Ray et al., 2004). Thus, our studies focused on understanding performance effects and potential mediators within these complex interactions, which comes as a response to the need indicated by the studies of Kohtamaki et al. (2015). This way, more can be learned about the mechanisms of how outcomes can be improved and further investigate the associated U-shape relationship of servitization over firm performance. This need was investigated by our first hypothesis showing statistically significant results. This finding implies that service offering has a direct relationship with firm performance, moreover, by investigating the quadratic relationship of service offering with firm performance the U-shape relationship was proven.

Our findings suggest a direct relationship between the provision of services and firm performance, meaning that more servitized manufacturing firms scored better on performance outcomes, making a stronger case for the need of transitioning towards more service centered product firms. By proving the U-shaped relationship, we can conclude that surveyed respondents have experienced the profitability dip of undergoing the servitization process. The studies of Fang et al. (2008) argued that in order to overcome this, firm's customers have to use around 20-30% of their services.

This is why the control variables used for this hypothesis were the number of employees and customer heterogeneity, in order to investigate the role of customers (hence, responding to the "profitability dip") and firm size. Results showed no significant effect of these control variables. Moreover, the number of employees had a stronger impact than the number of customers (both not statistically significant), meaning that potentially firm size has an impact on service quality, hence performance. Whereas, customer heterogeneity had a lower impact due mitigating effects of firm size. Probably, with a larger sample size, the significance of these control variables could have been further improved.

With regard to the impact of LSC on firm performance, there are no statistically significant results in our two models. This can be due to other moderating effects included in the model,

such as the inclusion of service offering. Hence, creating a different model where these moderating factors do not interact with the LSC, could potentially improve statistical significance of set results. Nevertheless, the first model predicted a positive effect of LSC on firm performance ($\beta=.232$, $P=.207$), but statistically not significant. Finally the third hypothesis investigated whether lean startup capability negatively moderates the U-shaped relationship between servitization and firm performance which showed statistically significant results. This means that service offering coupled with lean start-up capabilities improve the “performance dip”. Moreover, by using the quadratic model we proved the U-shape relationship and LSC’s mediating role.

5.1.1 Practical implications for organizations

The results suggest that having an extensive product-service offering yields performance benefits for manufacturing firms. Furthermore, by using lean startup capabilities these performance benefits can be further enhanced. However, lean startup did not show significant results on firm performance in isolation, instead, it has a mediating effect. Thus, we advise manufacturing companies to translate LSC into the firm’s strategy early on in order to minimize the profitability dip caused by initial learning costs. Nurturing the service offering with LSC within manufacturing firms is a vital component of transforming the firm’s strategy into increased sales and performance. Services such as design and development (from among the service list) can be improved significantly by using the customer-oriented experiential learning cycle (e.g., customer orientation, hypothesizing, experimentation, validation and learning). In doing so, when undergoing the servitization process, manufacturing companies should emphasize experimentation rather than formal planning, improvisational learning or trial and error (Block & MacMillan, 1985; Lynn, Morone, & Paulson, 1996; Miner, Bassoff, & Moorman, 2001; Sull, 2004). Thus, we advise manufacturing firms to use these principles especially during their Exploration stage described by Baines et.al (2020) where companies seek out the possibilities of creating additional value to their customers through services. During the Engagement stage (i.e. development of initial experiments and designate a team), LSC can be used to counteract the negative effects of initial experimentation. Furthermore, we advise manufacturing firms to form designated teams that are familiar with LSC culture. Managers should be aware that in order to be effective in using LSC, their business model might need adjustments. In doing so, they can use external partners to minimize internal resource conflicts, until better validation is achieved (Chesbrough & Tucci, 2020). Existing corporate roles might not be sufficient, hence we advise manufacturers to designate generalist managers instead of specialists, until venture is ready to scale. Thus, new ventures will need separate, focused management and resources (Chesbrough & Tucci, 2020). Flexibility will be key along this process.

