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Exploring demographic variables as mediators in the relationship between open innovation and creativity

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Abstract

Increased competitiveness and dire economic conditions are forcing companies to remain in the game by increasing profits, while margins are dropping, in the form of more novel ideas. In order to stimulate the creation fresh ideas managers require creative and innovative employees to foster idea generation. To prevent companies from missing incredible opportunities when they remain too internally focused, the relatively new concept of open innovation was included in the study. The purpose of this study was to identify the type of employee in terms of demographics that are considered more creative and open innovative which will assist management in deciding whom to employ.

At first an investigation was launched to gain a deeper understanding of the relationship between creativity and open innovation as well as including creative cognitive theory to gain an understanding of the influence of demographics on this relationship. Although there were some contradicting findings in the literature on the effect of demographics on the relationship between open innovation and creativity, the hypotheses were constructed based on the most supported views from literature.

Current individuals studying towards an MBA degree was sampled in order to find a representative sample of the decision makers in business situations. The results showed that only one construct of open innovation (clients and competitors as source) had a significant, positive relationship with creativity. It was also found that from the four demographics tested, only gender was found to have a mediating effect on this relationship. The results showed that management should encourage collaboration between employees and customers or competitors for improved idea generation. Also that women should be encouraged to collaborate more than men to achieve greater idea generation sessions.

Key Words

Creativity, Open innovation, demographics, idea generation

Declaration

I declare that this research project is my own work. It is submitted in partial fulfilment of the requirements for the degree of Master of Business Administration at the Gordon Institute of Business Science, University of Pretoria. It has not been submitted before for any degree or examination in any other University. I further declare that I have obtained the necessary authorisation and consent to carry out this research.

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Chapter 1 - Introduction

Dire economic conditions are leading to the downsizing and merging of large businesses in a fight for survival. Economic welfare and sustainability are being driven by unemployed and retrenched individuals that turned to entrepreneurship for a fighting chance (Ladzani & van Vuuren, 2002). It is predominantly these types of businesses that require collaborative knowledge sharing as a result of their limited access to resources (finance, technology, patents, etc.) (Ladzani & van Vuuren, 2002). However, not only SMEs can benefit from open innovation and creativity. In the fast-changing environment that we are currently living, all managers are under increasing pressure to sell more products with less new ideas while simultaneously revenue yields are dropping (Bharadwaj & Menon, 2000). It is therefore paramount that new products should bring in higher revenues than what was found in the past.

It is further explained that modern firms that find itself part of dynamic and highly technical environments are forced to find new ways to innovate since knowledge and infrastructure quickly become obsolete (Popa, Soto-acosta, & Martinez-conesa, 2017). With the competition growing stronger and product lifespan decreasing, the key to survival, profits and success lie in new product innovation (Sok & Cass, 2015). As a result of this, a company requires highly innovative and creative employees to stimulate idea generation (Bharadwaj & Menon, 2000).

However, a company that is too internally focused will miss innovative opportunities that do not tie in with their primary focus or that require external sources for the development of the idea (Laursen & Salter, 2006). To solve this dilemma, (Chesbrough, 2006) explains that open innovation serves as a way for companies to adapt to this new era of research and development in the rapidly changing environment. Open innovation is a means to collaborate with external or internal parties to gain knowledge that can be deployed in the innovation process of the company. Networking can be used to increase the inner expertise in the company to enrich the current innovation practices as well as maximize the value and profits from innovation (Randhawa, Wilden, & Hohberger, 2016).

Open innovation is not entirely focused on inflows of knowledge but should at the same time allow for outflows of knowledge. Therefore open innovation is about utilizing external expertise and technology to enhance the capabilities inside the firm or leveraging external opportunities where internal knowledge can add value outside the boundaries of the company (Saebi & Foss, 2015). Previous studies (Cheng & Huizingh, 2014) have

found both positive (Huggins & Thompson, 2017; Lichtenthaler, 2015; Love & Roper, 2015; Rubera, Chandrasekaran, & Ordanini, 2016; Theyel, 2012) and negative (Rubera et al., 2016; Theyel, 2012) effects of open innovation on company performance. It was stated that open innovation would lead to increased profitability (Chiang and Hung in C. Cheng & Huizingh, 2014), Research and Development (R&D) performance (Chiesa, Frattini, Lazzarotti, & Manzini, 2009), customer satisfaction (Chesbrough & Crowther, 2006), innovativeness (Laursen & Salter, 2006) as well as success of new products(Rohrbeck, Hölzle, & Gemünden, 2009).

On the negative side it was highlighted that there is a high cost associated with searching for new sources (Laursen & Salter, 2006), difficulties with holding the power to control knowledge (Cheng & Huizingh, 2014; Torkkeli, Kock, & Salmi, 2009) as well as the attitudes of internal employees towards open innovation (Cheng & Huizingh, 2014).

At the same time, Gilson and Litchfield (2017) posit that creativity is associated with idea generation. She goes on to emphasize that the more ideas an individual can come up with, the more can be implemented as a source of profit for the company. However having a creative employee that can come up with numerous creative ideas is not enough. Sarooghi, Libaers, & Burkemper (2015) describe creativity as the generation of ideas while innovation is taking the idea further into an actual product or service. Therefore to ensure numerous ideas that are implemented for the company in the form of a new revenue stream, an employee would have to be creative and innovative. Fossas-olalla, Minguela-rata, & Fernández-menéndez (2015) describe the importance of collaboration with outside sources for creative and innovative ideas. This is where open innovation plays a pivotal role.

Individuals that collaborate with suppliers, customers and other external sources when generating ideas have access to free-of-charge resources, a better understanding of problems and improved knowledge sharing (Fossas-olalla et al., 2015). As far as could be determined there is limited studies on open innovation which prevents an in-depth research on the field. The purpose of this dissertation is to add to the limited theoretical field of open innovation and explore the relationship between open innovation and creativity. Furthermore, the outcome of this study is to identify the type of individuals to employ that have high levels of open innovation and creativity that would aid a company in obtaining and implementing more ideas.

As seen in literature there has been evidence of age as a mediator in the relationship

with creativity (Binnewies, Ohly, & Niessen, 2008; Zwick, Frosch, Hoisl, & Harhoff, 2017), as well as creativity and gender (Furnham & Nederstrom, 2010; Rosa, Qualls, & Ruth, 2014), work experience (Dong, Bartol, Zhang, & Li, 2017; Y.-N. Lee & Walsh, 2016) and level of education (Chen, Shih, & Yeh, 2011; T. C. E. Cheng, Yefei, & Lee, 2016). Several studies on open innovation have also proved that it can be influenced by age (Wattal, Racherla, Mandviwalla, Wattal, & Racherla, 2017), gender (Berger, Benschop, & Brink, 2015; Tartari & Salter, 2015), work experience (S. J. Lee & Jung, 2017; Okamuro, Kato, & Honjo, 2011; Van Rijnsoever & Hessels, 2011) and level of education (Caner & Tyler, 2015; Cui, Chan, & Calantone, 2014). From the above, it is evident that these demographic variables have been investigated separately in the relationship between creativity and other constructs and well as the relationship between open innovation and other constructs but not for the relationship between open innovation and creativity. The importance of creativity and innovation in the business environment has also motivated the search for predictors of creativity in an individual (Sung, Antefelt, & Choi, 2017). The Attraction-Selection-Attrition theory (Baron, Franklin, & Hmieleski, 2016; David, Avery, Witt, & Mckay, 2015; Lounsbury, Foster, Carmody, Gibson, & Stairs, 2012) suggests that these demographic variables can be investigated as mediating variables in the relationship between creativity and open innovation. Therefore, we explore these variables as mediators in the relationship between creativity and open innovation.

This study makes three contributions to the literature. First, we investigate the link between open innovation and creativity through the argument around increased idea generation when the individual incorporates various sources in the idea generation process. Through this, we contribute to the literature on causes for the increased generation of ideas which is an ongoing argument in the literature (Bharadwaj & Menon, 2000; Salter, Wal, Criscuolo, & Alexy, 2015). The second contribution to the literature includes the focus on attributes of the individual that affects their open innovation and creativity. There are limited studies available that focus on the individual level of open innovation as a cause for increased innovative ideas that can be implemented (Salter et al., 2015). The third contribution of this study is to assist management of a company on the type of employees to employ in their organizations based on specific demographics to achieve a variety of ideas generated and implemented.

The Creative cognitive theory model was used to substantiate mediating effect that demographics have on creativity and open innovativeness of an individual. To determine which demographics act as a mediating variable on creativity and open innovation a few

demographics that can affect this was selected. Contrasting findings led to the selection of age and gender as two of the demographic variables to be tested. Since there is limited research done on open innovativeness and work experience as well as the level of education, these were the other two demographics selected to test in this study. The impact of the latter two demographics on creativity was easily supported however limited findings on its effect on open innovativeness were found. To bridge this gap in the literature, these four demographic variables were selected for testing in this study.

This dissertation is divided into five different sections. First, a comprehensive study of the literature is given in Chapter 2. In this chapter, the connection between open innovation and creativity is established, and reference is made to the literature. From this, the depth of the investigation increases as the role of individual characteristics in the form of demographics is viewed to find the effect that this has on the open innovativeness and creativity of the individual. Further, in this chapter, the research hypotheses are developed based on the literature findings. In Chapter 3 a detailed methodology is described to test the various hypotheses. From there the results are displayed in Chapter 4 and discussed in Chapter 5. The conclusion, recommendations, limitations and future research are discussed in Chapter 6.

Chapter 2 - Literature Review

The purpose of this chapter is to introduce and critique the current argument in the literature on the perspective on open innovation and creativity. In this chapter creative cognitive theory will be introduced in order to explain the decision to test demographics as a mediator on the relationship between open innovation and creativity. The possible mediating effect of each demographic will be investigated and a meaningful hypothesis will be constructed.

2.1 Open innovative employees

Open innovation is a means to collaborate with external or internal parties to gain knowledge that can be deployed in the innovation process of the company. It was further explained that networking can be used to increase the internal knowledge in the company to enrich the current innovation practices as well as maximize the value and profits from these innovations (Randhawa et al., 2016).

Open innovation is not entirely focused on inflows of knowledge but should at the same time allow for outflows of knowledge. Therefore open innovation is about utilizing external knowledge and technology to enhance the capabilities inside the firm or leveraging external opportunities where internal knowledge can add value outside the boundaries of the company (Saebi & Foss, 2015). Open innovation can be applied in three scenarios as discussed by Gassmann and Enkel (2004), these are outside-in, inside-out or coupled activities.

Outside-in or inbound activities are aimed at increasing the innovativeness of a company by utilizing the knowledge of external sources e.g. suppliers or customers (Saebi & Foss, 2015). Inside-out or outbound activities will enable the company to increase profits by selling intellectual property and ideas to the market (Gassmann & Enkel, 2004; Saebi & Foss, 2015). The last form known as coupled activities refers to the integration of internal and external ideas, a combination of inside-out and outside-in (Gassmann & Enkel, 2004). Various activities can be defined under the category of inbound open innovation including crowd sourcing, innovation contests and joint ventures (Saebi & Foss, 2015). The scope of this dissertation only cover the improvement of idea generation and implementation within the company and for this reason only the utilization of external ideas on the inside of the company was focused on (outside-in innovation).

In the study completed by Laursen and Salter, (2006) the firms with the highest levels of technology and science made use of the largest number of external sources to improve idea generation. The companies with lower technology requirements, for instance, paper and printing industries do not require additional information to enrich their products. The fact that the higher technology companies requires more sources highlights the importance of broadening the boundaries of the firm. On average a total of seven external sources are used by firms of which Laursen and Salter (2006) found the most popular sources being suppliers, followed by customers and finally standards e.g., health and safety standards.

Open innovation differs from normal or closed innovation since open innovation is aimed at gaining and implementing ideas through utilizing external sources (e.g. other companies, universities, customers) or by granting external parties access to unused ideas. In comparison normal innovation refers to the generation and implementation of ideas supplied only by the employees of the company (Anderson & Potočnik, 2014). The main difference between the two forms of innovation is the source of the information for the idea as well as the flow of ideas between sources (Huang, Lai, Lin, & Chen, 2013). Initially open innovation has been described as the opposite of normal or closed innovation, however more recent literature described it as an extension of normal innovation (Popa et al., 2017).

2.2 Creative employees

Creativity has been described as the generation and creation of valuable and usable ideas while innovation is associated with the implementation of these ideas (Gilson & Litchfield, 2017; Jiang & Gu, 2017; Sung et al., 2017). A creative idea should be rated on effectiveness and uniqueness while the creative thinking process is defined as the relations between way of thinking, personality type and method of motivation per individual (Soroa, Balluerka, Hommel, & Aritzeta, 2015). Even though creativity has been viewed in the past as a general construct, the multi-faceted nature of creativity should be recognized. Creativity in reality can range between drastic discoveries to small changes in existing ideas but it can also be distinguished on the creator or problem category (Sung et al., 2017).

Due to the increasing competitiveness in the market as well as decreased margins per new idea, companies are in need of fresh and unique ideas to add to their range of products or services for sustainable profit and competitive advantage (Anderson &

Potočnik, 2014; Sung et al., 2017). With more ideas to choose from the probability that more ideas will be implemented increased and this is expected to result in higher performance (Gilson & Litchfield, 2017; Kornish & Hutchison-Krupat, 2017). As a result of this, companies require employees with higher levels of creativity that will ensure that more ideas are available to choose from.

Since the purpose of a creative employee is to generate as much as possible ideas worth implementing, the focus of most studies was to identify how to increase the creativity of an employee (Binnewies et al., 2008; Gilson & Litchfield, 2017). However since it is more complex and takes more effort to implement an idea than merely creating a collection of ideas, it is important to focus on the innovation side of product development as well (Gilson & Litchfield, 2017). To ensure the ideas are not left on the table but are developed into products or services for the company, a combination of creativity and innovativeness will ensure product development and idea implementation.

A new model of innovation called open innovation has been created as a result of rising costs associated with R&D, shorter product life cycles and increased competition on a global scale. Companies are driven to move away from the old model of innovation to the new model called open innovation (Popa et al., 2017; Randhawa et al., 2016). With more creative employees employed in a company the pool of ideas generated will increase which will lead to higher number of implemented ideas for revenue generation (Gilson & Litchfield, 2017).

