The Influence of Social Media Properties on Software Developers' Creativity

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A thesis submitted to Auckland University of Technology
in fulfilment of the requirements of the degree
Doctor of Philosophy (PhD)

2019

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Abstract

Due to the uncertain nature of software development and the unique problems that software developers encounter in each project, the importance of software developers' creativity is increasingly being recognised in practice. Creativity is defined as the development of novel, useful and actionable ideas and solutions by individuals. The importance of software developers' creativity, the significance of knowledge about creativity and the potential value of social media in supporting software developers' knowledge acquisition all point to the importance of studying the relationship among social media platforms, knowledge acquisition and software developers' creativity. Thus, this study aims to examine the relationship between social media properties and software developers' creativity. In particular, this study evaluated the influence of two social media properties – i.e., perceptions of visibility of knowledge and association – on two aspects of software developers' creativity – i.e., domain-relevant knowledge and divergent thinking. The relationship between social media properties and software developers' creativity is explained through two cognitive mechanisms: the internal individual cognitive mechanism and the external collaborative cognitive mechanism.

With this goal in mind, in the absence of a validated instrument to measure perceived visibility of knowledge in social media, a new instrument was developed. To do so, a 10-step procedure was followed. Seven first-order constructs (broadness, up-to-datedness, diversity, timeliness, easiness, trustworthiness and appropriateness) were conceptualised and used to reflect perceived visibility of knowledge. The Covariance-Based Structural Equations Modelling (CB-SEM) method was used to analyse four datasets to develop and test the scales. The nomological validity of the instrument was established by examining its relationship with an outcome variable (i.e., the internal individual cognitive mechanism) and its association with a correlate variable (i.e., the perceived quality of content). Overall, the results indicated that the newly

developed instrument of perceived visibility of knowledge was a good predictor of the outcome variable and had a high correlation with the correlate variable.

Next, a survey with the newly developed items for perceived visibility of knowledge and adapted items for other constructs in the research model was designed to test the conceptual model and assess its fit to the collected data through structural equation modelling. Data was collected from software developers based in New Zealand to empirically validate the research model using the CB-SEM method.

The analysis results revealed that software developers' perceived social media properties positively influence their internal individual cognitive mechanism and external collaborative cognitive mechanism taking place in social media. In addition, software developers' cognitive mechanisms in social media positively influence their creativity components, namely domain-relevant knowledge and divergent thinking.

This study has theoretical and practical contributions. This research contributes to theory by developing a new instrument to measure perceived visibility of knowledge that future research can use. Also, this study contributes to the creativity literature as it provides a theoretical explanation supported by empirical evidence of the influence of social media use on software developers' creativity through the support of internal individual and external collaborative cognitive mechanisms.

The insights from this research offer practical implications for firms and individuals. Firms can use the newly developed instrument of perceived visibility of knowledge in relation to social media properties to evaluate their employees' perceptions of visibility of knowledge provided by their existing knowledge management systems. The insights from this research also contribute to practice by providing software developers' team managers with a better

understanding of how software developers' perceptions of social media properties can affect their cognitive mechanism and creativity.

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Attestation of Authorship

I hereby declare that this submission is my own work and that, to the best of my knowledge and belief, it contains no material previously published or written by another person (except where explicitly defined in the acknowledgements), nor material which to a substantial extent has been submitted for the award of any other degree or diploma of a university or other institution of higher learning.

Author's Name: Narges Safari

Signature:

Date: 18 September 2019

Acknowledgements

I would like to express my sincere gratitude to my supervisors, Associate Professor Antonio Díaz Andrade and Associate Professor Angsana A. Techatassanasoontorn for their patience, motivation, and immense knowledge. I could not have wished for better supervisors for my PhD study.

Thank you Antonio for being serious about your role as my supervisor, your dedication to your job, for always being very well organised, your close supervision and continuous attention to detail. These are skills I will take with me throughout my future career. Thank you for being a good role model to me. Thank you for all the time spent reviewing my work in such a professional and timely manner. Your vast knowledge and deep understanding of research helped me immensely to stay on the right track throughout my journey to completing my PhD. I appreciate all the effort you have made to encourage me to stay focused on my goal, while constantly reminding me to think ahead, preparing for the upcoming challenges during each step of my research.

Thank you Angsana. You did above and beyond your duty as my supervisor. I was privileged to have such dedication from you. Thank you for your continuous attention to detail and for all your time spent reviewing my research in such a professional and timely manner. I appreciate all the time you spent to give me useful advice on how to deal with challenges related to my research. Also, I appreciate your thoughtfulness and all the effort you have made to organise social events creating a positive and joyful research environment for PhD students. Thanks for all the amazing hikes we did together in the Waitakere and Hunua Ranges.

I would like to thank Associate Professor Harminder Singh and Dr Hadi Karimikia for their support and advice during my PhD. Many thanks to Ms. Ludwina Lafaele from BIS Department and Dr Andy Godfrey, Dr Eathar Abdul-Ghani and Ms. Carole Young from AUT Postgraduate Office for making my PhD journey pleasant. In addition, thanks to BIS PhD students, Hari S. Srivastava, Naseem Rahman, Catherine Xin, Shikha Shethia and Muhammad Farooque, for all the good times we shared during our PhD. Also, many thanks to all my participants who have participated in my research. I appreciate the time you volunteered to contribute to my research.

I would like to thank my parents and siblings for their unconditional love and support in every step of my life. Especially, thanks to my father for all of his hard work, dedication, on-going support and encouragement throughout my PhD. I would not be able to complete my PhD without your support and encouragement. Last, but not least, thank you Alexis Smale for your caring support and encouragement during the last year of my PhD.

Dedication

I would like to dedicate this thesis to my sister Faranak for being a good role model to me and for her unconditional love, encouragement and support.

Chapter 1: Introduction

Chapter overview

This chapter explains the significance of studying the relationship between software developers' perceived social media properties, knowledge and creativity. The chapter presents the research objective and its related research questions. Finally, the research structure of this thesis is illustrated and briefly described. The chapter ends with a chapter summary.

1.1 Significance and motivation of the research

In the organisational environment, creativity is defined as the development of novel, useful and actionable ideas and solutions by individuals (Amabile 1983). Individual creativity is an essential factor for many organisations to improve their performance (Sigala and Chalkiti 2015), customer satisfaction (Hon and Lui 2016), productivity (Moon et al. 2012) and competitive advantages (Howell 2005). To successfully develop new software and satisfy customers' needs, high-technology organisations rely on the creativity of their software developers (Açıkgöz and Günsel 2016).

Software development involves the generation and evaluation of new ideas, designs, solutions and artefacts (Tiwana and Mclean 2005) to transform abstract business ideas into new information systems and applications to support business functions (Pee et al. 2010). Due to the uncertain nature of software development projects and the unique problems encountered in each project, successful software development depends on software developers' creativity and their ability to come up with new ideas and solutions to accomplish tasks (Tiwana and Mclean 2005). In addition, as organisations constantly need to develop systems for novel business applications (e.g., a customer relationship management system with hierarchical tagging and reverse logistics in supply chains), software developers are increasingly required to come up with creative solutions (Seidel et al. 2010). While software developers' creativity is recognised

as an important element for software development, software developers' creativity has not received enough attention in the information systems literature (Müller and Ulrich 2013).

A crucial element for software developers' creativity is knowledge (Cooper 2000). When more is known about the potential of information technology (IT) (i.e. in terms of what it can do, what its impacts are and the procedures and processes in which IT is being applied), software developers are able to creatively develop a new system and apply it to a specific organisational context (Cooper 2000). Indeed, knowledge and creativity are closely linked (Aubke 2014; Perry-Smith 2006). Knowledge plays a role in creativity largely through two creativity components: domain-relevant knowledge and divergent thinking (Amabile 1983; Perry-Smith and Shalley 2003; Woodman and Schoenfeldt 1990). Domain-relevant knowledge refers to individuals' actual knowledge and the technical proficiency necessary to complete a task. Divergent thinking is an individual's ability to generate a variety of possible solutions and ideas for a problem that moves away from established ways of doing things. Previous research suggests that the ability to exchange ideas and access to repositories of knowledge about a specific task or problem enhances (1) the knowledge of the individual for completing their work tasks (domain-relevant knowledge) and (2) expands their horizon on how to execute their tasks (divergent thinking) (Liu 2013; Perry-Smith 2006).

Software development often includes heuristic tasks that do not always have a clear and identifiable path to solutions. It is not always easy for software developers to get the necessary knowledge through a requirements document, which in general is a written statement, and formal software specifications. Instead, software developers often rely on alternative and more encompassing sources (e.g., internet, intranet) to help them complete their tasks. In recent years, social media has been used as an influential platform to mediate information sharing and knowledge management for individuals (Hemsley and Mason 2012).

Social media provides an open information distribution environment that enables individuals to network with others to share knowledge, as well as to discuss and (co-)create ideas (Sigala and Chalkiti 2015). In recent years, social media has been used as a platform to mediate knowledge sharing amongst software developers (Hemsley and Mason 2012). Black, Harrison and Baldwin's (2010) study shows that 91 percent of software developers believe that social media gives them the opportunity to discuss new ideas related to specification, design and code issues. In another study, Shami et al. (2009) found that software developers express their preference to find experts in social media settings because they believe that social media users are more knowledgeable in a particular domain and more likely to respond to their enquiries (i.e., developers have a bigger audience when they ask questions in social media compared to their team; therefore, there is more chance that someone will answer their questions).

Compared to enterprise social media (e.g., Yammer and Slack), public social media (e.g., social network sites, blogs and wikis) facilitates access to knowledge external to an organisation's inspiring fresh ideas (Liu and Liu, 2008) and creativity (Perry-Smith 2014). This is because relationships among individuals within the same organisation mainly result in more redundant and repetitive information sharing (Baggio 2014) because most of these individuals possess similar information and perspectives about the job (Alavi and Leidner 2001). Individuals with similar backgrounds and experiences tend to view things similarly, thereby missing opportunities for exploring novel ideas and solutions (Tiwana and Mclean 2005).

Although accessing knowledge beyond the organisational borders can be more effective in facilitating employee creativity, most studies have focused on knowledge sharing within the same organisation (Aubke 2014; Perry-Smith 2006; Perry-Smith and Shalley 2003). Therefore, in this study, I take a different perspective and examine the relationship between public social media use and software developers' creativity. To that end, this research focuses on two properties offered by social media that are important for knowledge sharing: visibility of

knowledge and association (Treem and Leonardi 2013). Visibility of knowledge means that, using social media, experts can make their knowledge visible to others who need that knowledge (Treem and Leonardi 2013). Association refers to the way that social media enables individuals to identify and join social networks to communicate with experts to share knowledge (Sigala and Chalkiti 2015).

1.2 Research objective and research questions

The current study aims to examine the effects of software developers' perceptions of social media properties[1] on their creativity. Software developers' knowledge acquisition and sharing play a critical role in their creativity. Cognitive mechanisms – i.e., the internal individual cognitive mechanism and the external collaborative cognitive mechanism – involved in the acquisition and sharing of knowledge will be used to explain the effects of social media properties on software developers' creativity. This study examines how two properties of social media – i.e., perceptions of visibility of knowledge and association – affect two aspects of creativity – i.e., domain-relevant knowledge and divergent thinking – through two cognitive mechanisms – i.e., the internal individual cognitive mechanism and the external collaborative cognitive mechanism. Therefore, this research aims to address two research questions:

> *What are the effects of software developers' perceptions of social media properties – i.e., visibility of knowledge and association – on their cognitive mechanisms?*
>
> *What are the effects of software developers' cognitive mechanisms on their creativity components – i.e., domain-relevant knowledge and divergent thinking?*

To answer the research questions, a research model that hypothesises a cause-effect relationship between social media properties and software developers' creativity is proposed. Componential theory of creativity (Amabile 1983; Rigolizzo and Amabile 2015) provides the

[1] Hereafter in this document, the term social media refers to public social media.

theoretical foundation for this study. Based on this theory, two creativity components that are influenced by knowledge are included in the research model: domain-relevant knowledge and divergent thinking. In addition, drawing on the literature on social media, two properties are included in the research model: visibility of knowledge and association. Also, two cognitive mechanisms are incorporated into the research model: the internal individual cognitive mechanism and the external collaborative cognitive mechanism.

A comprehensive review of the relevant literature reveals a lack of validated items for measuring perceived visibility of knowledge as one of the properties of social media in the research model. Therefore, before collecting the data to empirically test the research model, a 10-step procedure was followed (Mackenzie et al. 2011) to develop and validate this construct.

Once a new instrument to measure perceived visibility of knowledge is developed, a complete survey with the newly developed items for perceived visibility of knowledge and adapted items for other constructs in the research model (i.e. perceived association, internal individual cognitive mechanism, external collaborative cognitive mechanism, domain-relevant knowledge and divergent thinking) was designed. Before collecting the data to test the entire research model, the survey instrument was refined based on feedback from a group of experts, then the pre-test and pilot test were conducted.

Data was collected from software developers in New Zealand who actively use social media to complete their tasks. Structural equation modelling (SEM) techniques were used to analyse the data.

1.3 Outline of the thesis

This thesis is organised into seven chapters, which are briefly explained next.

Chapter 1 discusses the significance and motivation of this study. The research questions of the study are then presented followed by an overview of the research approach.

Chapter 2 discusses the relevant literature to develop an understanding of software developers' perception of social media properties and their creativity. The chapter presents a conceptualisation of social media properties, cognitive mechanisms taking place in social media and creativity components. The research model is then proposed together with the development of a set of research hypotheses.

Chapter 3 explains and justifies the data collection methods and data analysis techniques of this study.

Chapter 4 explains in detail the 10-step procedure followed to develop an instrument to measure perceived visibility of knowledge in social media.

Chapter 5 reports the data analysis procedure and the results of testing the measurement model and the structural model of this study. The research hypotheses are tested in this chapter.

Chapter 6 discusses the results from the data analysis vis-à-vis the research questions.

Chapter 7 presents the theoretical contributions and practical implications of this study along with suggestions for future research.

Figure 1.1 depicts a schematic representation of this thesis.

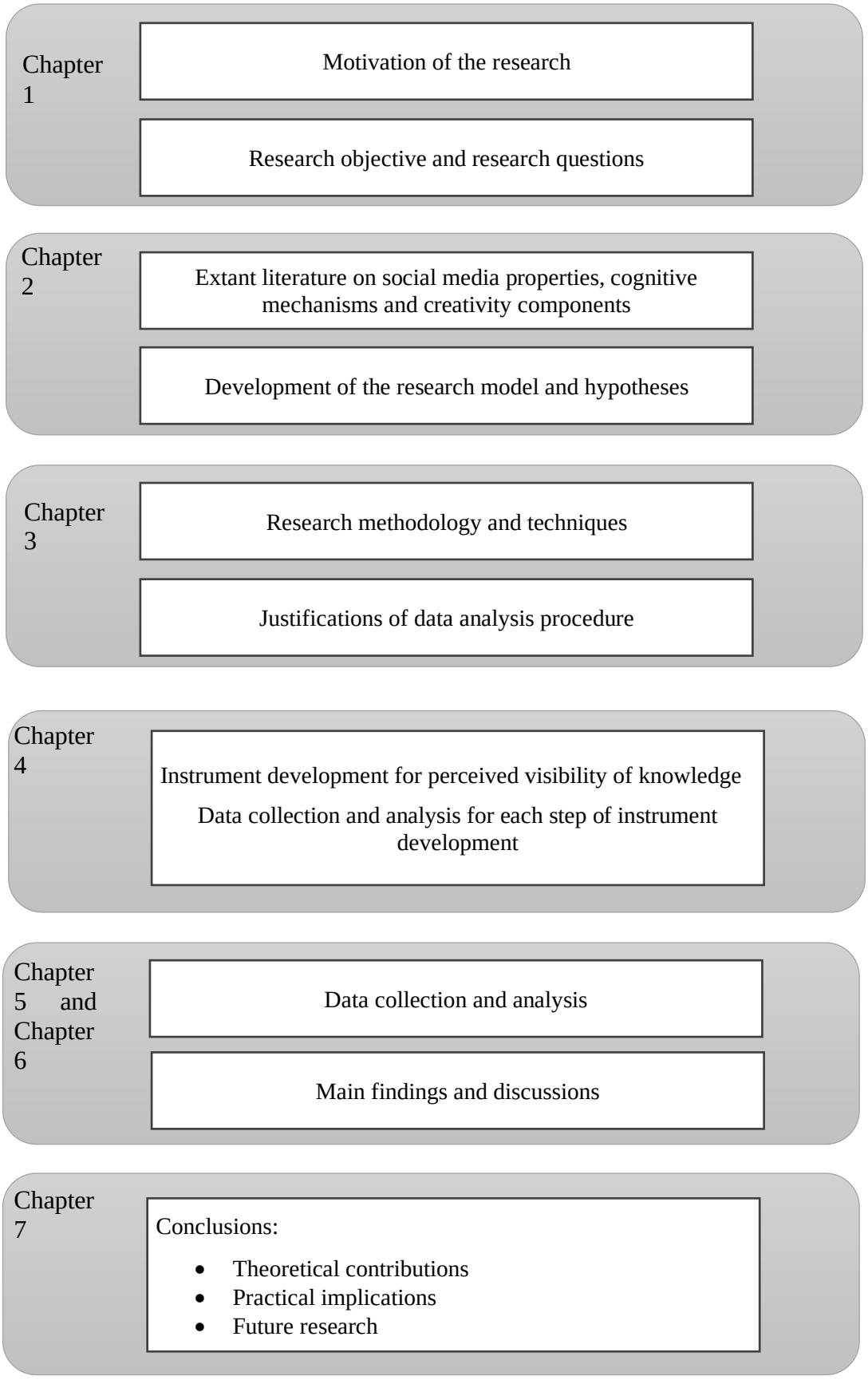

Figure 1.1 Outline of the thesis

1.4 Chapter summary

This chapter laid the foundations of this research. First, it introduced the research objective of the study and the related research questions. In addition, the structure of this thesis was illustrated and briefly described. The following chapter reviews the existing literature in order to develop a clear understanding of the impact of perceived social media properties on software developers' creativity.

Chapter 2: Literature review

Chapter overview

This study aims to examine the influence of social media properties on software developers' creativity. In particular, this research aims to examine the influence of social media properties (visibility of knowledge and association) on software developers' creativity through two cognitive mechanisms – i.e., the internal individual cognitive mechanism and the external collaborative cognitive mechanism..

This chapter provides background literature on creativity and discusses the componential theory of creativity as a theoretical foundation applied to examine software developers' creativity. Also, the chapter describes social media and its properties and presents two cognitive mechanisms to explain the link between social media properties and software developers' creativity. Next, the research model is presented, and the research hypotheses are explained. The chapter concludes with a summary.

2.1 Creativity

An individual's creativity is defined as their production of novel and useful ideas in any domain (Amabile 1983; Amabile and Pratt 2016; Mohanani, Ram, Lasisi, Ralph, and Turhan 2017; Rigolizzo and Amabile, 2015; Runco and Jaeger, 2012). In the domain of software development, developers' creativity is defined as their production of novel and useful ideas for their software development tasks (Mohanani et al. 2017).

Based on this definition of creativity, ideas that are merely good solutions to a problem without any element of novelty would be considered mundane. Also, ideas that are only novel without being feasible or appropriate in a given domain would be considered eccentric or weird. In other words, neither of these two types of ideas would be considered as creative (Reiter-Palmon 2018). Instead, ideas that are both novel and useful solutions to a problem in a given context are considered creative (Amabile, 1983; Amabile and Pratt 2016).

In addition, creativity is more applicable to heuristic tasks (which is one of the characteristics of software development). Heuristic tasks do not have clear and readily identifiable paths to the solution and may not have clearly defined goals (Amabile 1983).

Creative individuals break from the status quo, think beyond the apparent and diverge from their co-workers (Açıkgöz and Günsel 2016). They can successfully make new connections between ideas (Amabile, Conti, Coon, Lazenby, and Herron 1996). According to Perry-Smith (2006), such individuals can generate new ways to carry out project-related tasks, come up with unique ideas and reconfigure known approaches, expressing novel views and challenging others' attitudes with greater candour and less concern for a possible backlash.

2.2 Creativity in software development

Creativity is essential for software developers (Açıkgöz and Günsel 2016). Software development is an inherently creative process because it involves the generation and evaluation of new and useful ideas, designs, solutions and artefacts. The software development life cycle involves translating an abstract business idea into project requirements, which are then used to create project concepts and system specifications, and eventually the functionality and features in the software code (Tiwana and Mclean 2005). The job of software developers involves heuristic tasks through which the features of new software are designed, built, tested and demonstrated to the customers and stakeholders.

Software developers are often involved with the entire development process of a software program. Although developers try to draft as clear a specification as possible of what may be essential at the beginning of every development task (Coleman and O'Connor 2007), there is rarely "one right design" for a software development problem because there is often more than one possible solution to the same end (Tiwana and Mclean 2005). Uncertainties that developers encounter in completing their tasks make success a pure case of heuristic steps. These steps

involve exploring and experimenting with unfamiliar ideas, an activity that features a lot of creative thinking. Creativity is required in every task undertaken by software developers, from requirements definition through to the building of a new system (Cooper 2000; Crawford et al. 2012).

Previous studies have emphasised the importance of creativity in software development. For example, Glass (1994) compares two aspects in software development, creativity and discipline, and points out software construction is primarily a complex problem-solving activity which ultimately requires creativity. Mohanani et al. (2017) and Couger (1995) emphasise the crucial role of creativity in all phases of software development, from requirement definition through to implementation. Similarly, Gu and Tong (2004) argue that software developers need high creativity in the implementation phase of software development. In addition, several studies have referred to creativity as the only source through which software developers can solve their task-related problems and challenges (Cooper 2000; Crawford et al. 2012; Graziotin 2013). Creativity helps developers to build new software that meets the customer's needs (Nelson et al. 2010) and consequently brings the benefits of software development projects to organisations (Huang & Shiau, 2017). Tiwana and Mclean (2005) argue that the expertise, insights and skills of software developers result in creativity during the development process. A summary of these studies is presented in Table 2.1.

Table 2.1 The inherent creative nature of software development activities

Authors(s)	Key arguments
Huang and Shiau (2017)	Using the appropriate method to enhance the creativity of developers allows them to efficiently complete software development projects and thus bring more benefits of software development projects to their company.
Mohanani et al. (2017)	Software development, especially design, requirements engineering and programming, is intensely creative.
Graziotin (2013)	Creativity is the source from which to improvise solutions to problems for developing complex systems such as software development.
Crawford et al. (2012)	Creativity is one of the keys to respond to common problems and challenges of software development. The development of new software requires the generation of novel and useful ideas.
Nelson et al. (2010)	Information technology development, including software engineering, requires creative discourse among team members to design and implement a novel, competitive product that meets usability, performance and functional requirements set by the customer.
Tiwana and Mclean (2005)	Information system development is a creative effort that involves the expertise, insights and skills of many individuals.
Gu and Tong (2004)	In software development, there is most creative work in the implementation phase and the least creative work in the post-mortem analysis phase.
Cooper (2000)	It is only creative thinking that can develop the type of novel, non-analytical solutions that are the hallmark of software development.
Couger (1995)	Creativity can be important in all aspects of IT development, from requirements definition through to program design and implementation.
Glass (1994)	Software construction is primarily a complex problem-solving activity, which ultimately requires creativity.

Previous studies have suggested factors that influence creativity of software developers. Tiwana (2005) examines software developers' team creativity and finds that individually held expertise influences creativity in the software development process primarily through the process of expertise integration at the team level. Ocker et al. (1995) study the influence of online mediated communication technologies on software developers' team creativity in the requirements, specification and design stage of software development. They find that software developers' knowledge sharing in online mediated communication technologies can promote equality of participation which in turn leads to more opinion giving and the expression of more ideas (Ocker et al. 1995). My study contributes to the research on creativity by studying factors influencing the creativity of software developers in individual level.

To examine software developers' creativity, the componential theory of creativity (Amabile 1983; Amabile et al. 1996; Amabile and Pratt 2016; Rigolizzo and Amabile 2015) is applied. This theory prevails as one major model to explain individual creativity (Amabile 2012). The

componential theory of creativity explains that creativity should be at its highest when an individual is intrinsically motivated and has high domain expertise and high skill in creative thinking (Amabile 1983; Amabile et al. 1996).

2.3 Componential theory of creativity

The componential theory of creativity (Amabile 1983; Rigolizzo and Amabile 2015) provides the theoretical foundation for this study. This theory explains that the level of creativity that a person produces at any given point in time is a function of the creativity components operating, at that time, within and around that person (Amabile 2012; Amabile and Pratt 2016).

As outlined in Figure 2.1, this theory explains that creativity is an individual behaviour associated with three main components: domain-relevant skills (expertise in the relevant domain or domains), creativity-relevant skills (cognitive and personality processes conducive to novel thinking) and intrinsic task motivation (motivation to engage in the activity out of interest, enjoyment or a personal sense of challenge) (Amabile 2012; Amabile and Pratt 2016).

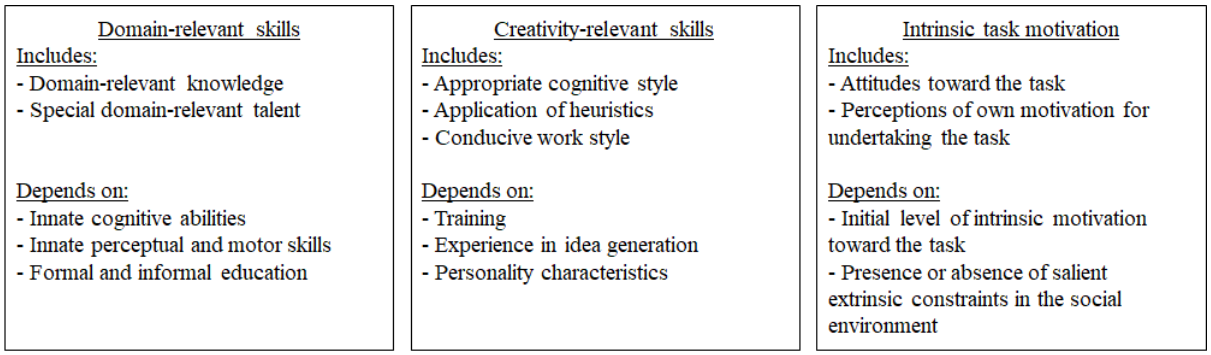

Figure 2.1 Components of creative performance (adapted from (Amabile (1983))

Domain-relevant skills reflect talent in, knowledge about and technical expertise in doing work in the domain or domains that are relevant to the problem or task at hand. Creativity-relevant skills refer to any problem-solving approach that helps individuals come up with different alternatives and generates new ideas and solutions. Intrinsic task motivation refers to

motivational factors that influence individuals' attitudes toward the task and perceptions of the reasons why they are undertaking the task (Amabile 1983; Rigolizzo and Amabile 2015).

As shown in Figure 2.1, among these three creativity components, individuals' intrinsic task motivation is shaped by the interest, satisfaction and challenge of the work itself and not by external factors, such as knowledge (Amabile et al. 1996). Amabile (1983) explains that the task motivation of individuals is affected by two factors: first, their baseline attitude toward the task, and second, their perceptions of the reason for undertaking the task. If an individual finds the task unpleasant or boring, there is no intrinsic motivation to engage in it. Individuals' intrinsic task motivation is determined by the extent to which they find the task meaningful and impactful (Zhang and Bartol 2010). People will be more motivated primarily by the interest, satisfaction and challenge of the work itself and not by external factors (Amabile 1983).

As shown in Figure 2.1, knowledge, as an external factor, mostly affects creativity-relevant skills and domain-relevant skills rather than intrinsic task motivation (Dewett 2003; Perry-Smith 2006, 2014). Therefore, this study focuses on individuals' domain-relevant skills and creativity-relevant skills as two key components of creativity affected by knowledge sharing in a social media setting. In the componential theory of creativity, there are different corresponding elements for domain-relevant skills and creativity-relevant skills (Amabile 1983) which are explained below.

2.3.1 Domain-relevant skills

Domain-relevant skills consist of two dimensions: domain-relevant knowledge and special domain-relevant talent (Amabile 1983). Individuals' domain-relevant knowledge refers to their actual knowledge and the technical proficiency necessary to complete a task or come up with feasible solutions to a given problem. Special domain-relevant talent refers to individuals' innate ability to do a particular task, for example, a composer's particular talent for an

imaginary hearing of all the instruments playing together. Previous research suggests that special domain-relevant talent is dependent on innate cognitive abilities and perceptual skills, while domain-relevant knowledge is mainly dependent on an individual's learning and their formal and informal education (Amabile 1983). Compared to special domain-relevant talent, individuals' domain-relevant knowledge can be affected by external conditions, such as knowledge management through which they can enhance their technical skills and required knowledge (Amabile 1983; Jiang et al. 2018). Since the interest/focus of this research is on the role of knowledge sharing and acquisition in public social media and the impact on software developers' creativity, this study focuses exclusively on domain-relevant knowledge rather than individuals' domain-relevant talent.

Domain-relevant knowledge reflects how much an individual knows about a given area (Amabile 1983). When individuals have more domain-relevant knowledge, creativity is likely to be enhanced by their increased ability to generate potential ideas during task accomplishment (Perry-Smith 2006). Domain-relevant knowledge is an important component for software developers' creativity. To successfully develop a new software, developers need a clear understanding of software development methodologies and IT applications, and their structures, functionality, behaviour and use in a given domain (Iivari, Hirschheim, and Klein 2004).

2.3.2 Creativity-relevant skills

In the componential theory of creativity, creativity-relevant skills, also called creativity-relevant cognitive mechanisms, encompass three elements (Amabile 1983). The first is the appropriate cognitive style, which is the ability to generate different alternatives in order to complete a task or solve a problem. The second is the application of heuristics such as analogies to explore new cognitive pathways and working style. The third is conducive work style to creativity, which means the ability to concentrate on efforts for a long period of time – the most

important factor of conducive work style being orientation toward working hard. Among these three elements, an appropriate cognitive style is dependent on knowledge sharing, while an application of heuristics and conducive work style are dependent on the experience of idea generation and personality characteristics, respectively (Amabile, 1983).

A work style conducive to creativity has several characteristics. For example, an ability to concentrate effort and attention toward the task (Amabile, 1983), an ability to be persistent in facing the difficulties of the problem at hand and a high energy level and willingness to work hard (Björkman 2004).

In addition, the application of heuristics is best described as a method of approaching a task-related problem that is most likely to lead to novel ideas rather than strict rules that are applied by routine (Amabile 1983). The heuristics that can lead to creativity include the ability of a person to use analogies and investigate paradoxical incidents (Amabile 1983). As for the application of heuristics, Satzinger, Garfield, and Nagasundaram (1999) suggest that one may use the power of analogies or metaphors as two methods of approaching problems to aid in the generation of ideas to solve a problem at work. For example, if companies compare their customers with water in a leaky pipe, they can imagine their customers leaking away, and focus on ways to plug the leak. Analogies make the familiar strange, by comparing something familiar with an unrelated element. Losing customers is (unfortunately) familiar; comparing this with a leaky pipe makes companies look at the problem differently.

It has been confirmed by other studies that knowledge sharing and acquisition affect software developers' cognitive style (Dewett 2007; de la Barra et al. 2013; Sarka and Ipsen 2017) rather than their application of heuristics (which is more dependent on the personal experience) or their conducive work style (which is more dependent on personal characteristics) (Amabile, 1983). Therefore, since individuals' appropriate cognitive style is influenced by knowledge

sharing rather than the two other factors (application of heuristics and conducive work style), this study focuses exclusively on the appropriate cognitive style.

Several different cognitive abilities are associated with creativity including field independence/dependence, creative thinking or problem-solving styles, cognitive complexity and divergent thinking. Since many of these cognitive abilities overlap with each other (Woodman et al. 1993), different models have been proposed to link cognitive abilities to creativity. One of the well-known models is the structure of intellect theory (Guilford 1967). This theory evaluates the relationship among different cognitive abilities and concludes that divergent thinking is critical for creative behaviour. Divergent thinking refers to the ability to generate a variety of possible solutions and ideas for a problem that moves away from established ways of doing things (Molony 2009; Perry-Smith 2006).

Divergent thinking involves the generation of a number of ideas that are qualitatively divergent from one another (Amabile, 1983). Divergent thinking exemplifies a creative cognitive style that is empirically well supported in various contexts (Woodman et al. 1993). The ability to produce a wide variety of possible ideas and solutions generated from different perspectives is linked with individuals' enhanced creativity (Elam and Mead 1990; Hoegl and Parboteeah 2007; Jiang et al. 2018). In software development projects, there are many subjective decisions (e.g., which method works better to fix a bug) made by developers in each project. This subjective decision-making requires software developers to have imagination and divergent thinking processes (Graziotin 2013).