By undergoing this strategy, manufacturing firms will offer more customer-oriented services next to their product offering. In doing so, organizations have to nurture the philosophy of LSC and integrate it into their business model and culture. This means that they will have to train, compensate and create policies such as LSC traits will be embedded in their culture. By developing these LS capabilities, organizations will be able to avoid costly mistakes early on when developing new service offerings to

its customers. This way, the cost of experimenting and co-creation can be significantly reduced, while attaining higher validation for their new services they want to develop.

5.1.2 Limitations and implications for future research

It is clear that the small sample size had a limitation on the statistical significance of some of the results, thus we urge practitioners to analyze a larger sample size for more accurate results. This way, all three hypotheses would have shown statistically significant results, instead of proving the first and the third hypotheses. By having 37 respondents, out of which 4 were excluded, overestimation or underestimation of constructs could have potentially skewed the results.

Another limiting factor is that these studies focused on a single-country sample, and service culture may be affected by national culture and context (Bontis et al., 2002). Future research should focus on international data collection, in order to get a clearer understanding of how culture affects servitization. Respondents to our questionnaire were SMEs and a few large manufacturing firms from Netherlands, thus extending the validity of results to multinational product-manufacturing firms will be of future interest. In doing so, would be of interest to see how different service cultures affect the use and efficacy of LSC in relation to the servitization-performance relationship.

The use of different performance measures, such as combining subjective with financial performance measures in order to understand better where is the strength of LSC in congruence with servitization (e.g., which services can be improved by using LSC).

This research has many implications for future research, as these studies showed that manufacturing firms that use LSC when undertaking servitization, have significantly improved performance. So we urge manufacturers who want to transition from a product-centered approach to a service-centered approach to use these capabilities early on in the development of their new services.

In theoretical terms, would be a great opportunity to do a qualitative study to see specifically how to incorporate LSC in the servitization journey; e.g., by creating a framework, future manufacturing firms will be able rip more benefits when combining these principles.

6. CONCLUSION

Throughout this study we managed to bring new insights into the servitization process and it’s relation with performance. Firstly, we confirmed the U-shape relationship between servitization and firm performance with regard to manufacturing firms that undergo this strategy. Our sampled companies did experience the “profitability dip” described by previous papers of Fang et al. (2008) and Kohtamaki et al. (2013). Further, we investigated whether these firms could reduce their “profitability dip” by measuring their activeness in using lean startup principles. We expected that companies that used LSC when they started the servitization journey, would yield higher performance outcomes. Our results showed that when undergoing the servitization process, LSC had a mediating role between the servitization-performance relationship. Hence, when servitizing, by using LSC, manufacturing firms can improve their performance outcomes by minimizing the steepness of the U-shape relationship. As this study was a quantitative research, a qualitative study would bring new insights into when and how

to apply LSC when undergoing servitization, helping further manufacturing companies in their transformation journey. Another interesting research would be to see how servitizing companies could benefit from agile principles, as these principles relate to the framework of the servitization journey described by Baines et al. (2020).

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Appendix 1.1

Concept	Definition	Operationalization
Servitization (Service Offering) Cronbach's alpha =.947	Servitization: coined by Vandermerwe and Rada (1988), is now widely recognised as the process of creating value by adding services to products. Service offering: “Service offering is closely related with the extent of service provisions from manufacturing firms”, for measurement, it can be seen as “the extent of the selected services offered by firms to customers ” (Wang et al., 2018)	Service offerings: How actively do you offer a particular service to your customer base (select 0 = if you do not offer the service at all, 1 = not active at all, 7 = very active) 1. Design and Development Services Product installation service (activeness in offering the service) Inspection & Diagnostics (activeness in offering the service) Repair & maintenance (activeness in offering the service) Spare parts and consumables delivery (activeness in offering the service) Product upgrades (activeness in offering the service) Product remanufacturing, refurbishing, cleaning & safe keeping (activeness in offering the service) Product recycling (activeness in offering the service) 2. Systems and Solutions Process-oriented engineering (activeness in offering the service) Feasibility studies (activeness in offering the service) Cooperation/support in R&D (activeness in offering the service) Prototype design & development service (activeness in offering the service) Analyses of product manufacturability (activeness in offering the service) 3. Retail and Distributions Services Written information material (activeness in offering the service) Customer seminars, lectures & events (activeness in offering the service) Technical user training (activeness in offering the service) Business training (activeness in offering the service) Help desk (email and phone) (activeness in offering the service) Customer consulting (activeness in offering the service) Product demonstration / sample delivery (activeness in offering the service) 4. Maintenance and Support Services Cost-benefit calculations / visualization of benefits (activeness in offering the service) Rental/mediation of machinery and tools (activeness in offering the service) Rental/mediation of personnel (activeness in offering the service) Managing the maintenance function (activeness in offering the service)