2.3 The relationship between open innovation and creativity

The relationship between open innovation and creativity can be described by ideas (Gilson & Litchfield, 2017). Creativity is defined as the generation of ideas (Gilson & Litchfield, 2017) while open innovation is defined as the use of external sources through collaboration with suppliers, partners, customers etc. to enrich these ideas (Bharadwaj & Menon, 2000). In a study done on scientists, the creative scientists were differentiated from the non-creative scientists through the measurement of their curiosity as indicated by their openness (Furnham & Nederstrom, 2010). Gilson and Litchfield (2017) posits that obtaining ideas from a combination of sources can produce a collection of ideas that is multifunctional and does not require the merging of various worlds of thought. Therefore a single employee can create multiple ideas that comply with multifunctionality without the need for vertical integration. This can be done through utilizing open innovation in idea generation where the combination of resources can be seen as

external sources such as customers, suppliers or academic institutions that are collaborated with to obtain fresh ideas (Colombo, Krogh, Rossi-lamastra, & Stephan, 2017; Sarooghi et al., 2015).

Interaction with people with a different background and knowledge than oneself is more likely to lead to the creation of a novel idea that can become an innovative project than working in isolation (Harryson, 2008). This is as a result of the increased knowledge base and different experiences of the group as compared to the individual. The value of adjusting the search process for ideas is shown whereby it is stated that a broad search that delivers 99 bad ideas and one extraordinary idea is better than a narrow search that resulted in 100 average ideas (Loch, 2017).

It is further explained that inventors are more productive when they have a broad network with whom they can interact during the idea generation process as a result of the exposure to multiple ideas and sources. The author posits that better idea generation can result from incorporating the following three open innovation principles as explained by the work of Radjou (2005):

1. Collaboration with customers as a source of information into the requirements for new products and developments. This can lead to better ideas applicable to the needs of customers in time to serve the right markets.
2. Make use of wide networks to ensure the most talented individuals contribute to enhancing your idea instead of avoiding this valuable insight.
3. This flexible method of idea generation whereby making use of various inputs allows one to anticipate and react in time to ever changing and turbulent markets.

In addition to the academic sources that are collaborated with, interacting with the customers of the company can also lead to valuable ideas. Companies will identify the needs of customers and develop ideas to solve these needs. The communication of these needs will enhance the idea generation process whereby the creative employees can improve their ideas to incorporate the external information (Kornish & Hutchison-Krupat, 2017). Opening up the idea generation process can lead to inputs that the specialists within the organization did not identify. It was found that in a case where the ideas of external users and internal experts were compared those of the external users were rated more novel and feasible than those of the internal expert (Poetz & Schreier, 2012). This shows that sources from the outside can make valuable contributions to the idea generation process in the company when identifying new product lines.

In order to fully utilize the information that can add value to the idea generation process, evolutionary economists posit that the borders should be removed when searching for new ideas (Walsh, Lee, & Nagaoka, 2016). It is further emphasized that the conditions for innovation is not explicitly bound to the inside of an organization but information sharing networks cultivate knowledge transfer and inspires specialization. The effectiveness of open innovation in terms of knowledge sharing can be explained by a number of principles identified by Gaál, Szabó, and Obermayer-Kovács (2014). These principles include how knowledgeable the source is perceived as, enthusiasm of the source to share their knowledge, how effective the channel of sharing is, attitude of the receiver to accept knowledge from the source and ability to absorb information of the receiver.

2.4 Mediating variables

Baron and Kenny, (1986) clarified the difference between moderating and mediating variables since these two concepts are often incorrectly used interchangeably. They explain that mediating variables serve the purpose of a third variable that signifies the generative instrument used to explain how the independent variable has an influence on the dependent variable. Generally it was found that a variable is seen as a mediator when it can be used to describe the relationship between the dependent and the independent variables.

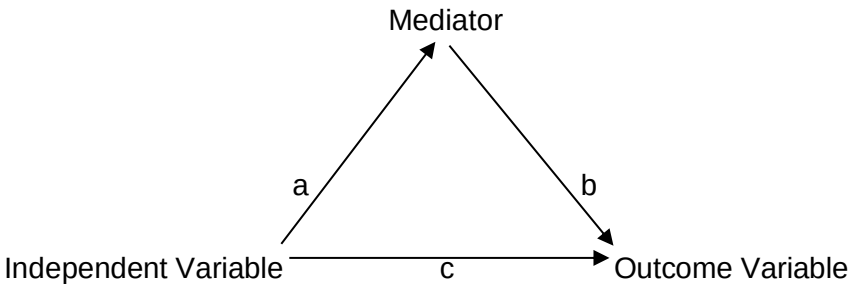


Figure 1: Mediation variable model

Figure 1 shows the effect of a mediation variable. In this model it can be seen that the outcome variable (Y) has a specific relationship with the independent variable (X). The mediating variable (M) causes a change in this relationship (path *ab* instead of *c'*). An

important part for this study is that a mediating effect occurs when a physical experience causes a psychological change (Baron & Kenny, 1986). It should therefore be established whether physical or psychological differences between individuals have a significant effect on the way in which individuals approaches generative processes and therefore the mediating variables were selected instead of moderating variables.

2.5 Demographic variables influencing the relationship between creativity and open innovation

According to the Oxford English dictionary, demographics can be defined as the characteristics of an individual (Simpson & Weiner, 2014) for example age, gender, prior work experience and level of education. The focus of previous studies have been mainly on identifying firm-level aspects to improve the idea generation capabilities of employees, however evidence exist that there are numerous individual level drivers and characteristics that promote idea generation (Zwick et al., 2017). As a result of this, employee demographics have been identified to aid idea generation capabilities.

2.6 Creative Cognition Theory

The creative cognition theory was derived from the thinking that every individual has it in them to think creatively (Yunlu, Clapp-Smith, & Shaffer, 2017). The authors continues to explain that the original theory by Finke, Ward and Smith (1992) was built on two concepts being generative and exploratory processes.

2.6.1 Generative Processes

A search for data in order to create new concepts with varying degrees of creativity is the first step to idea generation (Yunlu et al., 2017). The obtained data is assessed through the images, historical knowledge and blend of previous exposure of an individual to form a new concept or idea (Ward, 2001). It is further posited by the authors that this aptitude of human beings, to combine knowledge in order to create something new supports the generative process on which this theory is built and which can aid or destroy the creative thinking process (Yunlu et al., 2017).

2.6.2 Explorative Processes

Explorative processes flows from the generative processes in the form of an individual assessing which ideas from the generative process can be further explored. The ideas are then evaluated by making use of diverse perspectives to build on and stretch the limits to create the best new concept (Yunlu et al., 2017). The creative cognitive theory is explained by the following model:

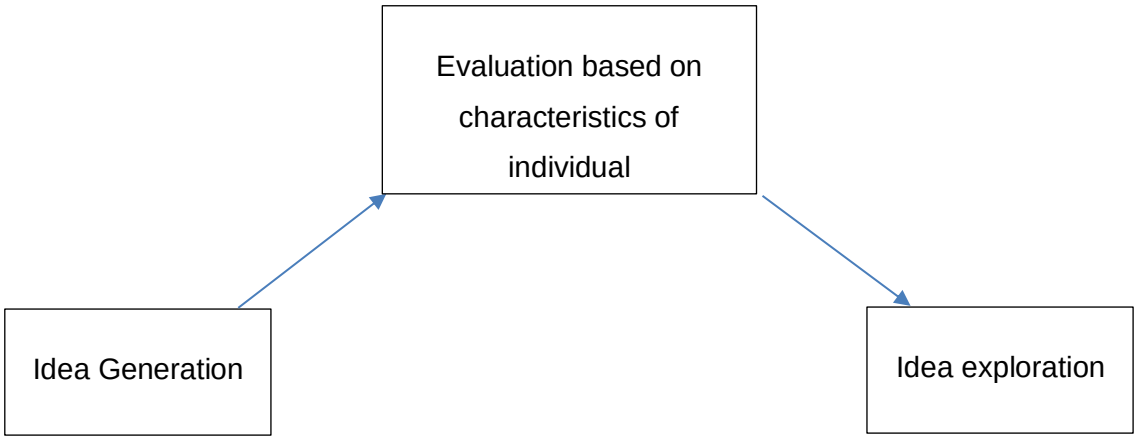


Figure 2: Creative cognitive theory model

From the model above it can be seen that the characteristics, past experiences and view point of an individual will play a critical part in the creation of novel ideas. The first step entails coming up with new possibilities, after this step the individual will assess the ideas based on their characteristics as a result of prior knowledge, experience or individual point of view. The final step is selection of the most suitable idea based on the perception of the individual. Based on the creative cognitive theory it is argued that the demographics of an individual mediates the idea generation process. As described in section 2.3, the relationship between creativity and open innovation is defined by the generation of ideas through the collaborative explorative process. In this study open innovation is seen as a collaborative process used to refine or enrich the idea generation process and is associated with the explorative part of the theory. This theory was therefore used to substantiate the study of the mediating effect on the relationship between creativity and open innovation.

2.7 Work experience

On the individual level idea generation is said to be as a result of various elements. The contributing elements include a knowledge base and skill set that is applicable to the area in which ideas is to be generated (Anderson & Potočnik, 2014). Work related skills and knowledge are said to be a significant element to creative product development (Dong et al., 2017). These skills are required when an individual attempts the process of idea generation. Existing knowledge is combined with unique ideas to form a fresh idea that can be developed into a new product (Anderson & Potočnik, 2014; Dong et al., 2017).This describes the link between work experience and creativity, where the skill set obtained from work experience can be combined with new insights to develop unique products.

Longer work experience was found to enhance both *declarative and procedural knowledge* (Ng & Feldman, 2013a). The authors explain these two concepts as declarative knowledge being an understanding of facts, guides and principles and procedural knowledge referring to the application of these in practice. A greater knowledge base in these aspects as a result of increased work experience was found to increase creative performance amongst employees. With the employees becoming more competent as their work experience accumulates, they have increasing successful ideas. These ideas are based on the knowledge obtained from their experience and the employee with more work experience is therefore considered to be more creative (Lee & Walsh, 2016).

Successful implementation of ideas are associated with increased number of ideas generated and therefore creativity (Gilson & Litchfield, 2017). As a result of increased experience employees develop a better understanding of their environment which can be applied when solving problems (Ng & Feldman, 2013b). However, it is posited that employees with more prior work experience become caught up in routines at work (Binnewies et al., 2008). Binnewies et al. (2008) found that routines can be either detrimental to creative solutions or it can free up mental resources critical for innovative and creative thinking.

Regarding open innovation, Okamuro, Kato, and Honjo (2011) posits that past work experience can make a positive difference in collaborating with external parties for research and development purposes. Okamura et al. (2011) describes these external parties that can aid idea generation as suppliers and customers. It was found that

increased work experience will result in more vigorous collaboration in terms of transfer of knowledge and that there is a positive relationship between prior work experience and knowledge transfer (Lee & Jung, 2017). This knowledge transfer as a result of collaboration can result in the link required to form a new idea.

Prior work experience also makes it easier for employees to build knowledge networks useful for transferring of ideas (Lee & Jung, 2017; Van Rijnsoever & Hessels, 2011). However Van Rijnsoever and Hessels (2011) goes on to state that as an employee continues to collaborate with external parties from prior work relationships, their knowledge becomes embedded within that of the employee. Due to the knowledge base of the individual that grows over time the relationship is stated to deteriorate after a number of years since no new knowledge comes from the former colleague anymore. Based on the review above the following hypothesis was formulated to determine the effect of prior work experience on open innovation and creativity.

H_1: Prior work experience is a mediator in the relationship between open innovation and creativity of employees.

2.8 Level of education

One of the antecedents to creativity and solution identification is education levels of an individual (Cheng et al., 2016), which means that increased level of skills will result in higher levels of creativity and idea generation. Increasing the level of skill in a specific field is known to be one of the most effective ways for an individual to increase their ability to generate and implement novel ideas (Anderson & Potočnik, 2014). Understanding of complexities required to develop possibilities that can be implemented requires a technical skill set and knowledge on the specific field (Dong et al., 2017). When individuals have a developed set of skills they are more likely to link various fields of learning to come up with a solution that can be implemented (Chen et al., 2011).

It is explained that ideas are generated mostly by linking two previously unrelated concepts into a new unique combination and the link can only be created through being educated in the relevant field (Zwick et al., 2017). Unique solutions come from the theoretical knowledge that an individual has obtained from their higher level of education. The underlying assumption for utilizing the professionals and technical specialists to generate ideas in a company is that these individuals has the expertise to identify what appeals to the customer and is therefore more likely to generate a new product that will

get ahead (Poetz & Schreier, 2012).

The absorptive capacity and problem-solving ability of an individual increases as a result of increased education (Garcia Martinez, Zouaghi, & Garcia Marco, 2017). The authors posit that this is due to the formation of diversity in knowledge structures. To build on this it was found that a higher level of education (especially to the level of a doctorate degree) is correlated to the number of patents of an individual (Zwick et al., 2017). More novel ideas that can lead to a patent are generated by individuals with higher levels of education.

Strategic relationships known as “Research and Development alliances” are formed with external sources that have a higher level of education and knowledge on a subject. These alliances are tapped into to develop new products (Caner & Tyler, 2015). It was found that prior education are critical to interpret the new information obtained from external sources and a higher level of education is therefore required for successful external knowledge transfer (Cui et al., 2014). Individuals with higher levels of education, for example individuals with a doctorate degree, are key players when it comes to collaboration and transfer of knowledge (Baruffaldi, Di Maio, & Landoni, 2017).

However Caner and Tyler (2015) posit that these types of external knowledge relationships are less likely to be established with an increase in knowledge per individual employee. It is explained that it is more costly to integrate external knowledge into idea generation than to only utilize internal knowledge. Therefore when an employee has increased education they would rather tackle the idea generation task themselves than try to collaborate with an external partner (Caner & Tyler, 2015). The following hypothesis was constructed to test this variable:

H_2: Level of education is a mediator in the relationship between open innovation and creativity of employees.

2.9 Gender

Rosa et al., (2014) posits that women are more creative than men and that this is the case among all age groups. Several studies show that there is a correlation between creativity and gender (Furnham & Nederstrom, 2010). For example, when existing products are pictured with the intent to create new concepts, women should reveal more creativity than men (Furnham & Nederstrom, 2010). However these authors posit that various studies show only a moderate correlation between creativity and gender.

In a different study on age and creativity where gender was included as a third mediating variable, Binnewies et al. (2008) found that there is no distinctive effect of gender on creativity. Differences in creative thinking styles and motivation towards creativity was found to lack gender effects (Soroa et al., 2015). Cheung and Lau (2010) and He and Wong (2011) found numerous studies with conflicting findings on the relationship between gender and creativity. This was ascribed to differences in emotional and cultural experiences in the specific samples that were tested (e.g. girls from single-gender high schools). As a result of this the findings of the previous studies can't be generalized and made applicable to the entire male/female population. Due to the opposing findings in the literature, the mediating effect of gender on creativity should be verified.