Bringing different perspectives from multiple knowledge sources challenges the thinking of software developers and improves their divergent thinking abilities and their creativity (Nazir and Pinsonneault 2012). In order to complete their tasks, software developers need to obtain diverse knowledge from multiple technical and functional domains. Access to diverse

knowledge helps software developers generate and evaluate potential solutions for software design and implementation problems (Tiwana and Mclean 2005).

In conclusion, individuals' domain-relevant knowledge and divergent thinking are heavily dependent on the accessibility and availability of knowledge (Amabile 2012, 1983; Amabile and Pratt 2016; Perry-Smith 2006, 2014). In the contemporary work context, social media is considered a valuable source of knowledge for individuals (Treem and Leonardi 2013). Thus, it is plausible that knowledge derived from social media use affects these two key components of creativity.

2.4 Social media

Social media refers to a set of tools (e.g., blogs, wikis and social networking sites) that enable individuals to connect, communicate and collaborate with others to access, share and generate knowledge (Sigala and Chalkiti 2015). Social media differs from traditional computer mediated communication (CMC) technologies, such as web 1.0 technologies (e.g., e-mail, intranets and instant messaging) (Steinhuser et al. 2011). Compared to other forms of communication technologies, social media tools are faster, easier to use and more actively used for sharing knowledge among larger groups of people (Ooms et al. 2015). For example, email is very slow and confusing in sharing knowledge in a communal way when more than two people aim to discuss that knowledge. While, in a social networking site, multiple people can share and discuss knowledge at the same time (Treem and Leonardi 2013).

In addition, compared to CMC tools (e.g., instant messaging), blogs allow users to share anything – a piece of information, insights from a project or a story from the previous experiences – quickly and easily with the entire community (Panahi et al. 2013). When someone communicates through CMC tools (such as email or instant messaging applications), it can be said that they are using a watertight pipe for message transmission. Unless the

recipients of a message actively share it with others, the content of that message remains invisible to others. However, when people communicate with others directly through social media (such as wall posting in social networking sites), the content of the message is visible to others who are a member of that social media (Leonardi 2017). In this sense, social media is not just a technological advance but a social and cooperative lever that enables knowledge sharing and creation (Kaplan and Haenlein 2010; Kietzmann et al. 2011).

2.4.1 Enterprise versus public social media

In recent years, social media has been used as an influential platform to mediate social relationships and information sharing beyond the organisational borders (Hemsley and Mason 2012). Social media is an open information distribution environment that enables individuals to network with others to share information as well as discuss and (co-)create ideas (Kietzmann et al. 2011). Two types of social media are used in an organisational setting: (1) public social media (e.g., Stack Overflow, TopCoder) that facilitates individuals' social interaction and knowledge sharing beyond the organisational borders and (2) enterprise social media (e.g., Yammer, Socialtext) that allows individuals to communicate and share knowledge within the same organisation.

Compared to enterprise social media, public social media is more effective in facilitating individual creativity because external knowledge sharing beyond the organisational borders is likely to provide individuals with more heterogeneous knowledge that can inspire their fresh thinking (Liu & Liu 2008) and boost their creativity (Perry-Smith 2014). On the other hand, relationships among individuals within the same organisation mainly result in more redundant and repetitive information sharing (Baggio 2014) because these individuals mostly possess similar information and perspectives about the job (Alavi and Leidner 2001). Individuals with similar backgrounds and experiences tend to view things similarly, thereby missing opportunities for exploring novel ideas and solutions (Tiwana and Mclean 2005).

In contrast, external social interactions, beyond the organisational borders, usually offer more opportunities for individuals to access more diverse knowledge through communication with others who have different job experiences, backgrounds and information about a specific task (Baggio 2014). In contrast to homogenous knowledge acquired from internal social relationships, external knowledge sharing mostly provides heterogeneous knowledge that can inspire fresh thinking (Liu and Liu 2008) and creativity among individuals (Perry-Smith 2014).

In addition, with the globalisation of software development, knowledge sharing is no longer confined within an organisation or a team, but broadened to cover various software communities (Wang, Wang, Yin, and Yang 2018). Public social media provides a rich set of tools that allow individuals to find information and stay continuously connected to others they share interests with (Hemsley and Mason 2012). For example, Stack Overflow, as a free public social networking site, has facilitated the communal exchange of knowledge between both novice and experienced programmers worldwide. The users of this social networking site post and answer questions related to computer programming and software development and may comment on both questions and answers shared by other users (Jimenez-Mavillard and Suárez 2018; Joorabchi et al. 2016). The screenshot shown in Figure 2.2 illustrates the exchange of knowledge between software developers in Stack Overflow.

Figure 2.2 An example of the exchange of knowledge between software developers in Stack Overflow

As can be seen in Figure 2.2, a developer asked a question about the “Null Pointer Exceptions”. This question received 12 answers posted by other developers. When an answer is posted in Stack Overflow, other members can give a vote to that answer. Stack Overflow lists the answers based on the highest to the lowest vote. In Figure 2.2, the first answer is recognised as the best

answer with 3562 votes. In addition to voting, others can discuss each answer by posting comments on the answer. For example, 23 people discussed the first answer and provided feedback and ideas on it. Furthermore, others are also able to vote on the ideas and information shared through comments on each answer. In this example, the knowledge shared by this group of people was viewed 2,364,249 times by others; see the green box in Figure 2.2.

Due to the effective role of public social media in facilitating software developers' external knowledge sharing and creativity, the current study aims to examine the effects of public social media rather than enterprise social media.

2.4.2 Social media properties

Many studies on social media have focused on what the technology itself does (or does not do) instead of focusing on why the use of technology produces particular effects (Leonardi 2009). For example, research has demonstrated that social media use facilitates communication (Correa et al. 2010) and knowledge management (Sigala and Chalkiti 2015). These studies have assessed the use of social media by measuring actual daily use (e.g., the amount of time spent or the frequency of use). However, few studies have provided insight into why the use of social media produces particular effects. It has been argued that in order to understand the effects of technologies, it is important to identify manifestations of the technologies themselves that lead to specific effects (Ayyagari et al. 2011). Also, the need for a deeper investigation of the IT artefact such as social media is further supported by Nelson (1990) and Orlikowski and Baroudi (1991), who encourage IS researchers to study specific characteristics of technology rather than treating technology in an undifferentiated manner. Therefore, the present study aims to consider social media properties that affect software developers' knowledge sharing and creativity.

The term ‘social media properties’, literally taken, refers to attributes or features of social media. As individuals use social media, it is important to consider how they evaluate social media rather than what social media is comprised of (Ayyagari et al. 2011; Orlikowski and Baroudi 1991). For instance, do they see social media as a platform of knowledge and communication – or do they see social media as a set of technical features? If individuals use social media, do they consider it more effective (e.g., in terms of knowledge management), or do they care about technical features such as a type of processor that is optimised for social media (e.g., Intel new processor, code named Black Butte Ranch that is optimised for social network sites)? Previous research argues that users’ perceptions of technology properties are aligned with their objective assessments of technology properties (Ayyagari et al. 2011). Therefore, this study believes the appropriate term for social media properties would be a user’s assessment of social media properties. However, for the purpose of conciseness, the term social media properties is used throughout this thesis.

Two properties of social media that make it distinct from other communication technologies are visibility of knowledge (social media makes knowledge visible that was once invisible to users) and association (social media provides established connections between individuals) (Leonardi et al. 2013). Social media offers visibility of knowledge and association as two new properties that were difficult or impossible to achieve before this technology was introduced into the workplace (boyd 2014; Treem and Leonardi 2013; Wagner, Vollmar, and Wagner 2014). Through the properties of visibility of knowledge and association, social media expands the range of people, networks and knowledge from whom individuals can learn beyond their organisational borders. Consequently, one of the most important outcomes of these two properties is the increased opportunities individuals have in expanding their knowledge (Leonardi et al. 2013; Treem and Leonardi 2013). Due to the important role of visibility of knowledge and the association with individuals’ knowledge acquisition and sharing beyond

their organisational borders, this study focuses on the relationship between these two properties and software developers' cognitive mechanisms and creativity.

2.4.3 Visibility of knowledge

Visibility of knowledge means that social media makes visible the preferences, information, knowledge, interests and expertise of individuals that were once invisible to other users (Treem and Leonardi 2013; Wagner et al. 2014). Social media, such as wikis and blogs, enables experts to easily describe their experience and skills, and talk about their stories, which is one of the powerful ways to make knowledge visible to individuals who need that knowledge (Panahi et al. 2013). Moreover, social media tools, such as media sharing sites (e.g., YouTube), are useful applications that help experts share their experiences and skills empirically via online video records. Through social media, experts can easily make their knowledge visible to a broad audience such as individuals working in different organisations (Treem and Leonardi 2013). The communal nature of social media affords individuals a place to access published knowledge and experiences, which was impossible to do previously (Wagner et al. 2014). In their study of software developers' weblogs at Microsoft, Efimova and Grudin (2008) concluded that individuals' ideas and personal experiences, that were previously unarticulated or hidden in personal archives, become visible, interlinked and searchable for other individuals.

GitHub, a well-known social media tool, has become a large repository of information for software developers. GitHub spans various sets of software development projects and contains information on the knowledge sharing and contributions of software developers. In Github, all this recorded information is now publicly visible, which provides an invaluable knowledge resource for other software developers (Moqri et al. 2018).

Moreover, the development and maturation of social networking sites such as Stack Overflow and Quora are built around focused communities in which a significant fraction of the

participants have deep expertise in the domain area. One consequence of this trend is that the content of these social networking sites increasingly has lasting value since questions and answers are saved on the site and often prominently ranked via search engines. People in the future who may not even be a priori aware of the site can be directed to the information there. Thus, rather than viewing each answer principally in terms of the immediate information need of the question-asker, the focus in recent years has broadened to further include potentially long-lasting value for people in the future who might have a similar question (Anderson, Huttenlocher, Kleinberg, and Leskovec 2012).

2.4.4 Association

Association refers to the established connections between individuals, which is also referred to as social ties (Treem and Leonardi 2013). Social media technologies allow individuals not only to self-present themselves by sharing and advertising their specialities and abilities in their online profiles but also to articulate and make their social networks visible (e.g., when others can see a person's friends list on Facebook). As a result, one can identify others' skills and expertise, become friends with them and then check their social networks in order to find more experts to expand one's social relationships (boyd and Ellison 2007). Association enables software developers to communicate with experts and participate in collective knowledge sharing through social media to stay informed professionally (Sarka and Ipsen 2017; Sigala and Chalkiti 2015). For example, wikis serve as platforms for software developers for idea exchange, discussion and general knowledge sharing (Sarka and Ipsen 2017; Wang and Wei 2011).

In a social media setting, association is not only actor oriented (e.g., when an actor searches through profiles and friends someone on Facebook). Social media also provides an additional association through technology itself, for example, when Facebook provides friend suggestions to users based on the content of their page or when Stack Overflow suggests a list of experts to

follow in someone's area based on their activities on the website (e.g., the topics that someone searched for or the concept of their questions/answers). These social media tools use tagging algorithms through which they recommend associations to users based on patterns of use and contributed information (Treem and Leonardi 2013). By facilitating interaction among users, social media provides individuals with greater social networks and connections.

In summary, visibility of knowledge and association give software developers the opportunity to access varieties of knowledge about a specific task that can help them think more deeply and flexibly in the execution of their tasks (Liu 2013; Perry-Smith 2006). This study focuses on examining the visibility of knowledge and association offered by social media use and their influence on software developers' creativity. The relationship between the effects of social media properties and software developers' creativity will be explained through two cognitive mechanisms involved in the acquisition and sharing of knowledge.

2.5 Cognitive mechanisms to explain the link between social media properties and creativity

The goal of software development is to take clients' vision and turn it into reality. Developers need to be able to create software based on the client's often vague, confusing and sometimes contradictory vision. To develop software, developers need proper knowledge to track down the inevitable bugs and deal with the details of the hardware and software that they are working with (Cooper 2000; José Gamaliel Rivera-Ibarra et al. 2010). It is against this background that knowledge is defined as facts or ideas acquired by study, investigation, observation or experience (Tockey 1999)

As a result, software developers need to have a certain familiarity with technical knowledge and tools, as well as to understand how they change, how they can be applied to the software developer's work environment and how they can be used to pursue their software development

goals. In this respect, the technical knowledge that each software developer needs to be familiar with includes different programming languages (from C++ to Java, C#, Python and PHP), software design, software-software and software-hardware integration, code optimisation and debugging techniques (Tockey 1999). This underlies the need for software developers to actively manage the knowledge required to perform tasks (Crawford et al. 2012). Knowledge management (KM) is a structured approach to describing the main processes of identifying, capturing, using and sharing knowledge (Rowley 2000). Through KM processes, individuals can expand and internalise their knowledge by adding new knowledge, changing existing knowledge and/or inferring new knowledge (Luhmann 1996).

Several studies have demonstrated the importance of KM in individual creativity. As shown in Table 2.2, individuals' KM has a direct relationship with their creativity in different working contexts (Rhee and Choi 2017), including information technology (Mittal and Dhar 2015; Shujahat et al. 2019), healthcare (Tehranineshat and Rakhshan 2018), tourism (Sigala and Chalkiti 2015), the service industry (Peng et al. 2014), research and development (R&D) (Chen and Hou 2016) and education (Azma and Mostafapour 2011; Yeh et al. 2011, 2012; Zhang et al. 2018). KM also influences the creativity among jazz musicians. Doffman (2012) found that musicians (i.e., a pianist and a guitarist) rely on sharing knowledge (e.g., knowledge of the chords) with each other to improve divergent thinking and creativity in their performance.

Sung and Choi (2012) found that individuals' KM processes provide rich information resources and make diverse ideas available, which offers the opportunity for individuals to recombine existing information and ideas, and to generate novel ideas and solutions. Darroch and McNaughton (2002) also regard KM as an important antecedent of individual creativity and firm innovation. Individuals' knowledge management as a whole can stimulate their critical and creative thinking (Aulawi et al. 2008). When individuals acquire diverse, broad and high

quality information, they combine it with their existing information, which enables them to generate creative ideas in their work (Perry-Smith and Shalley 2003).

Table 2.2 Summary of the selected empirical studies on the importance of KM for individual creativity in different contexts

Author(s)	Findings	Research Context
Shujahat et al. (2019)	The authors found that two knowledge management processes – i.e., knowledge creation and knowledge utilisation – have a direct relationship with worker creativity.	Knowledge workers in the IT sector
Tehranineshat and Rakhshan (2018)	The authors found that there is a significant positive relationship between knowledge management and creativity in nursing students.	Nursing students in the healthcare context
Zhang et al. (2018)	The authors argue that knowledge sharing through information communication technology (Slack and Video conferencing) leads to individual creativity.	Education
Rhee and Choi (2017)	The authors found that employees' knowledge management behaviour is positively related to their creativity.	Different industries including banking, research institutes, telecommunication, consumer service and manufacturing
Chen and Hou (2016)	The authors found that knowledge sharing enhances employee creativity.	Research and development (R&D)
Mittal and Dhar (2015)	Using the data of 348 manager-employee dyads from professionals in IT SMEs, the authors found that knowledge sharing acts as a moderator of employee creativity.	Information Technology (IT)
Sigala and Chalkiti (2015)	The authors maintain that knowledge management in social media enriches people's cognitive and creative processes.	Tourism
Peng et al. (2014)	The authors discuss the importance of enhancing employees' knowledge sharing as part of their creativity.	Manufacturing and service industry
Sung and Choi (2012)	The authors found that knowledge utilisation is positively related to employee creativity.	Sales and marketing
Yeh, Yeh, and Chen (2012)	The findings from both quantitative and qualitative analyses suggest that knowledge management is effective in improving students' knowledge, dispositions and creativity.	Education
Doffman (2012)	The author points out that musicians rely on varying degrees of prior knowledge and interactive conduct during their production. The author argues that musicians' creativity needs to be reimagined not only as a collaborative endeavour but also as a series of differentiated moments in which musicians draw on distinct knowledge resources to fulfil the demand.	Music

Azma and Mostafapour (2011)	The authors argue that the knowledge management process (knowledge creation, knowledge sharing, refining knowledge and group learning) has a significant positive relationship with creativity.	Education
Yeh, Huang, and Yeh (2011)	The authors found that knowledge management (socialisation, externalisation, combination and internalisation) improves teachers' creativity in their work.	Education
Darroch and McNaughton (2002)	Results of the authors' research showed that knowledge acquisition and responsiveness to knowledge are important factors for creativity.	Marketing

Software development is a creative effort that involves the expertise, insights and skills of many developers (Wang, Huang, and Yang 2012). Previous studies have emphasised the importance of software developers' KM for their creativity. For example, Tiwana and Mclean (2005) studied 142 software developers and found that knowledge sharing is the cement of creativity in software development. They argue that knowledge can be created only through interaction between specialists with varying backgrounds of expertise. According to Crawford et al. (2012), software development is knowledge-intensive. Knowledge can be created only when the existing knowledge base is disseminated via interaction between specialists with varying areas of expertise.

Moreover, based on a sample of 52 software development teams, Wang et al. (2012) concluded that software developers' knowledge management enables them to develop skills and competencies because creativity occurs when developers share and combine their personal knowledge with others. Another study conducted with 220 students and 187 practitioners who had previous software development experience found that knowledge enhanced their creativity (Huang and Shiau 2017). Khedhaouria and Ribiere (2013) also evaluated how a software developers' creativity is influenced by the degree of their knowledge management. The results indicated the strong influence of software developers' learning orientation on their creativity.

2.6 Cognitive mechanisms in social media

One of the recent technological advances that has altered individuals' KM in organisations is social media (Hemsley and Mason 2012). Social media is an important knowledge resource that provides updatable documentation and high-quality answers as well as dialogue opportunities for software developers. In social media, knowledge is transferred between participants bilaterally. On the one hand, participants share their knowledge, such as experiences and relevant information, and continue communicating with others. On the other hand, participants receive knowledge, such as downloading resources shared by others (e.g., when software developers download sample codes shared by others in GitHub) so as to enrich their knowledge and come up with creative ideas (Zhang et al. 2018).

Social media tools enable individuals to participate in collective knowledge-related processes by sharing and discussing experiences within various communities (Sigala and Chalkiti 2014). For example, the 'editing of information' function in wikis helps individuals easily collaborate in content creation or new idea generation (Krogh 2012).

In order to explain individuals' KM processes in social media settings, previous studies have suggested a systemic approach to explain the interplay between an individual's cognitive system and their social environment. This approach puts an emphasis on both the internal individual cognitive mechanism and the external collaborative cognitive mechanism taking place in a social media setting (Cress and Kimmerle 2008; Lin and Tsai 2012).

The internal individual cognitive mechanism refers to a process in which individuals engage in social media use to enhance their knowledge by searching, categorising and reading information in online resources (Sigala and Chalkiti 2015). For example, blogs and wikis are open-ended information resources designed to meet individual cognitive needs by providing person-information interactions. Individuals improve their internal KM process by searching

for these information sources and collecting, analysing, interpreting and synthesising the required information they identify (Lin and Tsai 2012). Then, they compare the new knowledge with pre-existing personal knowledge to internalise, adapt, accommodate or assimilate new knowledge (Cress and Kimmerle 2008; Kane 2015). Through internal individual cognitive mechanisms, individuals can access the required information through search mechanisms, without any need for establishing relational connections with the knowledge source.

The external collaborative cognitive mechanism refers to a process in which individuals use social media to build and maintain social interactions with others. The external collaborative cognitive mechanism involves collaborative activities such as sharing, discussing, negotiating, synthesising and (co-)creating knowledge (Lin and Tsai 2012; Sigala and Chalkiti 2015). The advent of conversational technologies such as social networking sites, discussion forums and wikis supports the external collaborative cognitive mechanism through discussions on social networking sites, 'questions and answers' sections in discussion forums and collaborative editing in wikis (Cress and Kimmerle 2008; Kane 2015). Through social interactions, individuals can deepen their personal knowledge and clarify their understanding of the information necessary to complete their task (Luhmann 1996). In other words, through the external collaborative cognitive mechanism, individuals can establish relational connections with knowledge resources (e.g., experts) in order to achieve knowledge by sharing and discussing information with them.

Therefore, based on this systematic approach, software developers have two primary means to seek for information in a social media setting. First, they can rely on the internal individual cognitive mechanism by accessing the required information through search mechanisms, without any need for establishing relational connections with the knowledge source. Second, they can also use the external collaborative cognitive mechanism to establish relational

connections with knowledge resources (e.g., experts) in order to obtain knowledge by sharing and discussing information with them (Jansen and Rieh 2010; Phang et al. 2009).

2.7 Research framework

Since social media expands the opportunities for the enhancement of software developers' cognitive mechanisms, it is important to understand the relation of the effects of social media properties and creativity through cognitive mechanisms. The research model proposed in this study is illustrated in Figure 2.3. This study examines the influence of social media properties on the internal individual cognitive mechanism and the external collaborative cognitive mechanism and, consequently, the effects of these two cognitive mechanisms on two key components of creativity – domain-relevant knowledge and divergent thinking.

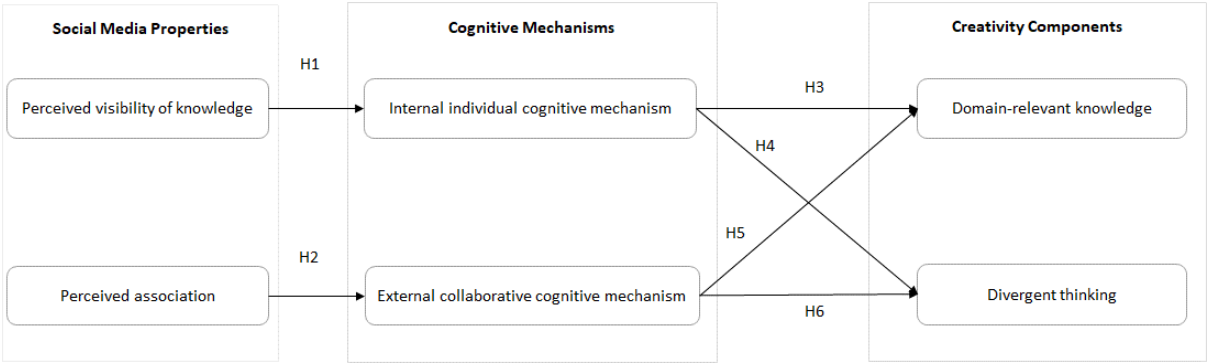

Figure 2.3 Research model

As shown in Figure 2.3, this study aims to evaluate the effects of visibility of knowledge offered by social media on the internal individual cognitive mechanism, and the effects of association offered by social media on the external collective cognitive mechanism. Moreover, this study examines the relationship between cognitive mechanisms – the internal individual cognitive mechanism and the external collaborative cognitive mechanisms – and individuals' domain-relevant knowledge and divergent thinking. These relationships are explained in more detail in the next section.

2.8 Development of research hypotheses

This section explains the relationship between social media properties, namely perceived visibility of knowledge and the association and creativity components of domain-relevant knowledge and divergent thinking, through two cognitive mechanisms, namely the internal individual cognitive mechanism and the external collaborative cognitive mechanism.

2.8.1 Perceived visibility of knowledge and internal individual cognitive mechanism

Perceived visibility of knowledge refers to the degree to which individuals believe that social media provides them with the opportunities to access the required knowledge beyond the organisational borders (Treem and Leonardi 2013). The relationship between perceived visibility of knowledge and the internal individual cognitive mechanism can be explained through the theory of the principle of least effort (O'Leary 2016), which explains that people tend to use a knowledge searching method that involves the least amount of effort and energy to discover and access information (Jansen and Rieh 2010). If individuals perceive that knowledge is difficult to access, or they do not know what information to access, they are unlikely to seek it out (Brown and Duguid 2001).

The principle of least effort explains that the social media user will be more appreciative when they perceive that minimum effort is required to learn features, make use of the applications and perform social-media-related activities such as searching for knowledge (Rauniar et al. 2014). In learning how to use an application programming interface (API) or a programming language, software developers often rely on social media tools such as Stack Overflow. The reason is because software developers believe that Stack Overflow enables them to easily find relevant knowledge that is complete (Yang, Hussain, and Lopes 2016), is of good quality and is easy to reuse in their task (Nasehi et al. 2012).

Perceptions of the visibility of knowledge offered by social media increase individuals' ability to look up and find the necessary expertise in social media settings (Krogh 2012). Thus:

> H1: Software developers' perceived visibility of knowledge offered by social media is positively related to their internal individual cognitive mechanism.

2.8.2 Perceived association and external collaborative cognitive mechanism

Perceived association refers to the degree to which individuals believe that using social media provides them with the opportunity to interact with others beyond their organisational borders (Treem and Leonardi 2013). Knowledge is distributed across networks of people, and individuals' learning depends on their ability to construct and navigate their social networks with others (cf. Siemens's (2014) connectivism learning theory).

Question and Answer (Q&A) websites in which users pose questions to a community of users or answer others' questions, such as Stack Overflow and Quora, are providing a new means for software developers to learn from each other beyond the organisational borders (Nasehi et al. 2012). Software developers prefer to search for knowledge in social media because social media helps them connect with other developers and enables them to learn from one another by asking and answering explicit questions (Murphy-Hill 2014). In addition, the interactive nature of social media tools makes it possible for both questioners and responders to clarify the vagueness in a question/answer (Nasehi et al. 2012). The perceived association offered by social media use empowers individuals to expand their knowledge base through the external collaborative cognitive mechanism that takes place in social networks (Sigala and Chalkiti 2015). Thus:

> H2: Software developers' perceived association offered by social media is positively related to their external collaborative cognitive mechanism.

2.8.3 Internal individual cognitive mechanism and creativity components

The internal individual cognitive mechanism refers to a process in which individuals engage in social media use to enhance their knowledge by searching, categorising and reading information. The internal individual cognitive mechanism provided by social media use can improve software developers' creativity components of domain-relevant knowledge and divergent thinking. In other words, both the domain-relevant knowledge and new ideas necessary for divergent thinking can be obtained through the internal individual cognitive mechanism (Sung and Choi 2012).

Previous research has suggested that software developers who are successful in developing new information systems engage their internal individual cognitive mechanism by searching, digesting, interpreting and assessing the required technical knowledge (Ko and Butler 2007). By seeking information about their field through the internal individual cognitive mechanism, individuals can gain greater domain-relevant knowledge (Kasperson 1978). For example, software developers use microblogs to expand their domain-relevant knowledge by seeking knowledge, ideas and suggestions shared by others in their work communities (Begel et al. 2010).

Individuals using social media for searching, storing and reading task-related information, gain greater knowledge and a stronger ability to generate creative ideas in their work (Sigala and Chalkiti 2015). Software developers can use social media to search and find the knowledge that other developers have shared and left behind on social media to help them gain required knowledge for building new applications (Begel et al. 2010).

The internal individual cognitive mechanism enables individuals to better understand information and explore the connections of work-related concepts and inter-relate meanings in new ways (Sigala and Chalkiti 2015). By searching, categorising and reading information in a

social media setting, software developers enhance their chance of obtaining the required domain-relevant knowledge to complete their tasks (Begel et al. 2010). Therefore:

> H3: Software developers' internal individual cognitive mechanism is positively related to their domain-relevant knowledge.

Moreover, by utilising the internal individual cognitive mechanism in social media, individuals can access a pool of different ideas and possible solutions that can enhance their divergent thinking (Sung and Choi 2012). For example, one of the creative individuals in Nov and Jones's (2006) study of commercial creative processes gave an example of how individual cognitive mechanism helped him improve his divergent thinking ability. He explained that by browsing online sources, he found information that was new for him about alligators' skin and related it to a creative advertisement for a skin product. In another instance, a creative software developer, who was able to suggest at least one creative business idea per day, explained that by utilising the internal individual cognitive mechanism of searching, categorising and reading information, he could find many new and seemingly unrelated ideas about his work and by linking them, he discovered novel ideas and perspectives (Ko and Butler 2007).

Thus, one common method for supporting individuals' divergent thinking is to explore and search for new ideas and perspectives in social media (Siemens 2014). Software developers who are more active in seeking new information and ideas and ways to apply the new knowledge to their day-to-day tasks have greater divergent thinking (de la Barra et al. 2013). By searching, categorising and reading information in social media, software developers can find many new and seemingly unrelated ideas about their work and, by linking them, they can explore novel ideas and perspectives (Ko and Butler 2007). Therefore:

> H4: Software developers' internal individual cognitive mechanism is positively related to their divergent thinking abilities.

2.8.4 External collaborative cognitive mechanism and creativity components

The external collaborative cognitive mechanism refers to a process in which individuals use social media to build and maintain social interactions with others. Software developers' external collaborative cognitive mechanism can facilitate their domain-relevant knowledge and divergent thinking. The relationships among the external collaborative cognitive mechanism and domain-relevant knowledge and divergent thinking can be explained through transfer and constructivist perspectives, respectively (Perry-Smith 2014). These two perspectives describe the types of knowledge (domain-relevant knowledge versus new ideas and perspectives that enhance divergent thinking) that an individual can achieve through collaborative cognitive mechanisms.

The transfer perspective assumes that through the external collaborative cognitive mechanism taking place in social networks, individuals obtain the knowledge required to complete their tasks or to solve problems (Cross and Sproull 2004). External collaboration helps software developers to combine and compare knowledge from diverse disciplines to generate creative ideas (Mohanani et al. 2017). Appropriate social interactions among software developers help them to remove barriers, improve collaboration and learn new knowledge, which plays a crucial role in inducing creativity (Mohanani et al. 2017).

By utilising the external collaborative cognitive mechanism in social media, individuals can improve their domain-relevant knowledge by discussing their experiences and knowledge with others and asking questions for clarification (Gaál et al. 2015). For example, YouTube videos were originally developed to share program execution and explain the relationships between the codes and the programs' outputs to help other software developers acquire the detailed knowledge they needed to complete their tasks (MacLeod et al. 2015). Therefore:

H5: Software developers' external collaborative cognitive mechanism is positively related to their domain-relevant knowledge.

The constructivist perspective explains that, through the utilisation of the external collaborative cognitive mechanism within social networks, individuals may gain access to content that shapes and transforms the way they think about and interpret job-related issues and problems (Cross and Sproull 2004). This perspective assumes that, through social interactions, the answers that individuals receive from others outside organisational boundaries expand their perspectives on key aspects of their jobs. In other words, these new perspectives may improve their divergent thinking. An increase in the external collaborative cognitive mechanism enhances individuals' access to diverse knowledge, ideas and information embodied in other members of a social network. This results in the enhancement of their divergent thinking and the probability of acquiring the specific sources of knowledge needed (Liu, 2013).

The greater the external collaboration between individuals is, the greater is the flow of information and ideas from one individual to another. Individuals, as a consequence, become exposed to a greater variety of new thoughts about, and approaches to work. Such a situation is likely to provide a stimulus for greater divergent thinking (Zhang et al. 2018). The use of social media for externalising, disseminating and discussing information with others within various social networks as well as for combining and generating shared (new) knowledge can further trigger, enrich and expand individuals' cognitive abilities and provide them with stimuli for generating and (co-)creating more and newer ideas/knowledge (Sigala and Chalkiti 2015). Social media increases the flow of knowledge and awareness among software developers, which helps them access different ideas and knowledge (Storey et al. 2010). Thus:

H6: Software developers' external collaborative cognitive mechanism is positively related to their divergent thinking.

2.9 Chapter summary

This chapter began by providing the theoretical background of creativity, social media properties and the cognitive mechanisms applied in this study. In particular, this chapter applied the componential theory of creativity to explain software developers' creativity (Amabile, 1983). Based on this theory, two creativity components were considered in the current study: domain-relevant knowledge and divergent thinking. Also, in terms of social media use, this chapter focused on two properties offered by social media: visibility of knowledge and association. Two cognitive mechanisms, the internal individual cognitive mechanism and the external collaborative cognitive mechanism, were used to explain the effects of individuals' perceptions of social media properties on their creativity.

Next, based on the theoretical foundations, the research model that specifies the hypothesised relationships was developed. The research model incorporates the social media properties (visibility of knowledge and association), the cognitive mechanisms (the internal individual cognitive mechanism and the external collaborative cognitive mechanism) and the creativity components (domain-relevant knowledge and divergent thinking). The following chapter discusses the research design and methodology used to address the research questions articulated in Chapter 1 and evaluates the hypotheses proposed in the current chapter.

Chapter 3: Research design and methodology

Chapter overview

In the previous chapter, a research model was developed to evaluate the relationship between perceived visibility of knowledge and association in social media and two aspects of software developers' creativity – i.e., domain-relevant knowledge and divergent thinking. The relationship between social media properties and creativity components was explained through two cognitive mechanisms – i.e., the internal individual cognitive mechanism and the external collaborative cognitive mechanism.