		Management of spare parts (activeness in offering the service) Procurement aid (activeness in offering the service) Electronic ordering / order processing (activeness in offering the service) 5. Installation and Implementation Services Full maintenance contract (activeness in offering the service) Service for operating the product sold to a customer (activeness in offering the service) Service for operating customer's process (activeness in offering the service) Project management / prime contractorship (activeness in offering the service) 6. Financial Services Financial services / aid (e.g., leasing or mediation of loans) (activeness in offering the service) Insurance services (activeness in offering the service) Consignment storage (activeness in offering the service)
Lean Startup Capability Cronbach's alpha=.960	We define Lean Startup Capability as the LS-based cross-functional capability bundle (Grant, 1996) that the venture performs when it engages in opportunity incubation (Vogel, 2016)	Iterative experimentation: 1. We viewed new product/service development as cycles of experiments, learning, and additional experiments. 2. We did not try many different product/service solutions before we found the right one. 3. We engaged in many trial and error processes in product/service development before we had a complete understanding of the market and technology. 4. We repeated the process of testing until all key business model assumptions have been validated. 5. We took an experimental approach that relied on frequent trial and error to find the right product/service solution. 6. We frequently design and run experiments on elements of our business model. Customer insight: 1. It is important to gain deep market insight (= talking directly to customers) to better understand our customer's problem. 2. When we developed the solution, we never had the customer in mind. 3. We invested significant effort into understanding the problem and learning about the user and its social context.

		4. It is important to gain deep market insight into how our solution solves the customer problem. Validation: 1. We used metrics to measure the impact of product/service improvements on customer behavior. 2. We did not use data-driven tests to improve our human judgment in the decision making process. 3. We have metrics available to test the product/service acceptance by customers and sales performance. Learning: 1. The organization's ability to learn is not considered as key to our competitive advantage. 2. The basic values of our organization include learning as a key to improvement. 3. Venture learning is an investment, not an expense. 4. Learning in our organization is a key commodity necessary to guarantee organizational survival. Hypotheses testing: 1. We formulated a series of assumptions about the market needs and how best to deliver it. 2. We translated the vision about our product/service and its value proposition into falsifiable assumptions.
Firm performance (Subjective firm performance) Cronbach's alpha=.857	Financial performance is measured by analyzing subjective performance measures as applied by Kohtamaki et al., 2015	1. How important do you consider the following measures to assess firm performance? - Sales level 2. How important do you consider the following measures to assess firm performance? - Sales growth 3. How important do you consider the following measures to assess firm performance? - Gross profit margin 4. How important do you consider the following measures to assess firm performance? - Net profit from operations 5. How important do you consider the following measures to assess firm performance? - Profit to sales ratio

		6. How important do you consider the following measures to assess firm performance? - Return on investment 7. How satisfied are you with your firm's performance in terms of the following measures? - Sales level 8. How satisfied are you with your firm's performance in terms of the following measures? - Sales growth 9. How satisfied are you with your firm's performance in terms of the following measures? - Gross profit margin 10. How satisfied are you with your firm's performance in terms of the following measures? - Net profit from operations 11. How satisfied are you with your firm's performance in terms of the following measures? - Profit to sales ratio 12. How satisfied are you with your firm's performance in terms of the following measures? - Return on investment
Control variables	Variables which may influence the implementation of servitization and hence firm performance	Firm size (as number of employees) Customer heterogeneity (number of customers)

1.1:KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.