In attempts to collaborate, relationships between industry and external parties (e.g. Academics) has to be formed to ensure that the relationship is beneficial to both parties (Tartari & Salter, 2015). These benefits are described as access to resources (financial, data or material) as well as a potential source of inspiration for new ideas. Tartari and Salter (2015) posits that women tend to participate less and form fewer of these types of relationships where the aim is to transfer technology. Women were found to have fewer networks than their male counterparts (Berger et al., 2015). This finding was supported by Jappelli, Nappi, and Torrini (2017) where it was found that women are at a disadvantage when it comes to building strong networks.

Based on the contrasting views found on the effect of gender as a mediating on creativity and open innovation, this should be investigated further. From the review above the following hypothesis is proposed:

H_3: Gender is a mediator in the relationship between open innovation and creativity of employees.

2.10 Age

Previous studies mostly found that there is no relationship or a slightly negative relationship between age and creativity (Binnewies et al., 2008; Zwick et al., 2017). Zwick et al (2017) posits that inventive performance decreases with age and that older generations have limited novel ideas when compared to their younger counterparts.

However other studies suggest contrasting findings with regards to age and creativity (Binnewies et al., 2008). Zwick et al (2017) found that there is a positive relationship between age and creativity, whereby it is stated that only successful inventors stay in the

line of inventing. A reputation of successful inventions serves as motivation for aging individuals to continue with the idea generation processes that led to initial inventions. When the younger generations fail in inventing and developing new ideas, older inventors would persist and stay in the business. Based on this Zwick et al. (2017) propose that there is a positive relationship between age and idea generation.

With another opposing view Lee and Hee (2011) found that creativity increases with age up until a peak point, after which the creativity will decrease with further aging. In support of this finding Ng and Feldman (2013b) stated that with age it becomes more difficult to recall previous knowledge and combine that with new found insights to formulate new concepts leading to fewer novel ideas being generated.

Collaboration with external sources to obtain new ideas requires some prior knowledge on the specific problem (Wattal et al., 2017). As a result of the prior knowledge requirement Wattal et al. (2017) found that there is a positive relationship between employee age and external collaboration. Older adults were found to have denser networking relationships which means that they have fewer connections, but the few connections are high quality (Cornwell, Laumann, & Schumm, 2008). It is further explained that older adults form these networks for various reasons, which includes access to information and resources. Older adults will therefore form networks with individuals that can contribute valuable information in the idea generation process. In a study done by Gaál et al. (2014) the relationship between the usage of technology for the purpose of knowledge sharing in business and age of the employee was investigated. The authors at first proposed that younger individuals would make use more extensively of technology for knowledge transfer purposes compared to older individuals. However the final results showed that younger individuals would only use technology for private purposes and not necessarily for the development of the business. The older individuals would utilize the knowledge sharing sources to benefit the development of the business.

In order to obtain clarity on the opposing views with regards to the effect of age on creativity and open innovation, the following hypothesis was proposed:

H_4: Age is a mediator in the relationship between open innovation and creativity of employees.

2.11 Conclusion

The purpose of this chapter was to introduce and critique the current argument in the

literature on the perspective on open innovation and creativity. Open innovation was introduced as a means to improve the idea generation process as well as the quality of innovation practices through collaboration with external parties (Randhawa et al., 2016). The three different forms of open innovation were described as outside-in, inside-out and grouped activities (Gassmann & Enkel, 2004). For the purpose of this dissertation the focus was on idea improvement inside the company and therefore the focus was decided to be on outside-in activities only.

Various authors defined creativity as being the creation of fresh and useful ideas (Gilson & Litchfield, 2017; Jiang & Gu, 2017; Sung et al., 2017). It was further posited that creativity is not only defined by the generation of completely new ideas but that it could refer to small changes of existing ideas (Sung et al., 2017). Increased creativity was shown to increase the number of ideas generated and ultimately the number of new products produced resulting in increased profits (Gilson & Litchfield, 2017; Kornish & Hutchison-Krupat, 2017). The link was created between creativity and open innovation through the concept of ideas (Gilson & Litchfield, 2017). Where creativity refers to the creation of ideas, open innovation is defined by the use of collaboration with external sources to enrich these ideas (Bharadwaj & Menon, 2000).

Interaction with individuals with a different background than oneself was found to increase the likelihood of an idea being a novel one than when idea generation is carried out in isolation (Harryson, 2008). It was found that better ideas can be generated through collaboration with customers to better understand their needs, including insights from talented individuals as well as various inputs improving the responsiveness to dynamic markets (Kornish & Hutchison-Krupat, 2017; Radjou, 2005).

Characteristics of an individual (for example age, gender, prior work experience and level of education) were found to improve the idea generation capabilities of an employee (Zwick et al., 2017). In this chapter creative cognitive theory was introduced in order to explain the decision to test demographics as a mediator on the relationship between open innovation and creativity. The creative cognitive theory states that characteristics (for example age, gender, level of education and experience) of an individual influence the creation of novel ideas (Yunlu et al., 2017). The possible mediating effect of each demographic was investigated based and based on the literature meaningful hypotheses were constructed.

The first demographic that formed part of this study was prior work experience. It was

found that work related knowledge and skills obtained through work experience, can aid in the generation of new ideas (Anderson & Potočnik, 2014; Dong et al., 2017). However it was also found that increased work experience can result in routines which could be either detrimental to creativity of an individual or free up mental resources for better creative thinking (Binnewies et al., 2008). Increased work experience were found to result in more collaborative knowledge transfer that can aid idea generation (Lee & Jung, 2017; Okamuro et al., 2011). Better knowledge networks are also expected to form as a result of increased work experience (Van Rijnsoever & Hessels, 2011).

Education levels of an individual was found to be one of the prerequisites to creative thinking for an individual (Cheng et al., 2016). A technical skill set acquired through higher education was found to enable better understanding of the problem when generating solutions (Anderson & Potočnik, 2014; Dong et al., 2017). Higher levels of education is expected to enable an individual to link solutions from different fields in order to obtain a unique idea (Chen et al., 2011; Zwick et al., 2017). There were some contrasting findings from the literature with regards to level of education and collaborative knowledge transfer. Some authors posited the strength of collaborative problem solving networks generated as a result of relationships formed with higher education (Caner & Tyler, 2015; Cui et al., 2014; Zwick et al., 2017), while it was also found that there are high costs associated with integrating external knowledge into the problem solving process (Caner & Tyler, 2015).

The third demographic as mediating variable to investigate was gender. No conclusive finding on the effect of gender on creativity could be found as a result of contrasting views. Some authors found that women tend to be more creative while others could not confirm any difference in creativity between men and women. With regards to collaborative knowledge transfer it was found that women tend to form fewer collaborative networks and also participate less in these types of relationships (Berger et al., 2015; Jappelli et al., 2017; Tartari & Salter, 2015). Based on these contrasting findings this part of the study was aimed at obtaining a conclusive result for the ongoing argument on gender in the literature.

A combination of motivation resulting from successful inventions as well as persistence to generate new ideas were found to be the reason for the positive relationship between age and creativity (Binnewies et al., 2008; Zwick et al., 2017). However a decaying memory as a result of age decreases the ability of an individual to recall previous knowledge resulting in decreased idea generation (Ng & Feldman, 2013a). Support were

found for older individuals forming stronger networks and making use of technology specifically for knowledge sharing purposes as compared to younger individuals who does not (Cornwell et al., 2008; Gaál et al., 2014; Wattal et al., 2017).

From the literature found during this study, four hypotheses were constructed to verify the, sometimes, opposing views with regards to the mediating effect of demographics on the relationship between creativity and open innovation.

Chapter 3 - Methodology

3.1 Research Design

The purpose of this research methodology section is to obtain data that can be applied in the study on demographics as mediating variables in the relationship between creativity and open innovation. To formulate a comprehensive methodology, the methodological fit was used in this section. The methodological fit is described as evenness among the parts of the research (Edmondson & McManus, 2007). They posit that core literature and prior knowledge in the field of a study should guide new research studies in selecting a methodology. The field of creativity is supported by comprehensive exploration and is considered a mature topic. Utilizing the vast and in-depth coverage of creativity allowed the researcher to identify under-researched areas that require further investigation. The literature on creativity also enabled the researcher to determine critical variables to use in this study. However, the researcher found limited literature covering the field of open innovation. The available research was used to identify possible variables that should be used in this study. The research methodology could be structured after the relevant variables were defined. The ongoing argument in the literature with regards to the effect of demographics on creativity and open innovation could be researched using a quantitative research approach. To follow a deductive path and test existing literature the hypotheses were supported by relevant literature (Saunders & Lewis, 2012).

The researcher used a hypothesis testing method whereby the relationships between identified constructs could be determined (Edmondson & McManus, 2007). The construct of creativity, as well as open innovation, was measured using a pre-existing questionnaire with a Likert scale. Data was gathered through sending out the surveys to the identified sample. No manipulation of the conditions took place under which the questionnaires were undertaken, and this study is thus considered non-experimental. The collected data were analyzed using SPSS to either reject or fail to reject the null hypothesis.

To test for mediation, three requirements should be met as described by Baron and Kenny, (1986). A multiple regression analysis with a significant finding in each relationship between the mediator and dependent variable, between the dependent and independent as well as a significant relationship between all three of the variables proves

a variable to be a mediator. These three steps were applied to each demographic variable to test for mediation.

3.2 Universe

The population for this study included current employees in South African organizations with formal work experience who are studying towards an MBA degree. No specific industry was focused on in this study, but a variety of listed companies was selected based on the availability of information. Multi-business focus creates more value than focusing on a single business according to Moschieri and Mair (2016) since it is relevant to and can be applied to a broader scope of industries. This finding is supported by Criscuolo, Salter and Ter Wal (2016) whereby it is stated that focusing on a single industry prevents the results from being generalized to other organizations. The questions in the survey addressed the open innovativeness and creativity of an individual.

3.3 Sampling

With the vast population at hand, it is unlikely that a list of the entire population would be obtained and therefore a non-probability sampling technique was used (Saunders & Lewis, 2012). The chosen method for this study was Purposive sampling. Purposive sampling is described by Saunders and Lewis (2012) as a non-probability technique where the judgment of the researcher is applied to strategically select a sample of people who would comply with the requirements to reach the outcomes of this study. The variety of purposive sampling that was used was a combination of the typical case as well as homogeneous. A specific group of people was selected to obtain illustrative results that can be inferred to the entire population (typical case). The selected group was also consistent, and minor differences could be easily identifiable (homogeneous).

A link of the survey was sent to 80 individuals within the specified population, and it was requested that each send this to others that fall within the population. The exact amount of recipients is unknown. 125 responses were received of which 1 in total was incomplete; the final sample size was therefore 124 datasets.

3.4 Unit of Analysis

The unit of analysis refers to the unit that is used to gather data from in the study (Cresswell, 2012). Two units of analysis were used for this study: 1) Proclivity for

improvisation scale to measure creativity, and 2) open innovativeness of an individual.

3.5 Measurement

According to Cresswell (2012), an instrument is defined as a tool used to measure quantitative data. In this study, four hypotheses were constructed based on relevant literature. To verify the hypotheses to reject or fail to reject the null hypotheses the variables were compared. In this study, the measurement instrument used were existing questionnaires used in previous studies. Pre-tests were conducted on the surveys to ensure correct interpretation of all the questions on a sample size of 10 people. The pre-testing was concluded when new errors or misinterpretations were established. The scales used were all numeric interval type data that are measured on a Likert Scale. The different constructs that were measured to verify each hypothesis included creativity, open innovation of an individual, age, level of education, work experience, and gender. Each of these constructs is explained below in more detail.

3.5 1 Open innovation of an individual

The dependent variable identified in the hypotheses is open innovation or open innovativeness of an individual. To determine the open innovativeness of an individual the approach followed by Laursen and Salter (2006) was used.

Laursen and Salter (2006) measured openness of an individual through a survey which determined the number of parties used to obtain new ideas as well as the number of times each of these parties are used by an individual to obtain new ideas. An individual that obtains ideas from a large number of sources as well as at a high frequency is considered an “open” individual. An example of this questionnaire is supplied in Appendix 1.

3.5.2 Demographics as mediators

To test the demographic variables as mediators in the relationship between open innovation and creativity, each was asked to provide the number of years which they have prior formal work experience. As well as the number of different companies that the individual has worked for to obtain their work experience. The name of the companies was not required since the number of companies was what was relevant to the current study. Each was asked their gender as well as their highest level of education. The respondents’ age was required and was asked as an open question where after the

researcher categorized the respondents into different age categories.

3.5.3 Creativity of an individual

To establish the creativity of an individual the creativity scale of the Proclivity for improvisation scale (PI) was used. This scale was developed to determine the creativity of an individual in the business context (Johnson et al., 2015). The questionnaire consists of nine questions, each with a seven-point Likert scale on frequency. A higher rating on this scale indicates an individual with more creativity in the business context (Hmieleski & Corbett, 2006). The original test showed a Cronbach's alpha value of average α=0.95. As a second determination, an individual was asked to rate themselves on creativity on a scale of 1 to 7.

3.5.4 Reliability and validity

Both scales used in this study is confirmatory models since they are supported in theory, and the constructs that come from the measures are explicitly defined (Podsakoff, MacKenzieb, Podsakoff, & Jeong Yeon, 2003). The Cronbach's alpha statistic is calculated to measure the internal uniformity of the data and can range between 0 and 1. A value closer to 1 indicates higher consistency.

A Cronbach's alpha for each of the scales was calculated as 0.95 for PI and 0.93 for the open innovation scale. Before performing factor analysis a Kaiser-Meyer-Olkin test and Bartlett's test of sphericity was used to confirm whether confirmatory factor analysis (CFA) could be applied to the data. A single construct was measured for the creativity scale, similar to what was found in this study. However, no factor analysis was confirmed for the open innovation scale in the original article. A CFA revealed four factors for the open innovation scale, of which two were deemed unreliable in the reliability test for this study.

3.6 Data gathering process

For the actual gathering of data, a survey was sent out to any individual that is currently employed. Podsakoff et al., (2003) posit that reliability increases when individuals get to complete the questions confidentially. Individuals that complete the survey without the presence of the researcher will reveal their true feelings instead of being biased by wanting to be viewed in a positive light. An electronic survey was distributed to the respondents to allow confidentiality. The surveys were constructed based on the

literature review and subsequent hypotheses (Saunders and Lewis, 2012).

In acknowledgment of the possible delicate topics addressed in the surveys, a confidentiality agreement preceded the questionnaire. Since no identity is revealed in the survey, the researcher also confirmed anonymity in the preceding statement. In the first part of the survey, respondents were asked some information on their demographical background. The following part included questions to determine the creativity of an individual and the final section pertained to open innovativeness of an individual.

The data obtained from the surveys enabled an in-depth study of the topic and ensured that the link between creativity and open innovation, and demographics were established.