The current chapter describes the philosophical approach and research design of the study. In addition, this chapter explains the data collection and analysis techniques applied to assess the research model. Also, the measures adopted for each construct of the research model and the control variables are introduced.

3.1 Philosophical approach

This study follows a positivist approach to examine the effects of social media properties on software developers' creativity components. Positivism as a philosophical approach is the belief that reality can be verified through experiments, observation and mathematical/logical proof (Bell et al. 2007; Creswell 2016). Generally speaking, positivist studies try to test theories and enhance the predictive understanding of the research phenomena. Following the positivist perspective, behavioural IS research aims to examine and justify theories that explain human phenomena and use of technology (Orlikowski and Baroudi 1991). Positivist research is based on formal propositions, quantifiable measures and hypothesis testing (Orlikowski and Baroudi 1991). This study follows three important research aspects: research design, data collection and data analysis. These three aspects are explained in the following sections.

3.2 Research design

In order to examine the hypothesised relationships in the research model, a quantitative method was applied. This is because the current research is a confirmatory study that tests the theory and investigates the association among constructs of a research model (Venkatesh et al. 2013). This study investigates the statistical relationship between social media properties – visibility of knowledge and association – and two key components of creativity, namely domain-relevant knowledge and divergent thinking. This study is based on correlational design as a non-experimental quantitative method that measures the association among six variables (perceived visibility of knowledge, perceived association, the internal individual cognitive mechanism, the external collaborative cognitive mechanism, domain-relevant knowledge and divergent thinking) (Creswell 2016). Correlational research is used to examine if changes in one or more variable are related to changes in another variable(s). This is referred to as co-variance. Correlations analyse direction, degree, magnitude and strength of the relationships or associations between the variables of the research model.

The survey method was adopted to collect data. The survey method was chosen to collect data from software developers in a natural situation without manipulating the study environment (e.g., manipulating the variables). A survey design can provide a quantitative description of the opinions of the population (software developers). This is conducted by studying a sample of a population which later can be generalised to other members of the population (software developers) (Newsted et al. 1998). A survey design allows the researcher to determine the values and relations of the variables and constructs in the research model (Newsted et al. 1998).

This study applied an explanatory approach because its main objective is to hypothesise and test the effects of software developers' perception of social media properties on their cognitive mechanisms and creativity components. An explanatory research is useful to find causal

relationships among variables in a model – in other words, to investigate theory-based expectations on how and why variables should be related (Malhotra and Grover 1998).

In addition, in terms of the design of the survey research, a cross-sectional design was used. In a cross-sectional design, data is collected at a point of time from a selected sample (Bell et al. 2007; Creswell 2016). This means that data was collected at a certain period of time from the chosen sample of software developers.

3.2.1 Survey population and sampling

In the survey method, data is collected from a sample that represents the population of the study with the intention of generalising the findings from the sample to the main population (Malhotra and Grover 1998). The population of interest in this study was software developers that use social media to gain knowledge for job-related tasks. In particular, this study focused on public social media (e.g., Stack Overflow) rather than enterprise social media (e.g., Yammer, Socialtext). Using public social media, software developers can communicate and share information with each other beyond their organisational borders. This study targeted software developers in New Zealand that were currently working on software development projects and were active users of social media to gain knowledge for their job-related tasks.

For this study, both online and paper-based surveys were used to collect data from software developers. The online survey was conducted via Survey Monkey. Software developers were contacted via widely known and large IS developers' community websites such as https://www.meetup.com/cities/nz/ and also through several general online media sites (e.g., New Zealand developers' community in LinkedIn, Facebook). The paper-based survey was conducted by participating in software development workshops and meetup groups and asking software developers to complete the survey.

3.2.2 Ethical considerations

The ethical guidelines set by the Auckland University of Technology Ethics Committee (AUTEC) were strictly adhered to throughout the data collection process of this study. Ethical approval for collecting data from participants was granted by AUTEC prior to conducting the actual survey on 7 February 2017. The ethics application approval letter and participant information sheets are available in Appendices A, B and C.

According to AUTEC, a research study needs to adhere to the principle of partnership, participation and protection. In particular, the participant information sheet for this study provided the research title and an introduction to the researcher and the research goal. It specified that this study was part of a PhD programme with the objective of examining the effects of social media properties on software developers' creativity. The contact details of the researcher were disclosed to participants so that they could follow up with any concerns/questions.

Participants were informed through the participant information sheet that their participation in this study was entirely voluntary and could be withdrawn at any stage of their participation.

In addition, participants were informed that their participation in this study is completely anonymous and this study does not involve any sensitive questions that may harm them. Also, participants were informed that their privacy will be managed by not identifying them in the process of data analysis. All the collected information is kept confidential and stored in a secured place that only the researchers who are engaged in this research have access to. Participants were informed that the collected information would be used for a PhD thesis and related academic publications and no information on specific individuals would be identified in any of these publications.

3.3 Measures

As explain in Chapter 2, the research model of this study has six constructs: perceived visibility of knowledge, perceived association, the internal individual cognitive mechanism, the external collaborative cognitive mechanism, domain-relevant knowledge and divergent thinking (see Figure 2.3).

The review of the relevant literature on IS and human-computer interactions (HCI) revealed no context-specific instrument to measure perceived visibility of knowledge in social media. Therefore, I first developed a context-specific conceptualisation of perceived visibility of knowledge in social media and developed a reliable and validated instrument to measure this construct – this process is explained in the next chapter. For the rest of the constructs in the research model (i.e, perceived association, the internal individual cognitive mechanism, the external collaborative cognitive mechanism, domain-relevant knowledge and divergent thinking), the validated measurement items were adapted from previous studies. These measurement items were slightly modified and adapted to the context of the research.

Since it was difficult to obtain objective measures or supervisor reports of creativity components, this study focused on self-reported creativity components (domain-relevant knowledge and divergent thinking). This study aimed to conduct an initial test of the effects of software developers' perception of social media properties on their creativity components using a large sample of developers currently working on software development projects. Among the prior studies on creativity, two groups of research highlight the interpretation of self-reported creativity. One group of creative research shows that self-reported creativity relates to objective measures of creativity. For example, Furnham, Zhang, and Chamorro-Premuzic (2005) demonstrated that self-reported creativity is significantly related to creativity as measured by the Barron Welsh Art Scale (which is a Freudian-based assessment in which the participant is asked to draw images). Further, Park, Lee, and Hahn, (2002) found that self-reported creativity

is significantly correlated with scores on the Torrance Tests of Creative Thinking (which attempts to measure the divergent-thinking skill in two domains, verbal and figural).

It is also important to emphasise that another group of creative research argues that self-reported creativity is more likely to reflect individuals' self-efficacy and motivation with regard to creativity than their objective creativity (Reiter-Palmon et al. 2012; Zacher et al. 2016). In particular, creativity scholars have argued that individuals' self-efficacy and motivation regarding creativity are important constructs in their own right, as they are associated with valued outcomes other than objective measures of creativity. For example, Silvia, Wigert, Reiter-Palmon, and Kaufman (2012) explain that self-assessments of creativity are of practical value because individuals use their self-assessments when making high-stakes decisions such as choosing social partners and career paths. Moreover, Kurtzberg (2005) acknowledges the difference between objective and subjective measures of creativity and describes several benefits of self-report measures of creativity. First, self-assessments of creativity are more closely related to affective measures (e.g., personal fulfilment, positive emotions and self-esteem) than objective measures and therefore represent a "subjective force that shapes our perceptions of ourselves and the world around us" (Kurtzberg, 2005, p. 51). Second, self-assessments of creativity can translate into actual active performance over longer time frames by creating self-fulfilling prophecies and strengthening individuals' commitment to implementing their creative ideas, as well as by reducing individuals' feelings of inconsistency between their self-assessments and behaviour. Finally, individuals with high self-assessments of their creativity may be more open about their own and others' creative thoughts and behaviours in the future (Kurtzberg 2005).

Therefore, the use of self-rated measures of creativity in this study was regarded as a suitable approach. Previous research has highlighted two assumptions in measuring self-assessment creativity: first, participants should be aware of what is being asked (personality traits, values

or creativity components). Second, participants should be willing to report them accurately (Reiter-Palmon et al. 2012). In designing the survey of this study, software developers were informed about the creativity components and encouraged to answer the questions accurately.

In addition, although self-reported creativity has been examined in a variety of studies, some researchers have recently demonstrated that perceptions regarding one's ability to be creative is domain-specific (Baer 2015; Kaufman et al. 2010; Reiter-Palmon et al. 2012). Reiter-Palmon et al. (2012) found differences in self-assessments of creative ability across three different domains: work, school and hobbies. They argue that believing that a person can be creative in a hobby does not necessarily translate into beliefs about this person's ability to be creative in a work setting. In this regard, previous research has recommended that researchers ensure that the measures used for creativity reflect the domain of interest (Reiter-Palmon et al. 2012). Therefore, in this study, software development (as the domain of the study) was emphasised in the measurement items of creativity components (domain-relevant knowledge and divergent thinking). These scales assessed the degree to which software developers believe that they have divergent thinking and domain-relevant knowledge in software development projects.

Table 3.1 shows the validated measurement items used in this research. These measurement items were slightly modified and adapted to the context of this research.

Table 3.1 Measurement items

Construct	Items	References
Perceived Association	• Social media provides various means to support my communications with other software developers • Social media supports various online events for me and other software developers to experience together • Social media provides various supports for me and other software developers to get together online	Son, Lee, Cho, and Kim (2016)
Internal individual cognitive mechanism	• I use social media to read information related to my work-related task. • I use social media to search and collect information related to my work-related task • I use social media to gather and categorise work-related information • I use social media to adapt information to my work-related problems	Sigala and Chalkiti (2014, 2015)
External collaborative cognitive mechanism	• I update my personal profile and status in social media • I share information to be discussed in social media • I become a member of professional networks in social media • I identify experts for debating information in social media • I use social media to participate in online discussions for creating new knowledge • I compare information in social media to come up with new ideas	Sigala and Chalkiti (2014, 2015)
Domain-relevant knowledge	• I have a good technical knowledge concerning my tasks in software development projects • I have a good knowledge of the applications (e.g., programming apps) that are used in software development projects • I can troubleshoot the software development-related problems by myself	Faullant, Schwarz, Krajger, and Breitenecker (2012); Jiang et al. (2018)
Divergent thinking	• I am interested in everything related to software development projects • Logic puzzles fascinate me • When I come across a problem in my job, I think it through thoroughly • I can evaluate a work-related issue from different points of view • During my work, when I come across a problem that I cannot solve immediately, I try to find out more information • I want to know about every detail related to software development	Faullant et al. (2012); Jiang et al. (2018)

As shown in Table 3.1, software developers' perceptions of association were assessed by a three-item scale presented by Son et al. (2016). The reliability and validity of these three items have been reported in previous studies (Phang et al. 2009; Son et al. 2016). Based on previous studies (Sigala and Chalkiti 2014, 2015), 10 items were used to measure the cognitive mechanisms: four items related to the internal individual cognitive mechanism and six items related to the external collaborative cognitive mechanism. To assess domain-relevant

knowledge, this study used three measurement items, and to assess divergent thinking, this study used six measurement items proposed by Faullant et al. (2012). The scales of both domain-relevant knowledge and divergent thinking have been used in previous research and their high reliability and validity have been reported (Faullant et al. 2012). All items of this study utilised a 7-point Likert scale (1 = strongly disagree; 7 = strongly agree).

As mentioned earlier, the review of the literature revealed that there is no validated instrument to measure perceived visibility of knowledge. For this reason, I developed an instrument to undertake this measurement. Once the validity of the items for the perceptions of visibility of knowledge was tested and the final items were set, I added items relating to the constructs, shown in Table 3.1 (perceived association, the internal individual cognitive mechanism, the external collaborative cognitive mechanism, domain-relevant knowledge and divergent thinking), to the newly developed items and designed the final survey.

3.4 Control variables

This research controlled for age and gender in the model relating to both divergent thinking and domain-relevant knowledge. It has been reported that age is significantly related to domain relevant knowledge (Faullant et al. 2012). In his study, Massimiliano (2015) also found that the age of peak divergent thinking was 40 years or younger. The ability of divergent thinking stabilised for participants in the 40-69 age bracket and declined for participants who were 70 years or older.

In addition, gender has been controlled for divergent thinking and domain-relevant knowledge in previous studies. Dewett (2007) examined the impact of gender on the divergent thinking of research and development (R&D) employees and concluded that males have a greater divergent thinking ability and they are more likely to take risks and to be creative in their work. Faullant et al. (2012) found that men have a different thinking style than women and that the divergent

thinking ability is more pronounced in men than women. The result also showed that men have more technical education and background than women, hence men have more domain-related knowledge than women (Faullant et al. 2012).

3.5 Data analysis techniques

Structural equation modelling (SEM) was used to test the research model. SEM is a modelling tool that empowers researchers to model relationships among multiple variables and statistically test a previously conceptualised theoretical assumption (Preacher et al. 2011). SEM includes measurement models that link the observed variable (items) to the latent variables (constructs), and a structural part that links the latent variables to each other by applying systems of simultaneous equations (Nachtigall et al. 2003). SEM was chosen to analyse the dataset due to its ability to investigate multiple relationships between a variable and its indicators and to evaluate the hypothesised relationships among variables in the structural model (Hair, Anderson, Tatham, and Black, 1998).

The two techniques of SEM are covariance-based SEM and Partial Least Squares (PLS). Covariance-based SEM examines all covariances (or correlations depending on how the model is run), including those that are not specified in the model. PLS, on the other hand, examines the proposed model alone and ignores any other covariance that is not explicitly specified in the model (Straub et al. 2004). In this study, covariance-based SEM was applied to analyse the data because the goal is to validate the proposed model (Straub et al. 2004).

I applied SPSS (Statistical Package for the Social Sciences) Version 24 and AMOS (Analysis of Moment Structures) Version 25 to perform the statistical tests. In particular, AMOS was used to perform Confirmatory Factor Analysis (CFA) through SEM using a two-step analytical approach. Before evaluating the structural model, the reliability and validity of the measurement model is assessed.

3.5.1 Validity consideration of the measurement model

The measurement model is a sub-model in SEM that (1) specifies the indicators (measurement items) for each construct, and (2) assesses the reliability of each construct for estimating the causal relationships (Gefen et al. 2000; Straub et al. 2004). Measurement model validity estimates how well an instrument measures what it purports to measure in terms of its match with the entire definition of the construct.

In positivist research, a properly validated and reliable measurement model gives the researcher confidence that the collected data represents the characteristics of the population of interest (Straub et al. 2004). In other words, the respectability of the research findings highly depends on the validity and reliability of the measurement model. In this study, validation of the measurement model was assessed by testing internal consistency, convergent and discriminant validity (Gefen et al. 2000).

Internal consistency

Internal consistency is a general term used for estimating the reliability of each construct. Internal consistency assesses the within-scale consistency of the responses to the items belonging to each construct. If the scores from each of the items of the same construct correspond highly with each other, it can be said that the construct demonstrates an accepted reliability (Straub et al. 2004). Reliability is the commonly used statistic for evaluating internal consistency (Straub et al. 2004). The philosophical foundation of reliability explains that the researcher is attempting to find proximal measures of the 'true scores' that perfectly describe the phenomenon (Straub et al. 2004). Cronbach's alpha (α) is a commonly used internal reliability technique to assess internal consistency. The recommended threshold for Cronbach's alpha is .70 (Mackenzie et al. 2011).

Although, Cronbach's alpha is most often used to measure reliability, its applicability is greatly undermined by the fact that it is related to the number of items forming the construct. This means that a large number of items related to one construct will often yield high alphas even if some items are not highly related to the other items of the same construct. The reason is that Cronbach's alpha underestimates internal consistency as it assumes all items measuring the same construct are equally weighted (Hair et al. 1998).

An alternative technique to measure internal consistency is construct reliability (Fornell and Larcker 1981). Construct reliability, also called composite reliability (CR), assumes that items measuring the same construct may have different loadings (Fornell and Larcker 1981). A value of more than .70 for CR indicates that the items of a construct have satisfactory internal consistency (Fornell and Larcker 1981)

Convergent validity

Convergent validity means the extent to which indicators (items) of a specific construct share a high proportion of variance in common. In other words, convergent validity means all items reflecting a specific construct are in agreement in measuring the same construct (Straub et al. 2004). To check convergent validity, the loading of each item on the intended construct should be checked. Item-to-construct loadings should be at least .70 or higher at the significant level of .05 to indicate that the intended construct explains at least 50 percent of the variance of its item (Hair et al. 1998).

In addition to measuring the loading of each item on the intended construct, the average variance extracted (AVE) should be calculated. AVE measures the percent of variance captured by a construct by showing the ratio of the sum of the variance captured by the construct and measurement variance (Straub et al. 2004). AVE should be .50 or greater to suggest adequate convergent validity (Mackenzie et al. 2011). The cut-off value of .50 for AVE indicates that at

least 50 percent of variance of the observed variable (measurement items) accounts for variance of its own latent variable (construct) (Fornell and Larcker 1981). An AVE of less than .50 indicates that on average, there is more error remaining in the items than there is variance explained by the latent factor structure that has been imposed on the measure.

Discriminant validity

In addition to convergent validity, it is also important to show that the items of each construct are distinguishable from the items of the other constructs (Mackenzie et al. 2011). This is called discriminant validity. In other words, discriminant validity is the extent to which a construct is truly distinct from other constructs. The rule of thumb for construct discriminant validity estimation is that the average variance extracted (AVE) should exceed the maximum shared variance (MSV) of all the constructs (Hair et al. 1998).

Table 3.2 provides a summary list of the validation guidelines applied to examine the measurement model.

Table 3.2 Validation guidelines applied in this study

Validity Component	Technique	Guidelines
Internal consistency	Cronbach's α	≥.70
	Composite reliability	≥.70
Convergent validity	Item-to-construct loading	≥.70
	AVE	≥.50
Discriminant Validity	AVE, MSV	AVE>MSV

After assessing the reliability and validity of the measurement model, I assessed the structural model and checked the strength of the relationships among the constructs of the model. The structural model consists of the hypothesised relationships among the constructs, where paths connect the constructs with each other (Tabachnick and Fidell 2001). SEM estimates the strength of the hypothesised relationships between the constructs in a theoretical model and compares the model to the empirical data. In this study, this comparison was done by means of fit statistics. The fit statistics was applied for accepting or rejecting the hypothesised

relationship for both the structural model (relationships between the latent variables) and measurement model (relationships between the observed and latent variables).

3.5.2 Fit indexes

The fit indexes provide a good indication of the extent to which the measurement model accounts for the covariance in the data. Low-fit-statistics indicate that the measurement model is not supported by the data (Straub et al. 2004). Covariance-based SEM takes into account the whole matrix of covariances, including those that are not explicitly specified in the model. For example, if the items in construct A are highly correlated with items in construct B, but the researcher neglects to explicitly specify that construct A is correlated with construct B, this will result in unacceptable low-fit-indexes (Straub et al. 2004). The three categories of fit indexes are absolute fit indexes, incremental fit indexes and adjusted fit indexes. Absolute fit indexes determine how well an estimated model closely fits the observed data (Hair Jr et al. 2016). One popular absolute fit index is the chi-square (X^2) statistic which reflects the 'exact fit index' (Hair et al. 1998). Mackenzie, Podsakoff and Podsakoff (2011) explain that although the chi-square statistic provides the best inferential test of overall model fit, its usefulness is greatly undermined by the fact that it has been found to be related to sample size, model complexity and nonnormality. Therefore, it is important to rely on other goodness of fit indexes to evaluate the extent to which the relationships hypothesised in the measurement model are consistent with the sample data (Hu and Bentler 1999). To address the 'exact fit' issue with large samples, the relative chi-square (the chi-square divided by the degree of freedom (df)) can be considered as an alternative fit index (Lomax and Schumacker 2004). The relative chi-square (X^2/df) indicates a good fit when its value does not exceed the cut-off point of three (Lomax and Schumacker 2004).

Another absolute fit index is the root mean square of approximation (RMSEA) that assesses how approximately the model fits the data. A RMSEA value less than .06 indicates a good fitting model (Hu and Bentler 1999; Mackenzie et al. 2011) and a RMSEA value less than .08 indicates a mediocre fitting model (Chau 1997). Root mean square residual (RMR) is another absolute fit index that should have a value less than .10 for a good fitting model (Chau 1997). As it is sometimes difficult to measure an unstandardised residual, since the scale of the variables affect the size of the residual, a standardised root mean square residual (SRMR) can be used as an alternative index to interpret an unstandardised residual (Tabachnick & Fidell, 2001). For SRMR, a value of .80 or less is accepted (Hu and Bentler 1999) and a value of .06 or less is desirable (Mackenzie et al. 2011).

The second category of fit indexes is incremental fit indexes, which examine how well a specified model fits relative to a baseline model (Hair et al. 1998). Normed fit index (NFI) is an incremental measure of fit index. Within the covariance-based SEM, NFI measures the normed difference in X^2 value between a single factor null model (baseline model) and a proposed multi-factor model (Straub et al. 2004). The recommended threshold for NFI is .80 for a reasonably fitting model (Tabachnick & Fidell, 2001) and .90 for a perfectly fitting model (Chau 1997). Non-normed fit index (NNFI or the Tucker-Lewis index [TLI]) is another incremental fit index. TLI was developed based on the disadvantage of NFI, which is affected by sample size. The cut-off value of TLI is .95 for a perfectly fitting model (Hu and Bentler 1999) and .90 for a reasonably fitting model (Tabachnick & Fidell, 2001).

Another incremental fit index is the comparative fit index (CFI), which indicates the extent to which the model accounts for the variance. The recommended threshold for CFI is .90 for an acceptably fitting model (Tabachnick & Fidell, 2001) and .95 for a perfectly fitting model (Hu and Bentler 1999). An adjusted fit index, known as a parsimonious fit index and labelled as an

adjusted goodness of fit index (AGFI), adjusts the GFI based on the number of parameters in the model. The most common recommended cut-off value for AGFI is .80 (Chau 1997).

Regarding which fit indexes should be reported, researchers maintain that fit indexes should be chosen from different fit index families. For example, McDonald and Ho (2002) suggest that the most common fit indexes are CFI, GFI, NFI and TLI. Hu and Bentler (1999) recommended a fit index presentation should always include SRMR, TLI, RMSEA and CFI, while, Kline (2015) strongly believes in reporting the Chi-Square, RMSEA, CFI and SRMR.

As shown in Table 3.3, the fit indexes reported in this study are: relative chi-square (X^2/df), RMSEA, SRMR, CFI, NFI and TLI. Table 3.3 shows the recommended cut-off values for reasonable fit and perfect fit.

Table 3.3 Recommended cut-off values for goodness-of-fit indexes

Fit Indexes	Cut-offs for Reasonable Fit	Cut-offs for Perfect Fit
Chi-square/degree of freedom	$1 \leq X^2/df \leq 3$	$1 \leq X^2/df \leq 2$
RMSEA	$\leq .08$	$\leq .06$
SRMR	$0 < SRMR < .10$	$\leq .08$
CFI	$\geq .90$	$\geq .95$
TLI	$\geq .90$	$\geq .95$
NFI	$\geq .80$	$\geq .90$

Among the fit indexes shown in Table 3.3, SRMR is sensitive to models with misspecified factor covariance(s) or latent structures(s) (Hu and Bentler 1999). Also, TLI is relatively unaffected by sample size or by the number of parameters in the model (Anderson and Gerbing 1991). Finally, CFI and RMSEA are the most frequently reported indexes (Tabachnick & Fidell, 2001). RMSEA is a sensitive index of models with misspecified factor loadings and varies with the number of variables in the model (Kenny et al. 2015).

3.5.3 Validity consideration of the structural model

The structural model is a set of one or more dependent relationships linking the model constructs. The structural model is useful in representing the interrelationships of constructs between dependence relationships (Gefen et al. 2000; Straub et al. 2004).

The structural model consists of the hypothesised relationships among the constructs, where paths connect the constructs with each other (Tabachnick and Fidell, 2001). Once the results of the measurement model of this study were accepted, the structural model was evaluated to assess the strength of relationships among the constructs. To validate the structural model, the path coefficients (β) and the coefficient of determination (R^2) were evaluated.

To test the relationships between constructs in the structural mode, the value of path coefficients (β) should be examined in terms of sign, magnitude and significance. A path coefficient sign can be either positive or negative, indicating the direction of the relationship. A path magnitude indicates the coefficient between the independent variable and the dependent variable and is represented by the standardised path coefficient in the AMOS output. In terms of the significance of the relationship, the p value of the path coefficient shows whether the relationship is significant and at what level (Hair et al. 1998). A standardised path coefficient should exceed .148, at least at the significant level of .05, to draw the conclusion that the hypothesised path in the structural model is meaningful (Cohen et al. 1990).

In SEM, the variable's coefficient of determination (R^2) measures the proportion of variance in the dependent variable that is predicted by the corresponding independent variables (Hair et al. 1998). In order for the structural model to show a certain level of predictive ability, the value of the coefficient of determination (R^2) should be sufficiently large. Generally, the value of the coefficient of determination (R^2) can be in the range of 0 to 1, where $R^2 = 1$ indicates a perfect fit.

3.6 Chapter summary

This chapter described the research design and methods used in the current research. This study follows a positivist approach to examine the effects of social media properties on software developers' creativity components. In particular, in order to answer the research questions by examining the hypothesised relationships, a quantitative method was chosen for this study. This research is based on a correlational design as a non-experimental quantitative method measureing the association between six variables (perceived visibility of knowledge, perceived association, the internal individual cognitive mechanism, the external collaborative cognitive mechanism, domain-relevant knowledge and divergent thinking). Also, a survey method was chosen as the correct research technique for this study.

This chapter also explained that due to the lack of validated items for measuring the perceptions of visibility of knowledge, I first developed an instrument that specifically and directly measures this construct. Once this instrument was validated, I then tested the research conceptual model. The following chapter describes the procedure followed to develop an instrument for perceived visibility of knowledge.

Chapter 4: Perceived visibility of knowledge: conceptualisation and instrument development

Chapter overview

One property of social media that makes it distinct from other communication technologies (e.g., email, instant messaging and tele-conferencing) is visibility of knowledge (boyd, 2014). Visibility of knowledge means that social media enables individuals' previously invisible preferences, knowledge and expertise to become visible to other users (Wagner et al. 2014). Other communication technologies afford some degree of visibility of knowledge, but not to the extent of social media, which allows information to be made visible to multiple audiences (Treem and Leonardi 2013). For instance, a status update on a social networking website can be made visible to part or the whole of a member's social network (Vaast and Kaganer 2013) or even to users who are not members of that social network (i.e., public posts on social networking sites). Most research on visibility of knowledge in online resources has focused on how to make information more visible for end users. For example, visibility of knowledge can be increased by improving technical features, such as search engine operations (i.e., building a practical search engine which can make additional information present in hypertext visible to the users) (Brin and Page 2012) or cloud services (Vijaya and Neelanarayanan 2016).

However, the review of the relevant literature on IS and human-computer interactions (HCI) revealed no context-specific instrument for measuring perceived visibility of knowledge in social media. The current work addressed this issue by developing a context-specific conceptualisation of perceived visibility of knowledge in social media and a reliable and valid instrument to measure this construct. Once this instrument had been validated, I empirically tested the conceptual model (the influence of two properties of social media – i.e., perceptions of visibility of knowledge and association – on two aspects of creativity – i.e., domain-relevant knowledge and divergent thinking) and assessed its fit to the collected data through SEM. This

chapter explains the procedure followed to develop an instrument for perceived visibility of knowledge in social media.

4.1 Scale development procedure

To develop and validate a context-specific conceptualisation and measures for perceived visibility of knowledge in social media, this study followed the 10-step procedure proposed by Mackenzie et al. (2011), as shown in Figure 4.1.

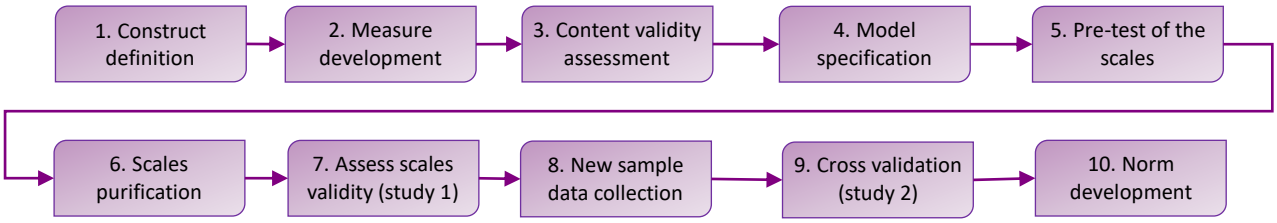

*Figure 4.1 10-step scale development procedure; adapted fro*m (Mackenzie et al. 2011)

The development and validation procedure began with the conceptualisation of the focal construct and perceived visibility of knowledge, and ended with the development of norms for the scales. Each of the steps shown in Figure 4.1 is discussed in the following sections.

4.2 Step one: Develop a conceptual definition of the construct

The first step of the scale development and validation process was to develop a conceptual definition of perceived visibility of knowledge, the focal construct in this study. This step is crucial in instrument development because the lack of a detailed conceptualisation of perceived visibility of knowledge could result in significant measurement errors during the rest of the research processes (MacKenzie 2003; Mackenzie et al. 2011). During this step, I specified the nature of perceived visibility of knowledge and its conceptual theme using unambiguous terms (MacKenzie, 2003).

This step not only required the identification of what perceived visibility of knowledge is intended to conceptually represent or capture, but also a discussion of how this construct differs

from other related constructs (Mackenzie et al. 2011). Table 4.1 summarises the key criteria considered in this step of instrument development.

Table 4.1 Factors to consider in perceived visibility of knowledge conceptualisation; adapted from Mackenzie et al. (2011)

Factor	Considerations
Examine how perceived visibility of knowledge has been used in prior research or by practitioners	• Literature review of previous theoretical and empirical research on perceived visibility of knowledge • Literature review on the meaning of related construct(s) • Conduct preliminary research with subject matter experts and/or practitioners
Specify the nature of perceived visibility of knowledge's conceptual domain	Identify the entity to which perceived visibility of knowledge applies and the type of property it represents
Specify the conceptual theme of perceived visibility of knowledge	Describe the necessary and sufficient attributes/characteristics as narrowly as possible • Common attributes/characteristics • Unique attributes/characteristics Dimensionality • Unidimensional • Multidimensional
Define perceived visibility of knowledge in unambiguous terms	• Provide clear, concise, conceptual definition of perceived visibility of knowledge • Should not be subject to multiple interpretations • Should not be overly technical • Should define perceived visibility of knowledge positively, not by the denial of other things; negation of one thing does not imply the affirmation of something else • Should not be circular or tautological or self-referential

As indicated in Table 4.1, at first, I examined how perceived visibility of knowledge has been defined in prior research, and conducted interviews with subject-matter experts and/or practitioners (Mackenzie et al. 2011). As further explained in the following section, these two methods were applied to identify potential attributes of perceived visibility of knowledge by collecting a representative set of definitions (Podsakoff et al. 2016).

4.2.1 Survey of the literature

The goal in surveying the literature was to collect a representative set of definitions of perceived visibility of knowledge and extract attributes and characteristics that other researchers consider critical to its definitions (Podsakoff et al. 2016). To identify the various ways in which perceived visibility of knowledge has been defined previously, I searched for the terms 'visibility of knowledge/information/content' in leading IS journals, namely, *MIS*

Quarterly, *Information Systems Research*, *Information Systems Journal*, *Information and Management*, *Journal of the Association for Information Systems*, *Information and Organization*, *Journal of Computer-Mediated Communication*, *Journal of Enterprise Information Management*. While surveying the literature, I kept track of (a) the different definitions that have been used in the literature and (b) the frequency with which these definitions have been reported (Podsakoff et al. 2016). When the definitions and usages of perceived visibility of knowledge became highly redundant, it was a signal for me to terminate the search (Podsakoff et al. 2016). As shown in Table 4.2., the key attributes of previous conceptualisations of perceived visibility of knowledge are ease of access, broadness of information, findability, appropriateness of information, timeliness, accuracy, availability, diversity and up-to-datedness.