.736

Bartlett's Test of Sphericity Approx. Chi-Square

276.189

df 55

Sig. .000

1.2

		DesignAndDe velopment_A VG	SystemAndSo lutions_AVG	RetailAndDist ributionServ ices_AVG	MaintenanceA ndSupportSer vices_AVG	InstallationAn dImplementat ionServices_ AVG	FinancialServi ces_AVG	IterativeExperi mentation_AV G	CustomerInsig hts_AVG	Validation_AV G	Learning_AV G	HypothesisTes ting_AVG
Correlation	DesignAndDevelopment_ AVG	1.000	.325	.718	.649	.695	.448	.236	.346	.477	.376	.244
	SystemAndSolutions_AV G	.325	1.000	.330	.518	.448	.002	-.013	-.208	.136	-.148	-.080
	RetailAndDistributionServ ices_AVG	.718	.330	1.000	.688	.689	.416	.206	.316	.374	.305	.173
	MaintenanceAndSupport Services_AVG	.649	.518	.688	1.000	.792	.452	.269	.247	.501	.181	.326
	InstallationAndImplement ationServices_AVG	.695	.448	.689	.792	1.000	.435	.075	.202	.331	.298	.115
	FinancialServices_AVG	.448	.002	.416	.452	.435	1.000	.158	.224	.398	.133	.143
	IterativeExperimentation_ AVG	.236	-.013	.206	.269	.075	.158	1.000	.581	.587	.422	.635
	CustomerInsights_AVG	.346	-.208	.316	.247	.202	.224	.581	1.000	.431	.894	.755
	Validation_AVG	.477	.136	.374	.501	.331	.398	.587	.431	1.000	.245	.660
	Learning_AVG	.376	-.148	.305	.181	.298	.133	.422	.894	.245	1.000	.618
	HypothesisTesting_AVG	.244	-.080	.173	.326	.115	.143	.635	.755	.660	.618	1.000
Sig. (1-tailed)	DesignAndDevelopment_ AVG		.025	.000	.000	.000	.003	.080	.018	.001	.011	.073
	SystemAndSolutions_AV G		.025	.023	.001	.003	.496	.470	.108	.212	.191	.319
	RetailAndDistributionServ ices_AVG		.000	.023	.000	.000	.005	.111	.029	.011	.033	.153
	MaintenanceAndSupport Services_AVG		.000	.001	.000	.000	.003	.054	.071	.001	.142	.024
	InstallationAndImplement ationServices_AVG		.000	.003	.000	.000	.004	.329	.115	.023	.037	.250
	FinancialServices_AVG		.003	.496	.005	.003	.004	.175	.092	.007	.216	.199
	IterativeExperimentation_ AVG		.080	.470	.111	.054	.329	.175	.000	.000	.005	.000
	CustomerInsights_AVG		.018	.108	.029	.071	.115	.092	.000	.004	.000	.000
	Validation_AVG		.001	.212	.011	.001	.023	.007	.000	.004	.072	.000
	Learning_AVG		.011	.191	.033	.142	.037	.216	.005	.000	.072	.000
	HypothesisTesting_AVG		.073	.319	.153	.024	.250	.199	.000	.000	.000	.000