3.7 Analysis approach

An analysis of the data was done by firstly drawing the data from a survey tool (Google drive) to Excel. After pulling in the data to excel, the data was coded into a data matrix. Saunders and Lewis (2012) posit that the data should be interpreted by first drawing up graphs and tables. A graphic representation of the data will allow the researcher to make sense of the load of numeric data obtained. Finally, a statistical analysis of the data is required to conclude. For the numerical data gathered in the survey the central tendency or dispersion of the data can be described (Saunders and Lewis, 2012). In most studies in the literature review, a dependent variable was explained by an independent variable, which will also be the case for the analysis of the data obtained from the surveys. Based on the analysis by either comparing the means of two groups or describing the dependent variable through the independent variable the null hypotheses that were constructed were either rejected or failed to be rejected.

From the work of Baron and Kenny, (1986) to test for mediation three steps should be applied in the analysis. The first requirement is a significant effect when regressing the mediator on the independent variable. The second condition for testing of mediation is that there should be a significant effect between the dependent and the independent variables. The last requirement is a significant effect when regressing the dependent variable on the mediator and independent variables. Should all three of these conditions be met, the variable is accepted as a mediator in the relationship between the independent and dependent variables.

3.8 Limitations

Since the Interpretivist approach will be followed the analysis will not be wholly objective, but some interpretations will be subject to the observations from the researcher. Due to the time constraints of this study, the sample size will be a limitation that will sacrifice some credibility of the results (in comparison with a larger sample size should saturation not be reached). It is widely accepted that Open innovation practices and the effects thereof are a function of the size of the firm. A limitation of this study is that extremely limited information is available on open innovation and this reduces the available resources for an in-depth theoretical background.

Chapter 4: Results

4.1 Introduction

This chapter presents the results obtained for the hypotheses identified from the Literature Review. The first part of the results includes the coding required to get usable data for further analysis as well as a detailed description of the sample. The coding will be followed by Kaiser-Meyer-Olkin to determine whether confirmatory factor analysis (CFA) can be used for the data. A CFA analysis for each of the two questionnaires (one for creativity and one for open innovation) is completed in this chapter. From this reliability is confirmed through a Cronbach's alpha test on each of the factors identified. Multiple regression analysis is conducted in three steps to determine mediation of a variable. The discussion of these results will take place in the next chapter.

4.1 Sample description

It was described in the Methodology section that the sample size was determined based on the key literature found on open innovation and creativity. Specific requirements must be met to carry out a valid multiple regression analysis (Wegner, 2016) . With a confidence interval of 95% the sample size requirement is a minimum of 119 responses (Kotrlik & Higgins, 2001). All of the respondents were, at the time of answering the questionnaire, enrolled for an MBA at the Gordon Institute of Business Science. The survey was distributed to the second and first years as well as to the Full-time MBA group of 2017. The questionnaire was created by making use of Google Forms which allows for the survey to be electronically distributed.

4.2 Validity and reliability

A pilot study was completed whereby the questionnaire was sent to 10 people that did not form part of the sample to receive feedback on the quality of the survey. Some questions were adjusted slightly, as per the feedback received from the pilot study:

- All data categories were changed to start from 1 to 7. This ensured consistency and ease of analysis.
- For the number of companies in which an individual has been employed, it was added in brackets that this includes the current company in which you are currently employed.

- The time required to complete the survey was changed from 20min to 5min as per suggestions from the pilot study.

The exact number of MBA students that the survey was sent to is not known and a total of 125 responses were obtained. From these responses, 6 were not fully completed and will be excluded from the study. The initial target for the sample size was 119 responses, and the 119 responses (excluding the six partially completed responses) were therefore considered to be adequate. Table 1 reflects the total responses obtained and the incomplete responses pertaining to the demographics.

Table 1: Valid and missing responses (demographics)

Demographic	Gender	Age	Active Employment	Nr Companies	Education
Valid	125	119	119	125	125
Missing	0	6	6	0	0
% Missing	0.0	4.8	4.8	0.0	0.0

Table 2 and Table 3 reflect the responses obtained for each of the questions testing for open innovation and creativity respectively.

Table 2: Valid and missing responses: Open Innovation

Question	Valid responses	missing	% missing
Market Suppliers of equipment, materials, components, or software as source	125	0	0
Clients or customers	125	0	0
Competitors	125	0	0
Consultants	125	0	0
Commercial laboratories/R&D enterprises	125	0	0
Institutional Universities or other higher education institutes	125	0	0
Government research organizations	125	0	0
Other public sector, e.g., business links, government offices	125	0	0
Private research institutes	125	0	0
Other Professional conferences, meetings	125	0	0
Trade associations	124	1	0.81
Technical/trade press, computer databases	125	0	0
Fairs, exhibitions	125	0	0
Specialized Technical standards	125	0	0
Health and safety standards and regulations	124	1	0.81
Environmental standards and regulations	125	0	0

Table 3: Valid and missing responses: Creativity

Question	Valid responses	missing	% missing

I am inventive.	125	0	0
I serve as a good role model for creativity.	125	0	0
I demonstrate originality in my work.	125	0	0
I am creative when asked to work with limited resources.	125	0	0
I identify ways in which resources can be recombined to produce novel products.	125	0	0
I find new uses for existing methods or equipment.	125	0	0
I think outside of the box.	125	0	0
I take risks in terms of producing new ideas in completing projects.	124	1	0.81
I identify opportunities for new services/products.	125	0	0
Please rate yourself on your own perceived level of creativity	125	0	0

The lowest number of responses to any of the questions were 119, and only five of the questions from the entire questionnaire had a missing response.

The number of valid responses for each of the variables as mentioned above is considered an adequate amount of responses. These values will also be taken into consideration when the data analysis is completed.

4.3 Construct Validity

Before detailed statistical analysis of the results was obtained, validation of the constructs on which the hypotheses were based on had to be completed. A confirmatory factor analysis was completed to get the different constructs as well as a Kaiser-Meyer-Olkin (KMO) and Bartlett's test of sphericity to determine the appropriateness of using factor analysis on the collected data.

4.3.1 Confirmatory factor analysis for creativity scale

In Confirmatory factor analysis (CFA) the researcher will generally be working with two sets of variables, observed (measured) and unobserved (constructs) variables (Schreiber, Nora, Stage, Barlow, & King, 2006). In CFA the purpose is to decrease the variance between the population matrices and the sampled matrices. The identified constructs are used to explain the differences between the observed variables. With CFA all variables are considered at once, and as a result, no distinction is made between dependent and independent variables. This is based on the assumption that a linear relationship exists among the investigated constructs. A CFA analysis was completed on both questionnaires, for creativity, as well as open innovation respectively to identify the underlying factors.

4.3.1.1 Kaiser-Meyer-Olkin measure and Bartlett's test for creativity

The Kaiser-Meyer-Olkin measure of sampling adequacy (KMO) confirms whether CFA can be utilized on a specific dataset. With a KMO value more than 0.5, CFA can be applied to the data (Kaiser, 1970). Bartlett's test of sphericity is used to confirm non-correlation between variables in the population.

From the above analysis, an anti-image correlation matrix table was generated. This table was analyzed to identify the measure of sampling acceptability for single variables. A value higher than 0.3 is accepted as an adequate correlation between variables and indicates that the variable is suitable to be used in the analysis. In the anti-image correlation matrix, the highest correlation obtained was 0.707 for the creativity scale, with the lowest correlation value being 0.394. As a result of this, all of the variables for this scale was included in the final analysis.

Table 4: KMO and Bartlett's test for creativity scale

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.907
Bartlett's Test of Sphericity	Approx. Chi-Square	645.40
	df	45
	Sig.	.000

Table 4 displays a KMO and Bartlett's test value of 0.907 for this test which is interpreted as a *Marvellous* match for this test indicating that Factor analysis can be applied to this scale. With the significance (P value) less than 0.05, this scale can, therefore, be analyzed with PCA.

Table 5: Total Variance explained creativity

Total Variance Explained						
	Initial Eigenvalues			Extraction Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	5.694	56.941	56.941	5.694	56.941	56.941
2	.812	8.116	65.057			
3	.723	7.227	72.284			
4	.646	6.465	78.749			
5	.541	5.413	84.162			
6	.416	4.163	88.325			
7	.343	3.426	91.751			

8	.331	3.310	95.061			
9	.286	2.862	97.923			
10	.208	2.077	100.000			
Extraction Method: Principal Component Analysis.						

With an Eigenvalue 1 rule, all of the ten components can be extracted into a single factor with a cumulative variance of 100% being represented by the components in the scale.

Table 6: Rotated component matrix creativity scale

Question	Component 1
I am inventive.	.807
I serve as a good role model for creativity.	.777
I demonstrate originality in my work.	.748
I am creative when asked to work with limited resources.	.694
I identify ways in which resources can be recombined to produce novel products.	.765
I find new uses for existing methods or equipment.	.732
I think outside of the box.	.767
I take risks in terms of producing new ideas in completing projects.	.651
I identify opportunities for new services/products.	.756
Please rate yourself on your own perceived level of creativity	.833

The factor analysis for the creativity scale revealed only 1 factor whereby all of the items were loaded onto the single factor. With all of the factor loadings being relatively high (close to 1), all of these questions were considered to be highly associated with the single creativity factor (Basto & Pereira, 2012). It was further explained that a factor yield loading less than 0.3 should be considered as the minimum loading of acceptability. Since all of the loadings were above 0.3, all of the questions were included in the statistical analysis for this study. The detailed results of the factor analysis are displayed in Table 6. The single factor for this scale contains all of the questions related to the construct of creativity of an individual as formulated in section 3.5.3.

4.3.2 Confirmatory factor analysis for open innovation

To identify the constructs for the scale used to measure open innovation, a separate factor analysis was completed for this scale. The factor analysis for the scale used to measured open innovation yielded slightly different results than the proclivity for improvisation scale.

4.3.2.1 Kaiser-Meyer-Olkin measure and Bartlett's test for open innovation

Sampling adequacy for the single variables was analyzed for this scale using a KMO and Bartlett's test separately from the creativity scale. This was done to overcome the problem of no distinction being made between dependent and independent variables. The anti-image correlation matrix was obtained from the data collected from the scale used to analyze open innovation. The correlation values for this scale was significantly lower than that obtained from the creativity scale. However, each variable showed at least one correlation above 0.3. This confirmed the correlation between the variables, and as a result, no variables had to be deleted to carry out the CFA analysis.

Table 7: KMO and Bartlett's test Open Innovation Scale

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.804
Bartlett's Test of Sphericity	Approx. Chi-Square	792.165
	df	120
	Sig.	.000

The KMO and Bartlett's test for the second scale shows a KMO value of 0.804 which can be interpreted as *meritorious* and shows that factor analysis applies to this scale. Factor analysis can, therefore, be applied successfully. With the P < 0.05 PCA applies to this scale.

Table 8: Total variance explained Open Innovation Scale

Total Variance Explained									
	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	5.744	35.90	35.901	5.74	35.901	35.901	3.55	22.246	22.246
2	1.775	11.09	46.997	1.77	11.096	46.997	2.84	17.775	40.021
3	1.440	8.999	55.997	1.44	8.999	55.997	2.04	12.747	52.768
4	1.162	7.265	63.262	1.16	7.265	63.262	1.67	10.494	63.262
5	.952	5.947	69.209						
6	.796	4.974	74.183						
7	.698	4.364	78.547						
8	.643	4.019	82.566						

9	.536	3.347	85.913						
10	.455	2.847	88.760						
11	.427	2.667	91.427						
12	.373	2.330	93.758						
13	.322	2.011	95.768						
14	.300	1.873	97.641						
15	.229	1.434	99.075						
16	.148	.925	100.000						
Extraction Method: Principal Component Analysis.									

Table 8 displays the Eigenvalues and since an Eigenvalue rule of 1 was selected, four components were extracted for this scale which represented 63.2% of the variance.

To obtain the questions that made up the four components, the values from Table 9 was used. The highest ranking for the specific question on a component shows that the question should form part of that component. The allocation of questions was therefore completed according to Table 9 into the various identified constructs.

Table 9: variable groupings from factor analysis

Component Matrix				
	Component			
	Factor 1	Factor 2	Factor 3	Factor 4
Market Suppliers of equipment, materials, components, or software as source	.455	**.558**	.377	-.159
Clients or customers	.424	-.094	**.724**	.145
Competitors	.344	-.164	**.639**	.461
Consultants	**.628**	.078	-.048	.207
Commercial laboratories/R&D enterprises	**.677**	.018	-.145	.283
Institutional Universities or other higher education institutes	**.655**	-.273	-.243	.205
Government research organizations	**.641**	-.373	-.279	.084
Other public sector, e.g., business links, government offices	**.581**	-.339	-.171	-.106
Private research institutes	**.718**	-.205	-.139	.157
Other Professional conferences, meetings	**.625**	-.458	.160	-.164
Trade associations	**.659**	-.256	-.020	-.284

Technical/trade press, computer databases	**.588**	.056	.010	-.506
Fairs, exhibitions	.446	-.010	.304	**-.460**
Specialized Technical standards	**.696**	.402	-.068	-.215
Health and safety standards and regulations	**.622**	.584	-.198	.135
Environmental standards and regulations	**.628**	.519	-.144	.238
Extraction Method: Principal Component Analysis.				
a. 4 components extracted.				

The factors were highlighted in bold to represent the general theme across all of the questions that ranked highest for each factor. The general themes identified resulted in four different factors being institutions, clients and competitors, suppliers and exhibitions. From here the results per respondent for each of the questions allocated to each component will be added to provide four factors that will be used in the analysis. Each factor will be explained below in more detail.

Factor 1 contains all of the questions associated with relevant institutions that conduct research to improve their own field of expertise. These include consultants, laboratories, universities and other research organizations. These institutions can act as a source for open innovative practices since the specialists in these fields can provide significant insights to external individuals who can stimulate creativity (Gassmann & Enkel, 2004; Saebi & Foss, 2015). All of the questions that were associated with this factor has a coefficient value higher than 0.6 except the technical/trade press, computer database as a source. Since this last question had a coefficient close to 0.6, it was decided to include this question and not remove it from the further analyses to be completed.

Factor 2 only included the question of market suppliers as a source for open innovation purposes. Saebi and Foss (2015) explicitly mentions suppliers as a source of information for open innovative purposes. The only question associated with this factor had a low coefficient but was included in the study since the loading was not far below 0.6 and was considered adequate.

The third factor contained two questions associated with clients and competitors. Both factors had a coefficient higher than 0.6 indicating a strong association among the questions. The creation of fresh ideas was found to be enhanced through collaboration

with clients and competitors (Colombo et al., 2017; Sarooghi et al., 2015).

Factor 4 had only one question associated with fairs and exhibitions. The coefficient value was low however at 0.460 it was still above the minimum threshold. It was decided to make use of Cronbach's alpha to test for the reliability of the factor.