Table 4.2 Summary of prior conceptualisations and key attributes for perceived visibility of knowledge

Study	Conceptualisation of Perceived Visibility of knowledge	Key Attributes
Treem and Leonardi (2013)	"If social media technologies enable people to easily and effortlessly see information [shared by] someone else, we say that the technology was used to make that person's knowledge visible." (p. 150) "Notion of visibility is tied to the amount of effort people must expend to locate information." (p. 150)	Ease of access
Leonardi and Treem (2012)	"Visibility of knowledge allows users to display all materials (e.g., descriptions, instructions, reports) to others." (p. 150)	Broadness of information
Michener and Bersch (2013)	Visibility of knowledge means "the degree to which information is complete and easily located." (p. 237) Visibility of knowledge means "the degree to which information is complete and findable." (p. 238)	Broadness of information, Ease of access
Leonardi, Huysman, and Steinfield (2013)	"Visibility is tied to the amount of effort people must expend to locate information." (p. 3)	Ease of access
Ellison, Gibbs, and Weber (2015)	Visibility means, "the content is more likely to be 'found' using search tools, tagging, or other means of increasing the findability of the answers." (p. 115) Visibility of knowledge of social media tools "may facilitate knowledge sharing by making it easier to identify distributed expertise." (p. 110)	Findability, Ease of access
Sherman and Price (2003)	Information is visible when "the websites return the specific types of content [related to a topic]." (p. 290) The visible web content means that "users know what is available and have them ready to go." (p. 298) "A web content is invisible when it is not easily located with the information-seeking tools used by users." (p. 282)	Appropriateness of information, Timeliness, Ease of access
Goswami, Engel, and Krcmar (2013)	"The extent to which information is available to different members of the network will determine the visibility within the network." (p. 279) "Information visibility refers to having access to relevant information that can be used for various decision making." (p. 279) To provide the required visibility of knowledge "the systems should deliver a variety of information that is needed to support decision making." (p. 279)	Availability, Appropriateness of information, Accuracy, Diversity of information
Sedighi and Isaai (2017)	"Visibility of knowledge is a property of social media that enable users to save time in finding knowledge contents and experts." (p. 48)	Timeliness
(Wang and Wei (2007)	"Information visibility means that an information demander has accurate [and] up-to-date information." (p. 647)	Up-to-datedness

4.2.2 Distinguishing perceived visibility of knowledge from other related constructs

The first step of instrument development not only requires the identification of what perceived visibility of knowledge is intended to conceptually represent or capture, but also a discussion

of how it differs from other related constructs (Mackenzie et al. 2011). The importance of distinguishing perceived visibility of knowledge from other constructs is that it helps to distinguish the attributes that define perceived visibility of knowledge from the attributes that define other constructs. Also, it diminishes the possibility of concept proliferation and identifies the concepts that could be used in empirical tests of the measures of the focal concept's discriminant validity (Podsakoff et al. 2016). This requirement is consistent with Churchill's (1979) recommendation that when specifying the domain of a concept, ''the researcher must be exacting in delineating what is included in the definition and what is excluded'' (p. 67). For this aim, surveying the literature was helpful since it provided critical information about those concepts from which perceived visibility of knowledge should be distinguished (Podsakoff et al. 2016).

One construct that is often conflated with perceived visibility of knowledge is perceived transparency of information (Stohl et al. 2016). The reason for this conflation is that both perceived visibility and transparency of information are considered to be users' perceptions of the ability of information to be seen (Flyverbom 2015). However, it is important to note that visibility of knowledge is distinct from transparency in the sense that visibility of knowledge enables transparency of information (Michener and Bersch 2013; Stohl et al. 2016). In other words, visibility of knowledge constitutes transparency of information. Two indicators of transparency of knowledge are enhanced visibility of knowledge and increased understandability of information (Schnackenberg and Tomlinson 2016). Previous research has defined transparency of information as the ability of users to see the information (visibility of knowledge) and draw accurate conclusions from information (inferability) (Michener and Bersch 2013; Schnackenberg and Tomlinson 2016). In fact, not only is the concept of visibility of knowledge different from transparency but also visibility of knowledge does not guarantee transparency. Stohl et al. (2016) argue that sometimes information is visible but not necessarily

transparent; instead, transparency is achieved by understanding the information that users see (DiStaso and Bortree 2012). Therefore, it can be concluded that perceived visibility of knowledge is distinct from perceived transparency of information. For instance, a shared code in social media to solve a system's bug using Python Programming Language may be visible to all software developers who are a member of that social media. However, it may not be transparent for those who do not understand the code.

4.2.3 Interviews of practitioners and subject-matter experts

The second method that was applied in this step was conducting interviews with subject-matter experts and practitioners to identify the key aspects (or attributes) of the focal construct's domain (Mackenzie et al. 2011). The reason for interviewing practitioners in addition to subject-matter experts was to achieve my own interpretive understanding, rather than relying exclusively on how other researchers have already interpreted what perceived visibility of knowledge means (Smith et al. 1996). To capture rich and detailed information about perceived visibility of knowledge, a semi-structured interview was conducted with four software developers who actively used public social media to support their work and two academic experts who were active researchers in the field of social media. The number of respondents was decided when the last interview did not produce any new radical insights into the content of previous interviews (Flores and Ekstedt 2012). In general, interview data should be collected until data saturation takes place and a too high number of respondents makes thorough interpretations of the interviews difficult (Flores & Ekstedt, 2012). In this study, the interviews took place between 23 March 2017 and 12 May 2017. Four of the interviews were carried out face-to-face at the participants' respective places (i.e., in their offices), and two were carried out over skype due to the geographical distance. Table 4.3 provides an overview of participants' information.

Table 4.3 Interview participants' information

Participants	Title	Gender	Country	Age	Education	Date
01	Software Developer	Male	New Zealand	37	Bachelor	23/March/2017
02	Software Developer	Female	Canada	39	Bachelor	05/April/2017
03	Software Developer	Female	The Netherlands	28	Professional Doctorate	23/April/2017
04	Academic expert	Female	New Zealand	44	PhD	04/May/2017
05	Academic expert	Male	New Zealand	41	PhD	07/May/2017
06	Software Developer	Male	New Zealand	33	PhD	12/May/2017

Prior to the interviews, participants were informed of the purpose of the research, assured of their confidentiality and asked for their agreement with regard to audio recording (Kupfer and Tiefenbeck 2016). All interviews were audio recorded and transcribed. The objective of the interviews was to gain a deeper understanding of important attributes that shape perceived visibility of knowledge in social media. To guide the interview process, the following questions were asked:

- Can you describe what visibility of knowledge in social media means to you?
- In what ways does social media provide visibility of knowledge to you/users?
- If you wanted to describe the concept of visibility of knowledge in social media to your colleague, how would you describe it?
- In what ways is visibility of knowledge in social media helpful to you/users in completing a software development job?
- How central is the visibility of knowledge to you/users in completing a software development job? Why?
- How much visibility of knowledge is important in your/developers' task accomplishment? Why?

During the interviews, in addition to asking the questions above, I encouraged the participants to describe their actual experiences or episodes related to visibility of knowledge in a social media setting (Chen 2013).

To identify conceptually similar themes, the interview transcripts were coded using open and axial coding procedures proposed by Strauss and Corbin (1990). Open coding is the "analytical

process through which concepts are identified and their properties and dimensions are discovered in the data" (Strauss and Corbin 1990, p. 101). Axial coding is the process of "relating categories to their subcategories, termed 'axial' because coding occurs around the axis of a category, linking categories at the level of properties and dimensions" (Strauss and Corbin 1990, p. 123).

Initially, the interview transcripts were open coded using line-by-line coding. Next, the open codes were identified. Then, they were clustered and formed by summarising conceptually similar codes. The illustrative open codes and illustrative quotations are listed in Table 4.4. The illustrative quotations are linked to related participants by participant codes (e.g. 01 is the code for participant number one). Then, using axial coding, I inspected the open codes for similarities and/or differences and then related them into conceptual units (axial codes). The axial codes identified in this step are broadness of information, up-to-datedness of information, diversity of information, timeliness, easiness, trustworthiness and appropriateness. The axial codes are shown in the leftmost column of Table 4.4.

Table 4.4 Coding matrix for perceived visibility of knowledge

Axial Codes	Illustrative Open Codes	Illustrative Quotations
Broadness of information	Contain a lot of information	"By searching through social media, I can access heaps of knowledge." (01)
	Provide any information	"According to my experience, in social media, you can find anything, even details about how to solve a problem." (06)
	Provide any details	
	Contain supplementary information	"In social media, you will see some additional information that you can use to prevent something else (e.g., another bug) from happening." (04)
Up-to-datedness of information	Introduce new features of technologies	"Social media helps employees [i.e., software developers] access updated information and new features of latest technologies." (04)
	Contain recent news about technology	"I use social media to learn about new topics or new areas." (05)
	Address new problems with recent technologies	"Many times, when I have a question about new tools (e.g., Power BI), I refer to social media." (02)
Diversity of information	Provide different approaches	"In social media, I can see different ideas and approaches about one subject." (03)
	Contain variety of information	"In social media, I can see a variety of knowledge shared by different people." (06)
	Contain different solutions	"Usually, in social media, I can find different solutions for one question and choose which one is more efficient for me." (02)
Timeliness	Quick access to information	"Visibility of knowledge means using social media to access knowledge very fast." (05)
	Quick way of finding the information	"I think social media is the quickest way to find the required knowledge." (04)
	Not much time is wasted to access information	"I do not waste too much time finding the knowledge that I need." (06)
Easiness	Easy to search for information	"It is very easy to search for information [in social media]." (004)
	Easy to look for experiences	"I can see others' experiences easily." (01)
	Easy to search for information	"I can easily search for answers to my questions in social media." (03)
Trustworthiness	Contain pre-tested solutions	"In social media, you can find the solutions that have been tested by someone else." (03)
	Provide correct solutions	"I can find the most correct solutions that have been tested by others." (01)
	Provide a reliable source of information	"It is a very reliable resource for me." (02)
Appropriateness	Contain specified information	"Visibility of knowledge means I can find specific knowledge." (01)
	Contain relevant information	"Visibility of knowledge means searching social media to get related knowledge and codes." (04)
	Contain customised information for problems	"It means you can find particular information related to your specific task." (05)

Next, the two PhD supervisors reviewed the interview transcripts and related coding outcomes. In a few cases where there was a disagreement between me and the supervisors, two independent judges were asked to facilitate a discussion in order to reach a coding consensus. Both judges were IS researchers who held PhD degrees. Although both judges were familiar

with human-computer interaction principles in general, neither of them considered himself/ herself as an expert on social media properties. The reason to purposefully select judges who were unfamiliar with the literature on social media properties was because I aimed to gain unbiased feedback on the codes derived from the interviews.

All generated axial codes (broadness of information, up-to-datedness of information, diversity of information, timeliness, easiness, trustworthiness and appropriateness), shown in the left column of Table 4.4, were used as a basis for the construct development. In the next step, as suggested by Mackenzie et al. (2011), I used these axial codes and related them to the extant visibility of knowledge literature and the attributes shown in Table 4.2. In all cases, the axial codes derived from the interviews matched the attributes in the existing literature. In other words, in all cases, I could identify existing theoretical conceptualisations in the literature for suggested construct domains derived from interviews. For instance, one suggested construct is easiness. Interviews suggest that visibility of knowledge means that users can find information easily. Previous research has also established that visibility of knowledge refers to having access to information with relative ease (Michener and Bersch 2013; Treem and Leonardi 2013).

Table 4.5 illustrates the initial constructs (broadness, up-to-datedness, diversity, timeliness, easiness, trustworthiness and appropriateness), illustrative codes from interviews and examples of supporting evidence from the literature on each construct. The leftmost column lists the construct domains I identified based on the coding procedure explained earlier. The next two columns show the illustrative quotations derived from the interviews and the supporting evidence from the literature. The rightmost column provides additional references of prior research that has studied the construct domains identified in the current study.

Table 4.5 Interplay between interview data and relevant literature

Constructs	Illustrative Quotations from Interviews	Examples in the Literature	Other References
Broadness	"By searching through social media, I can access heaps of knowledge." (01) "According to my experience, in social media, you can find anything, even details about how to solve a problem." (06)	Yang, Cai, Zhou, and Zhou (2005) argue that adequacy of information in the websites leads to the overall satisfaction of the users of the websites. Websites need to provide [enough] information to facilitate user understanding of the issues at hand.	Dutta-Bergman (2004); (Hsu and Liao (2014); Jeong, Oh, and Gregoire (2003)
Up-to-datedness	"Social media helps employees [i.e., software developers] access updated information and new features of latest technologies." (04) "I use social media to learn about new topics or new areas." (05)	Comparing the uses of two social media applications, Facebook and Instant Messaging, Quan-Haase and Young (2010) argue that both applications serve as a means to convey up-to-date information [to students].	Zhang, Von Dran, Blake, and Pipithsuksunt (2001)
Diversity	"In social media, I can see different ideas and approaches about one subject." (03) "In social media, I can see a variety of knowledge shared by different people." (06)	Duffy (2000) discusses that it is no longer enough to provide a simple answer to a simple question for employees. Instead, they need access to a wide variety of information to help them, which can be facilitated by using web-enabled technologies.	Hsu and Liao (2014)
Timeliness	"Visibility of knowledge means using social media to access knowledge very fast." (05) "I think social media is the quickest way to find the required knowledge." (04)	Doherty and Doig (2011) argue that the improvement of information accessibility can lead to additional benefits (e.g., improvement of usage of the system) by saving information users time in organisations.	Zheng and Zheng (2014)
Easiness	"It is very easy to search for information [in public social media]." (04) "I can see others' experiences easily." (01)	Jeong et al. (2003) found that information ease of use is an important determinant of website use.	Hsu and Liao (2014)
Trustworthiness	"In social media, you can find the solutions that have been tested by someone else." (03) "I can find the most correct solutions that have been tested by others." (01)	Adams (2010) studied health information in web 2.0 technologies. The findings suggested that interactive and collaborative web applications can facilitate reliability of information.	McNutt and Marchildon, (2009); Vedder and Wachbroit, (2003)
Appropriateness	"Visibility of knowledge means I can find specific knowledge." (01) "Visibility of knowledge means searching social media to get related knowledge and codes." (04)	Having studied Web 2.0 technologies, Metzger and Flanagin (2011) suggest that users engage with information that they perceive as relevant to their information seeking goals.	Akter, D'Ambra, and Ray (2013); Eppler (2001) Gorla, Somers, and Wong (2010)

After formulating the initial constructs that represent the most essential attributes of perceived visibility of knowledge, the next step was to specify the nature of each construct by identifying (1) the conceptual domain to which perceived visibility of knowledge belongs and (2) the entity to which it applies.

Identifying the conceptual domain of perceived visibility of knowledge means that researchers should specify the general type of property to which perceived visibility of knowledge refers. For instance, the definition should specify if the construct refers to a feeling (e.g., emotion, attitude), a thought (e.g, cognition, intention, value), a perception (e.g., perceived ease of use of technology, perceived usefulness of technology, fairness perceptions), an outcome (e.g., degree of use, a stock price, performance), an action (e.g., behaviour, activity), or an intrinsic characteristic (e.g., cognitive skill, structure, conscientiousness) (Mackenzie et al. 2011). Identifying the entity means the object to which the construct applies (e.g., a person, a process, a group/team or an organisation). Previous research has argued that the failure to specify the entity to which a construct applies is a common problem in many instrument development studies (Kozlowski and Klein 2000). Specifying the general type of property to which perceived visibility of knowledge refers and the entity to which it applies was important in the early stage of the construct's conceptualisation. Table 4.6 lists all the seven constructs formulated in this study, their general properties, entities and definitions.

Table 4.6 Constructs, their general properties, entities and definitions

Construct Name	General Property (GP) of the Construct and Entity (E) to which it Applies	Construct Definition
Broadness	GP = perception about the extensiveness of information in social media; E = person	The degree to which a user perceives that social media provides information that is broad in scope or content.
Up-to-datedness	GP = perception about the up-to-datedness of information in social media; E = person	The degree to which a user perceives that social media provides up-to-date information.
Diversity	GP = perception about the diversity of information in social media; E = person	The degree to which a user perceives that social media contain a variety of information.
Timeliness	GP = perception about the timeliness of access to information in social media; E = person	The degree to which a user perceives that, in social media, it is quick to locate information.
Easiness	GP = perception about the easiness of searching for information in social media; E = person	The degree to which a user perceives that, in social media, it is easy to search for information.
Trustworthiness	GP = perception about the accuracy of information in social media; E = person	The degree to which a user perceives that, in social media, information is free of error, correct and believable.
Appropriateness	GP = perception about the appropriateness of information in social media; E = person	The extent to which retrieved information is specific to the task at hand.

Once all constructs have been carefully conceptualised and defined, the next phase of the construct conceptualisation included the identification of higher-order constructs (Mackenzie et al. 2011).

To identify potential higher-order construct(s), I examined the initial constructs listed in Table 4.6 for conceptual similarities. In addition, I reviewed the existing literature on each construct. During this phase, I asked my supervisors to discuss how distinctive the constructs are from each other and if eliminating any of them would restrict the domain of the construct in a significant way (Mackenzie et al. 2011). In addition, I asked an IS researcher who is unfamiliar with the study's content to serve as a judge to help me identify conceptual similarities among the constructs. The judge was provided with the initial constructs and their definitions (as shown in Table 4.6) that were identified in the previous phase of the construct conceptualisation.

The discussion with the judge and supervisors were based on two questions proposed by Mackenzie et al (2011):

(1) How distinctive are the essential characteristics from each other?

(2) Would eliminating any one of them restrict the domain of the construct in a significant or important way?

If the essential characteristics from each construct have no unique aspects and eliminating any one of them would not restrict the conceptual domain of the construct, then the construct is unidimensional from a conceptual perspective. However, if the essential characteristics describe relatively unique aspects of the construct and eliminating any of them would restrict the conceptual domain of the construct, then the construct is multi-dimensional from a conceptual perspective (Mackenzie et al. 2011). After a thorough discussion with the two supervisors and judge, I identified that each of the seven first-order constructs (broadness, up-to-datedness, diversity, timeliness, easiness, trustworthiness and appropriateness) represents a unique part of perceived visibility of knowledge and it is not necessary or useful to form second-order constructs.

4.2.4 The nature of the relationships between perceived visibility of knowledge and its sub-dimensions

Since perceived visibility of knowledge is a multidimensional construct with seven first-order constructs (broadness, up-to-datedness, diversity, timeliness, easiness, trustworthiness and appropriateness), the next question that should be considered is the nature of the relationship between this construct and its first-order constructs (Mackenzie et al. 2011).

If the sub-dimensions of perceived visibility of knowledge are viewed as defining characteristics of this construct, perceived visibility of knowledge is a function of its first-order constructs, and a change in only one of the first-order constructs can be associated with a change in perceived visibility of knowledge, then the first-order constructs are best viewed as formative indicators of the second-order focal construct. In contrast, if the first-order constructs

are viewed as manifestations of perceived visibility of knowledge, perceived visibility of knowledge exists separately at a deeper and more embedded level than its first-order constructs, and a change in perceived visibility of knowledge would be expected to produce a change in all of its first-order constructs, then the first-order constructs are best thought of as reflective of the second-order focal construct (Mackenzie et al. 2011).

It is important to note that the terms 'formative' and 'reflective' describe the relationship between sub-dimensions and the focal construct with which it is associated (Mackenzie et al., 2011). Constructs are not inherently reflective or formative in nature. In fact, most constructs can be modelled as having either reflective or formative sub-dimensions depending upon the researchers' theoretical expectations about how they should be related (Mackenzie et al. 2011). For instance, job satisfaction, as a focal construct, has been conceptualised as both a multidimensional construct with several distinct facets (Smith et al. 1996) and a unidimensional construct (Cammann 1983). In the case of a unidimensional construct, job satisfaction is measured with three reflective items (a sample item for this construct is, "*All in all I am satisfied with my job*"); whereas in the case of a multidimensional construct, it has multiple formative constructs (i.e., leader-member exchange, job perception and liking), each of which represents one of the facets (e.g., Law and Wong 1999). The key point is that the way in which the second-order construct and its first-order constructs are linked depends on the content of the first-order constructs and how the second-order construct is conceptualised by the researcher (Mackenzie et al. 2011). This is consistent with Borsboom (2005), who argues that even a construct such as socio-economic status (SES), which is frequently considered as a typical example of a formative construct, can be measured with reflective indicators.

To identify the nature of the relationship between perceived visibility of knowledge and its sub-dimensions, I carefully examined the content of the sub-dimensions and the conceptualisation of perceived visibility of knowledge. I discussed the type of relationship

between perceived visibility of knowledge and its sub-dimensions with my supervisors and also two marketing professors in a New Zealand university, who have a strong research background on instrument development. The discussion with the supervisors and the judges (the two marketing professors) was shaped by the following questions (Bollen and Lennox 1991; Mackenzie et al. 2011; Wong et al. 2008):

(1) Are the first-order constructs (broadness, up-to-datedness, diversity, timeliness, easiness, trustworthiness and appropriateness) viewed as manifestations of perceived visibility of knowledge or as defining characteristics of it?

(2) Does perceived visibility of knowledge exist separately at a deeper and more embedded level than its first-order constructs, or is perceived visibility of knowledge a function of its first-order constructs?

(3) Would a change in perceived visibility of knowledge be associated with the change in all of the first-order constructs or is it possible for a change in perceived visibility of knowledge to be associated with a change in one of the first-order constructs?

It is reasonable to say that a change in visibility of knowledge is expected to produce a change in all of its first-order constructs. For example, if part of information becomes invisible in social media (i.e., due to failure in search engines), it might be possible that users perceive that information as no longer complete, trustworthy or easy to search for. Suppose that an admin of a social network site (e.g., Stack Overflow) removes part of a code that was shared by several developers about how to solve a bug in developing an application. Other software developers who refer to the new version of that code may no longer find this information complete (part of the code was deleted by the admin of the social media and they cannot see it any more), trustworthy (it would be risky for other software developers to run new code as it may cause new bugs in their system), not easy to search for (if users do not find another source for that

code, they have to email the admin to fix that code or find another way to search for it), not timely (the users need to wait to get the code from admin or spend time searching other resources), or not appropriate (the new version of the code may not be relevant to that particular bug as the wrong answer may no longer fix the problem).

Based on the discussion with the supervisors and the judges, in thinking through the relationships between the first-order constructs (broadness, up-to-datedness, diversity, timeliness, easiness, trustworthiness and appropriateness) and perceived visibility of knowledge, I concluded that perceived visibility of knowledge is not a function of its first-order constructs. Instead, perceived visibility of knowledge exists separately at a deeper and more embedded level than its first-order constructs. In other words, the first-order constructs (i.e., broadness, up-to-datedness, diversity, timeliness, easiness, trustworthiness and appropriateness) are manifestations of perceived visibility of knowledge, a focal construct in this study. In other words, the relationship between perceived visibility of knowledge and its first-order constructs are considered as reflective.

4.3 Step two: Measurement items development

Once perceived visibility of knowledge is conceptually defined, the next step is to generate a set of items that represents the conceptual domain of the construct (Mackenzie et al. 2011). The newly developed items may come from different sources, for example, reviews of the literature, previous theoretical and empirical research on the construct, suggestions from experts in the field, and interviews or focus group discussions with representatives of the population to which perceived visibility of knowledge is expected to be generalised (see Churchill 1979).

Regardless of whether perceived visibility of knowledge is unidimensional or multidimensional, the ultimate goal of the item generation process is to generate a set of items for each of the first-order constructs of the focal construct (Churchill 1979). In case of multi-

dimensional constructs, that would mean generating a set of items for each individual first-order construct, while also making sure that the first-order constructs comprise all essential aspects of the focal construct's definition.

During the item development, the codes derived from the interviews in step one were leveraged. In addition, I searched the relevant literature that examined similar constructs and their associated items. Altogether, 80 items were initially generated to capture most essential aspects of the first-order constructs outlined in step one (see Appendix D).

Once the initial items were developed, the simplicity and wording of the items were evaluated (Mackenzie et al. 2011). Each item should be written so that its wording is as simple and precise as possible. Double-barrelled items (e.g., in social media, information is free of error and easy to search for) should be split into two single-idea statements, and if that proves impossible, the item should be eliminated altogether (Churchill 1979). In addition, items that contain unfamiliar terms should be clarified. Items that possess complicated syntax should be simplified to be more specific and concise. Efforts should be made to refine or eliminate items that contain obvious social desirability (Podsakoff, MacKenzie, Lee, and Podsakoff, 2003). For example, a social desirability item drawn from a domain of behaviours which are culturally sanctioned and approved, but which are unlikely to occur, would be, "*Before voting, I thoroughly investigate the qualifications of all candidates*" (Crowne and Marlowe 1960).

A face validity check was used to examine the simplicity and wording of the items. A face validity check is useful when measurement items are developed from scratch and have not yet been tested with the population of study (Hoehle and Venkatesh 2015; Mackenzie et al. 2011; Straub et al. 2004). A face validity check focuses on the measurement items themselves and does not require participants to rank or respond to the items. To conduct a face validity check, four administrative staff members and one PhD student from a New Zealand university

volunteered to participate in this research. A prerequisite for participation in the face validity check was that participants use social media for their work-related tasks (e.g., searching an answer for the problem at hand). This was to ensure that they understood the context of the items. To conduct the face validity check, participants were provided with a paper-based survey that included all the 80 initially developed items. I asked the participants to evaluate all items and to comment on the clarity of the questions. I also asked the participants to flag items whose wording was vague or confusing.

In total, 44 items were identified as too vague or worded unclearly, with specific changes suggested to certain items. These items are listed in Table 4.7.

Table 4.7 Flagged items in the face validity check

Constructs	Items
Broadness	I can access a wide range of information
	I can see details about every job-related matter I have
	I can access information that covers all my needs of my tasks
	I can click on hyperlinks to access further information
	I can access complete information
Up-to-datedness	I can access brand-new information
	I can access first-hand information
	Information is current
	I can access newly released information
	The information is up-to-date and not obsolete
	I can learn about new topics
Diversity	I can see a variety of information regarding my problems
	I can obtain a variety of information about how software developers solved their problems
	I can see different ideas and approaches about one subject
	I can access information in different formats
	I can see different options and choose which one is the best to apply in my task
	I can find diverse content
Timeliness	I can quickly browse the required content
	I can access information very quickly
	I have direct access to the content
	I can access the required information immediately
	I can find information at the time I need
	Information can be retrieved rapidly without delay
	Information is delivered on time
	It does not take too much time for me to get the required information
Easiness	I can easily browse through social media applications
	I have different easy ways to search for the required information
	I do not need to ask for help from others to search for information
	I can easily search for an answer to my questions
	I can search for others' experiences easily
Trustworthiness	I am confident that the retrieved information is reliable
	I can find workable solutions for my task-related problems
	There are a few errors in the information I obtain
	Information is valid
	Information does not contain a substantial amount of bias
	I am confident that the retrieved information is true
Appropriateness	I can retrieve specific information for my tasks
	The information that I retrieve addresses my need
	Information that I find is applicable to my work
	Experts write their idea about inaccurate information shared by others
	I can find appropriate information for my work
	Information is dependable
	I can apply the retrieved information to my task
	The information that I retrieve, addresses my needs

I discussed the 44 flagged items with my supervisors. Seven of these 44 items remained in the item pool after the wording was modified. Table 4.8 shows the seven items that were modified and kept in the pool.

Table 4.8 Seven items that were modified and remained in the item pool

Constructs	Initial Items	Modified Items
Broadness	I can click on hyperlinks to access further information	I can click on tags (hyperlinks) to find related content on other pages
Up-to-datedness	I can access brand-new information	I can access cutting-edge information
Diversity	I can see a variety of information regarding my problems	I can see different solutions to my problem
	I can access information in different formats	I can access information in different formats (e.g. text, video and image)
Timeliness	I can quickly browse the required content	I can quickly go through content until I get information that I need
Trustworthiness	I am confident that the retrieved information is reliable	Information that I find is reliable
Appropriateness	I can retrieve specific information for my tasks	I can retrieve information that fulfils specific needs for my tasks

In total, 37 items were removed from the item pool because they were too vague or worded unclearly. This led to a pool of 43 remaining items shown in Table 4.9. These 43 items were used to conduct the content validity test in the next step.

Table 4.9 The newly developed items after the face validity check

Constructs	Items
Broadness	I can get additional information to what I originally searched for
	I can learn about any particular problems from basic to advanced level
	I can access comprehensive information related to problems at hand
	I can click on tags (hyperlinks) to find related content on other pages
	I can see many comments on particular posts
	I can access all the required information to complete a certain task
	I can get access to heaps of information
	I can come across information that can be useful in the future
	I can access a sufficient amount of information for my needs
	I can access supplementary information related to what I am looking for
Up-to-datedness	I can access cutting-edge information
	I can access recently released information related to the problem
	I can access up-to-date information that I need for my work
	I can catch up with recently released information
Diversity	I can see different solutions to my problem
	I can access information in different formats (e.g., text, video and image)
	I can see a variety of information
	I can observe how software developers exchange ideas about a subject related to my task
	I can compare information provided by different social media platforms (e.g., blogs, wikis and social networking sites)
	I can obtain multiple approaches for solving a specific problem
	I can read others' multiple experiences about the same problem I have at hand
	I can access information about how different solutions worked on a specific problem
Timeliness	I can quickly go through content until I get information that I need
	I do not have to waste time finding the information that I need
	I can readily access the information that I need
	I can save time gaining the required information compared to obtaining the same information offline
	I can find the solution for my job-related problems quickly
Easiness	I can easily search for others' experiences
	I can search for information easily
	I can easily navigate through available information
	I do not need to put a lot of effort into searching for the information that I need
Trustworthiness	Information that I find is reliable
	I can find information that is trustworthy
	I can access information that is free of error
	If I apply the retrieved information in my tasks, it will work for me
	I can find solutions that have been verified by experts
Appropriateness	I can retrieve information that fulfils specific needs for my tasks
	I can find the exact information that I am looking for
	I can access information that fulfils my job needs
	I can find detailed information about how to solve a problem
	I can find information that is highly relevant to my work
	I can obtain information that helps me solve the problems at hand
	I can access information about particular problems

4.4 Step three: Assessment of the content validity of the items

Once items have been generated to represent perceived visibility of knowledge, they should be evaluated for their content validity. Content validity is defined as the degree to which items in

an instrument represent all facets of a given construct (Mackenzie et al. 2011; Straub et al. 2004). In this step, researchers should consider two major components when evaluating the content validity of an instrument:

(1) Is the individual item representative of an aspect of the content domain of the construct?

(2) Are the items as a set collectively representative of the entire content domain of the construct?

Mackenzie et al. (2011) suggest using the variance analysis approach proposed by Hinkin and Tracey (1999) to assess content validity of the items. Although the variance analysis technique has been rarely used in IS research, organisational studies have used it frequently (Hinkin and Tracey 1999; Yao et al. 2008). Variance analysis provides a direct empirical test for determining item distinctiveness. This technique is based on an analysis of variance (ANOVA) which eliminates the use of subjective judgment for item retention (Hinkin & Tracey, 1999). In this procedure, the researcher constructs a matrix with items listed in the rows and construct definitions listed at the top of the columns. Next, the researcher asks raters to indicate the extent to which items capture each aspect of the construct domain using a Likert-type scale.

I attempted to apply Hinkin and Tracey's (1999) approach to measure the content validity of the newly developed scales. To do so, I developed a matrix in which the initially developed items were listed in the rows and the construct definitions were listed at the top of the columns. Mackenzie et al. (2011) emphasise that it is important to avoid overburdening the raters by exposing them to too many content domains at the same time. They suggest limiting the content domains to a maximum of 8 to 10 aspects at the same time. Therefore, to reduce the complexity of the rating exercise, I split the pool of items and developed six matrixes. Figure 4.2 illustrates a snapshot of one matrix that I developed based on Hinkin and Tracy’s (1999) variance analysis

approach. Appendix E shows the instruction and online matrixes used for the content validity check.