a. Determinant = .000

1.3

		Firm_perform ance	How many employees (FTE) does your firm have?	How many customers does your firm approximately have?	Lean_Startup _use_AVG	Service_offeri ng_squared	Service_offeri ng	Service_offeri ng_squaredx LSC	Service_offeri ngxLSC
Pearson Correlation	Firm_performance	1.000	.109	.107	.509	.571	.524	.376	.352
	How many employees (FTE) does your firm have?	.109	1.000	.208	.270	.288	.295	.119	.132
	How many customers does your firm approximately have?	.107	.208	1.000	.229	-.021	.007	-.148	-.102
	Lean_Startup_use_AVG	.509	.270	.229	1.000	.539	.528	.051	.008
	Service_offering_squared	.571	.288	-.021	.539	1.000	.991	.579	.498
	Service_offering	.524	.295	.007	.528	.991	1.000	.506	.428
	Service_offering_squared xLSC	.376	.119	-.148	.051	.579	.506	1.000	.989
	Service_offeringxLSC	.352	.132	-.102	.008	.498	.428	.989	1.000
Sig. (1-tailed)	Firm_performance		.279	.283	.002	.000	.001	.019	.026
	How many employees (FTE) does your firm have?	.279		.131	.071	.058	.054	.261	.240
	How many customers does your firm approximately have?	.283	.131		.107	.455	.486	.214	.292
	Lean_Startup_use_AVG	.002	.071	.107		.001	.001	.392	.482
	Service_offering_squared	.000	.058	.455	.001		.000	.000	.002
	Service_offering	.001	.054	.486	.001	.000		.002	.008
	Service_offering_squared xLSC	.019	.261	.214	.392	.000	.002		.000
	Service_offeringxLSC	.026	.240	.292	.482	.002	.008	.000	
N	Firm_performance	31	31	31	31	31	31	31	31
	How many employees (FTE) does your firm have?	31	31	31	31	31	31	31	31
	How many customers does your firm approximately have?	31	31	31	31	31	31	31	31
	Lean_Startup_use_AVG	31	31	31	31	31	31	31	31
	Service_offering_squared	31	31	31	31	31	31	31	31
	Service_offering	31	31	31	31	31	31	31	31
	Service_offering_squared xLSC	31	31	31	31	31	31	31	31
	Service_offeringxLSC	31	31	31	31	31	31	31	31

1.4

Model Summary^c

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.700 ^a	.489	.387	.69225
2	.768 ^b	.590	.465	.64697

- a. Predictors: (Constant), Service_offering, How many customers does your firm approximately have?, How many employees (FTE) does your firm have?, Lean_Startup_use_AVG, Service_offering_squared
- b. Predictors: (Constant), Service_offering, How many customers does your firm approximately have?, How many employees (FTE) does your firm have?, Lean_Startup_use_AVG, Service_offering_squared, Service_offeringxLSC, Service_offering_squaredxLSC
- c. Dependent Variable: Firm_performance

1.5

ANOVA^a

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	11.481	5	2.296	4.791	.003 ^b
	Residual	11.980	25	.479		
	Total	23.461	30			
2	Regression	13.834	7	1.976	4.721	.002 ^c
	Residual	9.627	23	.419		
	Total	23.461	30			

- a. Dependent Variable: Firm_performance
- b. Predictors: (Constant), Service_offering, How many customers does your firm approximately have?, How many employees (FTE) does your firm have?, Lean_Startup_use_AVG, Service_offering_squared
- c. Predictors: (Constant), Service_offering, How many customers does your firm approximately have?, How many employees (FTE) does your firm have?, Lean_Startup_use_AVG, Service_offering_squared, Service_offeringxLSC, Service_offering_squaredxLSC

1.6

Coefficients ^a									
		Unstandardized Coefficients		Standardized Coefficients			Correlations		
Model		B	Std. Error	Beta	t	Sig.	Zero-order	Partial	Part
1	(Constant)	7.126	1.707		4.174	.000			
	How many employees (FTE) does your firm have?	-4.811E-6	.000	-.099	-.647	.524	.109	-.128	-.092
	How many customers does your firm approximately have?	6.200E-5	.000	.148	.949	.352	.107	.186	.136
	Lean_Startup_use_AVG	.244	.188	.232	1.295	.207	.509	.251	.185
	Service_offering_squared	.000	.000	2.742	2.518	.019	.571	.450	.360
	Service_offering	-.055	.026	-2.286	-2.128	.043	.524	-.392	-.304
2	(Constant)	10.150	2.454		4.137	.000			
	How many employees (FTE) does your firm have?	-9.647E-6	.000	-.199	-1.325	.198	.109	-.266	-.177
	How many customers does your firm approximately have?	1.297E-5	.000	.031	.199	.844	.107	.041	.027
	Lean_Startup_use_AVG	.067	.214	.063	.311	.759	.509	.065	.042
	Service_offering_squared	.001	.000	5.590	3.084	.005	.571	.541	.412
	Service_offering	-.107	.037	-4.417	-2.849	.009	.524	-.511	-.381
	Service_offering_squared xLSC	-5.216	2.203	-4.239	-2.368	.027	.376	-.443	-.316
	Service_offeringxLSC	4.470	1.917	3.681	2.332	.029	.352	.437	.311