4.4 Cronbach's Alpha

The validity of data refers to whether the data truly measures what is intended to be measured (Saunders & Lewis, 2012). Cronbach's Alpha is generally applied to data obtained from a questionnaire with multiple interval type answers where the same fundamental aspect is being measured. Cronbach's Alpha is applied to measure the internal consistency of the data (Cronbach, 1951). The Cronbach's Alpha for the scales used to measure open innovation and creativity in this study was determined and is presented in Table 10 to Table 12**.** A Cronbach's Alpha is represented with a value between 0 and 1 and any value below 0.6 shows insufficient consistency (Cronbach, 1951). According to work done by Peterson (1994), a Cronbach's alpha value above 0.7 is considered to reflect acceptable internal consistency in the data. A Cronbach's alpha test was completed on each of the constructs determined in the CFA.

4.4.1 Cronbach's alpha- Open innovation (Institutions)

Table 10: Cronbach's alpha open innovation factor 1

Cronbach's Alpha	N of Items			
.878	12			
	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Consultants	41.05	167.799	.551	.870
Commercial laboratories/R&D enterprises	41.07	162.822	.597	.867
Institutional Universities or other higher education institutes	40.76	165.290	.615	.866
Government research organizations	41.48	164.632	.590	.867

Other public sector, e.g., business links, government offices	41.53	168.069	.518	.872
Private research institutes	40.90	162.403	.667	.863
Other Professional conferences, meetings	40.41	171.368	.518	.872
Trade associations	41.30	166.527	.593	.867
Technical/trade press, computer databases	40.66	169.200	.509	.872
Specialized Technical standards	40.57	163.355	.607	.866
Health and safety standards and regulations	40.83	163.185	.553	.870
Environmental standards and regulations	40.75	163.381	.553	.870

The reliability for the first construct with 12 items was high with a Cronbach's alpha of 0.878. The values indicated in the last column shows that deleting any of the items would not significantly improve the Cronbach's alpha and therefore all of these items were included in the analysis of results for this construct.

4.4.2 Cronbach's alpha- Open innovation (suppliers)

Since only one item was identified as part of this construct, a Cronbach's alpha value could not be determined. As a result of unreliability, this factor was not included for further analysis in this study (Wanous, Reichers, & Hudy, 1997).

4.4.3 Cronbach's alpha- Open innovation (clients and competitors)

Table 11: Cronbach's alpha open innovation factor 3

Cronbach's Alpha	N of Items
.677	2

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Clients or customers	4.65	2.084	.515	.
Competitors	4.93	1.661	.515	.

The reliability for the third factor revealed a Cronbach's alpha of 0.677 which is considered reliable. Deleting any one of the questions would result in an unreliable factor and both variables therefore remained in this factor for further analysis.

4.4.4 Cronbach's alpha- Open innovation (Exhibitions)

For this construct, a single item was also identified which reduces reliability (Wanous et al., 1997). With this construct, it was also decided to not include in the further analysis of any results since reliability will be sacrificed.

4.4.5 Cronbach's alpha- Creativity

Table 12: Cronbach's Alpha for creativity scale

Cronbach's Alpha	N of Items
.938	10

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
I am inventive.	47.82	65.619	.796	.929
I serve as a good role model for creativity.	48.02	65.475	.753	.931
I demonstrate originality in my work.	47.69	67.781	.753	.931
I am creative when asked to work with limited resources.	47.37	67.928	.711	.933
I identify ways in which resources can be recombined to produce novel products.	47.66	66.373	.758	.931
I find new uses for existing methods or equipment.	47.82	67.232	.723	.932
I think outside of the box.	47.41	67.550	.774	.930
I take risks in terms of producing new ideas in completing projects.	47.74	69.015	.646	.936
I identify opportunities for new services/products.	47.73	65.603	.750	.931

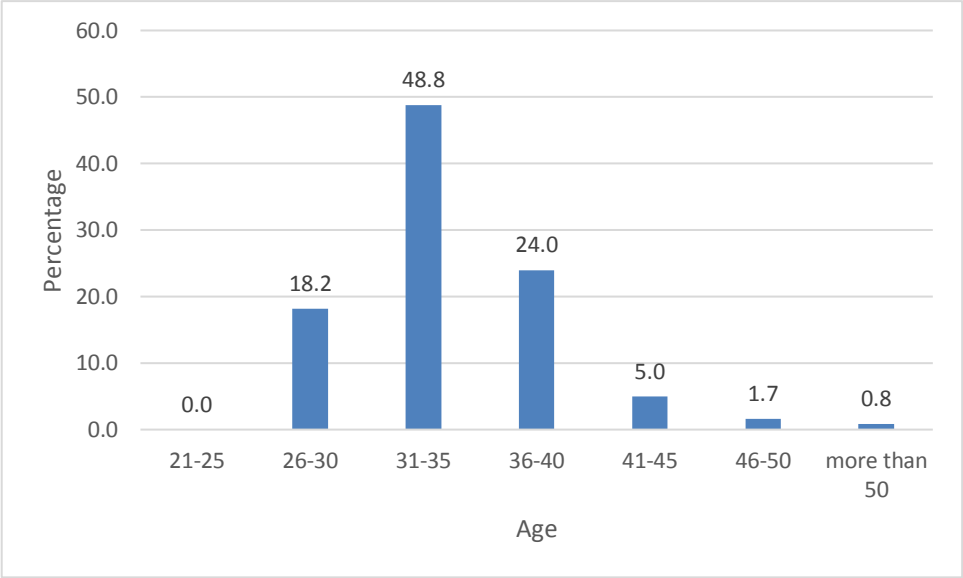
Please rate yourself on your own perceived level of creativity	47.68	66.171	.827	.927

From the results in the table above the overall Cronbach's Alpha value for the creativity scale can be seen in the second row of Table 12. The value obtained 0.938 indicates consistent internal data. The values for each of the individual variables for this scale can be read from the third and fourth columns of Table 12. The lowest value for the scale for creativity is 0.927 for the individual rating of creativity with the highest reading being 0.936 for risk-taking when new projects are completed. The analysis of the creativity scale shows acceptable levels of internal consistency, and therefore no items were deleted for the final analysis.

4.5 Descriptive statistics of participants

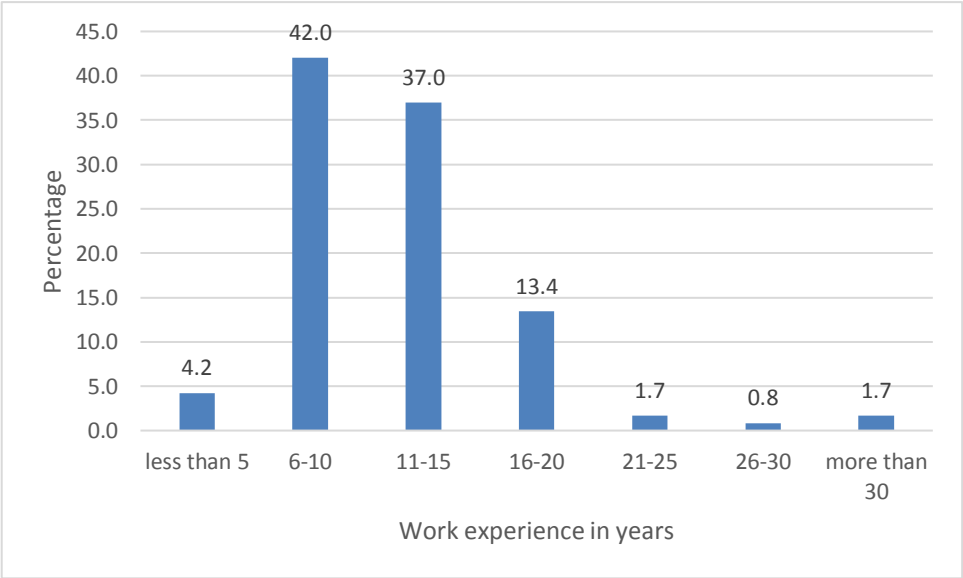
From the 119 valid responses 51 was female and 67 male. The percentage split between male and female was 43% female and 57% Male. The sample therefore evenly represents both genders and enables further analysis with gender as mediating variable. The mean age of the respondents was 34 years with a standard deviation of 4.6 years. Figure 3 shows the percentage split on the age of all the respondents. This graph indicates that almost half of the respondents fall within the age category of 31 to 35 while only 0.8% is older than 50. The age distribution is normally distributed with a skewness to the right. The different age groups are not represented extensively with the majority of the respondents falling within the 31-35 year old group.

Figure 3: Percentage respondents by age



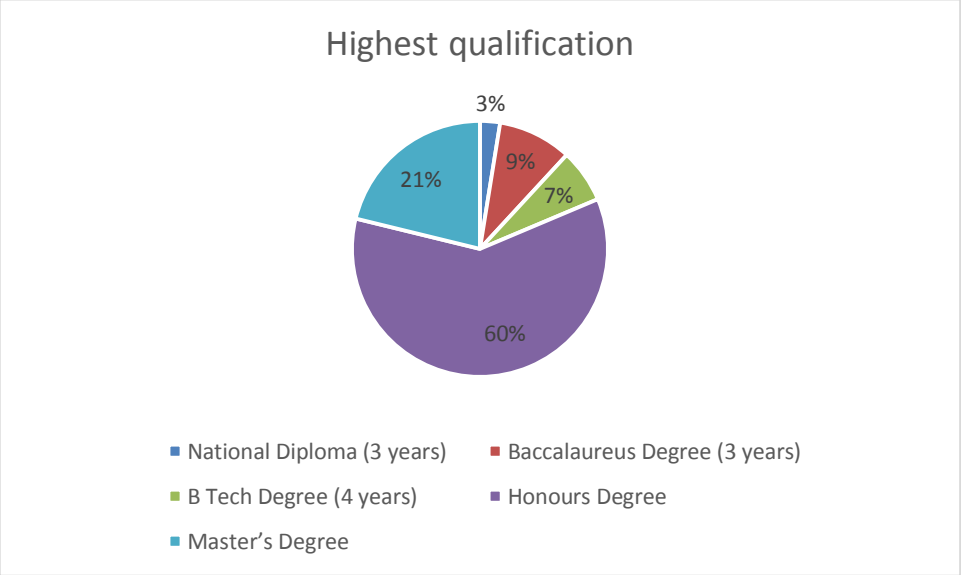
The minimum number of active years of working experience was three years with a maximum of 34 number of years' experience.

Figure 4: Percentage respondents by work experience



From the sample, 92% of respondents have worked for 15 companies or less with 8% having worked for more than 15 companies. The highest qualification distribution of the sample is displayed in the graph below:

Figure 5: Highest qualification distribution



From the entire sample, all respondents had completed higher levels of education than grade 12. However, the highest form of education obtained was a master's degree. No individual with a doctorate degree has completed the questionnaire.

4.5.1 Synopsis descriptive statistics

The respondents can, therefore, be classified based on the descriptive statistics above. From the respondents, the gender representation was relatively even with 43% being female and 57% male. The highest number of participants are represented by the age category of 31-35 years old (Figure 3). 99.2% of the respondents were within the age limits of 26 to 49 years old with only one respondent being older than 51. The majority of the respondents had work experience of between 6 to 15 years (Figure 4). All of the respondents were literate and most held an Honours degree as the highest form of qualification (Figure 5).

4.5.2 Measures

To assess the creativity of an individual the Creativity scale of the Proclivity for Improvisation technique was used as obtained from work completed by Hmieleski and Corbett (2006). This scale was used to determine the ability of an individual to identify unique solutions and how one goes about the task of creating new and novel ideas through the use of limited resources. Individuals with a high score on this assessment are more likely to try and find prospective breaks where they can apply their unique

approach to problem-solving.

4.5.3 Creativity results

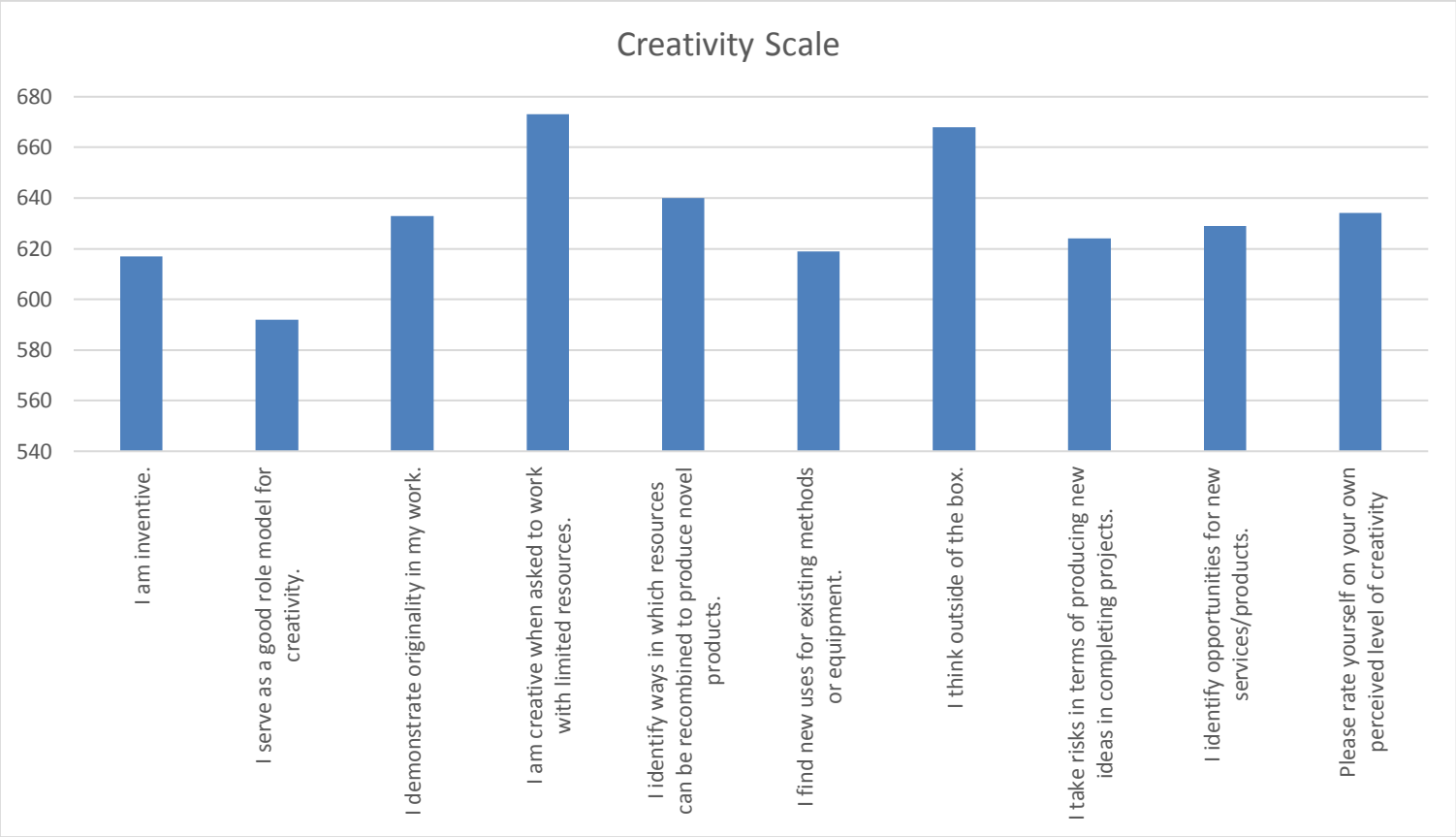


Figure 6: Creativity scale results

The results obtained from the creativity scale showed that individuals rated the highest on being creative when having to work with limited resources while low ratings were observed on being a role model for creativity. This shows that people tend to practice creativity however they might feel that others do not see their creative attempts too easily.