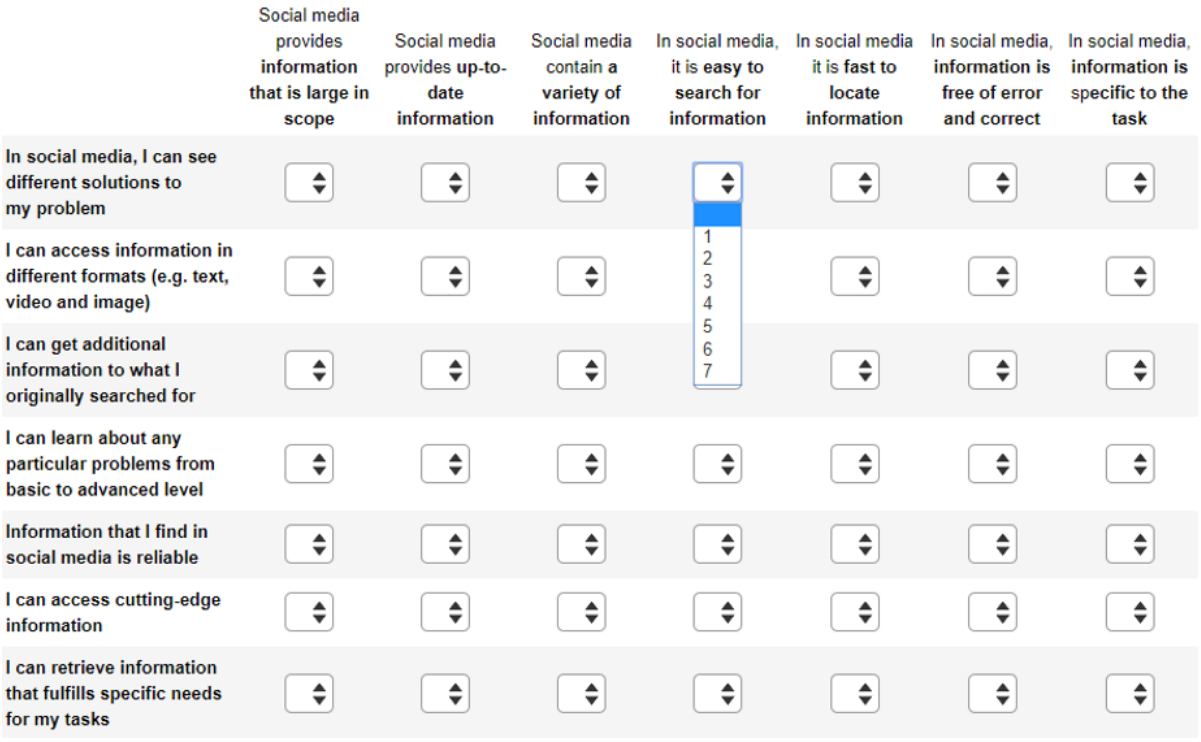

Figure 4.2 Snapshot example of the online matrix used for the content validity check

Next, I asked three independent raters to evaluate and examine the matrix. One rater was an IS researcher and two were administrative staff at a New Zealand university. I also asked three software developers, based in New Zealand, to complete the matrix and provide their feedback on the matrixes, including whether they considered them understandable and clear. Each participant was provided with instruction and paper-based matrixes. The raters were also asked to keep track of the overall time they spent on completing the matrix. On average, raters spent 20 minutes on completing the matrix. Once the raters completed the matrix, I interviewed them and asked about their experience with the rating procedure. All raters explained that the instructions were clear; however, they believed that it was not easy to complete the matrixes. They also warned that the research participants (software developers) may have difficulties completing the matrixes. For instance, one administrative staff stated:

> "I find that the survey design is making me do a lot of mental/cognitive work. As there are two different factors that I need to consider – first the relationship between statements and second the strength of this relationship – there is a lot of cognitive processing involved, which becomes tiring very quickly."

Based on participants' feedback, I found that Hinkin and Tracy's (1999) technique of ranking all the initial item-to-construct definition combinations would overburden raters. In a recent study that developed a new instrument for perceived mobile application usability, Hoehle and Venkatesh (2015) also applied Hinkin and Tracy's (1999) technique to test the content validity of their newly developed items. Interestingly, they also found that the Hinkin and Tracy's (1999) technique of ranking all the initial item-to-construct definition combinations would overburden their participants. Once I found that Hinkin and Tracy's (1999) technique would overburden raters, I did not proceed with this technique. Instead, I decided to apply a slightly less comprehensive technique proposed by Anderson and Gerbing (1991) to assess the content validity of new items. Anderson and Gerbing's (1991) approach argues that each item relates to a single construct. Therefore, rather than rating each item-construct combination, respondents are only asked to assign each item to a single corresponding construct definition. Following Anderson and Gerbing's (1991) technique, I developed a new matrix in which the initially developed items were listed in the rows and the construct definitions were listed at the top of the columns. Figure 4.3 illustrates a snapshot of the new matrix developed to collect data for the content validity test. Appendix F shows the instruction and online matrixes used for the content validity check based on Anderson and Gerbing's (1991) approach.

	Social media provides information that is large in scope	Social media provides up-to-date information	Social media contain a variety of information	In social media, it is easy to search for information	in social media, information can be located quickly	In social media, information is free of error and correct	In social media, information is specific to the task
In social media, I can see different solutions to my problem	○	○	✓	○	○	○	○
I can access information in different formats (e.g. text, video and image)	○	○	○	○	○	○	○
I can get additional information to what I originally searched for	○	○	○	○	○	○	○
I can learn about any particular problems from basic to advanced level	○	○	○	○	○	○	○
Information that I find in social media is reliable	○	○	○	○	○	○	○
I can access cutting-edge information	○	○	○	○	○	○	○
I can retrieve information that fulfills specific needs for my tasks	○	○	○	○	○	○	○

Figure 4.3 Snapshot example of the revised matrix used for the content validity check

Next, I asked the same independent raters who had previously assessed the earlier matrix to evaluate and examine the revised matrix. Each participant was provided with instructions and paper-based matrixes and they were asked to select the most appropriate item-to-construct combination (Anderson and Gerbing 1991). On average, raters spent seven minutes completing the matrix. This compared to the 20 minutes that the participants spent completing the first matrix, indicating that the second matrix was less demanding than the first one.

Once the participants completed the marix, I interviewed them and asked them about their experience with the rating procedure of the newly designed matrix. All the respondents completed the second matrix and confirmed that the rating task was more meaningful and it was easier to complete. Due to the overall length of the matrix and feedback received from participants, I concluded that Anderson and Gerbing's (1991) approach would be a practical way to move forward. Therefore, I applied the content validity assessment technique suggested by Anderson and Gerbing (1991) to collect data for a content validity check from the main population of the study.

Mackenzie et al. (2011) and Anderson and Gerbing (1991) argue that for a content validity check, it is important for the participants to be representative of the main population of interest. Therefore, using Survey Monkey software, I collected data from software developers in New Zealand who were active users of social media. In total, 247 responses were obtained. Based on the average time that raters (one IS researcher and two administrative staff from a New Zealand university and three software developers from New Zealand who had examined the survey earlier) took to complete the survey, I applied a cut-off threshold of seven minutes for survey completion. I assumed that respondents who took less than seven minutes to complete the survey had not paid enough attention to the questions. The completion time for each participant was measured by Survey Monkey software. Out of 247 responses, 218 participants took a reasonable length of time (more than seven minutes) to complete the survey. Table 4.10 shows the respondents' demographics.

Table 4.10 Content validity check: respondent demographics

Demographic	Category	n=218	%
Gender	Female	67	3.73
	Male	151	69.3
Age Groups	29 or younger	80	36.69
	30-39	72	33.02
	40-49	50	22.93
	50 or older	16	7.34
Occupation	Software developer	188	86.23
	University student in software development	30	13.76

The sample had a population of 30 students who were studying software development at university. At first glance, a population of 30 students may seem problematic. However, in this study, I considered it acceptable that students check the content validity of the scales. The reason is that first, in the process of learning software development, students primarily refer to social media to find help and learn more about their software-development assignments at university (Friesen and Lowe 2012) and second, previous research has argued that even samples that exclusively contain students are suitable for conducting a content validity check.

The reason is because the sorting procedure needs analytical thinking skills (Hinkin and Tracey 1999). Therefore, the demographics were regarded as acceptable for the content validity check.

To analyse the data, the proportion of substantive agreement (P_{SA}) and the substantive validity coefficient (C_{SA}) were computed (Anderson and Gerbing 1991). P_{SA} indicates the proportion of respondents who assigned items to their intended constructs, while C_{SA} is the extent to which respondents assigned items to the posited construct rather than to any other construct.

First, P_{SA} was computed by using the following formula:

$$P_{SA} = \frac{nc}{N}$$

where nc is the number of respondents who assigned an item to its intended construct and N is the total number of respondents (Anderson and Gerbing 1991). For example, if 151 out of 218 respondents assigned the item, "*I can get additional information to what I originally searched for*" to the definition of construct broadness – "*Social media provides information that is large in scope*" – then the P_{SA} would be .69 for this item.

Second, C_{SA} was computed using the following formula:

$$C_{SA} = \frac{nc - n0}{N}$$

where nc is the number of respondents assigning an item to the intended construct, $n0$ is the highest number of assignments of the measure to any other construct, and N is the total number of respondents (Anderson and Gerbing 1991). For example, if 151 out of 218 respondents assigned the item, "*I can get additional information to what I originally searched for*" to the construct definition, "*Social media provides information that is large in scope*" and 37 respondents, the highest number, assigned this item to another construct definition, "*Social*

media contains a variety of information", then the C_{SA} would be .52 for this item. The results of these analyses are shown in Table 4.11.

Table 4.11 Proportion of substantive agreement (P_{SA}) and substantive validity coefficients (C_{SA})

Constructs	Item	P_{SA}	C_{SV}
Broadness	I can get additional information to what I originally searched for	.69	.52
	I can learn about any particular problems from basic to advanced level	.54	.32
	I can access comprehensive information related to problems at hand	.70	.61
	I can click on tags (hyperlinks) to find related content on other pages	.59	.42
	I can see many comments on particular posts	.50	.28
	I can access all the required information to complete a certain task	.63	.51
	I can access a large amount of information	.74	.61
	I can come across information that can be useful in the future	.26	.11
	I can access a sufficient amount of information for my needs	.70	.57
	I can access supplementary information related to what I was looking for	.76	.64
Up-to-datedness	I can access cutting-edge information	.79	.74
	In social media, I can access recently released information related to the problem	.78	.71
	I can access up-to-date information that I need for my work	.87	.81
	I can gain new information	.82	.76
Diversity	In social media, I can see different solutions to my problem	.73	.65
	I can access information in different formats (e.g., text, video and image)	.67	.51
	I can see a variety of information	.82	.75
	I can be an observer of how software developers exchange ideas about a subject related to my task	.34	.10
	I can compare information provided by different social media platforms (e.g., blogs, wikis and social networking sites)	.69	.53
	I can obtain multiple approaches for solving a specific problem	.72	.61
	I can read multiple experiences from others who have the same problem as me	.73	.60
	I can access information about how different solutions worked on a specific problem	.72	.61
Timeliness	In social media, I can quickly go through content to get information that I need	.72	.63
	I don't have to waste time finding the information that I need	.73	.61
	In social media, I can readily access the information that I need	.57	.43
	I can save time gaining the required information compared to obtaining the same information offline	.66	.50
	I can find the solution for my job-related problem quickly	.71	.61
Easiness	I can easily search for others' experiences	.77	.67
	I can search for information easily	.81	.75
	In social media, I can easily navigate through available information	.79	.72
	I do not need to put a lot of effort into finding the information that I need	.67	.52
Trustworthiness	Information that I find in social media is reliable	.66	.56
	I can find information that is trustworthy	.77	.70
	I can access information that is free of error	.81	.74
	If I apply the retrieved information in my tasks, it will work for me	.46	.13
	I can find solutions that have been verified by experts	.76	.69
Appropriateness	I can retrieve information that fulfils specific needs for my tasks	.70	.61
	I can find the exact information that I am looking for	.59	.46
	I can access information that fulfils my job needs	.60	.49
	I can find detailed information about how to solve a problem	.55	.39
	I can find information that is highly relevant to my work	.71	.60
	I can obtain information that helps me solve the problems at hand	.62	.51
	I can access information about particular problems	.72	.64

I applied a threshold of .60 as a cut-off value for both P_{SA} and C_{SA} values for the content validity analysis (Hoehle and Venkatesh 2015). Using a .60 cut-off value, the results suggest that more than 60 percent of all raters associated the items with the intended construct definitions. As indicated in Table 4.12, overall, the content validity ratios (both P_{SA} and C_{SA}) were high, which means that most respondents assigned the majority of items into their posited construct domains. Table 4.12 shows the 19 items that did not meet the .60 cut-off value.

Table 4.12 Items that did not meet the .60 cut-off value

Constructs	Item	P_{SA}	C_{SV}
Broadness	I can get additional information to what I originally searched for	.69	.52
	I can learn about any particular problems from basic to advanced level	.54	.32
	I can click on tags (hyperlinks) to find related content on other pages	.59	.42
	I can see many comments on particular posts	.50	.28
	I can access all the required information to complete a certain task	.63	.51
	I can come across information that can be useful in the future	.26	.11
	I can access a sufficient amount of information for my needs	.70	.57
Diversity	I can access information in different formats (e.g. text, video and image)	.67	.51
	I can be an observer of how software developers exchange ideas about a subject related to my task	.34	.1
	I can compare information provided by different social media platforms (e.g., blogs, wikis and social networking sites)	.69	.53
Timeliness	In social media, I can readily access the information that I need	.57	.43
	I can save time gaining the required information compared to obtaining the same information offline	.66	.5
Easiness	I do not need to put a lot of effort into finding the information that I need	.67	.52
Trustworthiness	Information that I find in social media is reliable	.66	.56
	If I apply the retrieved information in my tasks, it will work for me	.46	.13
Appropriateness	I can find the exact information that I am looking for	.59	.46
	I can access information that fulfils my job needs	.60	.49
	I can find detailed information about how to solve a problem	.55	.39
	I can obtain information that helps me solve the problems at hand	.62	.51

Therefore, I decided to exclude these items from the item pool. Table 4.13 shows the final 24 items as a result of the content validity check.

Table 4.13 Initial item pool as a result of the content validity check

First-Order Constructs	Items
Broadness (BRO1-3)	In social media, I can access comprehensive information related to problems at hand
	In social media, I can access a large amount of information
	In social media, I can access supplementary information related to what I was looking for
Up-to-datedness (UPT1-4)	In social media, I can access cutting-edge information
	In social media, I can access recently released information related to the problem
	In social media, I can access up-to-date information that I need for my work
	In social media, I can gain new information
Diversity (DIV1-5)	In social media, I can see different solutions to my problem
	In social media, I can see a variety of information
	In social media, I can obtain multiple approaches for solving a specific problem
	In social media, I can read multiple experiences from others who have the same problem as me
	In social media, I can access information about how different solutions worked on a specific problem
Timeliness (TIM1-3)	In social media, I can quickly go through content to get information that I need
	In social media, I don't have to waste time finding the information that I need
	In social media, I can find the solution for my job-related problem quickly
Easiness (EAS1-3)	In social media, I can easily search for others' experiences
	In social media, I can search for information easily
	In social media, I can easily navigate through available information
Trustworthiness (TRUS1-3)	In social media, I can find information that is trustworthy
	In social media, I can access information that is free of error
	In social media, I can find solutions that have been verified by experts
Appropriateness (APPR1-3)	In social media, I can retrieve information that fulfils specific needs for my tasks
	In social media, I can find information that is highly relevant to my work
	In social media, I can access information about particular problems

4.5 Step four: Formally specify the measurement model

Once the content validity of the items has been generated, the next step is to formally specify a measurement model. This step focuses on identifying how the measurement items relate to the constructs and the relationships between perceived visibility of knowledge and its sub-dimensions (Mackenzie et al. 2011). The scale of measurement for a first-order construct with multiple reflective or formative items can be set by fixing a path between the latent construct and one of its items at some nonzero value (usually 1.0). It is also necessary to set the scale of measurement for a second-order construct with multiple reflective or formative first-order sub-dimensions as indicators. This can be done by fixing a path between the second-order construct and one of its sub-dimensions at some nonzero value (usually 1.0). The advantage of fixing the

path at 1.0 is that it aids interpretation by causing the scale of measurement for the second-order construct to be the same as one of its sub-dimensions (Mackenzie et al., 2011).

I developed two alternative measurement models: a first-order measurement model and a second-order measurement model. Although this study developed the rationale for the second-order constructs earlier in step one, I wanted to ensure that the proposed second-order model was a good specification. In the first measurement model, all constructs were modelled as first-order constructs. In this case, one path between the reflective items and each first-order construct was set as 1 when setting up the measurement model (MacCallum and Browne 1993; Mackenzie et al. 2011), whereas in the second model, one path between the items and each first-order construct was set as 1 and a path between the second-order construct and one of its sub-dimensions was set as 1. The two alternative measurement models are shown in Figure 4.4.

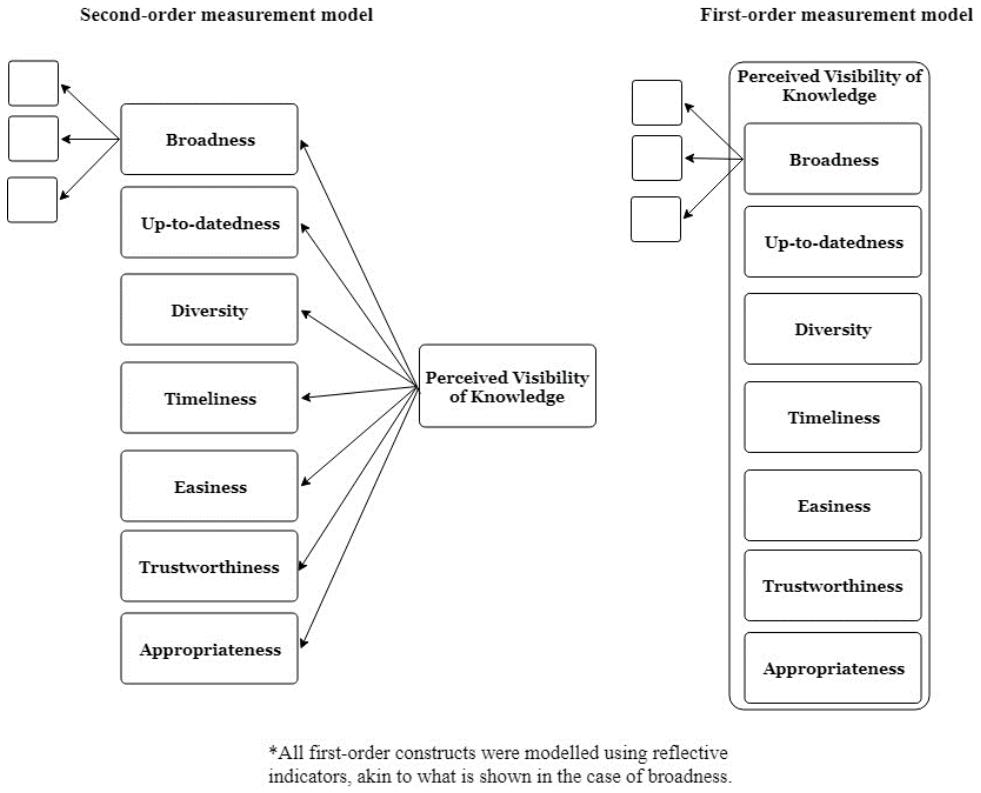

Figure 4.4 Two proposed measurement models

4.6 Step five: Collect data to conduct pre-test

Once the measurement model had been formally specified, I obtained data from a sample of respondents to examine the psychometric properties of the scale, and to evaluate its convergent, discriminant and nomological validity (Mackenzie et al. 2011). To evaluate the nomological validity, data for constructs that are theoretically related to perceived visibility of knowledge was required (Mackenzie et al. 2011). In other words, in developing a new instrument, I considered the relationship of the concept under investigation to other concepts in an overall context of a theoretical structure. Additional research on the construct often results in an expansion of the nomological network to include consequences of perceived visibility of knowledge. Learning more about the theoretical construct is a matter of elaborating a nomological network in which it occurs (Mackenzie et al. 2011).

One construct that is theoretically related to perceived visibility of knowledge is the internal individual cognitive mechanism. There are theoretical explanations and empirical evidence demonstrating that perceived visibility of knowledge is a key predictor of an individual's internal individual cognitive mechanism. The internal individual cognitive mechanism refers to a process in which an individual enhances their knowledge by searching, categorising and reading information available online (Sigala and Chalkiti 2015). In this cognitive mechanism, individuals seek knowledge by themselves without any need to establish relational connections with knowledge sources (Jansen and Rieh 2010).

The relationship between perceived visibility of knowledge and the internal individual cognitive mechanism can be explained through the principle of least effort (O'Leary 2016). The principle of least effort explains that people tend to use a knowledge searching method that involves the least amount of effort and energy to discover and access information (Jansen and Rieh 2010). If individuals perceive that knowledge is difficult to access, or they do not know what information to access, they are unlikely to seek it out (Brown and Duguid 2001).

Individuals' perceptions of the visibility of knowledge and the availability of easy search facilities (e.g., keyword searches) in social media increase their ability to look up and find the necessary expertise in social media settings (Krogh 2012). Therefore, I decided to expand the nomological network of perceived visibility of knowledge and examine whether perceived visibility of knowledge is a predictor of internal individual cognitive mechanism.

To collect data for the pre-test, I designed a survey that included instructions for the participants, newly developed items for perceived visibility of knowledge and items related to the internal individual cognitive mechanism. As shown in Table 4.14, the internal individual cognitive mechanism was measured by adopting validated reflective items (Sigala and Chalkiti 2014, 2015). All items were measured on a seven-point Likert-agreement scale (1=strongly disagree; 7=strongly agree).

Table 4.14 Scales used to measure the outcome variable

Outcome Variable	Items	Scales Adapted From
Internal individual cognitive mechanism	I use social media to read information related to my task I use social media to search and collect information related to my task I use social media to gather and categorise work-related information I use social media to adapt information to my work-related problems	Sigala and Chalkiti (2014, 2015)

Appendix G illustrates the survey used to collect data in this step. When gathering data for a pre-test, one factor that should be considered is that the sample respondents should represent the population for which the measures are designed. Another factor that should be considered at this step is the size of the sample (Mackenzie et al. 2011). In exploratory factor analysis (EFA), recommendations of the minimum sample size range from 100 to 500 and recommendations of the minimum ratio of the number of respondents to the number of items in the scale range from 3:1 to 10:1 (Mackenzie et al. 2011).

Before collecting data from software developers, two administrative staff from a New Zealand university were asked to evaluate the survey structure and provide feedback on the survey

instructions and items. The two participants read the instructions that accompanied the survey and completed the survey shown in Appendix G. They also confirmed that the instructions were clear and easy to follow.

During data collection, I targeted software developers in New Zealand who were active users of social media in their work. At the beginning of the survey, one qualifying request was asked: "*Please indicate if you use social media to gain knowledge for your software development activities*". Software developers who were not using social media in their work at all were disqualified from participating in the study and no data was collected from these individuals.

In total, 212 complete responses were collected for the pre-test. This study applied a cut-off threshold of three minutes to complete the survey, including all questions of the study and excluded those responses that were completed in less than three minutes. This study supposed that a response ratio of more than 15 questions per minute would indicate that the participant did not pay enough attention to the survey questions (Hoehle and Venkatesh 2015). Next, all responses were scrutinised and those respondents who took too little time (less than three minutes) were excluded from the sample. This led to 202 usable responses. Table 4.15 provides information on the respondents' demographics.

Table 4.15 Pre-test: respondent demographics

Demographic	Category	n = 202	%
Gender	Male	177	87.62
	Female	25	12.38
Age Groups	29 or younger	80	39.61
	30-39	94	46.53
	40-49	22	1.89
	50 or older	6	2.98

As can be seen in Table 4.15, 87.62 percent of the population were male and 12.38 percent were female. At first glance, including a large population of males and small population of females in the sample may seem problematic. However, based on the outcome of previous studies on demographics of software developers around the world, the respondents'

demographics were regarded as acceptable. In 2018, Stack Overflow[2], a popular knowledge-sharing social media website for developers, conducted a study entitled "Ways Developers Learn on Their Own". To do so, they surveyed 100,000 software developers fielded from 183 countries, including New Zealand. In their study, they asked their respondents about their gender identity and found that over 90 percent of developers were men. Based on these findings, the respondent demographics of the current study were seen to be acceptable.

4.7 Step six: Scale purification and refinement

This step in instrument development involves conducting statistical tests to examine the measurement properties of the newly developed scales using the pre-test data. According to Mackenzie et al. (2011), the procedure that should be followed to evaluate the measurement model requires the following: (1) evaluating goodness of fit of the measurement model; (2) assessing validity of the set of indicators at the construct level; (3) assessing reliability of the set of indicators at the construct level; (4) evaluating individual indicator validity and reliability; and (5) eliminating problematic indicators.

This study applied Covariance-Based Structural Equations Modelling (CB-SEM) to analyse the data. SEM was chosen to analyse the dataset due to its ability to investigate multiple relationships between a variable and its indicators, and to evaluate the hypothesised relationships among variables in the structural model (Hair et al. 1998). Mackenzie et al. (2011) explain that although the chi-square statistic provides the best inferential test of overall model fit, its usefulness is greatly undermined by the fact that it has been found to be related to sample size, model complexity and nonnormality (Hu and Bentler 1999). Therefore, it is important to rely on other goodness of fit indexes to evaluate the extent to which the relationships hypothesised in the measurement model are consistent with the sample data. Hu and Bentler

[2] https://insights.stackoverflow.com/survey/2018/

(1999) conducted a series of Monte Carlo simulations that showed that it is best to rely on multiple goodness of fit measures from different families of fit indexes to balance Type I and Type II error rates. The fit indexes applied in this study were Root Mean Square Error of Approximation (RMSEA), Standardised Root Mean Square Residual (SRMR), Comparative Fit Index (CFI), Adjusted Goodness of Fit Index (AGFI), Normed Fit Index (NFI) and Tucker-Lewis Index (TLI). Although it is difficult to designate a specific cut-off value for each fit index because the best value depends upon the combination of fit indexes used, generally speaking a cut-off value close to .95 for CFI, .08 for SRMR, and .06 for RMSEA are indicative of a good fitting model, and can be interpreted as evidence in favour of the validity of the hypothesised model (Mackenzie et al. 2011).

At first, I compared the two alternative measurement models discussed in step four: first-order versus second-order measurement models. To compare the two measurement models, the chi-square difference test (Tanriverdi 2005) and comparative model fit (using SRMR, CFI, AGFI, NFI and TLI) were used. As shown in Table 4.16, the results show that the model including the second-order construct had a higher chi-square. Moreover, all other fit statistics were in the acceptable range (Mackenzie et al. 2011; Straub et al. 2004); however, they were not significantly different from each other in both models. Also, the c-square/df in both models ranged between 1 and 2, indicating that both models fit the data perfectly (Tabachnick and Fidell 2001). Since both models had good specifications, based on the rationales developed in step one in which each first-order construct (broadness, up-to-datedness, diversity, timeliness, easiness, trustworthiness and appropriateness) represents a unique part of perceived visibility of knowledge, I decided to proceed with the second-order measurement model.

Table 4.16 The results of model comparison

Fit Indexes and Cut-offs for Perfect Fit	Second-Order Model	First-Order Model
Chi-square	309.8 with 245 df	288.5 with 231 df
RMSEA (≤ .06)	.04	.03
SRMR (≤ .08)	.04	.04
CFI (≥.95)	.98	.98
AGFI (≥.8)	.87	.87
NFI (≥ .90)	.91	.92
TLI (≥ .95)	.98	.98

Next, in order to purify and refine the scales, the procedure recommended by Mackenzie et al. (2011) were followed. The average variance extracted (AVE) was calculated for the first-order constructs by averaging the squared, completely standardized factor loading for the indicators, the results of which are shown in Table 4.17. All the AVE scores for the first-order constructs were greater than the threshold of .50 (Mackenzie et al. 2011). In addition, the AVE was calculated for the second-order construct. The result confirmed that the AVE for the second-order construct was greater than the threshold of .50 (Mackenzie et al. 2011). Also, as shown in Table 4.17, the reliability of all the first-order constructs were examined using Cronbach's alpha. All the Cronbach's alpha values ranged from .85 to .91 and were above the desired threshold of .70 (Bollen and Lennox 1991).

Table 4.17 Pre-test: reliabilities and AVES

Constructs	Cronbach Alpha	AVE
Broadness	.89	.73
Up-to-datedness	.89	.69
Diversity	.91	.66
Timeliness	.87	.70
Easiness	.86	.68
Trustworthiness	.86	.67
Appropriateness	.85	.65
Individual cognitive mechanism	.86	.62
Perceived visibility of knowledge	NA	.64

Then, the construct reliability was computed using the completely standardised estimates of the second-order factor loadings and error variances associated with the first-order sub-dimensions. All construct reliability index scores for first-order constructs (broadness, up-to-datedness, diversity, timeliness, easiness, trustworthiness and appropriateness) and perceived visibility of knowledge as the second-order construct were above the recommended threshold

of .70 (Fornell and Larcker 1981). The reliability of each indicator of the first-order constructs was measured by examining the squared multiple correlation for the indicator. As shown in Table 4.18, the value of all the indicators ranged from .60 to .83 and were greater than the threshold of .50, which explains that the latent construct accounted for a majority of the variances in the indicators.

Table 4.18 Pre-test: squared multiple correlation of indicators

Constructs	Indicators	R_2
Broadness	BRO1	.62
	BRO2	.76
	BRO3	.83
Up-to-datedness	UPT1	.67
	UPT2	.75
	UPT3	.60
	UPT4	.72
Diversity	DIV1	.60
	DIV2	.70
	DIV3	.67
	DIV4	.64
	DIV5	.70
Timeliness	TIM1	.63
	TIM2	.70
	TIM3	.79
Easiness	EAS1	.62
	EAS2	.72
	EAS3	.71
Trustworthiness	TRUS1	.77
	TRUS2	.61
	TRUS3	.64
Appropriateness	APPR1	.60
	APPR2	.67
	APPR3	.70

In addition, the reliability of each first-order construct was calculated by examining the squared multiple correlation for the first-order constructs. The value for all the first-order constructs was above the threshold of .50, which indicates that the second-order later construct accounted for the majority of the variances in the first-order construct (Fornell and Larcker 1981). Table 4.19 shows the results of the construct reliability index and squared multiple correlation of the first-order constructs.

Table 4.19 Pre-Test: construct reliability index and squared multiple correlation

	Construct Name	Fornell and Larcker's Construct Reliability Index	R_2
First-order construct	Broadness	.77	.57
	Up-to-datedness	.81	.64
	Diversity	.80	.89
	Timeliness	.76	.50
	Easiness	.78	.67
	Trustworthiness	.73	.54
	Appropriateness	.74	.68
Second-order construct	Perceived visibility of knowledge	.90	NA

Next, I examined the item loadings for the first-order constructs and evaluated the weight loadings of each first-order construct on the second-order construct. Also, standardised error variance (error) was calculated as 1 minus the squared factor loadings. As shown in Table 4.20, the item-to-construct loadings ranged between .77 and .91. This indicates that all items loaded highly on the intended construct and supported convergent validity.

Table 4.20 Pre-test: item loadings

Constructs	Error	Loadings	Loadings on 2nd Order
Broadness (BRO 1-3)	.38	.79	.76***
	.24	.87	
	.17	.91	
Up-to-datedness (UPT 1-4)	.33	.82	.80***
	.25	.88	
	.40	.77	
	.28	.85	
Diversity (DIV 1-5)	.40	.78	.94***
	.30	.84	
	.33	.82	
	.36	.80	
	.30	.84	
Easiness (EAS1-3)	.38	.79	.82***
	.29	.85	
	.29	.85	
Trustworthiness (TRUS 1-3)	.23	.88	.73***
	.39	.78	
	.36	.80	
Appropriateness (APPR 1-3)	.40	.77	.83***
	.33	.82	
	.30	.84	
Timeliness (TIM 1-3)	.37	.80	.71***
	.31	.83	
	.21	.89	

*p < .05, **p < .01, and ***p < .001

The structural model results are shown in Table 4.21. Perceived visibility of knowledge explained 40 percent of the variance in the internal individual cognitive mechanism. In addition, the path between perceived visibility of knowledge and the internal individual cognitive mechanism was significant (p<.001). This explains that perceived visibility of knowledge was a significant predictor of the internal individual cognitive mechanism, so no items needed to be removed.

Table 4.21 Pre-test: structural model results

	Internal Individual Cognitive mechanism
R_2	.40
Estimated path coefficient with perceived visibility of knowledge	.63***

*p < .05, **p < .01, and ***p < .001

4.8 Step seven: Conduct new sample data collection (study 1)

The next step was to reestimate the measurement model using a new sample of data. This was important in order to assess the extent to which the psychometric properties of the scale may have been based on idiosyncrasies in the developmental sample of data and to permit a valid statistical test of the fit of the measurement model (Mackenzie et al. 2011). Using this new sample, the measurement model was reestimated, its fit re-examined and the psychometric properties re-evaluated.

Similar to the pre-test (see Appendix G), a survey including instructions for the participants, items related to the internal individual cognitive mechanism and items developed in this study was designed. The data for this step was collected from software developers based in New Zealand who were active users of social media. To ensure that a new sample had been considered, I contacted software developers that were not invited to the research previously. Following the procedure outlined in step five, at the beginning of the survey, one qualifying question was asked: "*Please indicate if you use social media to gain knowledge for your software development activities*". Software developers who did not use social media in their

work at all were disqualified from participating in the survey and no data was collected from these individuals. In total, 281 complete responses were collected in this step. Next, all responses were scrutinised and those respondents who took too little time (less than three minutes) were excluded from the sample. This led to 265 usable responses. Table 4.22 provides information on the respondents' demographics. Next, I examined the fit of the measurement model (the second-order measurement model proposed in this study).