a. Dependent Variable: Firm_performance

1.7

		Firm Performance (Standardized β)	
Variables	Hypothesis	Model 1	Model2
Intercept		7.126 (1.707)**	10.150 (2.454)**
Service Offering	H1	-2.286 (.026)*	-4.417 (.037)*
Service Offering^2	H1	2.742 (.000)*	5.590 (.000)*
Lean startup	H2	.232 (.188)	.063 (.214)
Moderating effects			
Service Offering x Lean Startup	H3		3.681 (1.917)*
Service Offering^2x Lean Startup	H3		-4.239 (2.203)*

Control variables

Customer heterogeneity .148 (.000) .031 (.000)

Firm Size -.099 (.000) -.199 (.000)

R squared .489 .590

Adjusted R2 .387 .465

F-statistics 4.791 4.721

*p < .05.

**p < .001

SE=()

1.8

Tests of Normality

	Kolmogorov-Smirnov ^a			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Unstandardized Residual	.131	31	.189	.982	31	.868
Standardized Residual	.131	31	.189	.982	31	.868

a. Lilliefors Significance Correction

1.9 Syntax file computations

```

COMPUTE Firm_performance=Q14_1*(Q13_1/(Q13_1+Q13_2+Q13_3+Q13_4+Q13_5+Q13_6))+Q14_2*(Q13_2/(Q13_1+
Q13_2+Q13_3+Q13_4+Q13_5+Q13_6))+Q14_3*(Q13_3/(Q13_1+Q13_2+Q13_3+Q13_4+Q13_5+Q13_6))+Q14_4*
(Q13_4/(Q13_1+Q13_2+Q13_3+Q13_4+Q13_5+Q13_6))+Q14_5*(Q13_5/(Q13_1+Q13_2+Q13_3+Q13_4+Q13_5+Q13_6))+
Q14_6*(Q13_6/(Q13_1+Q13_2+Q13_3+Q13_4+Q13_5+Q13_6)).
EXECUTE.
COMPUTE Lean_Startup_use_AVG=Mean(Q33_1,Q33_2,Q33_3,Q33_4,Q33_5,Q33_6,Q34_1,Q34_2,Q34_3,Q34_4,Q35_1,
Q35_2,Q35_3,Q35_4,Q35_5,Q36_1,Q36_2,Q36_3,Q36_4,Q36_5,Q36_6,Q37_1,Q37_2,Q37_3,Q37_4).
EXECUTE.
COMPUTE Service_offering=sum(Q65_1,Q65_2,Q65_3,Q65_4,Q65_5,Q66_1,Q66_2,Q66_3,Q66_4,Q66_5,Q66_13,
Q66_14,Q67_1,Q67_2,Q67_3,Q67_4,Q67_5,Q67_13,Q67_14,Q68_1,Q68_2,Q68_3,Q68_4,Q69_1,Q69_2,Q69_3,Q63_1,
Q63_2,Q63_3,Q63_4,Q63_5,Q63_6,Q63_7).
EXECUTE.
COMPUTE Service_Performance=Q24_1*(Q63_1/(Q63_1+Q63_2+Q63_3+Q63_4+Q63_5+Q63_6+Q63_7))+Q24_2*
(Q63_2/(Q63_1+Q63_2+Q63_3+Q63_4+Q63_5+Q63_6+Q63_7))+Q24_3*(Q63_3/(Q63_1+Q63_2+Q63_3+Q63_4+Q63_5+
Q63_6+Q63_7))+Q24_4*(Q63_4/(Q63_1+Q63_2+Q63_3+Q63_4+Q63_5+Q63_6+Q63_7))+Q24_5*(Q63_5/(Q63_1+Q63_2+
Q63_3+Q63_4+Q63_5+Q63_6+Q63_7))+Q24_6*(Q63_6/(Q63_1+Q63_2+Q63_3+Q63_4+Q63_5+Q63_6+Q63_7))+Q24_7*
(Q63_7/(Q63_1+Q63_2+Q63_3+Q63_4+Q63_5+Q63_6+Q63_7)).
EXECUTE.
* Curve Estimation.
TSET NEWVAR=NONE.
CURVEFIT
/VARIABLES=Firm_performance WITH Service_offering
/CONSTANT
/MODEL=LINEAR QUADRATIC
/PRINT ANOVA
/PLOT FIT.