4.5.4 Open innovation results

The Open Innovation of an individual was measured using the open innovation scale developed by the authors in the study done by Laursen and Salter (2006). This scale measures the external sources of knowledge that individuals use to identify new ideas in their daily tasks. The data obtained can be grouped into four factors according to the results of the CFA test. The four groups were identified as the different sources being institutions, clients and competitors, suppliers, and exhibitions.

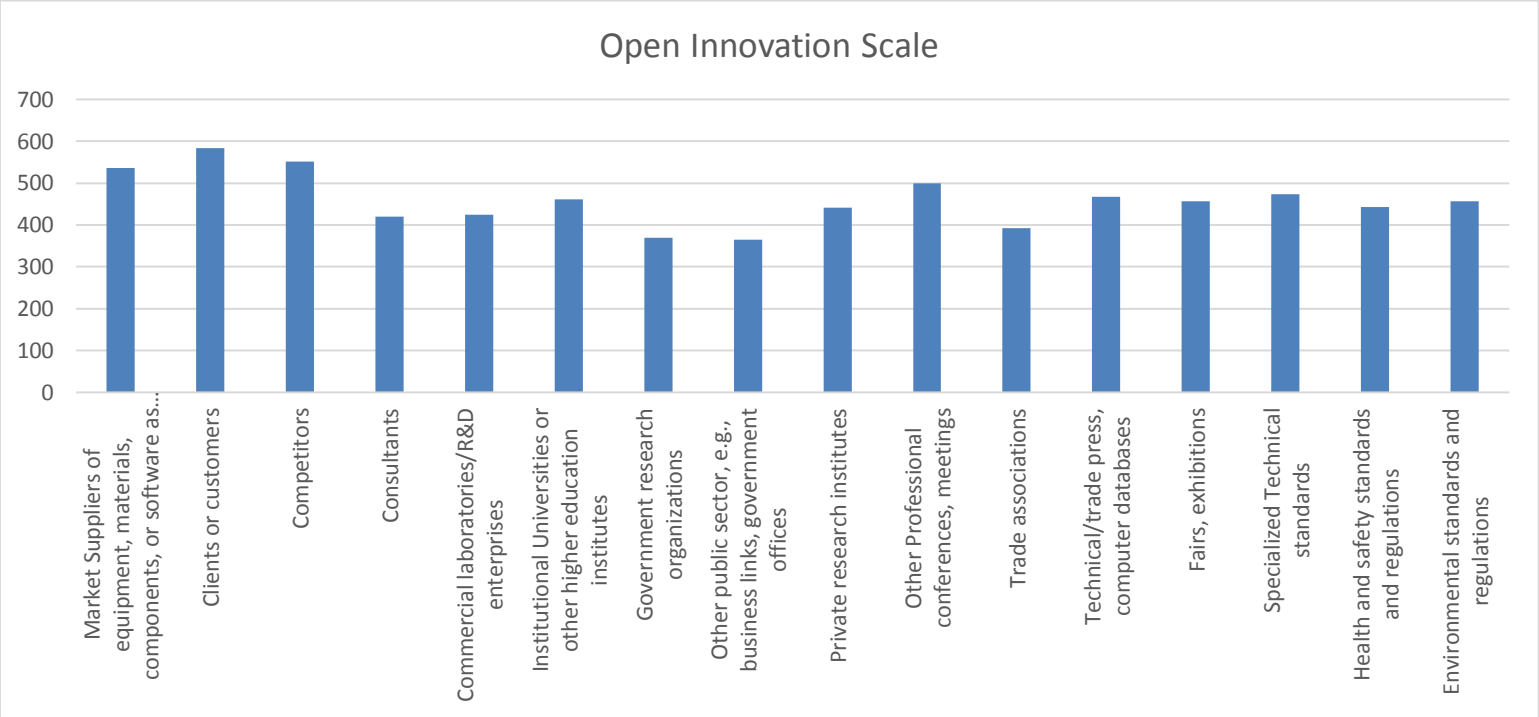


Figure 7: Open innovation results

The results obtained from the scale for open innovation revealed that individuals would most frequently make use of customers for sources of ideas in the workplace. The least used source for new ideas was found to be government research organizations and the public sector. Another two sources that were rated high on this scale as potential sources of ideas was market suppliers and competitors.

4.6 Regression analysis

To establish the effect of the mediating variables on the relationship between open innovation and creativity, a three-step regression analysis as described by Baron and Kenny (1986) was run with creativity as the dependent variable and open innovation as the independent variable. The three-step regression analysis as described in the methodology section of this dissertation entails testing for a mediation effect on a dependent and independent variable. To establish mediation, three separate requirements should be met. The first condition is an effect between the mediator and independent variable (open innovation), the second condition is an effect between the dependent (creativity) and independent variable (open innovation). The last requirement for mediation is an effect between the dependent variable (creativity) and both the

independent and mediating variables. Once all of these conditions are met, to establish mediation the effect of the dependent variable on the independent variable must be less in the last step than in the second (Baron & Kenny, 1986).

Since each of the hypotheses require the regression analysis between creativity and open innovation, this test will be done first to establish whether the second requirement is met. From there the first and third step will be shown for each of the hypotheses. The regression analysis between open innovation and creativity will include all of the creativity questions representing the creativity variable, while the open innovation scale was subdivided into the four identified constructs. The relevant questions for each construct were added to represent each form of open innovation as an individual independent variable. Since two of the four constructs were proven unreliable in the reliability analysis, only factor 1 and 4 (institutions and clients/competitors) were tested as independent variables for representation of open innovation.

Table 13: Regression creativity and open innovation

Coefficients

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B		Collinearity Statistics	
	B	Std. Error	Beta			Lower Bound	Upper Bound	Tolerance	VIF
(Constant)	42.078	3.422		12.295	.000	35.298	48.858		
Clients and competitors_code	.873	.317	.263	2.753	.007	.245	1.501	.866	1.154
Other_institutions_code	.001	.057	.001	.013	.990	-.112	.113	.765	1.307

a. Dependent Variable: Creativity_code

Table 14: Regression creativity and open innovation model summary

Model Summary					
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.314[a]	.098	.067	7.5920	2.203
a. Predictors: (Constant), Other_institutions_code, Clients and competitors_code					
b. Dependent Variable: Creativity_code					

The regression analysis confirmed the findings from chapter 3 that there is a relationship between creativity and open innovation. However, the outcome was only significant for one of the factors (Clients and competitors). This is a fascinating result showing that for this group, only clients and competitors as sources of information provides valuable input into the idea generation process.

The regression analysis shows a significant finding ($p=0.007<0.05$) of a positive relationship between the two variables ($B=0.263$). Although the results show a significant finding, the explanatory power of the model is not very high (R squared = 0.098).

Since only the one factor proved to have a significant finding, this will be the only factor used for further mediation analysis. To clarify this, only the variable representing clients and competitors as obtained by the open innovation scale will be used to represent open innovation in the rest of the regression analyses. The mediating variables will be assessed individually per hypothesis to determine the effect thereof, as well as to

determine whether this can increase the explanatory power of the models.

4.6.1 Hypothesis 1- Prior work experience is a mediator in the relationship between open innovation and creativity of employees.

The purpose of this hypothesis was to determine whether the skills obtained as a result of the work experience of an employee will affect his or her levels of creativity as well as open innovation. This mediating variable was assessed regarding the number of years active employment as well as the number of companies that an individual has worked for. To determine the mediator effect of prior work experience as a mediator in the relationship between creativity and open innovation, the first and third steps will have to be completed to establish a mediating effect. The first mediator variable assessed for prior work experience was *nr of years employed*.

Table 15: Regression prior work experience as mediator (Step 1)

Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B		Collinearity Statistics	
		B	Std. Error	Beta			Lower Bound	Upper Bound	Tolerance	VIF
1	(Constant)	3.138	.393		7.974	.000	2.358	3.917		
	Clients and competitors_code	-.038	.040	-.088	-.954	.342	-.117	.041	1.000	1.000

a. Dependent Variable: Active_employ_code

Table 16: Regression prior work experience as mediator model summary

Model Summary[b]					
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.088[a]	.008	-.001	1.029	1.917
a. Predictors: (Constant), Clients and competitors_code					
b. Dependent Variable: Active_employ_code					

From the multiple regression results obtained from the test of the number of active years of employment, it was found that an insignificant small negative effect ($p = 0.342 > 0.05$ and $\beta = -0.088$) can be found on the relationship between prior work experience and open innovation. Since this is the first step to test mediation and it was not accepted, the mediation effect can already be rejected. To determine whether a diversified work experience can account for an increase in the relationship between creativity and open innovation, a separate model was run with this variable as mediator.

Table 17: Regression number of companies worked for as mediator (Step 1)

Coefficients									
	Unstandardized Coefficients		Standardized Coefficients			95.0% Confidence Interval for B		Collinearity Statistics	
Model	B	Std. Error	Beta	t	Sig.	Lower Bound	Upper Bound	Tolerance	VIF

1	(Constant)	1.832	.440		4.169	.000	.962	2.703		
	Clients and competitors_code	.020	.045	.042	.452	.652	-.068	.109	1.000	1.000
a. Dependent Variable: Nr_Comp_code										

Table 18: Regression number of companies worked for as mediator model summary (Step 1)

Model Summary					
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.042[a]	.002	-.007	1.150	1.762
a. Predictors: (Constant), Clients and competitors_code					
b. Dependent Variable: Nr_Comp_code					

Again an insignificant extremely small ($p = 0.652 > 0.05$ and $\beta = 0.042$) mediation effect of prior work experience on open innovation was found. Since the effect of both of these variables as a mediator in the relationship between open innovation and creativity was rejected in the first step, it can be concluded that this variable is not a mediator in the relationship between open innovation and creativity.

4.6.2 Hypothesis 2- Level of education is a mediator in the relationship between open innovation and creativity of employees

The purpose of this hypothesis was to determine whether an employee with higher levels of education has higher levels of open innovation and creativity as a result of the

increased knowledge obtained. To determine the mediating effect of level of education as a mediator in the relationship between creativity and open innovation, the first and third steps will have to be completed to establish a mediating effect.

Table 19: Regression level of education as mediator (Step 1)

Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B		Collinearity Statistics	
		B	Std. Error	Beta			Lower Bound	Upper Bound	Tolerance	VIF
1	(Constant)	4.973	.348		14.287	.000	4.284	5.662		
	Clients and competitors_code	.004	.035	.010	.105	.917	-.066	.074	1.000	1.000

a. Dependent Variable: education_code

Table 20: Regression level of education as mediator model summary (Step 1)

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.010[a]	.000	-.008	.910	1.552

a. Predictors: (Constant), Clients and competitors_code

b. Dependent Variable: education_code

The regression analysis with the level of education as mediating variable also revealed an insignificant minimal mediating effect of level of education on the relationship between creativity and open innovation ($p = 0.917 > 0.05$ and $\beta = 0.010$). The R squared decreased slightly however the findings of the low effect determined in the first step led to the rejection of H_2.

4.6.3 Hypothesis 3- Gender is a mediator in the relationship between open innovation and creativity of employees.

Hypothesis 3 was constructed and tested to determine whether men or women show higher levels of open innovation and creativity. To examine the mediating effect of gender on the relationship between creativity and open innovation two separate regression analyses were run, one on the male and one on the female sample. The first test was a linear regression analysis with only the male sample. The following tables show the results obtained.

Table 21: Regression with gender as mediator (male)

Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B		Collinearity Statistics	
		B	Std. Error	Beta			Lower Bound	Upper Bound	Tolerance	VIF
1	(Constant)	1.549	.745		2.079	.042	.061	3.037		
	Clients and competitors_code	.664	.153	.475	4.346	.000	.359	.969	1.000	1.000

a. Dependent Variable: Creativity

Table 22: Regression gender as mediator model summary (male)

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.475[a]	.225	.213	1.390	2.106

a. Predictors: (Constant), Open_innovation

b. Dependent Variable: Creativity

From the first regression analysis run on the male sample, the results showed that there was an increase in the strength of the relationship between creativity and open innovation when only male respondents were analyzed. The finding was significant (p = 0.000 and β = 0.475). The strength of the relationship between the two variables increased from 0.434 to 0.475 showing that there is a slightly stronger relationship between creativity and open innovation when the male respondents are considered compared to the mixed sample. The explanatory power of this model also increased from 0.188 to 0.225. To determine whether this finding was indeed significant, a second linear regression analysis revealed the results for the female sample.

Table 23: Regression gender as mediator (female)

Coefficients										
		Unstandardized Coefficients		Standardized Coefficients			95.0% Confidence Interval for B		Collinearity Statistics	
Model		B	Std. Error	Beta	t	Sig.	Lower Bound	Upper Bound	Tolerance	VIF
1	(Constant)	1.301	.969		1.343	.185	-.645	3.247		
	Clients and competitors_code	.616	.196	.405	3.135	.003	.221	1.010	1.000	1.000
a. Dependent Variable: Creativity										

Table 24: Regression gender as mediator model summary (female)

Model Summary					
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.405[a]	.164	.148	1.674	2.376
a. Predictors: (Constant), Open_innovation					
b. Dependent Variable: Creativity					

The findings for the hypothesis of gender as mediating variable on the relationship between creativity and open innovation was supported by the second regression analysis where the test was run for only the female respondents. It was found that the relationship between creativity and open innovation was weaker (p = 0.003 < 0.05) with a β = 0.405

compared to the original test with β = 0.434. This shows that the relationship between open innovation is stronger for males than for that of females. Hypothesis 3 was therefore accepted: Gender is a mediator in the relationship between open innovation and creativity.