Table 4.22 Study 1: respondent demographics

Demographic	Category	n = 265	%
Gender	Male	221	83.4
	Female	44	16.6
Age Groups	29 or younger	77	29
	30-39	127	47.9
	40-49	57	21.5
	50 or older	4	1.5

As reported in Table 4.23, all the fit indexes met the recommended threshold (Hair et al. 1998; Mackenzie et al. 2011; Straub et al. 2004), thus indicating a good model fit.

Table 4.23 Model fit for study 1

Fit Indexes and Cut-Offs for Perfect Fit	Values
RMSEA (≤ .06)	.04
SRMR (≤ .08)	.05
CFI (≥.95)	.96
AGFI (≥.80)	.88
NFI (≥ .90)	.90
TLI (≥ .95)	.96

In addition, the average variance extracted (AVE) was calculated for the first-order constructs by averaging the squared, completely standardised factor loading for the indicators. As shown in Table 4.24, all the AVE scores for the first-order constructs were between .56 and .65 and greater than the threshold of .50 (Mackenzie et al. 2011). The AVE was also calculated for the second-order construct. The results confirmed that the AVE for the second-order construct was .57 and greater than the threshold of .50 (Mackenzie et al. 2011). The reliability of all the first-order constructs were also examined using Cronbach's alpha. As illustrated in Table 4.24, all

the Cronbach's alpha values ranged from .79 to .88 and were above the desired threshold of .70 (Bollen and Lennox 1991).

Table 4.24 Study 1: construct reliability, AVEs and correlation matrix

Constructs	Cronbach Alpha	AVE
Broadness	.84	.64
Up-to-datedness	.83	.57
Diversity	.87	.56
Timeliness	.81	.59
Easiness	.82	.61
Trustworthiness	.79	.56
Appropriateness	.85	.65
Internal individual cognitive mechanism	.88	.62
Perceived visibility of knowledge	NA	.57

Then, the reliability of the first-order constructs as indicators of the second-order construct was measured by Fornell and Larcker's (1981) index of construct reliability. In addition, using Fornell and Larcker's (1981) index of construct reliability, the reliability of the indicators for each individual first-order construct was calculated. The construct reliability was computed using the completely standardised estimates of the second-order factor loadings and error variances associated with the first-order sub-dimensions. All construct reliability index scores for first-order constructs and the second-order construct were above the recommended threshold of .70 (Fornell and Larcker 1981). The reliability of each indicator of the first-order constructs was measured by examining the squared multiple correlation for the indicator. The value of all the indicators ranged from .50 to .60 and were greater than the threshold of .50, which explains that the latent construct accounted for the majority of the variances in the indicators.

In addition, the reliability of each first-order construct was calculated by examining its squared multiple correlation. The value for all the first-order constructs was above the threshold of .50, which indicates that the second-order later construct accounted for the majority of the variance in the first-order construct (Fornell and Larcker 1981). Table 4.25 shows the results of the construct reliability index and squared multiple correlation of the first-order constructs.

Table 4.25 Study 1: unique proportion of variance in the second-order constructs

	Construct Name	Fornell and Larcker's Construct Reliability Index	R^2
First-order constructs	Broadness	.84	.50
	Up-to-datedness	.83	.60
	Diversity	.97	.72
	Timeliness	.76	.53
	Easiness	.78	.58
	Trustworthiness	.72	.51
	Appropriateness	.81	.52
Second-order construct	Perceived visibility of knowledge	.92	NA

Next, I assessed the item loadings for the first-order constructs and examined the weight loadings of each first-order construct on the second-order construct. Also, standardised error variance (error) was calculated as 1 minus the squared factor loadings. Table 4.26 shows these results. All items loaded highly on the intended constructs, with item-to-construct loadings between .71 and .87, thus supporting convergent validity.

Table 4.26 Study 1: item loadings and weights

Constructs	Error	Loadings	Loadings on 2nd Order
Broadness (BRO 1-3)	.30	.84	.71***
	.36	.80	
	.42	.76	
Up-to-datedness (UPT 1-4)	.42	.76	.78***
	.41	.77	
	.48	.72	
	.40	.77	
Diversity (DIV 1-5)	.45	.75	.85***
	.41	.77	
	.39	.78	
	.44	.75	
	.50	.71	
Timeliness (TIM 1-3)	.35	.81	.73***
	.49	.71	
	.40	.78	
Easiness (EAS1-3)	.43	.76	.77***
	.25	.87	
	.50	.71	
Trustworthiness (TRUS 1-3)	.43	.76	.71***
	.42	.76	
	.47	.73	
Appropriateness (APPR 1-3)	.37	.80	.72***
	.32	.82	
	.36	.80	

*p < .05, **p < .01, and ***p < .001

4.9 Step eight: Assess scale validity

This step examined whether the responses to the scale behaved as one would expect if they were valid indicators of perceived visibility of knowledge. The goal was to assess whether the indicators of the focal construct (1) were accurate representations of the underlying construct (through experimental manipulation or comparing groups known to differ on the construct), (2) adequately captured the multidimensional nature of the construct, (3) were distinguishable from the indicators of other constructs (discriminant validity), and (4) were related to the measures of other constructs specified in the construct's theoretical network (nomological validity) (Mackenzie et al. 2011).

Mackenzie et al (2011) suggest two methods to assess whether a set of reflective indicators accurately measure the phenomenon: experimental manipulation and known group comparison. In the experimental manipulation method, a medium (e.g., video, audio or visual depiction) can be used to experimentally manipulate a construct to validate its measures. This method is more appropriate for validating behavioural/performance measures (e.g., leadership behaviours, task performance, customer service, etc.), interpersonal interaction measures (e.g., conflict, attraction, etc.), group process measures (e.g. communication among team members, encouragement by other group members, etc.), or emotional display measures (e.g., anger, disgust, frustration, etc.). However, the experimental manipulation method is not practical for validating internal states (e.g., attitudes, beliefs, values, anxiety, etc.) and personality traits. Since perceived visibility of knowledge is a subjective judgment made by users (Treem and Leonardi 2013), experimental manipulation is not appropriate to validate the newly developed instrument.

The second method, known as group comparison, requires using groups with recognised differences on the construct of interest and testing whether the mean levels of the measure differ across these groups in the hypothesised direction (Bollen and Lennox 1991; Mackenzie

et al. 2011). However, a literature review did not reveal any meaningful theoretical patterns across groups that could be applied to validate the newly developed scales for perceived visibility of knowledge. Therefore, this study could not develop hypotheses comparing perceived visibility of knowledge in different groups.

In other words, due to the above reasons, it did not seem possible to examine whether indicators of perceived visibility of knowledge were (1) accurate representations of the underlying construct by conducting an experimental manipulation or comparing groups known to differ in perceived visibility of knowledge. Therefore, I assessed whether the indicators of perceived visibility of knowledge met the rest of the conditions, namely, whether they (2) adequately captured the multidimensional nature of the construct, (3) were distinguishable from the indicators of other constructs (discriminant validity), and (4) were related to the measures of other constructs specified in the construct's theoretical network (nomological validity) (Mackenzie et al. 2011).

4.9.1 Assessment of nomological and/or criterion-related validity

Apart from establishing the validity of the indicators of the focal construct using the experiment-based or known-groups validity method, it is important to (1) specify the nature of the lawful relationships between the focal construct and other constructs, and (2) test whether the indicators of the focal construct relate to measures of other constructs in the manner expected (Mackenzie et al. 2011). Specifying the nomological network is important for determining construct validity because it is not sufficient to focus only on semantic criteria of the language used to represent concepts and the relationship among concepts and operationalisation. In addition, it is not sufficient to assess only the empirical criteria of the internal consistency of the operationalisation or even convergent and discriminant validity. Therefore, in validating the newly developed instrument, researchers must also consider the

relationship of the concept under investigation to other concepts in an overall context of a theoretical structure (Mackenzie et al. 2011).

The other constructs in the nomological network may be antecedents, correlates or consequences (Mackenzie et al. 2011). Antecedents are constructs that are hypothesised to cause the focal construct. Correlates are constructs whose conceptual definitions overlap with the focal construct. Consequences are constructs that are hypothesised to be caused by the focal construct. At least in the early stage of the construct development, the nomological network may be limited, with only a few other constructs that can be expected to serve as antecedents, correlations and/or consequences of the focal construct (Bollen and Lennox 1991). The reason is that there has been little or no previous research involving the construct, and little theoretical discussion about why it might be related to other constructs (Mackenzie et al. 2011). However, additional research on the construct often results in an expansion of the nomological network to include additional antecedents, correlates and consequences of the focal construct as well as potential mediators and moderators of its relationships with other variables (Bollen and Lennox 1991; Mackenzie et al. 2011).

To assess the nomological validity of the newly developed construct, the procedure involves estimating the latent constructs (to control measurement error) and testing whether estimates of their relationships with hypothesised antecedents, consequences and correlates are significantly different from zero (with the anticipated sign). For example, as specified in the nomological network, if the path between a focal construct and its consequence is significant, it suggests that the focal construct relates to that construct, thus increasing confidence in the validity of the indicators (Mackenzie et al. 2011). Moreover, the magnitude of the completely standardised coefficient associated with these paths indicates the strength of the relationship between the focal construct and its antecedents or consequences. This can be evaluated for consistency with the theoretical expectations. For instance, if the focal construct is expected to

be strongly related to one of the other constructs in the nomological network because of the conceptual similarity, then the coefficients should not only be significantly different from zero but also large in magnitude.

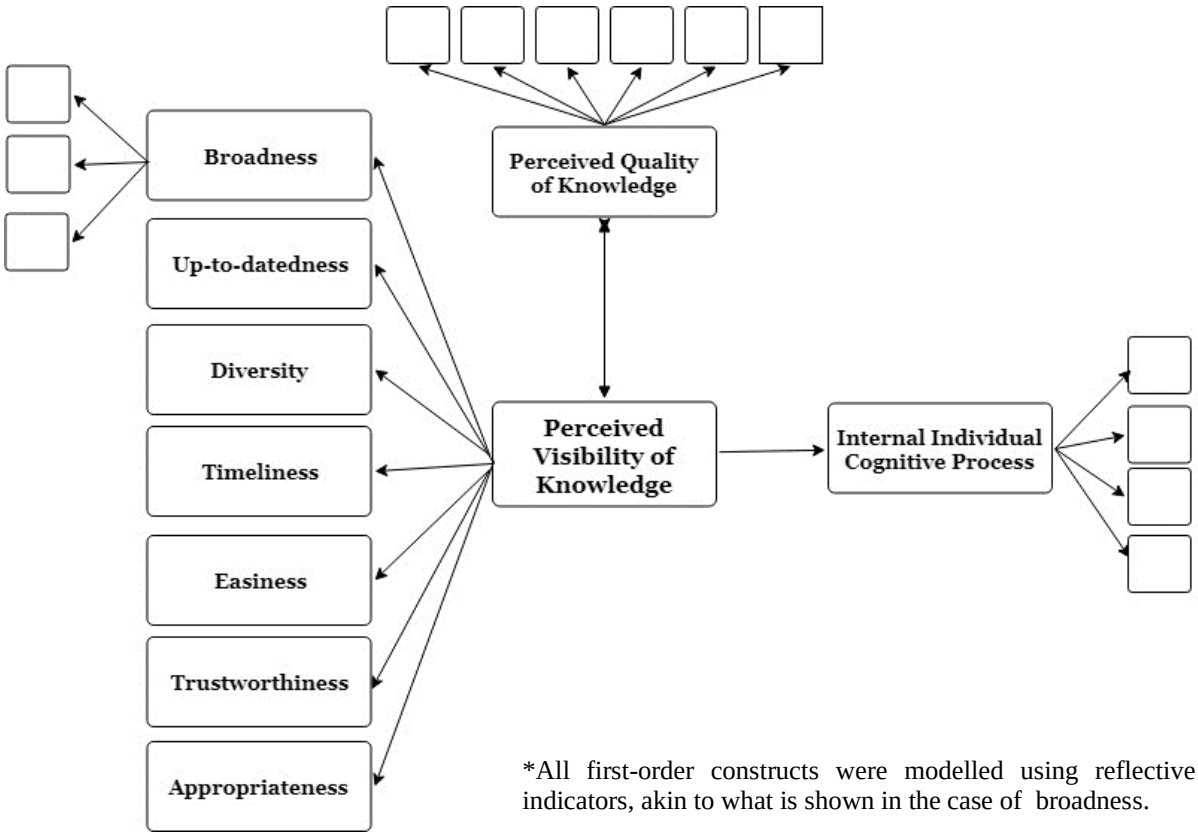

Figure 4.5 The nomological network applied in step eight

As shown in Figure 4.5 to assess the nomological validity of perceived visibility of knowledge, this study examined the relationship between perceived visibility of knowledge as a focal construct and its consequence construct, the internal individual cognitive mechanism. As explained earlier in step five, it is expected that perceived visibility of knowledge positively affects the internal individual cognitive mechanism as a consequence construct.

I also considered the correlation between perceived visibility of knowledge and perceived quality of knowledge. Perceived quality of knowledge is defined as users' evaluation of the quality of a website's information in meeting their needs (Aladwani and Palvia 2002). Aladwani and Palvia (2002) conceptualised and developed an instrument that measures users'

perceptions about the key characteristics of knowledge quality shared in websites from the perspective of internet users. They developed six items to measure perceived quality of knowledge in the websites (see Table 4.27). As shown in Table 4.27, the attributes that Aladwani and Palvia (2002) considered to measure perceived quality of knowledge conceptually correlate with the aspects that I developed to measure perceived visibility of knowledge. For example, one item that they considered to measure perceived quality of knowledge was, "*The content of [social media] is complete*", which is conceptually similar to broadness of information in my study. I measured broadness of information as a first-order construct with three items (*In social media: I can access comprehensive information related to problems at hand, I can access a large amount of information and I can access supplementary information related to what I was looking for*). In other words, in both studies, broadness of information was considered to be a common aspect to measure both perceived quality of knowledge and perceived visibility of knowledge.

Table 4.27 Scales used in the nomological network

Constructs	**Items**	**Scales Adapted From**
Perceived Quality of Knowledge	The content of social media is useful The content of social media is complete The content of social media is clear The content of social media is current The content of social media is concise The content of social media is accurate	Aladwani and Palvia (2002)
Internal Individual Cognitive Mechanism	I use social media to read information related to my task I use social media to search and collect information related to my task I use social media to gather and categorise work-related information I use social media to adapt information to my work-related problems	Sigala and Chalkiti (2014, 2015)

The structural model results are shown in Table 4.28. Perceived visibility of knowledge explained 31 percent of the variance in the internal individual cognitive mechanism. In addition, the path between perceived visibility of knowledge and the internal individual

cognitive mechanism (.56) was significant (p<.001). This explains that perceived visibility of knowledge was a significant predictor of the internal individual cognitive mechanism.

Table 4.28 Study 1: structural model results of perceived visibility of knowledge and its consequence construct

	Internal individual cognitive mechanism
R^2	.31
Estimated path coefficient with perceived visibility of knowledge	.56***

*p < .05, **p < .01, and ***p < .001

The correlation between perceived visibility of knowledge with perceived quality of knowledge in social media setting was tested. The magnitude of the standardised coefficient (.73) associated with the path between the focal construct (perceived visibility of knowledge) and its correlate (perceived quality of knowledge) with the significance level of p<.001 provided an indication of the strength of the relationship between these two constructs.

In summary, as explained above, the focal construct (perceived visibility of knowledge) related to its consequence (internal individual cognitive mechanism) and correlate (perceived quality of knowledge), as specified in the nomological network, thus increasing confidence in the validity of the indicators.

4.9.2 Assessing the validity of the multidimensional structure through the nomological network

Examining the relationships in the nomological network can also be useful in further evaluating the adequacy of the multidimensional structure of the focal construct (Edwards 2001). This can be done by evaluating if the sub-dimensions of the multidirectional construct have significant direct effects on a consequence construct over and above the direct effect that the focal construct has on the consequence. The direct effects between the sub-dimensions of perceived visibility of knowledge and the internal individual cognitive mechanism are presented by dashed lines in Figure 4.6.

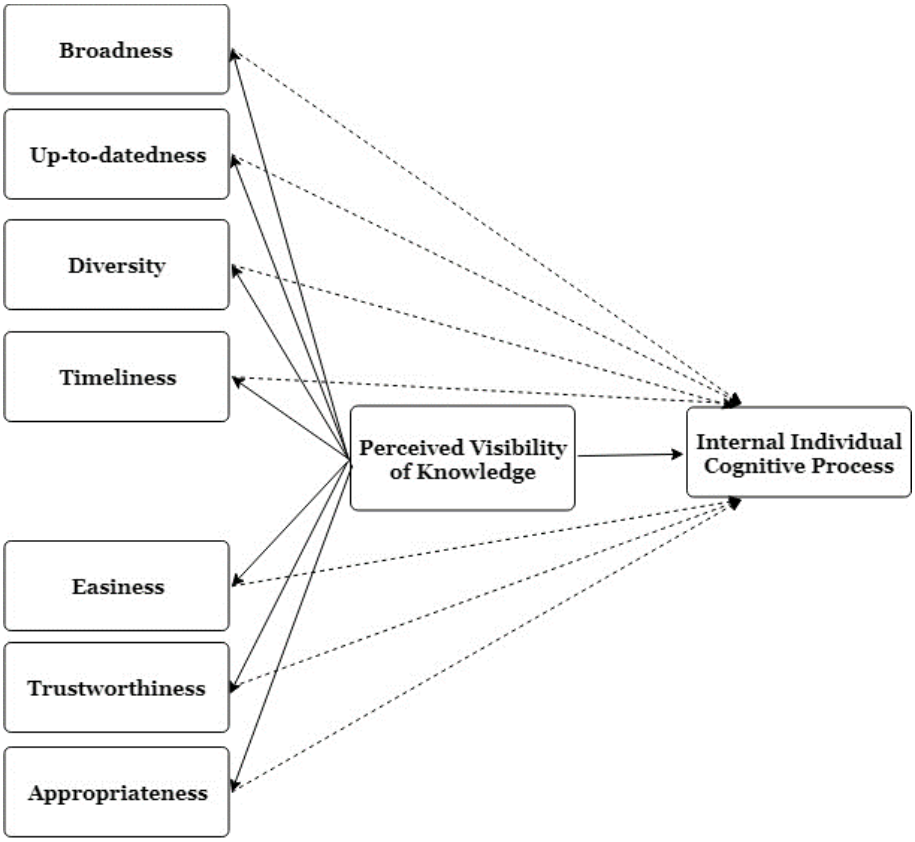

Figure 4.6 Direct and indirect paths between sublimations of perceived visibility of knowledge and its consequence

As shown in Table 4.29, the direct paths between the sub-dimensions of perceived visibility of knowledge and the internal individual cognitive mechanism are not significant. This means that the sub-dimensions of perceived visibility of knowledge did not account for additional variance in the internal individual cognitive mechanism as the consequence construct.

Table 4.29 Regression weights of indirect path between the first-order constructs and the internal individual cognitive mechanism

Consequence construct		Constructs	Estimate	S.E.	C.R.	P
Internal Individual Cognitive Mechanism	←	Broadness	.248	.126	1.958	.050
	←	Up-to-datedness	.059	.100	.592	.554
	←	Diversity	.091	.181	.506	.613
	←	Easiness	.125	.102	1.232	.218
	←	Trustworthiness	-.080	.094	-.847	.397
	←	Appropriateness	.156	.083	1.883	.060
	←	Timeliness	.037	.086	.434	.665
	←	Perceived visibility of knowledge	.711	.113	6.288	< .001

*p < .05, **p < .01, and ***p < .001

4.9.3 Assessing discriminant validity

In addition to showing that the indicators behave in a manner that is consistent with the nomological network, it is also important to show that these indicators are distinguishable from the indicators of the other constructs: discriminant validity (Mackenzie et al. 2011). In this step, discriminant validity was evaluated by examining whether the average variance extracted (AVE) for each construct was greater than the square of the correlation between the constructs (Fornell and Larcker 1981). Table 4.30[3] shows the results of the discriminant validity test. The results indicated that there was no discriminant validity as the AVE for each construct was greater than any inter-construct correlation.

Table 4.30 Discriminant validity test

First-order Constructs	**1**	**2**	**3**	**4**	**5**	**6**	**7**
1. Easiness	**.78**						
2. Diversity	.63	**.75**					
3. Up-to-datedness	.53	.65	**.74**				
4. Appropriateness	.57	.59	.63	**.81**			
5. Timeliness	.64	.62	.56	.49	**.77**		
6. Broadness	.47	.68	.67	.49	.42	**.80**	
7. Trustworthiness	.64	.57	.55	.53	.57	.42	**.75**

Note: the values in the diagonal are AVE.

4.10 Step nine: Cross-validation (study 2)

The next step in the scale development process is to cross validate the psychometric properties using a new sample (Mackenzie et al. 2011).

To do so, I collected data from a new sample which comprised 214 software developers based in New Zealand who use social media applications in their job. During data collection (see Appendix G), care was taken not to invite any participants who were invited to the previous steps (step six: pre-test and step seven: conduct new sample data collection). Similar to the previous steps, participants who were not qualified to participate in the survey (e.g., not using

[3] To test the discriminant validity of the first-order constructs, the second-order factor (perceived visibility of knowledge) was removed from the measurement model and the first-order constructs were correlated to each other.

a social media application to gain knowledge for their task) were excluded from the sample. Also, participants who spent too little time (less than three minutes) on the survey were excluded. This led to 207 usable responses. Table 4.31 shows the respondent demographics.

Table 4.31 Study 2: respondent demographics

Demographic	Category	n = 207	%
Gender	Male	152	73.4
	Female	55	26.6
Age Groups	29 or younger	66	31.9
	30-39	101	48.8
	40-49	36	17.4
	50 or older	4	1.9

Next, I tested the measurement and structural models. As illustrated in Table 4.32, all fit indexes were in line with recommended cut-off values (Hair et al. 1998), indicating that the measurement model fit was good.

Table 4.32 Model fit for study 2

Fit Indexes and Cut-Offs for Perfect Fit	Value
GFI (≥.90)	.90
RMSEA (≤ .06)	.03
SRMR (≤ .08)	.05
CFI (≥.95)	.98
AGFI (≥.80)	.87
NFI (≥ .90)	.90
TLI (≥ .95)	.98

Also, as shown in Table 4.33, all AVEs exceeded the .50 threshold. The results confirmed that the AVEs for each construct exceeded the squared correlation of the construct with other constructs (Fornell & Larcker, 1981). Further, all Cronbach's alphas ranged from .81 to .87 and were above the recommended .70 threshold (Bollen & Lennox, 1991).

Table 4.33 Study 2: unique proportion of variance in the second-order construct

Constructs	Cronbach Alpha	AVE
Broadness	.86	.68
Up-to-datedness	.86	.61
Diversity	.87	.57
Timeliness	.87	.69
Easiness	.83	.63
Trustworthiness	.81	.60
Appropriateness	.82	.61
Perceived visibility of knowledge	NA	.57

Next, I inspected the item loadings for the first-order constructs and assessed the weight loadings of each first-order construct on the second-order construct. Table 4.34 shows these results. All items loaded highly on the intended constructs, with item-to-construct loadings between .72 and .77, thus supporting convergent validity.

Table 4.34 Study 2: item loadings and weights

Constructs	Error	Loadings	Loadings on 2nd Order
Broadness (BRO 1-3)	.32	.82	.77***
	.28	.85	
	.35	.80	
Up-to-datedness (UPT 1-4)	.42	.76	.72***
	.38	.79	
	.38	.79	
	.38	.79	
Diversity (DIV 1-5)	.43	.75	.72***
	.44	.75	
	.40	.78	
	.40	.77	
	.49	.71	
Timeliness (TIM 1-3)	.37	.80	.73***
	.26	.86	
	.31	.83	
Easiness (EAS 1-3)	.42	.76	.75***
	.29	.84	
	.42	.76	
Trustworthiness (TRUS 1-3)	.44	.75	.75***
	.40	.77	
	.37	.79	
Appropriateness (APPR 1-3)	.47	.73	.73***
	.36	.80	
	.32	.82	

*p < .05, **p < .01, and ***p < .001

The structural model results are shown in Table 4.35. Perceived visibility of knowledge explained 32 percent of the variance in the internal individual cognitive mechanism. In addition, the path between perceived visibility of knowledge and the internal individual cognitive mechanism was significant (p<.001). This means that perceived visibility of knowledge was a significant predictor of the internal individual cognitive mechanism.

Table 4.35 Study 2: structural model results

	Internal Individual Cognitive mechanism
R_2	.32
Estimated path coefficient with perceived visibility of knowledge	.56***

*p < .05, **p < .01, and ***p < .001

4.11 Step ten: Norm development

The final step in the scale development process is to develop norms for the new scales. This is an important step because it aids in interpretation of the findings and guides future research (Mackenzie et al. 2011). Estimating the population distribution requires administering the scale to a representative sample of members of the population of interest. If the population of interest is managers at a particular level of the organisational hierarchy, then a representative sample of that population should be obtained. On the other hand, if a scale is designed to measure attributes or characteristics of IT workers, then a representative sample of that population should be obtained.

Aside from the extra effort associated with collecting this data (which is not trivial), perhaps the biggest barrier to the development of scale norms is the difficulty of obtaining "representative" samples of the population from which to generalise. Another important consideration in the development of scale norms is the size of the normative samples. The sample needs to be large enough to ensure that the scale scores obtained are stable. However, the required normative sample size varies depending on the size of the population for which the researcher wants to generate norms. For example, generalised ability measures that are used for college admission might require normative samples that number in the tens of thousands, whereas normative samples for measures that are applicable only to members of specialised occupational groups may require only hundreds (Mackenzie et al. 2011). Generally, it is valuable to evaluate the distribution of the population of interest before developing

sampling strategies (Mackenzie et al. 2011). For instance, as explained before, studying the gender demography of software developers, I found that over 90 percent of software developers around the world are men.[4] Therefore, the representative sample with more male participants than female in the current study was seen to be acceptable.

Another important consideration in the development of a new instrument is the sample size (Mackenzie et al. 2011). The sample size should be large enough to show that the scales are truly stable (Lee and Baskerville 2003; Mackenzie et al. 2011). The newly developed scales in this study were validated using four independent samples (218, 202, 265 and 207 individuals respectively). In total, this study surveyed around 900 software developers based in New Zealand who use social media to gain knowledge for their work-related tasks. The total number of 900 individuals was reasonably large enough sample to draw meaningful conclusions.

A final consideration in developing norm for new scales is to consider that the scales can vary across research contexts and time (Johns 2006; Mackenzie et al. 2011). A particular context of study can lead to different results, such as relationships going from significant to nonsignificant (Johns, 2006). Also, the concept of time is important and can impact the stability of theories and associated scales (Mackenzie et al. 2011). Except for the two participants from Canada and The Netherlands in the interview step, due to the practical constraints, this study only tested the newly developed conceptualisation and survey instrument in the context of software developers in New Zealand using cross-sectional data.[5]

4.12 Chapter summary

This chapter presented the instrument development for perceived visibility of knowledge in social media. To do so, I followed the 10-step procedure recommended by Mackenzie et al.

4 https://insights.stackoverflow.com/survey/2018/

5 Cross-sectional data, or a cross section of a study population, in statistics and econometrics is a type of data collected by observing many subjects (such as individuals, firms, countries, or regions) at the same point of time, or without regard to differences in time.

(2011). Specifically, I surveyed the literature and interviewed subject matter experts and practitioners to develop the conceptualisation of perceived visibility of knowledge in social media, which I then developed into seven first-order constructs that reflected the focal construct (perceived visibility of knowledge). To achieve this objective, I collected four datasets: content validity (n=218), pre-test (n=202), validation (n=265) and cross-validation (n=207). The nomological validity of the instrument was established by examining its relationship with an outcome variable, the internal individual cognitive mechanism, and its correlation with a correlate variable, perceived quality of content. This study found that the newly developed instrument was a good predictor of the outcome variable and had a high correlation with the correlate variable.

Chapter 5: Data analysis and findings

Chapter overview

A new instrument for perceived visibility of knowledge was developed and validated as explained in the previous chapter. This chapter presents the testing process of the hypothesised relationships in the conceptual model. A complete survey with the newly developed items for perceived visibility of knowledge and adopted items for other constructs in the research model (i.e., perceived association, the internal individual cognitive mechanism, the external collaborative cognitive mechanism, domain-relevant knowledge and divergent thinking) was designed.

This chapter describes the data collection process. It also reports the results of statistical methods applied to conduct data screening, examine normality and common method bias (CMB) and test hypothesised relationships between variables of the research model.

5.1 Data collection

Both online and paper-based surveys were used to collect data from software developers in New Zealand. At the beginning of the survey, the purpose of the survey and a brief introduction about the number of questions were provided. Also, the introduction clarified the reason behind the similarity of some questions, which was to establish statistical reliability and validity. Appendix H shows the complete survey used in this study.

As shown in Appendix H, at the beginning of the survey, one qualifying question was asked: "*Please indicate if you use social media to gain knowledge for your software development activities.*" Software developers who did not use social media in their work at all were disqualified from participating in the survey and no data was collected from these individuals. The next section of the survey included the demographic questions including gender and age. The remaining pages of the questionnaire asked the key questions corresponding to the constructs of the study – i.e., perceived visibility of knowledge, perceived association, the

internal individual cognitive mechanism, the external collaborative cognitive mechanism, domain-relevant knowledge and divergent thinking. All the items were measured using a seven-point Likert-agreement scale (1=strongly disagree; 7=strongly agree).

For this study, both online and paper-based surveys were used to collect data from software developers in New Zealand. The online survey was conducted via Survey Monkey. Software developers were contacted via widely known and large IS developers' community websites such as https://www.meetup.com/cities/nz/ and also through several general online media (e.g., LinkedIn, Facebook). The paper-based survey was distributed by participating in software development workshops and meetup groups and asking software developers to complete the survey.

In order to fine-tune and refine the survey and to ensure that the items of each construct were understandable, the validity of the wording of the items and the time necessary for each session was estimated by conducting a pre-test and a pilot test as follow.

5.1.1 Pre-test of the instrument

Before collecting data from the large sample, a pre-test study was conducted to evaluate and refine the survey. The pre-test process is a necessary step because unclear items and instructions may cause frustration for the respondents, which may result in an incomplete response to the survey (Ray and Tabor 2003). To conduct the pre-test, two academics who had experience with survey studies and behavioural research, and two practitioners who were active users of social media for software development activities, were approached. The four participants were asked to provide feedback on the clarity of the survey instructions and design and also the flow of the questions in the survey in order to avoid respondent bias (Ray and Tabor 2003). Participants gave minor comments on the wording and flow of some questions and the survey was refined according to their feedback.

5.1.2 Pilot test of the instrument

A pilot study is a rehearsal of the instrument with a small sample size, in which participants are similar to the population of the final survey (Churchill 1979). A pilot test is conducted to fine-tune the instrument and assess the measurement model prior to the main data collection (Churchill, 1979).

In this study, the pilot study was conducted with software developers who actively used social media to gain knowledge for their job. All participants in the pilot study were located in Auckland, New Zealand. In total, 25 software developers completed the pilot study survey (12 completed the online version of the survey on the Survey monkey platform and 13 completed the paper-based survey). To ensure that a new sample had been considered for the pilot study, I contacted software developers that were not invited to the research previously. Table 5.1 provides the sample demographics of the participants in the pilot study.

Table 5.1 Pilot study: sample demographics

Demographic	**Category**	**n = 25**	**%**
Gender	Male	18	72
	Female	7	28
Age Groups	29 or younger	5	20
	30-39	10	40
	40-49	8	32
	50 or older	2	8

As shown in Table 5.1, 18 of the respondents were male and 7 were female. The majority of the respondents had an average age of 30-39 (40 percent) and 40-49 (32 percent), while 20 percent of the respondents were aged 29 years or younger and eight percent were 50 years or older.

Since a minimum sample of 100 responses was required to conduct structural equation modelling (SEM) (Tabachnick and Fidell 2001), this study reports only Cronbach's alpha for the pilot test. Table 5.2 shows that the values of Cronbach's alpha of the constructs ranged

from .70 to .76, which are equal or greater than the recommended threshold of .70 (Nunnally and Bernstein 1994).