```

```

COMPUTE Service_offering_squaredxLSC=ZService_offering_squared*ZSco01.
EXECUTE.
COMPUTE Service_offeringxLSC=ZSco01*ZSco02.
EXECUTE.
REGRESSION
  /DESCRIPTIVES MEAN STDDEV CORR SIG N
  /MISSING LISTWISE
  /STATISTICS COEFF OUTS R ANOVA ZPP
  /CRITERIA=PIN(.05) POUT(.10)
  /NOORIGIN
  /DEPENDENT Firm_performance
  /METHOD=ENTER Q8 Q10 Lean_Startup_use_AVG Service_offering_squared Service_offering
  /METHOD=ENTER Q8 Q10 Service_offering_squaredxLSC Service_offeringxLSC Service_offering_squared
    Service_offering Lean_Startup_use_AVG
  /SCATTERPLOT=(*ZPRED ,*ZRESID)
  /RESIDUALS HISTOGRAM(ZRESID) NORMPROB(ZRESID).

```

```

FACTOR
  /VARIABLES DesignAndDevelopment_AVG SystemAndSolutions_AVG RetailAndDistributionServices_AVG
    MaintenanceAndSupportServices_AVG InstallationAndImplementationServices_AVG FinancialServices_AVG
    IterativeExperimentation_AVG CustomerInsights_AVG Validation_AVG Learning_AVG HypothesisTesting_AVG
  /MISSING LISTWISE
  /ANALYSIS DesignAndDevelopment_AVG SystemAndSolutions_AVG RetailAndDistributionServices_AVG
    MaintenanceAndSupportServices_AVG InstallationAndImplementationServices_AVG FinancialServices_AVG
    IterativeExperimentation_AVG CustomerInsights_AVG Validation_AVG Learning_AVG HypothesisTesting_AVG
  /PRINT INITIAL CORRELATION SIG DET KMO EXTRACTION ROTATION
  /CRITERIA MINEIGEN(1) ITERATE(25)
  /EXTRACTION PC
  /CRITERIA ITERATE(25)
  /ROTATION VARIMAX
  /METHOD=CORRELATION.

```

```

COMPUTE DesignAndDevelopment_AVG=MEAN(Q15_1,Q15_2,Q15_3,Q15_4,Q15_5,Q15_6,Q15_7).
EXECUTE.
COMPUTE SystemAndSolutions_AVG=MEAN(Q65_1,Q65_2,Q65_3,Q65_4,Q65_5).
EXECUTE.
COMPUTE RetailAndDistributionServices_AVG=MEAN(Q66_1,Q66_2,Q66_3,Q66_4,Q66_5,Q66_13,Q66_14).
EXECUTE.
COMPUTE MaintenanceAndSupportServices_AVG=MEAN(Q67_1,Q67_2,Q67_3,Q67_4,Q67_5,Q67_13,Q67_14).
EXECUTE.
COMPUTE InstallationAndImplementationServices_AVG=MEAN(Q68_1,Q68_2,Q68_3,Q68_4).
EXECUTE.
COMPUTE FinancialServices_AVG=MEAN(Q69_1,Q69_2,Q69_3).
EXECUTE.
COMPUTE IterativeExperimentation_AVG=MEAN(Q33_1,Q33_2,Q33_3,Q33_4,Q33_5,Q33_6).
EXECUTE.
COMPUTE CustomerInsights_AVG=MEAN(Q34_1,Q34_2,Q34_3,Q34_4).
EXECUTE.
COMPUTE Validation_AVG=MEAN(Q35_1,Q35_2,Q35_3,Q35_4,Q35_5).
EXECUTE.
COMPUTE Learning_AVG=MEAN(Q36_1,Q36_2,Q36_3,Q36_4,Q36_5,Q36_6).
EXECUTE.
COMPUTE HypothesisTesting_AVG=MEAN(Q37_1,Q37_2,Q37_3,Q37_4).
EXECUTE.
FACTOR
/VARIABLES DesignAndDevelopment_AVG SystemAndSolutions_AVG RetailAndDistributionServices_AVG
MaintenanceAndSupportServices_AVG InstallationAndImplementationServices_AVG FinancialServices_AVG
CustomerInsights_AVG IterativeExperimentation_AVG Validation_AVG Learning_AVG HypothesisTesting_AVG
/MISSING LISTWISE
/ANALYSIS DesignAndDevelopment_AVG SystemAndSolutions_AVG RetailAndDistributionServices_AVG
MaintenanceAndSupportServices_AVG InstallationAndImplementationServices_AVG FinancialServices_AVG
CustomerInsights_AVG IterativeExperimentation_AVG Validation_AVG Learning_AVG HypothesisTesting_AVG
/PRINT INITIAL CORRELATION SIG DET RMO EXTRACTION ROTATION
/PLOT EIGEN
/CRITERIA MINEIGEN(1) ITERATE(25)
/EXTRACTION PC
/CRITERIA ITERATE(25) DELTA(0)
/ROTATION OBLIMIN
/METHOD=CORRELATION.