4.6.4 Hypothesis 4 - Age is a mediator in the relationship between open innovation and creativity of employees.

Table 25: Regression age as mediator (Step 1)

Coefficients										
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B		Collinearity Statistics	
		B	Std. Error	Beta			Lower Bound	Upper Bound	Tolerance	VIF
1	(Constant)	3.718	.354		10.502	.000	3.017	4.419		
	Clients and competitors_code	-.050	.036	-.126	-1.379	.171	-.121	.022	1.000	1.000
a. Dependent Variable: Age_code										

Table 26: Regression age as mediator model summary (Step 1)

Model Summary					
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.126[a]	.016	.008	.926	2.206

a. Predictors: (Constant), Clients and competitors_code
b. Dependent Variable: Age_code

The final hypothesis was analyzed to assess the mediating effect of age on the relationship between creativity and open innovation. It was found in the first step that the mediating effect of age on open innovation was negative, very small and insignificant ($p = 0.171$ and $\beta = -0.126$). As a result of this insignificant finding, H_4 was also rejected.

Since H_1, H_2, and H_4 was rejected based on the results from the first step, the results from the third step were not included in the results section. The third step results can be seen in the appendix.

4.7 Conclusion

The results section included a detailed description of the sample as well as the coding of the data required to complete the analysis. From the coded data validity tests were completed after which the CFA analysis revealed one factor for the creativity scale (labeled creativity) and four factors for the open innovation scale (labeled institutions, clients and competitors, suppliers and exhibitions). The reliability test for the creativity scale in the form of Cronbach's alpha (value of 0.938) confirmed that all of the questions for the creativity scale could be used for further analysis. The Cronbach's alpha for the open innovation scale revealed slightly different results. Two of the factors had only one question associated therewith and were found to be unreliable. These two factors (suppliers and exhibitions) were not used in further analysis of the results. The other two factors revealed a Cronbach's alpha of 0.878 for the institutions and 0.677 for clients and competitors. These two factors were the only two factors considered as dependent variables for further analysis. To test for mediation three steps should be verified per mediating variable. These steps include a significant finding between the mediator (demographic) and dependent variables (open innovation two factors), a significant finding between the dependent and independent (creativity factor) variable and finally and significant finding between all three of the variables. Since all four of the hypotheses required the same analysis for step 2, this step was completed first. A significant relationship between only one of the two factors (clients and competitors) and creativity

resulted in this being the only factor used as a dependent variable in further analysis.

After the remaining two steps were completed for the hypotheses, H_1, H_2, and H_4 were rejected, and only H_3 was accepted which showed that gender is a mediator in the relationship between creativity and open innovation. In the following chapter, the results will be discussed in more detail.

Chapter 5 – Discussion of results

5.1 Introduction

An in-depth discussion of the results found in Chapter 5 will be given in this chapter concerning the literature findings in Chapter 2. In this study, the researcher aimed to determine the link between open innovation and creativity through the argument around increased idea generation when the individual incorporates various sources in the idea generation process. The second aim was to determine whether attributes of the individual that affects their open innovation and creativity and finally to assist management of a company on the type of employees to employ in their organizations based on specific demographics to achieve a variety of ideas during problem-solving.

5.2 Findings and discussion of general findings

From the results section on creativity and open innovation it was found in Figure 6 that even though individuals rated that they were able to generate new ideas when having to work with limited resources, they did not rank as high on being a role model for creativity. This can reflect that individuals will generally practice idea generation on an individual basis and not make their creative findings known publicly. This can be concluded from the fact that individuals that are seen as role models for creativity would have to be recognized for their creative idea generation capabilities. Lower ratings on being a role model show that people do not feel that others see them as creative in general. An interesting finding from the results of the factor analysis of this study (Table 6) compared with the findings in Chapter 2, is that the measurement instrument used for creativity in this study revealed only a single construct for creativity. It was noted in Chapter 2 that the concept of creativity should start to be noticed as the broad and multifaceted construct that it is (Sung et al., 2017).

The findings as shown in Figure 7 reflects the more evident sources of ideas for individuals in the work environment. It was found that the customers, competitors and suppliers serve as better sources of information and ideas. The lowest source of information for idea generation purposes was government institutions and the public sector. This supports the findings of Laursen and Salter, (2006) that posited that the most popular sources of external ideas are suppliers followed by customers and finally standards. These two themes (suppliers and customers) were also identified as constructs in the confirmatory factor analysis.

The results also proved that the only construct of open innovation with a significant effect on creativity is that of clients and competitors. This was highlighted explicitly by Kornish and Hutchison-Krupat (2017), in the form of consulting with customers to identify their underlying need. A deeper understanding of the customer and their requirements can help an individual to solve the problem. The products that address their needs are the ones in which the customers are interested.

From this can also be concluded that those with whom individuals have frequent contact with will serve as a more resourceful unit when wanting to obtain fresh ideas. However, the reason for the lower rating of government institutions and sources could be investigated. Should this be due to the quality of information obtained from these resources or is it the fact that most individuals do not have frequent contact with these types of institutions? When looking at the demographics of the sample, it can be seen that the sample was, in general, a younger generation with lower levels of work experience. This could also describe the sources since the younger generation might not be aware of all of the different resources available. The most frequently encountered sources will form part of the general source of supply of ideas for individuals.

5.3 Findings and discussion of Hypothesis 1

Hypothesis 1: Prior work experience is a mediator in the relationship between open innovation and creativity of employees.

To assess this hypothesis a multiple regression analysis was run on the entire sample with creativity the dependent and open innovation the independent variables with prior work experience being the mediating variable. Two tests were conducted: One with the number of years of active employment serving as the mediating variable while the second test was run with the number of companies that an individual has worked for as the mediating variable. From the results in Table 15, it was found that prior work experience in the form of the number of years active employment was an insignificant mediator in this relationship with the effect of the potential mediator on open innovation revealing a $p = 0.652$ and $\beta = 0.042$. The second multiple regression analysis was run with the number of companies that an individual has worked for as a mediating variable. From this, a significance of 0.179 and β of 0.119 was obtained. This showed that there was an insignificant and extremely small effect of prior work experience as a mediator in the relationship between creativity and open innovation. As a result of this, the null hypothesis was rejected.

From the literature study on prior work experience and the relationship between creativity and open innovation, the main findings included that idea generation comes from combining the knowledge obtained from prior work experience to create new ideas (Anderson & Potočnik, 2014; Dong et al., 2017). It was further posited by these authors that work experience forms part of the potential sources of new knowledge and skills required for idea generation. Ng and Feldman (2013b) described how work experience should increase the understanding an individual has on their specific work environment and how this increases their potential to create new ideas. This study does not challenge the fact that an individual gains a better understanding of their work environment as a result of more work experience, however, the hypothesis was rejected that supports this as a cause for increasing the number of ideas generated (Table 15 and Table 17). The findings of this study supported what is stated by Okamuro et al. (2011) that customers and competitors are collaborated with to create new ideas and solve problems (Figure 7). Since this was one of the areas of open innovation sources that individuals rated the highest, however, the finding of this being as a result of prior work experience and the relationships formed was not supported by this study (Table 15 and Table 17).

The results of this study support the work of Binnewies et al. (2008) and Van Rijnsoever and Hessels (2011). These authors stated that prior work experience could result in employees becoming caught up in routines which are detrimental to creativity as well as knowledge obtained from former colleagues becoming embedded in that of an individual that will result in the individual not gaining any new insight from former colleagues. This shows that prior work experience does not serve as a mediator in the relationship between creativity and open innovation.

5.4 Findings and discussion of Hypothesis 2

H2: Level of education is a mediator in the relationship between open innovation and creativity of employees.

The purpose of this hypothesis was to establish whether an employee will display higher levels of creativity and open innovation as a result of skills obtained from further education. The information attained from research (Cheng et al., 2016) showed that the skills that an individual gain as a result of higher education are one of the precursors for idea generation. Further education paves the way for strategic alliances that employees form with other higher educated individuals. These relationships are the foundation for knowledge sharing that enables the linkages between existing ideas to create new

concepts (Anderson & Potočnik, 2014; Caner & Tyler, 2015; Dong et al., 2017). To test this hypothesis, a multiple regression analysis was run on the sampled data with creativity and open innovation as the dependent variables and level of education used as a mediator. The results showed a slight positive mediating effect (β = 0.010) the finding was insignificant (p = 0.917>0.05). As a result of this, the null hypothesis was rejected, and it was found that level of education is not a mediating variable in the relationship between creativity and open innovation.

Baruffaldi, Di Maio, and Landoni (2017) explicitly referred to the collaboration ability of individuals with a doctorate level of education. In this study, the highest level of education of the sample was up until Master's degree. This might also affect the support for the findings of the relevant literature. Another aspect to consider is that 60% of the sample consisted out of individuals sporting an Honours degree. Therefore with regards to the level of education, the sample is not considered as entirely representative of the working environment. It might also be revealed that the skillset is in place for individuals with the higher level of education to interpret the findings from external parties (Cui et al., 2014), but a lack of networks might prevent the extent of collaboration as described in this article.

The findings from this study supported the work of Caner and Tyler (2015) who mentions the increased costs associated with collaborating with partners during the idea generation process. These authors posited that highly educated individuals would rather make use of their own knowledge base and skill set to lower the risk of increased costs during the idea generation process. However, the results obtained in this study did not show a negative mediating effect of level of education on the relationship between creativity and open innovation. The small positive mediating effect was just insignificant and sufficient support for the mediating effect was not found.

5.5 Findings and discussion of Hypothesis 3

H3: Gender is a mediator in the relationship between open innovation and creativity of employees.

This hypothesis was selected to determine the mediating effect of gender on the relationship between open innovation and creativity. This is the only demographic variable tested in this study where the null hypothesis was accepted. To assess this hypothesis two linear regression analyses were completed, one for the male sample and

one for the female sample. The results were compared to that of the original regression analysis that tested the relationship between creativity and open innovation. The original test had a significant ($p = 0.000 < 0.05$) positive relationship ($\beta = 0.434$) between open innovation and creativity. The explanatory power of the model was fairly low (R squared = 0.188). The results obtained for the male sample showed an increase in the relationship ($\beta = 0.475$) with the finding being significant ($p = 0.00 < 0.05$) and the explanatory power of the relationship was increased (R squared increased from 0.188 to 0.225). The results tested for the female sample yielded a slightly smaller relationship than the original ($\beta = 0.405$) the finding was still also significant ($p=0.003<0.05$) however the R squared decreased from 0.188 to 0.164. These results indicate that there is a positive relationship between open innovation and creativity for both male as well as female, but the relationship is stronger for that of men. An increase in creativity will result in a higher increase in open innovation for men than it would for women. This conclusion was drawn based on the results that showed that only 16% of the change in the creativity and open innovation relationship was described by gender in the female sample, while 22.5% of the change in the relationship can be explained by gender in the male sample.

Strong support for higher creativity in women than men were found in the literature (Furnham & Nederstrom, 2010; Rosa et al., 2014). However, most of the literature stated that women tend to operate without the formation of strong networks when it comes to knowledge sharing (Berger et al., 2015; Jappelli et al., 2017; Tartari & Salter, 2015). Even though some literature stated that women tend to be more creative, there were some opposing views from other studies (Binnewies et al., 2008). Other studies found inconclusive results with regards to gender as a mediator (Cheung & Lau, 2010; He & Wong, 2011). This study tested whether gender would mediate the creativity and open innovation relationship and not only have an effect on one or the other. The findings of this research, therefore, support the observations of the authors that supported the collaborative networks of men compared to that of women in the corporate environment (Berger et al., 2015; Jappelli et al., 2017; Tartari & Salter, 2015). It was found that men have a stronger relationship between creativity and open innovation than that of women.

5.6 Findings and discussion of Hypothesis 4

H_4: Age is a mediator in the relationship between open innovation and creativity of employees.

The last hypothesis was created to assess whether a younger or older individual would

be more creative as well as apply open innovation during the idea generation process to enrich the ideas. The sample used to determine the results of this study covered a very small age group. More than 72% of the sample fell within the age group of 31 to 40 years old (see Figure 3). This limits the study since the literature touches on a broad age group.

From the literature memory loss due to aging contributes to one of the factors of a supposed negative relationship with open innovation and creativity (Ng & Feldman, 2013b). With a very young group in this sample concluding remains difficult. Many contradicting findings in the literature made this an interesting hypothesis to investigate. Some possibilities were found including a positive mediating effect where age causes increased skills to form knowledge sharing relationships and aid with the linking of ideas (Cornwell et al., 2008; Wattal et al., 2017; Zwick et al., 2017). Another opposing view found that younger individuals can recall information more readily and at the same time have more networking relationships (although not all dense relationships for knowledge sharing effectiveness) that will enable productive ideation processes (Cornwell et al., 2008; Ng & Feldman, 2013b). A third view proposed an inversely U shaped relationship between age and creativity where creativity is supposed to increase until a peak age whereafter it would start decreasing again (Lee & Hee, 2011). However just as the literature revealed opposing views on the mediating effect of age, this study found that there is no mediating effect of age. As mentioned before the age spectrum covered in the sample of this study might have affected the findings of this hypothesis, and it is, therefore, difficult to draw a conclusive finding from the results.

In summary, this study proved that there is a positive relationship between creativity and open innovation for this sample of MBA employees in South African organizations. It was found that collaboration with clients and competitors is the only outside source that has a significant positive relationship with creativity. Furthermore, only gender was proved to be a mediator in the relationship between open innovation and creativity.

Chapter 6 – Conclusion

6.1 Introduction

A need to understand how corporations can improve their profitability through the idea generation process motivated a study to discover a deeper understanding of what enables employees to come up with higher quantity and quality ideas. Demographics as mediating variable were selected to find the impact thereof on the idea generation process based on the creative cognitive theory. A new branch of literature was investigated by researching the emerging concept of open innovation and a link was established between this and creativity.

Data was gathered from 125 individuals that are in the process of studying towards an MBA degree at universities in South Africa. Measurement instruments were obtained from previous researchers in the form of established questionnaires to assess the variables of concern. Subsequently, statistical tests were used to analyze results and findings were reported based on the insights from these statistical outputs.

In this chapter, the findings are summarized based on the conclusions drawn from the previous chapters. The key findings are further explained to describe their practical and theoretical implications.

6.2 Key findings and theoretical contributions

This research has contributed to the field of open innovation adding to the limited research available in this field through linking the field to creativity and idea generation. Consequently, the rudimentary theory of open innovation was further developed and researched opening the field up to further research possibilities.

Moreover, this study added to the theoretical knowledge of creativity and the idea generation process, presenting recommendations on how managers can refine their search and selection criteria for suitable candidates to improve the idea pool in a company. The literature and research findings directed the following key findings which are outlined below.

6.2.1 Relationship between creativity and open innovation

From the CFA analysis the questions used to assess open innovation was found to

represent four underlying concepts. An interesting finding from this study was the fact that the only significant relationship between the constructs of open innovation and creativity was for that of clients and customers. This proved the work of Kornish and Hutchison-Krupat (2017) as well as Poetz and Schreier (2012) that posited the value of spending the time to understand the more profound need of the customer. Once a new invention is created to address the specific need of a customer, customers will find value in this, and the idea is considered as a novel one.