Table 5.2 Pilot study: Cronbach's alpha of the constructs

Constructs	Cronbach Alpha
Broadness	.72
Up-to-datedness	.70
Diversity	.74
Timeliness	.75
Easiness	.72
Trustworthiness	.72
Appropriateness	.76
Perceived association	.72
Individual cognitive mechanism	.72
External collaborative cognitive mechanism	.71
Domain-relevant knowledge	.71
Divergent thinking	.70

5.1.3 Survey administration

The population of interest to this study was software developers who actively used social media to gain knowledge for job-related tasks. Both online and paper-based surveys were used to collect data from software developers in New Zealand.

When conducting both online and paper-based surveys, the time duration that participants took to complete the survey was measured. In the online data collection, the time duration that participants took to complete the survey was measured using Survey Monkey software. In the paper-based format of data collection, I asked participants to note their start/end time in completing the survey. All responses were scrutinised and those respondents who took too little time were excluded from the sample. A response ratio of more than 15 questions per minute indicated that the survey takers did not pay adequate attention to the questions (Hoehle and Venkatesh 2015). Therefore, I applied a cut-off threshold of four minutes to complete the survey including all items of the questionnaire shown in Appendix H and excluded those responses that were completed in less than three minutes.

To ensure that a new sample had been considered for this study, I contacted software developers that were not invited to the research previously. In total, 301 participants accepted the survey invitation. 30 percent of the sample used in this study was collected while I was collecting data for instrument development. The overlap between the 30 percent of sample in this step and the sample used for instrument development is seen to be acceptable. The reason is because the purpose of the two studies were different; one study develops an instrument for perceived visibility of knowledge in social media and the other study examiness the influence of social media properties on creativity.

The online survey was set to "force responses to all questions" before proceeding to the next page or submission. However, five participants stopped answering the questions and left the survey half-way through. In addition, 15 participants who completed the paper-based survey had more than 20 percent of incomplete answers. These responses were regarded as incomplete responses.

In total, 281 complete responses were collected. Next, all responses were scrutinised and those respondents who took too little time (less than four minutes) were excluded from the sample. This led to 265 usable responses. In order to determine sample size, a general rule of thumb was followed. Several studies (Hoehle and Venkatesh 2015; MacCallum and Browne 1993; Mackenzie et al. 2011) have recommended that the minimum ratio of the number of respondents to the number of items should be in the scale range from 3:1 to 10:1. Given that the survey instrument included 46 measurement items,, the ratio of items to responses was in a range specified by previous research. The sample demographics of the respondents are shown in Table 5.3.

Table 5.3 Respondent demographics

Demographic	Category	n = 265	%
Gender	Male	221	83.4
	Female	44	16.6
Age Groups	29 or younger	77	29.1
	30-39	127	47.9
	40-49	57	21.5
	50 or older	4	1.5

As evident from Table 5.3, 83.4 percent of the population were male, and 16.6 percent were female. Based on these findings, the respondent demographics of the current study were seen to be acceptable. In total, 47.9 percent of the participants were in the age group 30-39, followed by 29.1 percent in the age group 29 or younger while 21.5 percent of the participants were in age group 40-49 and the rest (1.5 percent) were 50 years or older.

5.2 Data screening

Dealing with missing value is an important condition due to its effects on the generalisability of the results (Lynch 2007). Missing value was not a concern for this study as the collected answers were fully completed. Through SurveyMonkey, there was an option to download the completed responses and exclude all the incomplete answers. The collected paper-based responses were checked, and the incomplete responses were removed from the dataset.

5.2.1 Normality

In this research, normality of the variables was evaluated through statistical tests of skewness and kurtosis. Skewness and kurtosis values between -1 and +1 indicate a normal distributed sample (Mertler and Reinhart 2016). As shown in Table 5.4, the skewness value of all the items is in the range of -1 and +1. Also, the kurtosis value of all items except three items is in the accepted range of -1 and +1. The kurtosis value of these three items is slightly greater than 1: one item belongs to the construct timeliness (with a kurtosis value of 1.06), one item beloings to the construct domain-relevant knowledge (with a kurtosis value of 1.03) and one item belongs to the construct divergent thinking (with a kurtosis value of 1.02). If only a few of the

skewness and kurtosis values are greater than 1, they do not distort normality (Tabachnick and Fidell 2001).

Table 5.4 Assessment of normality of items

Constructs	Items	Skewness	Kurtosis
Broadness (BRO 1-3)	BRO 1	-.50	-.33
	BRO 2	-.62	.08
	BRO 3	-.87	.76
Up-to-datedness (UPT 1-4)	UPT1	-.54	.14
	UPT2	-.57	.27
	UPT3	-.54	.10
	UPT4	-.57	-.35
Diversity (DIV 1-5)	DIV1	-.54	-.07
	DIV2	-.60	.11
	DIV3	-.68	.68
	DIV4	-.72	.32
	DIV5	-.43	-.14
Timeliness (TIM 1-3)	TIM1	-.25	-.38
	TIM2	-.44	1.06
	TIM3	-.62	.63
Easiness (EAS 1-3)	EAS1	-.57	.65
	EAS2	-.69	.88
	EAS3	-.41	.22
Trustworthiness (TRUS 1-3)	TRUS1	-.44	.51
	TRUS2	-.60	.72
	TRUS3	-.54	.81
Appropriateness (APPR 1-3)	APPR1	-.26	-.04
	APPR2	-.50	.33
	APPR3	-.73	.97
Perceived association (ASSO 1-3)	ASSO1	-.75	1.00
	ASSO 2	-.80	.86
	ASSO 3	-.71	.60
Internal individual cognitive mechanism (INTR 1-4)	INTR1	-.70	.74
	INTR2	-.73	.92
	INTR3	-.70	.88
	INTR4	-.70	.96
External collaborative cognitive mechanism (EXTR 1-6)	EXTR1	-.32	-.32
	EXTR2	-.65	.45
	EXTR3	-.49	.46
	EXTR4	-.52	.34
	EXTR5	-.47	-.04
	EXTR6	-.87	.63
Domain-relevant knowledge (DOMN 1-3)	DOMN1	-.54	.14
	DOMN2	-.64	.67
	DOMN3	-.66	1.03
Divergent thinking (DVGT 1-6)	DVGT1	-.32	-.27
	DVGT2	-.44	.19
	DVGT3	-.57	-.04
	DVGT4	-.51	-.12
	DVGT5	-.74	.02
	DVGT6	-.86	1.02

Previous research (Field 2013) has explained that skewness and kurtosis can be linked to the effect of the sample size. In fact, the standard error of skewness and kurtosis are directly related to the sample size (Micceri 1989). Therefore, to evaluate the normality, the frequency histograms of constructs as graphical devices were used.

Below, the histogram of each construct is presented, and their skewness and kurtosis values are discussed. In terms of the skewness of the constructs, a) if the value is less than -1 or greater then +1, the distribution is highly skewed, b) if the value is between -1 and -1/2 or between +1/2 and 1, the distribution is moderately skewed and c) if the value is between -1/2 and +1/2, the distribution is approximately symmetric (Bulmer 1979). In terms of the kurtosis value of the constructs, a) if the value is between -3 and 3, the distribution has normal kurtosis b) if the value is greater than 3, the distribution is too peaked (leptokurtic) and c) if the value is less than -3, the distribution is too flat (platykurtic) (Bulmer 1979).

The histogram below (Figure 5.1) shows the curve for the broadness variable. The skewness value of this construct is -.72 which is moderately skewed. Also, the kurtosis is .52, which falls between the appropriate interval of -3 and +3. Therefore, in terms of broadness, the values of skewness and kurtosis are in agreement with the values of normal distribution.

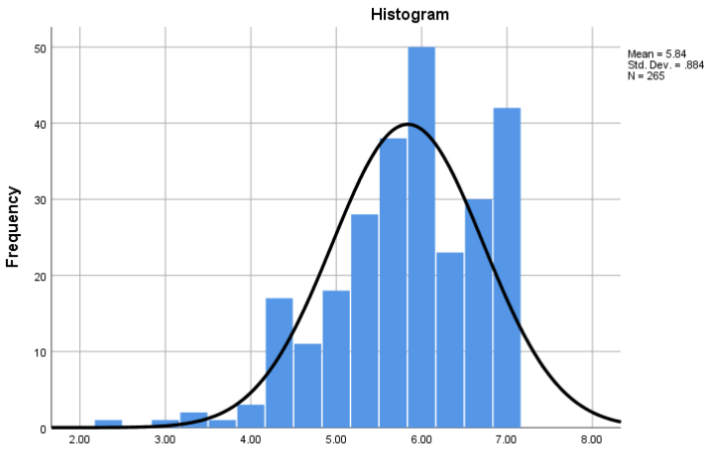

Figure 5.1 Frequency histogram of broadness

Figure 5.2 demonstrates the curve of up-to-datedness. The values of skewness and kurtosis for up-to-datedness are -.56 and .61, respectively. This indicates that the distribution is moderately skewed and normally kurtotic.

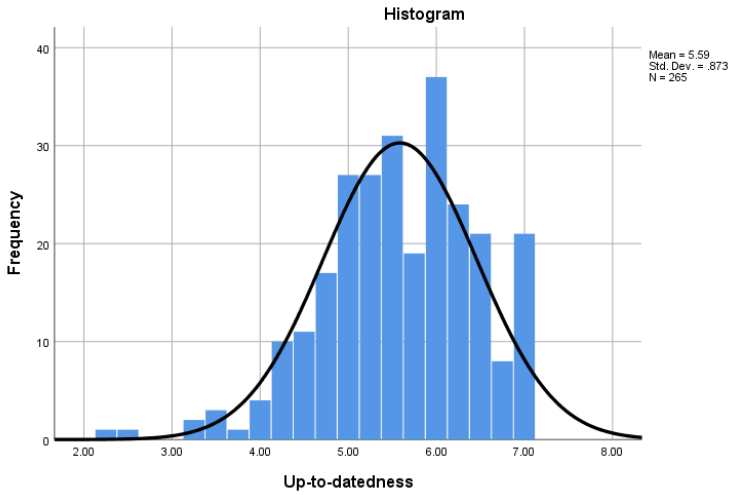

Figure 5.2 Frequency histogram of up-to-datedness

Figure 5.3 shows the curve of diversity. The value of skewness for diversity is -.84, which indicates that the distribution is moderately skewed. Also, the value of kurtosis is 1.62, which is between -3 and +3 and indicates that the distribution has normal kurtosis for this construct.

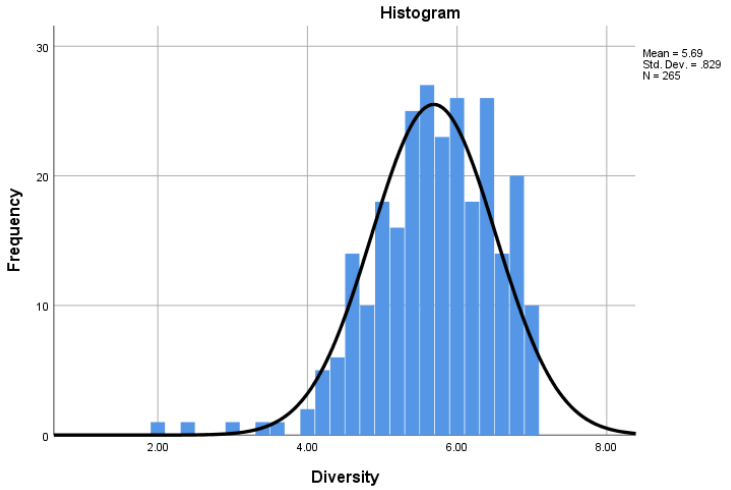

Figure 5.3 Frequency histogram of diversity

Figure 5.4 shows the distribution curve for timeliness. The value of skewness and kurtosis are -.66 and .97, respectively, which are indications of moderate skewness and normal kurtosis.

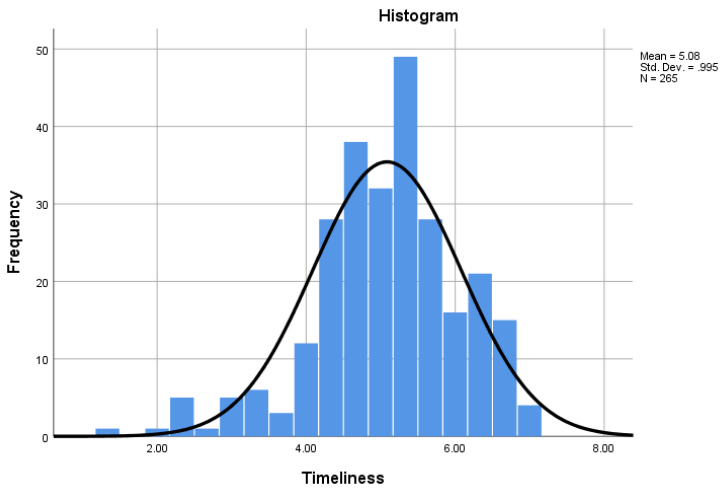

Figure 5.4 Frequency histogram of timeliness

Figure 5.5 illustrates the distribution curve for easiness. This variable is moderately skewed with a skewness of -.65 and normally kurtotic with a kurtosis value of .87.

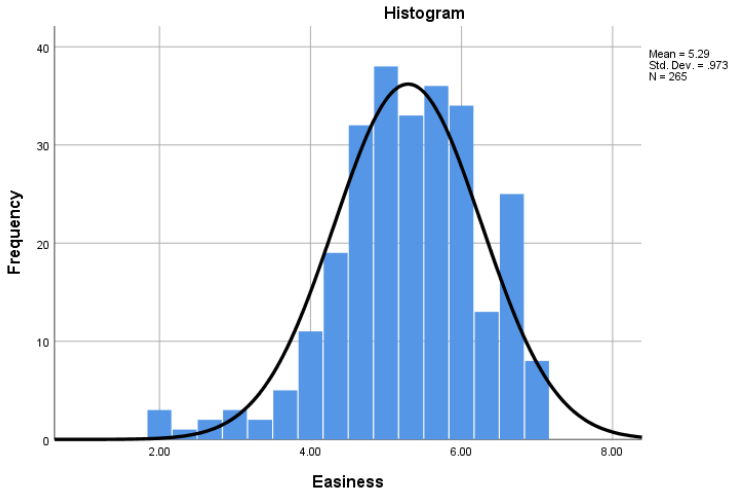

Figure 5.5 Frequency histogram of easiness

The distribution curve of trustworthiness is presented in Figure 5.6. This variable has a moderate skewness of -.68 and normal kurtosis of 1.45.

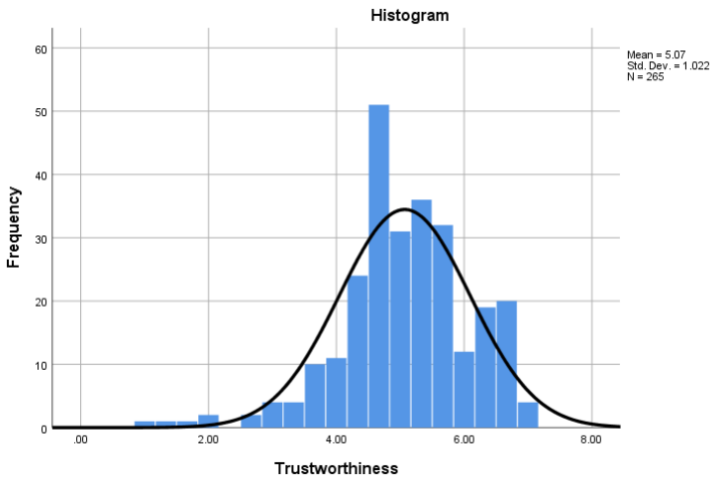

Figure 5.6 Frequency histogram of trustworthiness

Figure 5.7 shows the distribution curve for appropriateness. The value of skewness is -.62 and kurtosis is .59. This construct is moderately skewed and has a normal kurtosis.

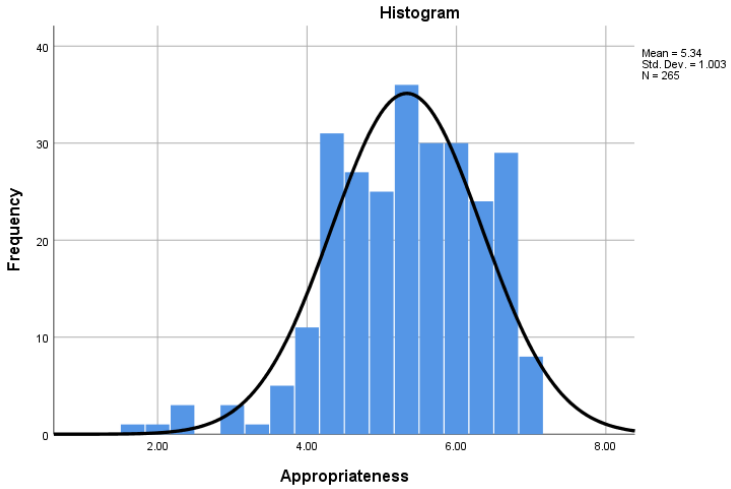

Figure 5.7 Frequency histogram of appropriateness

Figure 5.8 demonstrates the distribution curve for perceived association. The skewness is -.96 which is moderately skewed, and the value of kurtosis is 2.13 representing a normal kurtosis.

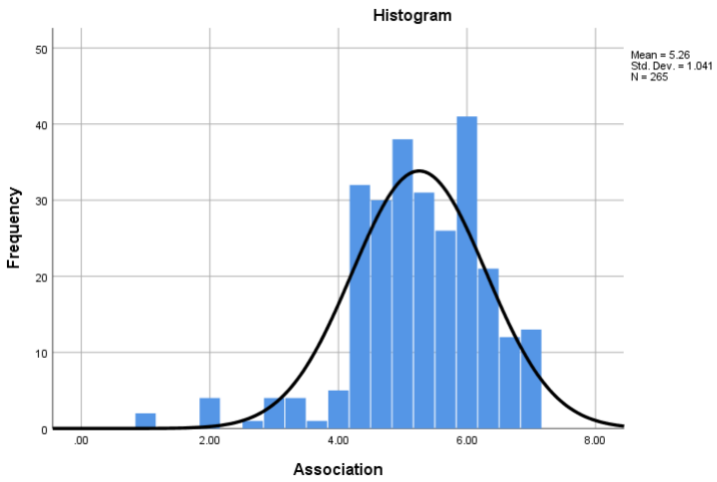

Figure 5.8 Frequency histogram of perceived association

The distribution curve of the internal individual cognitive mechanism is shown in Figure 5.9. This construct has moderate skewness with the value of -.9 and normal kurtosis with the value of 1.85.

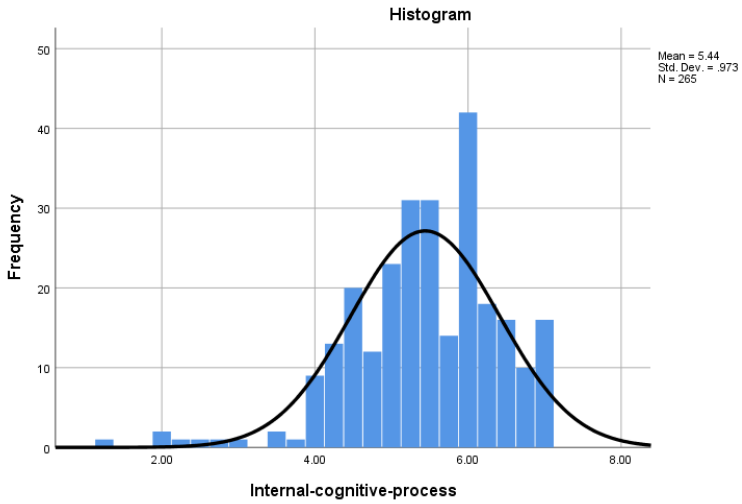

Figure 5.9 Frequency histogram of the internal individual cognitive mechanism

Figure 5.10 shows the distribution curve of the external collaborative cognitive mechanism. This variable has a moderate skewness with the value of -.54 and normal kurtosis with the value of .52.

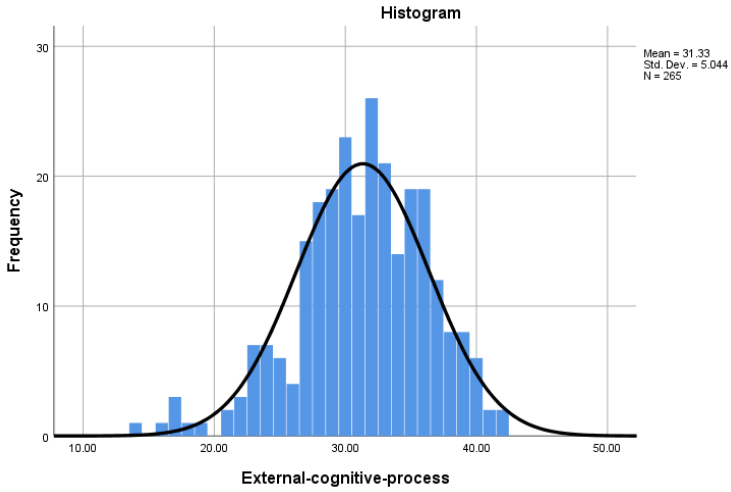

Figure 5.10 Frequency histogram of the external collaborative cognitive mechanism

Figure 5.11 shows the distribution curve for domain-relevant knowledge. The values of skewness (-.50) and kurtosis (.43) show that the distribution of this construct is approximately symmetric and normally kurtotic.

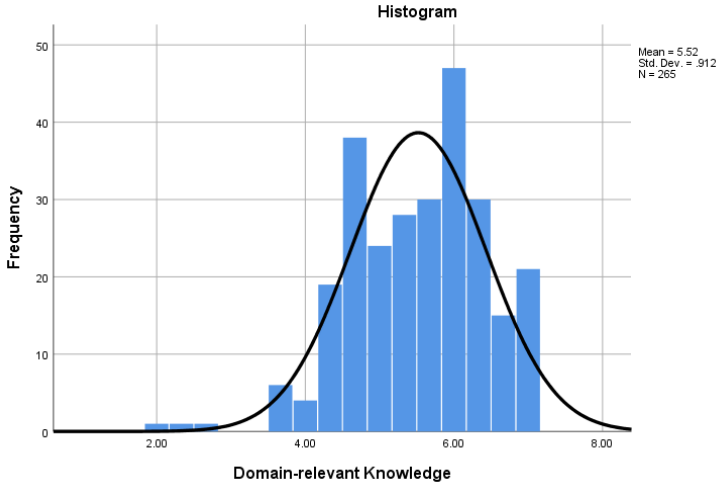

Figure 5.11 Frequency histogram of domain-relevant knowledge

Finally, the distribution curve of divergent thinking is shown in Figure 5.12. The distribution of this construct is moderately skewed (with the skewness value of -.71) and normally kurtotic (with the kurtosis value of 1.2).

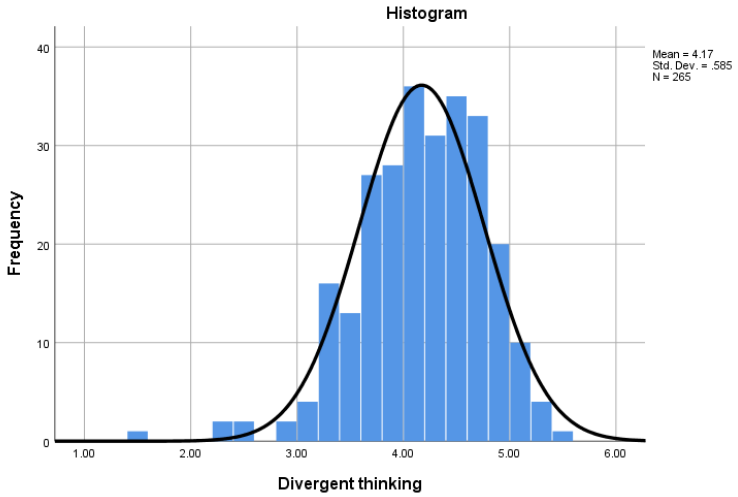

Figure 5.12 Frequency histogram of divergent thinking

Based on the frequency histograms of constructs shown above, the values of skewness and kurtosis were in agreement with values of normal distribution for all the constructs in the research model.

5.3 Exploratory factor analysis

Exploratory factor analysis (EFA) is used as a statistical approach to determine the correlation among the variables (Tabachnick and Fidell 2001).

The Maximum Likelihood (ML) was chosen as the factor extraction method and Promax was chosen as the rotational method. Promax is a non-orthogonal (oblique). The maximum likelihood (ML) allows researchers to examine the statistical significance of the factor loadings and evaluate correlations among variables (Cudeck and O'dell 1994; Tabachnick and Fidell 2001). In addition, Promax is a non-orthogonal (oblique) rotation method that offers the unique contribution of each factor to the variance of each variable (Gorsuch 1997).

The interpretations of the tests conducted to analyse the factors are explained below: 1) To measure the sampling adequacy for each variable, the Kaiser-Meyer-Olkin (KMO) test was used. The recommended value for KMO is between .8 and 1 (Tabachnick and Fidell 2001). The calculated KMO was .87, which means that sampling was adequate enough to suit the factor analysis. Bartlett's test of sphericity was another test applied to check whether the

variance of the variables was equal across the sample. The result of this test was significant (α = .000), indicating that the variance was homogenous across the sample. 2) To estimate the number of factors from eigenvalues, Promax rotation was chosen. As shown in Table 5.5, the 12 factors produced eigenvalues greater than the threshold of 1. In addition, as shown in Table 5.5, the cumulative percentage of variance on 12 factors was 58.46 percent. This shows that the number of factors should be 12.

Table 5.5 Total variance explained

Factors	**Initial Eigenvalues**			**Extraction Sums of Squared Loadings**			**Rotation Sums of Squared Loadings**
	Total	**% of Variance**	**Cumulative %**	**Total**	**% of Variance**	**Cumulative %**	**Total**
1	1.565	22.968	22.968	1.122	22.005	22.005	6.583
2	4.525	9.836	32.804	4.037	8.776	3.780	3.677
3	3.390	7.369	4.173	2.931	6.371	37.152	5.481
4	2.155	4.685	44.858	1.808	3.929	41.081	3.992
5	1.737	3.775	48.633	1.338	2.908	43.989	6.742
6	1.687	3.666	52.300	1.326	2.882	46.871	5.252
7	1.600	3.479	55.778	1.251	2.720	49.592	3.565
8	1.353	2.941	58.720	.926	2.013	51.604	3.472
9	1.301	2.828	61.547	.956	2.077	53.682	5.085
10	1.230	2.673	64.220	.814	1.770	55.451	4.683
11	1.091	2.372	66.592	.758	1.649	57.100	5.521
12	1.011	2.197	68.789	.625	1.360	58.460	5.898
Extraction Method: Maximum Likelihood.							

3) A pattern matrix was used to measure the unique relationship between each factor and its related items and to demonstrate the group of items' loading on their respective factors (Tabachnick and Fidell 2001). Hair et al. (1998) suggest that in EFA, a factor loading greater than .3 is considered as acceptable, a factor loading greater than .4 is considered as more important, while a factor loading greater than .5 is considered as very significant. A further study by Pituch and Stevens (2015) recommended the threshold of .4 for factor loading and explained that each item should indicate at least 15 percent of the shared variance in its respective construct. Drawing on these recommendations, the threshold of .4 was chosen for factor loading.

As shown in Table 5.6. the pattern matrix indicated that three items failed to load greater than .4. One item (i.e., EXTR6) belonged to the variable, external collaborative cognitive mechanism, and had a factor loading of .311. In addition, two items (i.e., DVGT5 and DVGT6) belonged to the variable divergent thinking and had factor loadings of .314 and .337, respectively. Therefore, these three items were excluded from the factor structure.

The remaining 43 items had significant factor loadings between .62 and .88, which were greater than the cut-off value of .5. These items were extracted in 12 factors with an eigenvalue greater than 1, accounting for 58.46 percent of total variance.

Table 5.6 Items and cross loadings

Items	DIV	EXTR	DVGT	INTR	UPT	APPR	ASSO	TRUS	TIM	DOMN	EAS	COM
BRO1	.00	.00	-.01	-.02	-.04	.13	.05	-.02	.13	.02	-.09	.84
BRO2	.17	-.02	.02	.10	.09	-.04	.02	.09	-.15	.02	-.05	.67
BRO3	-.04	.08	.03	.00	.02	.00	-.06	.02	.08	-.05	.11	.69
UPT1	.00	.03	.05	.03	.66	.11	.00	-.02	-.03	-.09	.01	.07
UPT2	-.01	.05	.02	-.07	.72	.06	-.01	-.01	.09	-.01	-.03	-.01
UPT3	-.10	.00	-.06	-.01	.83	.01	-.04	.10	.06	.05	-.06	-.06
UPT4	.11	-.06	-.03	.04	.68	-.09	.01	-.07	-.06	-.02	.06	.09
DIV1	.63	.04	.07	.03	.00	-.05	-.07	-.06	.14	-.09	.02	.06
DIV2	.78	-.06	.03	-.04	-.03	.00	.02	-.03	-.07	-.05	.05	.02
DIV3	.70	.01	-.12	.04	.05	-.02	-.03	-.03	.02	.08	.09	-.05
DIV4	.69	-.07	.07	.03	-.06	.02	.03	.08	.03	.00	-.08	.05
DIV5	.66	.06	-.09	-.07	-.01	.12	-.01	.01	.09	.07	-.04	-.03
TIM1	.06	-.03	-.01	.02	.13	-.13	.05	.06	.67	.02	.04	.06
TIM2	.02	-.05	-.01	-.02	-.01	-.02	-.01	-.03	.79	-.04	-.01	.07
TIM3	.11	.05	.03	.02	-.01	.03	.02	.06	.62	.11	.06	-.03
EAS1	.11	-.04	.07	.02	.03	.05	.00	-.02	-.07	-.05	.74	-.07
EAS2	-.03	.08	-.04	.04	-.07	.13	-.01	.03	.04	.02	.79	.01
EAS3	.00	-.02	.00	-.04	-.02	-.07	.04	.08	.12	-.03	.66	.04
TRUS1	.03	.03	-.06	-.04	-.01	.03	-.05	.63	-.01	.00	.14	.06
TRUS2	-.11	-.06	.00	-.03	.00	.03	-.01	.76	.09	-.01	.08	-.02
TRUS3	.07	.04	.04	.08	.04	-.01	.05	.73	-.05	-.03	-.11	.04
APPR1	.12	-.01	.02	.04	-.03	.72	-.03	.07	-.09	-.04	.07	-.02
APPR2	-.04	-.01	-.01	-.06	-.05	.85	-.02	.02	.01	.02	.00	.18
APPR3	.01	-.06	.02	.04	.22	.69	.06	-.05	-.05	.05	.04	-.08
ASSO1	-.12	.00	-.05	-.02	.02	-.05	.72	-.07	.05	.02	-.07	.19
ASSO2	.01	.05	.00	.10	-.02	.01	.80	-.14	.04	-.05	.06	.09
ASSO3	-.03	.06	.02	.00	-.06	-.05	.85	.10	.03	.03	.02	-.07
INTR1	.13	.03	-.01	.77	.03	.01	.09	.13	-.12	.04	.01	-.16
INTR2	.04	.09	-.09	.88	-.06	.03	-.08	.10	-.01	-.02	-.07	.08
INTR3	-.05	.01	.04	.85	-.04	-.03	-.02	-.09	.02	-.03	.01	.01
INTR4	-.02	-.04	.00	.71	.05	-.03	-.02	.02	.02	.02	.07	-.06
EXTR1	.04	.73	-.10	.03	-.01	-.04	.06	-.08	.01	-.05	.00	.10
EXTR2	-.05	.76	.06	-.01	-.02	-.04	.11	.08	.00	.00	.01	.12
EXTR3	.02	.70	-.05	-.05	.00	-.02	.03	-.03	-.20	.11	.08	.11
EXTR4	-.12	.73	.00	-.01	.05	.05	-.01	.03	.04	-.01	.04	-.08
EXTR5	.04	.66	.12	-.09	.01	.03	-.06	.03	.06	-.08	-.14	-.21
EXTR6	.15	.31	.08	-.06	.04	.03	.02	-.12	.12	.01	.01	-.08
DOMN1	.04	.11	.00	.08	.01	.02	-.06	-.06	-.08	.71	-.02	-.03
DOMN2	.00	-.02	.01	.11	-.02	-.01	-.02	-.08	.05	.86	.03	-.02
DOMN3	-.03	-.09	.06	.01	-.02	.07	-.04	.09	.05	.74	-.07	.04
DVGT1	-.15	-.02	.79	-.02	-.06	.01	.19	-.03	.06	-.07	.04	.01
DVGT2	.09	-.06	.79	.02	-.04	.08	.03	-.06	.02	-.06	-.02	.00
DVGT3	.13	.09	.71	.03	.01	-.19	.09	.08	-.06	.02	-.08	.00
DVGT4	.00	.05	.66	.08	.08	-.12	-.08	.06	-.05	.13	.09	.02
DVGT5	-.04	-.11	.31	-.04	.08	-.05	-.02	-.04	-.13	.13	.09	.21
DVGT6	-.13	.08	.34	-.05	-.03	.01	-.02	-.03	.07	.15	-.04	-.05

BRO = Broadness; UPT = Up-to-datedness; DIV = Diversity; TIM = Timeliness; EAS = Easiness; TRUS = Trustworthiness; APPR = Appropriateness; ASSO = Perceived association; INTR = Internal individual cognitive mechanism; EXTR = External collaborative cognitive mechanism; DOMN = Domain-relevant knowledge; DVGT = Divergent thinking.