```

REGRESSION

```

/DESCRIPTIVES MEAN STDDEV CORR SIG N
/MISSING LISTWISE
/STATISTICS COEFF OUTS BCOV R ANOVA COLLIN TOL
/CRITERIA=PIN(.05) POUT(.10)
/NOORIGIN
/DEPENDENT Firm_performance
/METHOD=ENTER Q10 Q8 Lean_Startup_use_AVG Service_offering Service_offering_squared
/METHOD=ENTER Q8 Q10 Service_offering Service_offering_squared Lean_Startup_use_AVG
Service_offering_squaredxLSC Service_offeringxLSC
/SCATTERPLOT=(*ZRESID ,*ZPRED) (*ZRESID ,*ZPRED)
/RESIDUALS HISTOGRAM(ZRESID) NORMPROB(ZRESID).

```

RELIABILITY

```

/VARIABLES=Q15_1 Q15_2 Q15_3 Q15_4 Q15_5 Q15_6 Q15_7 Q65_1 Q65_2 Q65_3 Q65_4 Q65_5 Q66_1 Q66_2
Q66_3 Q66_4 Q66_5 Q66_13 Q66_14 Q67_1 Q67_2 Q67_3 Q67_4 Q67_5 Q67_13 Q67_14 Q68_1 Q68_2 Q68_3 Q68_4
Q69_1 Q69_2 Q69_3
/SCALE('ALL VARIABLES') ALL
/MODEL=ALPHA
/STATISTICS=DESCRIPTIVE SCALE CORR
/SUMMARY=TOTAL.

```

RELIABILITY

```
/VARIABLES=Q13_1 Q13_2 Q13_3 Q13_4 Q13_5 Q13_6 Q14_1 Q14_2 Q14_3 Q14_4 Q14_5 Q14_6  
/SCALE('ALL VARIABLES') ALL  
/MODEL=ALPHA  
/STATISTICS=DESCRIPTIVE SCALE CORR  
/SUMMARY=TOTAL.
```

RELIABILITY

```
/VARIABLES=Q37_1 Q37_2 Q37_3 Q37_4 Q36_1 Q36_2 Q36_3 Q36_4 Q36_5 Q36_6 Q35_1 Q35_2 Q35_3 Q35_4  
Q35_5 Q34_1 Q34_2 Q34_3 Q34_4 Q33_1 Q33_2 Q33_3 Q33_4 Q33_5 Q33_6  
/SCALE('ALL VARIABLES') ALL  
/MODEL=ALPHA  
/STATISTICS=DESCRIPTIVE SCALE CORR  
/SUMMARY=TOTAL.
```

EXAMINE VARIABLES=RES_1 ZRE_1

```
/PLOT BOXPLOT NPLOT  
/COMPARE GROUPS  
/STATISTICS DESCRIPTIVES  
/CINTERVAL 95  
/MISSING LISTWISE  
/NOTOTAL.
```