6.2.2 Creativity and open innovation is not mediated by prior work experience

As an individual obtains work experience through active employment networking with colleagues can initially result in knowledge sharing relationships. However, as a result of the knowledge becoming embedded within an individual which restricts further learning (Van Rijnsoever & Hessels, 2011), work experience is not required to improve knowledge sharing. Working in the same environment for an extended period was also associated with routine work which could reduce creativity and idea sharing amongst employees (Binnewies et al., 2008). From the results of this hypothesis, the finding of prior work experience as a mediating variable in the relationship between open innovation and creativity was not significant resulting in the null hypothesis being rejected. The hypothesis was assessed with two regression analyses, the first being the number of years of active employment as a mediator and the second test was run using the number of companies an individual has worked for as mediator. Both of these mediators proved to have an insignificant effect on the relationship between open innovation and creativity.

Most of the literature found on the effect of prior work experience in this relationship supported that higher levels of work experience would improve the skill set required to link ideas in the specific work environment (Anderson & Potočnik, 2014; Dong et al., 2017; Ng & Feldman, 2013a). Support for the formation of collaborative knowledge relationships as a result of prior work relationships was also found (Lee & Hee, 2011; Okamuro, Kato, & Honjo, 2011). However, since the hypothesis was rejected in this study the work of Van Rijnsoever and Hessels (2011) as well as Binnewies et al. (2008) was supported.

6.2.3 Level of education is not a mediator in the relationship between creativity and open innovation

As a result of further education, it is expected that an individual would obtain more

knowledge and build their skill set. Cheng et al. (2016) posit that successful idea generation and creativity entails education. The formation of knowledge structures as a result of higher levels of education are said to increase the ability of an individual to solve problems creatively (Garcia Martinez et al., 2017). Individuals with higher levels of education can form knowledge sharing relationships that require the necessary education for successful interpretation of information (Baruffaldi et al., 2017; Cui et al., 2014). However, Caner and Tyler (2015) warns of the increased cost associated with incorporating the knowledge of another highly educated individual. It was identified that an individual with additional education might not want to form a collaborative knowledge relationship with other highly educated individuals since they already possess enough acumen to solve the problem at hand.

From the regression analysis, it was found that a very small, insignificant mediating effect of level of education on the relationship between creativity and open innovation was perceived. This led to the rejection of hypothesis 2 and led us to agree with the findings of Caner and Tyler (2015). It can be concluded that individuals with higher levels of education would instead lean on their own understanding of a problem to identify solutions than to collaborate with other specialists. One thing that was identified in chapter 6 was the fact that the highest level of education in the data was a Master's degree and more than half of the sample consisted out of individuals with an Honours degree. To gain a better understanding of this demographic, it is advisable to obtain a more representative sample covering all levels of education, from grade 12 up until Doctorate degree.

6.2.4 A stronger relationship between open innovation and creativity is observed by men than women

In general women was portrayed in the literature as more creative when it comes to problem-solving compared to men (Furnham & Nederstrom, 2010; Rosa et al., 2014). However, there were other findings that remained inconclusive with regards to the mediating effect of gender on creativity and open innovation (Cheung & Lau, 2010; He & Wong, 2011). Most of the sources depicted men as more open to collaborative problem solving than women (Berger et al., 2015; Jappelli et al., 2017; Tartari & Salter, 2015).

To conclude on the mediating effect of gender two linear regression analyses were completed and the results were compared to that of the original creativity and open innovation regression test (Table 13) to decide on the effect of gender on this

relationship. It was found that the relationship is more positive and the model more descriptive for men (Table 21) than for women (Table 23), although both tests showed a significant finding. From the results, it could be concluded that men are more open to collaborative problem-solving techniques than women. This supports the work done by Berger et al. (2015), Jappelli et al. (2015) and Tartari and Salter (2015).

6.2.5 Age has no mediating effect on open innovation and creativity

Some different views with regards to age and the relationship between creativity and open innovation were found in the literature. Some authors found that there is a negative relationship between age and creativity (Binnewies et al., 2008; Ng & Feldman, 2013b; Zwick et al., 2017), Zwick et al. (2017) found a positive relationship and Lee and Hee (2011) proposed an inverse U-shaped relationship. Negative findings were based on the explanation of decreasing memory to recall solutions for older people while a positive relationship is ascribed to successfully implemented ideas being the driver to increased idea generation which favors older individuals. Age of an individual was found to be beneficial to the relationships formed for knowledge sharing. It is stated that even though older individuals have fewer knowledge sharing relationships, the ones that they do have provide better quality information for problem-solving and technique exchanging (Cornwell et al., 2008; Wattal et al., 2017).

From the regression analysis, no significant mediating effect of age on the relationship between creativity and open innovation was found. The finding was questioned based on the majority of the sample that fell within the age group of 31-40 years old. It was suspected that the results might not be representative of the entire population.

6.2.6 Implications for theory

This study makes three contributions to the literature. First, we investigated the link between open innovation and creativity through the argument around increased idea generation when the individual incorporates various sources in the idea generation process. It was found that the only sources of information in the idea generation process that had a significant effect was that of clients and competitors. This showed that understanding the need of the customer to allow an employee to focus their idea generation process, will result in more novel ideas and increased creativity. It can be concluded that a customer-centric view or perspective can improve the creativity of an individual. In addition to this, keeping a close eye on your competitor might also aid idea

generation. This has not been highlighted explicitly in the field of open innovation in the literature. Through this, we contributed to the literature on causes for the increased generation of ideas which is an ongoing argument in the literature (Bharadwaj & Menon, 2000; Salter et al., 2015).

The second contribution to the literature includes the focus on attributes of the individual that affects their open innovation and creativity. There are limited studies available that focus on the individual level of open innovation as a cause for increased innovative ideas that can be implemented (Salter et al., 2015). It was found in this study that the relationship between open innovation and creativity was higher for men than that of women. However, it was posited that training and encouragement of women to collaborate more freely might improve their creative ability. It was also found that neither education, prior work experience nor age has a significant effect on the relationship between open innovation and creativity.

6.2.7 Implications for practice: management

One of the intentions of this study was to provide management with a guideline of what type of employee to appoint for creative problem-solving. The purpose was to identify a kind of employee who may increase the number of novel ideas which are more likely to result in a successful product and therefore increased profits. Based on the only hypothesis where the results proved to be significant, the recommendation from this study is to consider the type of environment that an individual has to work in.

The results of this study provide ground for management to encourage women to be trained on collaborative problem-solving techniques. Although a smaller positive correlation between open innovation and creativity for women was found compared to men, it shows that women also can be creative and participate in collaborative problem-solving. Even though men are more open to collaborations, the ability to find solutions should also increase for women in these conditions, just not as drastically as for that of men. No other demographical information was found to impact the creativity and open innovation of an individual.

An exciting yet unintended finding of this study was that the only construct from the open innovation scale that proved to have a significant effect on creativity was that of clients and competitors. It was therefore concluded that a customer-centric approach could aid the creation of novel ideas. When employees spend the time to collaborate with clients

to understand their more profound need, they can have an advantage when trying to create a new product that can solve exactly that need. It is also interesting to find that competitors formed part of this construct. It can, therefore, be interpreted that understanding what the competitors are doing and combining these ideas with internal ideas could lead to better creativity amongst employees. It could, therefore, be beneficial for management to consider allowing employees to interact with competitors to gain insight into the needs of customers.

6.3 Limitations

- Researching the relatively new field of open innovation presented a challenge to finding literature on the subject. This caused the researcher to rely on limited studies which were relevant to the scope.
- The sample included only individuals studying towards an MBA which limited the diversity of the results, e.g., age group and level of education.
- The non-probability techniques utilized to obtain the results might affect the generalizability of the results. However, the results were tested for validity and reliability which rendered the findings relevant.
- Sample size and more complex analysis should be encouraged

6.4 Future research suggestions

After the completion of this study, a few opportunities and gaps for additional research have been identified.

- Even though the study found that collaboration with competitors can result in increased levels of creativity in an employee, the reason for this is not apparent. The cause could be a combination of either encouragement of an individual to improve when confronted with the work of a competitor, increased competition between competitors that motivates employees to grow, combining ideas from competitors with internal ideas that might lead to a better and more diverse product or various other reasons. The specific purpose can be investigated in future research.
- From the results, it was found that the age group was limited in this sample. Further investigation can provide more clarity on the mediating effect of age through increasing the diversity of age groups in the sample. Younger students up until retired individuals should be included in a new sample size to determine

the mediating effect of age with certainty.

- It was found that gender is a mediating variable, however even though this study proved that men are more open to collaborative idea generation and thus enable a larger idea pool, it should be investigated whether women or men might work better in a smaller unit. It might prove that women are more creative and come up with better quality ideas through more intimate groups.
- Individuals that portray higher creativity with the increase in open innovation might indicate an individual that performs better with higher levels of support from external individuals. To determine whether an employee would attempt idea generation through low levels of support might be valuable to management. Employing an individual who requires low support levels can prove beneficial in certain conditions. It should, therefore, be investigated whether open innovation correlates with the required level of support as well as identifying the type of support needed.
- The surveys used for the determination of creativity and open innovation in this research project can be combined with personality tests (e.g., the Big Five personality test) to determine the effect of personality on the creativity and open innovation relationship. This might provide more detail on the type of individual that might fit in a particular position to optimize idea generation in a department.

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Appendix 1- Proposed Questionnaire

Demographics

Please complete your demographic information as per the questions below:

1. Gender: Male/Female
2. What is your age ……..
3. Number of years you have been working……..
4. Number of companies that you have worked for in the past:……

5. What is the highest level of education you are in possession of?

Less than Grade 12	1
Completed Grade 12	2
National Diploma (3 years)	3
Baccalaureus Degree (3 years)	4
B Tech Degree (4 years)	5
Honours Degree	6
Master's Degree	7
Doctorate Degree	8
Other ……	9

Individual level of creativity:

Please answer as truthfully as you can.

Item	Never.	Rarely, in less than 10% of the time	Occasionally, in about 30% of the time	Sometimes, in about 50% of the time	Frequently, in about 70% of the time	Usually, in about 90% of the time	Always
I am inventive.	1	2	3	4	5	6	7
I serve as a good role model for creativity.	1	2	3	4	5	6	7
I demonstrate originality in my work.	1	2	3	4	5	6	7

I am creative when asked to work with limited resources.	1	2	3	4	5	6	7
I identify ways in which resources can be recombined to produce novel products.	1	2	3	4	5	6	7
I find new uses for existing methods or equipment.	1	2	3	4	5	6	7
I think outside of the box.	1	2	3	4	5	6	7
I take risks in terms of producing new ideas in completing projects.	1	2	3	4	5	6	7
I identify opportunities for new services/products.	1	2	3	4	5	6	7

Please rate yourself on your own perceived level of creativity	1	2	3	4	5	6	7

Open innovation:

Please mark on a scale of 0 to 6 the frequency that you have used the following as sources of information and knowledge for the purpose of generating or implementing any new ideas:

Source	Never.	Rarely, in less than 10% of the time	Occasionally, in about 30% of the time	Sometimes, in about 50% of the time	Frequently, in about 70% of the time	Usually, in about 90% of the time	Always
Market Suppliers of equipment, materials,	1	2	3	4	5	6	7

components, or software							
Clients or customers	1	2	3	4	5	6	7
Competitors	1	2	3	4	5	6	7
Consultants	1	2	3	4	5	6	7
Commercial laboratories/R&D enterprises	1	2	3	4	5	6	7
Institutional Universities or other higher education institutes	1	2	3	4	5	6	7
Government research organizations	1	2	3	4	5	6	7
Other public sector, e.g., business links, government offices	1	2	3	4	5	6	7
Private research institutes	1	2	3	4	5	6	7
Other Professional conferences, meetings	1	2	3	4	5	6	7
Trade associations	1	2	3	4	5	6	7
Technical/trade press, computer databases	1	2	3	4	5	6	7

Fairs, exhibitions	1	2	3	4	5	6	7
Specialized Technical standards	1	2	3	4	5	6	7
Health and safety standards and regulations	1	2	3	4	5	6	7
Environmental standards and regulations	1	2	3	4	5	6	7

Third step results for each hypothesis

Table 27: Nr of comp regression (Step 3)

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B		Collinearity Statistics	
		B	Std. Error	Beta			Lower Bound	Upper Bound	Tolerance	VIF
1	(Constant)	42.337	3.079		13.751	.000	36.239	48.435		
	Clients and competitors_code	.963	.292	.290	3.293	.001	.384	1.542	.998	1.002
	Nr_Comp_code	.817	.604	.119	1.352	.179	-.380	2.014	.998	1.002

a. Dependent Variable: Creativity_code

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.318[a]	.101	.086	7.5143	2.252

a. Predictors: (Constant), Nr_Comp_code, Clients and competitors_code

b. Dependent Variable: Creativity_code

Table 28: Regression analysis total years experience (Step 3)

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.372[a]	.138	.123	7.3585	2.245

a. Predictors: (Constant), Active_employ_code, Clients and competitors_code

b. Dependent Variable: Creativity_code

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B		Collinearity Statistics	
		B	Std. Error	Beta			Lower Bound	Upper Bound	Tolerance	VIF
1	(Constant)	38.397	3.495		10.986	.000	31.474	45.319		
	Clients and competitors_code	1.046	.287	.315	3.641	.000	.477	1.615	.992	1.008
	Active_employ_code	1.733	.661	.227	2.621	.010	.424	3.042	.992	1.008

a. Dependent Variable: Creativity_code

Table 29: Regression analysis education (Step 3)

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.303[a]	.092	.076	7.5533	2.210

a. Predictors: (Constant), education_code, Clients and competitors_code

b. Dependent Variable: Creativity_code

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B		Collinearity Statistics	
		B	Std. Error	Beta			Lower Bound	Upper Bound	Tolerance	VIF
1	(Constant)	40.838	4.784		8.536	.000	31.363	50.314		
	Clients and competitors_code	.977	.294	.294	3.328	.001	.396	1.559	1.000	1.000
	education_code	.602	.767	.069	.785	.434	-.917	2.121	1.000	1.000

a. Dependent Variable: Creativity_code

Table 30: Regression analysis age (Step 3)

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.297[a]	.088	.073	7.5683	2.230

a. Predictors: (Constant), Age_code, Clients and competitors_code

b. Dependent Variable: Creativity_code

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B		Collinearity Statistics	
		B	Std. Error	Beta			Lower Bound	Upper Bound	Tolerance	VIF
1	(Constant)	42.729	4.033		10.595	.000	34.741	50.717		
	Clients and competitors_code	.994	.297	.300	3.352	.001	.407	1.582	.984	1.016
	Age_code	.297	.756	.035	.393	.695	-1.200	1.794	.984	1.016

a. Dependent Variable: Creativity_code