As explained above, the EFA determined the correlation among the items and identified the number of factors, which was 12. In the next step, I conducted confirmatory factor analysis (CFA) to confirm the factor structure extracted in the EFA and to test the research hypotheses.

To do so, AMOS was used to perform CFA through structural equation modelling. First, the reliability and validity of the measurement model was examined. Once the results of the measurement model were accepted, the structural model estimation was conducted to evaluate the strength of the relationships among the variables.

5.4 Reliability and validity analysis

To check the reliability and validity of the data, the internal consistency, convergent validity and discriminant validity were tested. Table 5.7 shows the standardised factor loadings and Cronbach's alpha for each measurement item.

As shown in Table 5.7, the Cronbach's alpha values for all the items ranged from .70 to .87 and were above the desired threshold of reliability of .70 (Bollen and Lennox 1991). Regarding the threshold of item loadings, Joseph F Hair, Black, Babin, Anderson, and Tatham (2006) suggest that the standardised item loadings should be .50 or greater. All item loadings shown in Table 5.7 are in the accepted range.

Table 5.7 Item loadings and reliabilities of the items

Constructs	Items	Item Loadings	Cronbach's Alpha if Item Deleted
Broadness	BRO1	.84	.75
	BRO2	.80	.78
	BRO3	.76	.81
Up-to-datedness	UPT1	.77	.77
	UPT2	.74	.78
	UPT3	.74	.77
	UPT4	.70	.79
Diversity	DIV1	.70	.81
	DIV2	.70	.81
	DIV3	.74	.80
	DIV4	.74	.80
	DIV5	.70	.81
Timeliness	TIM1	.81	.72
	TIM2	.71	.75
	TIM3	.78	.75
Easiness	EAS1	.76	.76
	EAS2	.87	.71
	EAS3	.71	.79
Trustworthiness	TRUS1	.75	.72
	TRUS2	.76	.70
	TRUS3	.73	.74
Appropriateness	APPR1	.79	.80
	APPR2	.82	.77
	APPR3	.80	.79
Perceived association	ASSO1	.76	.79
	ASSO 2	.77	.77
	ASSO 3	.84	.73
Internal individual cognitive mechanism	INTR1	.74	.85
	INTR2	.82	.82
	INTR3	.86	.82
	INTR4	.68	.87
External collaborative cognitive mechanism	EXTR1	.71	.80
	EXTR2	.74	.79
	EXTR3	.67	.81
	EXTR4	.73	.79
	EXTR5	.70	.81
Domain-relevant knowledge	DOMN1	.75	.78
	DOMN2	.84	.70
	DOMN3	.74	.77
Divergent thinking	DVGT1	.65	.78
	DVGT2	.65	.78
	DVGT3	.79	.77
	DVGT4	.78	.78

Since perceived visibility of knowledge is the second-order construct and broadness, up-to-datedness, diversity, timeliness, easiness, trustworthiness and appropriateness are its first-order construct, the loadings of first-order constructs on perceived visibility of knowledge were

examined. As shown in Table 5.8, all first-order constructs loaded highly on perceived visibility of knowledge with loadings between .70 to .78.

Table 5.8 Factor loadings of the first constructs on perceived visibility of knowledge

Second-order Construct	First-order Constructs	Factor Loadings
Perceived visibility of knowledge	Broadness	.71
	Up-to-datedness	.78
	Diversity	.75
	Timeliness	.73
	Easiness	.77
	Trustworthiness	.70
	Appropriateness	.72

Next, the composite reliability (CR), AVE and maximum shared squared variance (MSV) were calculated for each construct. As illustrated in Table 5.9, all the constructs exhibited satisfactory values for composite reliability and convergent and discriminant validity. The value of composite reliability for all the constructs ranged between .81 to .89. In addition, the value of AVE for all the constructs was between .50 and .62 and greater than or equal to the threshold of .5. This means that 50 percent or more variance of the observed variables was due to variance in their own latent variables (Chin 1998; Fornell and Larcker 1981).

Moreover, the discriminant validity among the constructs was examined by comparing the AVE with the MSV for each construct. To claim discriminant validity, AVE should be greater than MSV (Chin 1998). As shown in Table 5.9, for all the constructs, AVE was greater than MSV, confirming that more variance was shared between each latent variable (construct) and its block of observed variables than observed variables of other latent variables (Chin 1998).

Table 5.9 Convergent and discriminant validity

Constructs	CR	AVE	MSV
Perceived visibility of knowledge	.89	.55	.33
Perceived association	.83	.62	.18
Internal individual cognitive mechanism	.86	.61	.33
External collaborative cognitive mechanism	.84	.50	.18
Domain-relevant knowledge	.82	.61	.32
Divergent thinking	.81	.52	.32

In this study, multicollinearity was not a threat since the dependent variables were predicted by no more than two variables (Tabachnick and Fidell 2001). .

5.5 Measurement and structural models

The statistical tests applied to assess the measurement model and structural model are explained below.

5.5.1 Fit indexes

The fit indexes applied in this study were the Root Mean Square Error of Approximation (RMSEA), Standardized Root Mean Square Residual (SRMR), Comparative Fit Index (CFI), Adjusted Goodness of Fit Index (AGFI), Normed Fit Index (NFI) and Tucker-Lewis Index (TLI). These fit indexes were measured to evaluate whether both measurement and structural models fit the data (Tabachnick and Fidell, 2001).

Table 5.10 shows the results of fit indexes for both the measurement and structural models of the study.

Table 5.10 fit statistics results for measurement and structural models

Fit Indexes	Measurement Model	Structural Model
Chi-square/df	1121.86 with 835 df	1188.75 with 845 df
RMSEA	.04	.04
SRMR	.06	.07
CFI	.95	.94
NFI	.82	.81
TLI	.94	.93

As shown in Table 5.10, the fit indexes of the measurement model were within an acceptable range of the cut-off values. In other words, the data had good fit with the measurement model. The results indicated that $(X^2/_{df})$ was 1.34, which falls between the range of 1 and 2 and RMSEA was .04, which is less than the threshold of .06. SRMR had a fit of .06, which is less than .08. CFI had a fit of .95, whereas TLI, NFI had a reasonable fit of .94, and .82, respectively.

In terms of the structural model, the fit indexes were also within an acceptable range of the cut-off values. The chi-(X^2/df) was 1.41, which is a perfect fit value, falling in the accepted range of 1 and 2. RMSEA had a perfect fit value of .04, which is less than the cut-off of .05 and SRMR had a perfect fit value of .07, which is less than the cut-off value of .08. In addition, CFI, NFI and TLI had a reasonable fit of .94, .81, and .93, respectively. The values of RMSEA (i.e. .04 in both measurement and structural models) confirmed the factor loadings and the appropriate number of variables specified in EFA analysis (Kenny et al. 2015).

5.5.2 Common method variance

Common method variance, which is also called common method bias, refers to the variance that is attributable to the measurement method rather than to the constructs the measures represent (Podsakoff et al. 2003). To examine the common method variance in behavioural research, it is recommended to use appropriate procedural remedies during the designing of the study and statistical remedies during the data analysing (Podsakoff et al. 2003). I applied several procedural and statistical remedies to control the common method variance. The procedural remedies used in this study were as follows: (1) As shown in Table 5.11, I created a psychological separation between the measurements of the predictors and the dependent variables using the cover story (Podsakoff et al. 2003). The cover story is used to make it appear that the measures of predictor variables are not connected to the measures of the dependent variables (Podsakoff et al. 2003). Through the cover story, I communicated with respondents to increase their motivation to respond to the questions accurately. Respondents were informed on how valuable their opinions were and how accurate responses would provide valuable insights into this research.

Table 5.11 Cover stories used in the current study

Statements	Comments
Please read through the questions carefully and select the response that best describes you. Did you know that different software developers follow different paths while trying to find a solution to the same problem?	Used before questions related to cognitive mechanisms
All information will be kept anonymous and confidential. The information that you provide will be used only for academic purposes.	Used before questions related to domain-relevant knowledge
The results of accurate responses to the following questions help managers provide you and your colleagues with a more supportive environment for being more creative. As a software developer, it's hard to keep up with everything. This is true for everybody.	Used before questions related to divergent thinking

(2) I protected respondents' anonymity and ensured participants that their responses would remain anonymous and there would be no wrong and right answers (see Appendix H, and Table 5.11). Participants were asked to respond to questions as honestly as possible. (3) I avoided using vague and double-barrelled questions in the survey. I kept questions simple, specific and concise.

In terms of statistical remedies, Harman's single-factor test is a common statistical technique used in IS research to test the common method variance (Podsakoff et al. 2003). This test evaluates if the majority of the variance among the measures can be explained by a single factor. In this test, if a single factor accounts for the majority of the variance in the model (greater than 50 percent of the variance), then common method variance is an issue because one factor accounts for substantial variance in the variables (Chang et al. 2010). As shown in Table 5.12, the results of the Harman's single factor test showed that the emerged single factor only explained 21.44 percent of the variance, which is less than the 50 percent. Therefore, based on the Harman's single factor test, common method variance was not an issue in this study.

Table 5.12 Total variance explained

Factor	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	1.56	22.97	22.97	9.86	21.44	21.44

Extraction Method: Principal Axis Factoring.

Since Harman's single factor test does not produce a quantitative estimate of the level of common method variance, it is not possible to tease out and thereby control for a specific amount of common method variance (Chang et al. 2010; Podsakoff et al. 2003).

Due to the disadvantages of Harman's single factor test, Podsakoff et al. (2003) recommend the unmeasured latent methods factor as an alternative test for common method variance. This method uses a common latent factor (CLF) to capture the common variance among all measurement items (observed variables) in the model. In this test, measurement items are loaded on their corresponding constructs, as well as on a common latent factor. Next, the significance of the structural parameters is evaluated both with and without the common latent factor (Podsakoff et al. 2003). In this method, the model constrains the measurement factor loadings on the common latent factor to be equal (Podsakoff et al. 2003).

To test the common method variance, two models were built: the unconstrained measurement model (model 1) with all items loaded on their respective constructs, and the constrained measurement model (model 2) with all the items loaded on their respective construct and a common latent factor. If the constrained model (model 2) fits data better than the unconstrained model (model 1), then significant common method variance exists (Widaman 1985). Table 5.13 shows the results of these two tests.

Table 5.13 Common method variance test

Model	Chi-Square	CFI	RMSEA	Comment
Model 1: all items loaded on their respective constructs	1121.86 with 835 df	.95	.036	If model 2 fits better than model 1, then significant method bias exists (Widaman 1985). However, the null hypothesis of common method variance should not be rejected if the difference between CFIs (ΔCFI) is less than .05, indicating a lack of method variance (Little 1997).
Model 2: all items loaded on both their respective constructs and common latent factor	968.44 with 792 df	.97	.029	

As shown in Table 5.13 the chi-square difference test indicated that model 2 (with common latent factor) would fit the data better than model 1 (without common latent factor). This indicated the existence of the shared variance. Therefore, the common latent factor (CLF) was retained in the structural model when testing the hypotheses.

In addition, it has been recommended that the chi-square difference test is used to examine which model fits data better, while this test is sample-size sensitive. Therefore, researchers have suggested the difference between comparative fit indexes (ΔCFI) as an alternative criterion to analyse common method variance (Cheung and Rensvold 2002; Little 1997). It can be said that common method variance is absent if the ΔCFI is less than .05 (Little 1997). In this study, the chi-square difference test was significant and the ΔCFI yielded a value of .02, which is less than the recommended cut-off of .05. Therefore, it can be said that the common method variance was not a concern.

5.5.3 Results of hypotheses testing

To test the hypotheses, the factor covariances were replaced with the structural paths, while the common latent factor was retained in the model. Figure 5.13 shows the results of standardised estimate (β) and the significance level.

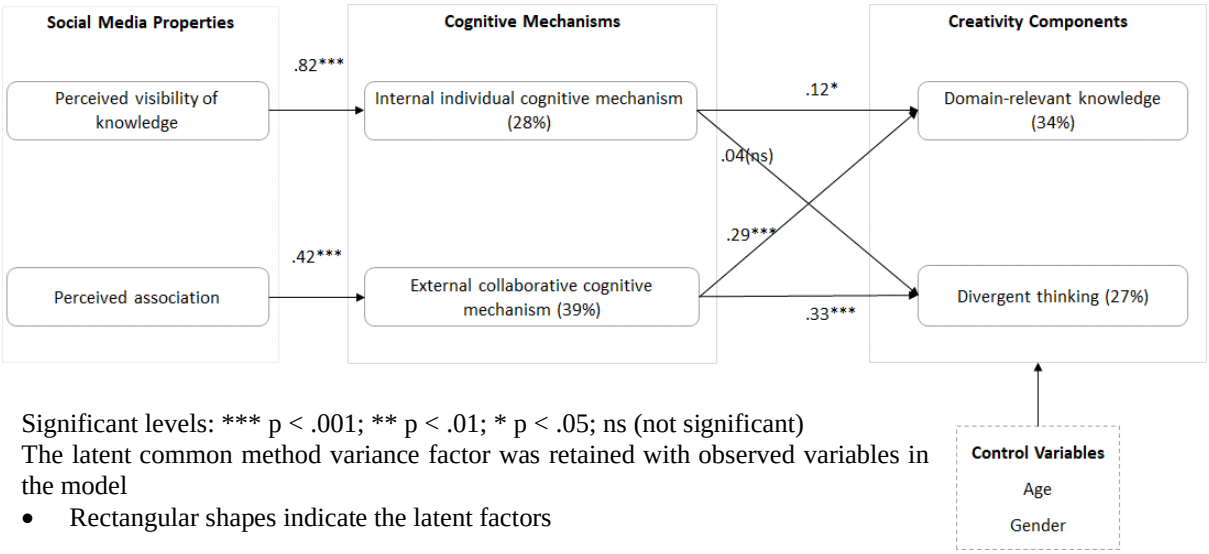

Figure 5.13 Results of hypotheses testing

Based on the path coefficient assessment (shown in Figure 5.13), all the proposed hypotheses except the relationship between the internal individual cognitive mechanism and divergent thinking were supported. The significant hypotheses had the expected positive sign direction (i.e. positive). A summary of hypotheses testing is presented in Table 5.14.

Table 5.14 Summary of hypotheses testing

Hypothesis statement	Supported?
H1: Software developers' perceived visibility of knowledge offered by social media use is positively related to their internal individual cognitive mechanism (β = .82, p = .000).	Yes
H2: Software developers' perceived association offered by social media use is positively related to their external collaborative cognitive mechanism (β = .42, p = .000).	Yes
H3: Software developers' internal individual cognitive mechanisms are positively related to their domain-relevant knowledge (β = .12, p = .025).	Yes
H4: Software developers' internal individual cognitive mechanisms are positively related to their divergent thinking abilities (β = .036, p = .472).	No
H5: Software developers' external collaborative cognitive mechanisms are positively related to their domain-relevant knowledge (β = .29, p = .000).	Yes
H6: Software developers' external collaborative cognitive mechanisms are positively related to their divergent thinking (β = .33, p = .000).	Yes

The analysis shows that perceived visibility of knowledge offered by social media positively affected software developers' internal individual cognitive mechanism (H1). This relationship was strongly significant with β = .82 and p < .001. Also, as shown in Figure 5.13, 28 percent of the variance in the internal individual cognitive mechanism could be explained by perceived

visibility of knowledge. In addition, perceived association offered by social media positively affected software developers' external collaborative cognitive mechanism (H2). This relationship was strongly significant with $\beta = .42$ and $p < .001$. As shown in Figure 5.13, 39 percent of the variance in external collaborative cognitive mechanism could be explained by perceived association.

The results indicated that the internal individual cognitive mechanism significantly affected domain-relevant knowledge ($\beta = .12$, $p < .05$). Therefore, H3 is supported. However, there was no significant relationship between the internal individual cognitive mechanism and divergent thinking ($\beta = .04$, $p > .05$). Hence, H4 is not supported.

The analysis shows that software developers' external collaborative cognitive mechanism was positively related to their domain-relevant knowledge (H5). This relationship was strongly significant with $\beta = .29$ and $p < .001$. In addition, the results indicated that software developers' external collaborative cognitive mechanism was positively related to their divergent thinking. This relationship was strongly significant with $\beta = .33$ and $p < .001$.

Control variables

Age and gender were tested as controls for both domain-relevant and divergent thinking. The results indicated that neither age nor gender had a significant relationship with domain-relevant knowledge and divergent thinking. The p-values for all the relationships between control variables and domain-relevant knowledge and divergent thinking were greater than .05.; therefore, there is no evidence that gender was a determinant of either domain-relevant knowledge or divergent thinking in this study. Similarly, there is no evidence that age was a determinant of either domain-relevant knowledge or divergent thinking.

5.6 Chapter Summary

This chapter presented the process followed to collect and analyse data to test the research model. Once the pre-test and pilot test were completed, 265 completed responses were collected to test the research model. The reliability and validity of the data were tested by analysing the internal consistency, convergent validity and discriminant validity. Next, the measurement and structural models were tested and their fit indexes were examined. In addition, the remedies applied for common method variance were explained. Finally, this chapter presented the results of the hypotheses in the research model. All the hypotheses except the relationship between the internal individual cognitive mechanism and divergent thinking were supported. The next chapter further discusses the hypotheses based on the research findings reported in the current chapter.

Chapter 6: Discussion of results

Chapter overview

This chapter discusses the findings of the research based on the results presented in the previous chapters. First, this chapter provides an overview of the key findings in relation to the research questions outlined in Chapter 1. Next, a detailed discussion regarding the findings for each relationship of the research model is presented. This chapter ends with a brief chapter summary.

6.1 Summary of key findings

Creativity is important for software developers due to the uncertain nature of their job and the unique problems they encounter in different projects (Seidel et al. 2010). Knowledge is a crucial element for software developers to engage in creative activities (Cooper 2000). When software developers have knowledge for completing their projects, they can be more creative in generating potential ideas and solutions for their task-related problems (Cooper 2000). Knowledge plays a role in creativity largely through domain-relevant knowledge and divergent thinking, two of creativity's components (Amabile 1983; Perry-Smith and Shalley 2003; Woodman and Schoenfeldt 1990). In recent years, social media has become a common information sharing platform for developers to broaden their knowledge and find the required knowledge and experts for consultation (Jimenez-Mavillard and Suárez 2018; Joorabchi et al. 2016).

The importance of knowledge for software developers' creativity and the significant role of social media for software developers' knowledge sharing and acquisition motivated this study of the relationship between software developers' perceptions of social media properties and their creativity. Cognitive mechanisms – i.e., the internal individual cognitive mechanism and the external collaborative cognitive mechanism – involved in the acquisition and sharing of knowledge were used to explain the effects of social media properties on software developers' creativity.

This study aimed to address two main research questions:

1: What are the effects of software developers' perceptions of social media properties – i.e., visibility of knowledge and association – on their cognitive mechanisms?

2: What are the effects of software developers' cognitive mechanisms on their creativity components – i.e., domain-relevant knowledge and divergent thinking?

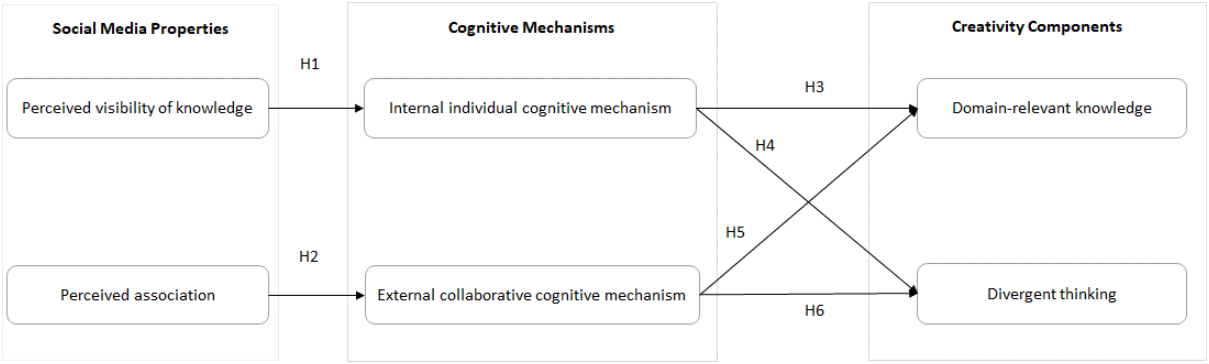

Figure 6.1 Research model

In order to address the research questions, this study examined the hypothesised relationship between software developers' perception of social media properties, their cognitive mechanisms and creativity components (see Figure 6.1).

Due to the lack of validated items to measure perceived visibility of knowledge, a 10-step procedure was followed to develop and validate a conceptualisation and survey instrument for this construct. The scales were tested and found to be reliable and valid. Based on the findings, seven first-order constructs were conceptualised and used to reflect perceived visibility of knowledge: broadness, up-to-datedness, diversity, timeliness, easiness, trustworthiness and appropriateness.

Next. this study examined the relationship between software developers' perception of social media properties, their cognitive mechanisms and creativity components (Figure 6.1). Based on the findings, it is clear that software developers' perception of social media properties

influences their cognitive mechanisms. In other words, software developers' perception of visibility of knowledge offered by social media is positively related to their internal individual cognitive mechanism. Similarly, software developers' perceived association in social media is positively related to their external cognitive mechanism.

Regarding the relationship between software developers' cognitive mechanisms in social media and their creativity components, software developers' internal individual cognitive mechanism in social media was found to be positively related to their domain-relevant knowledge, whereas, software developers' internal individual cognitive mechanism was found to have an insignificant relationship with their divergent thinking. In addition, software developers' external collaborative cognitive mechanism in social media was found to be positively related to both their domain-relevant knowledge and divergent thinking abilities. Table 6.1 provides a summary of the research findings under each research question.

Table 6.1 Summary of key findings

Research Questions	**Findings**
Research Question 1: What are the effects of software developers' perceptions of social media properties – i.e., visibility of knowledge and association – on their cognitive mechanisms?	• Software developers' perceived visibility of knowledge offered by social media is positively related to their internal individual cognitive mechanism • Software developers' perceived association offered by social media is positively related to their external collaborative cognitive mechanism
Research Question 2: What are the effects of software developers' cognitive mechanisms on their creativity components – i.e., domain-relevant knowledge and divergent thinking?	• Software developers' internal individual cognitive mechanism is positively related to their domain-relevant knowledge • Software developers' external collaborative cognitive mechanism is positively related to their domain-relevant knowledge • Software developers' external collaborative cognitive mechanism is positively related to their divergent thinking

In the next section, the research findings shown in Table 6.1 are discussed in more details.

6.2 Discussion of the findings

In this section, the results of the study are discussed and compared with related previous studies. This study posited that software developers' perceived social media properties affect their creativity components through two cognitive mechanisms: the internal individual cognitive mechanism and the external collaborative cognitive mechanism. In other words, it was hypothesised that there is a positive relationship between software developers' perception of social media properties and their cognitive mechanisms. In addition, a positive relationship was hypothesised between software developers' cognitive mechanisms taking place in social media and their creativity components.

Overall the results of this study indicated that all the relationships in the research model were positive and significant except the relationship between software developers' internal individual cognitive mechanism and their divergent thinking, which was insignificant.

The results of this study emphasise the importance of knowledge sharing and acquisition for creativity in software development. Previous studies show that knowledge and expertise sharing among software developers empower software developers' team creativity (Tiwana 2005; Ocker et al. 1995). The current study takes a different perspective and shows that knowledge sharing also influences individual creativity in software development. This study shows that sharing and discussing knowledge in social media inspire fresh thinking and creativity of software developers. These findings are discussed in detail below.

6.2.1 Social media properties and software developers' cognitive mechanisms

The results of this study indicate a positive and significant relationship between perceived visibility of knowledge in social media and the internal individual cognitive mechanism. This suggests that developers use social media for searching, collecting and categorising information (i.e., the internal individual cognitive mechanism) when they believe that social

media enables them to easily search for and quickly access a variety of information that is complete, up-to-date, reliable and relevant to their tasks. This result confirms the principle of least effort theory (O'Leary 2016), explaining that individuals tend to use a knowledge searching method that involves the least amount of effort and energy to discover and access information.

The findings of this study are in line with previous studies that have emphasised the importance of visibility of knowledge for individuals' internal cognitive mechanism (Fathizargaran and Cranefield 2017; Nasehi et al. 2012; Sedighi and Isaai 2017; Treem and Leonardi 2013). In particular, the results of this study reinforce Leonardi et al.'s (2013) argument that one of the most important effects of visibility of knowledge in social media is that it enables individuals to learn from published knowledge and others' experiences.

In addition, the research findings show that software developers' perception of association in social media has a positive and significant relationship with their external collaborative cognitive mechanism. This means that developers' perception of association in social media persuades them to use social media for sharing, discussing, negotiating, synthesising and co-creating knowledge with others (i.e., the external collaborative cognitive mechanism). This finding suggests that the perceived association offered by social media use encourages software developers to engage in social media-enabled collaboration to expand their knowledge base.

In other words, developers use social media to share and discuss knowledge related to software development. This is because they believe that social media provides various means and support for them to communicate with other developers beyond their organisational borders. This study confirms Siemens's (2014) connectivism learning theory that knowledge is distributed across networks of people and individual's learning depends on their ability to construct and navigate their social networks with others.

In addition, the results of this study are in line with previous studies that have argued that individuals expand their external collaborative cognitive mechanism in social media when they perceive that social media provides them with association with others (Cress and Kimmerle 2008; Phang et al. 2009; Sigala and Chalkiti 2015; Treem and Leonardi 2013).

6.2.2 Software developers' cognitive mechanisms and their creativity components

The findings also reveal a significant relationship between cognitive mechanisms associated with knowledge obtained from social media and knowledge-related creativity components: domain-relevant knowledge and divergent thinking.

Software developers' domain-relevant knowledge reflects their actual knowledge and technical proficiency necessary to complete a task. To successfully develop new software, developers need a clear understanding of IT applications, their structures, functionality and use in a given domain (Iivari et al. 2004). The research findings indicate that both internal individual and external collaborative cognitive mechanisms contribute to domain-relevant knowledge.

These findings are important as they confirm the previous literature (Sigala and Chalkiti 2014, 2015) by arguing that individuals can expand their domain-relevant knowledge not only when they add knowledge to their existing knowledge by searching, categorising and reading information on social media (the internal individual cognitive mechanism) but also when they add knowledge to their existing knowledge by sharing, discussing, integrating knowledge and comparing/combining shared knowledge for co-creating knowledge (the external collaborative cognitive mechanism).

Based on the findings, the external collaborative cognitive mechanism has a stronger influence on domain-relevant knowledge ($\beta = .29$, $p = .000$) compared to the internal individual cognitive mechanism ($\beta = .12$, $p = .025$). Hence, it is suggested that to gain domain-relevant knowledge, developers should not only exploit social media for searching, acquiring and reading

information but also for sharing and discussing information with others. This can help them to better understand work-related information and more effectively combine and compare knowledge from diverse disciplines and integrate it into their daily professional life.

This result is in line with the study conducted by Sigala and Chalkiti (2015) on the use of social media by Greek tourism professionals for knowledge management. They also found that both internal individual and external collaborative cognitive mechanisms enable tourism professionals to better understand the information and gain greater domain-related knowledge and creativity in their work.

Finally, the results suggest a positive significant relationship between external collaborative cognitive mechanisms and divergent thinking. The use of social media for sharing and discussing information with others as well as for combining and generating new knowledge can provide individuals with stimuli for generating and (co-)creating new ideas – i.e., divergent thinking. This study confirms the constructivist perspective, arguing that through external collaborative cognitive mechanisms in social media, individuals can gain knowledge that leads them to think differently about their job-related problems (Cross and Sproull 2004). The results of this study are in line with previous studies that have argued that knowledge sharing through discussions facilitated on social media enriches the ideation process and enable individuals to co-create new ideas for their work (Liu 2013; Storey et al. 2010).

In addition, the results of the study indicate that there is no significant relationship between developers' internal individual cognitive mechanisms in social media and divergent thinking. This finding highlights the importance of collaborative knowledge co-creation in social media to support software developers' divergent thinking and creativity (Aubke 2014; Perry-Smith 2006). This finding is in line with the previous research that has shown that in order to maximise individuals' divergent thinking ability, firms must primarily nurture and support

collective thinking rather than individual cognitive mechanisms (Baer 2010; Hargadon and Bechky 2006).

6.3 Chapter summary

This chapter discussed the findings presented in Chapter 5. The two main research questions were answered and the hypotheses were discussed in the light of theoretical arguments and previus studies.

The results of this study indicate that software developers' perceived social media properties positively influence their internal individual cognitive mechanism and external collaborative cognitive mechanism. In addition, software developers' cognitive mechanisms in social media positively influence their creativity components, namely domain-relevant knowledge and divergent thinking. In sum, all the hypotheses except the relationship between the internal individual cognitive mechanism and divergent thinking were supported. In the next chapter, an overall summary of this research and theroretical and practical contributions of the study are presented.

Chapter 7: Conclusions

Chapter overview

After presenting a brief summary of the study, this chapter discusses the theoretical and practical contributions to the research. Next, the limitations of the study and suggestions for future research are presented. Finally, this thesis ends with concluding remarks.

7.1 Summary of the study

This study examined the relationship between social media properties and software developers' creativity. In particular, this study evaluated the influence of two properties of social media – i.e., perceptions of visibility of knowledge and association – on two aspects of software developers' creativity – i.e., domain-relevant knowledge and divergent thinking. The relationship between social media properties and software developers' creativity was explained through two cognitive mechanisms: the internal individual cognitive mechanism and the external collaborative cognitive mechanism. A comprehensive review of the relevant literature reveals a lack of validated items for measuring perceived visibility of knowledge, as one of the properties of social media in the research model. Therefore, before conducting data collection to test the research model, an instrument was developed and validated to measure perceived visibility of knowledge in social media. To do so, a 10-step procedure proposed by Mackenzie et al. (2011) was followed. Seven first-order constructs were conceptualised and used to reflect perceived visibility of knowledge in social media. The scale development process included item generation and a content validity assessment using 218 software developers. Once the measurement model was specified, three waves of data from 202, 265 and 207 different software developers were collected. The scales were tested and found to be reliable and valid. The fit indexes of the proposed measurement model were good in all three samples. In addition, the nomological and predictive validity of the scales were tested. This study found that the newly developed instrument was a good predictor of the outcome variable (the internal

individual cognitive mechanism) and had a high correlation with the correlate variable (perceived quality of knowledge).

Next, the newly developed scales for perceived visibility of knowledge and the adopted scales for other constructs of the research model (perceived association, internal individual and external collaborative cognitive mechanisms, domain-relevant knowledge and divergent thinking) were used to collect data to test the research model. The data was collected from software developers using online and paper-based surveys to empirically test the research model. In total, a dataset of 265 was used to test the research model. The results of data analysis supported five of the six hypotheses formulated in the research model.

The findings of the study showed that software developers' perception of visibility of knowledge in social media has a positive and significant relationship with their internal individual cognitive mechanism. Similarly, software developers' perception of association in social media has a positive and significant relationship with their external collaborative cognitive mechanism. Moreover, the results indicated that software developers' internal individual cognitive mechanism positively affects their domain-relevant knowledge as one of the creativity components, whereas it does not have a significant relationship with their divergent thinking. Finally, the results showed that software developers' external collaborative cognitive mechanism has a positive and significant influence on their domain-relevant knowledge and divergent thinking as two components of their creativity.

7.2 Theoretical contributions

Technological advances in social media have changed the way software developers search, read, share and discuss information (Black, Harrison and Baldwin 2010). Given the vital importance of knowledge in creativity, this study found that social media can contribute to

developers' creativity through internal individual and external collaborative cognitive mechanisms.

This study contributes to the creativity literature as it provides a theoretical explanation supported by empirical evidence of the influence of social media properties on software developers' creativity through internal individual and external collaborative cognitive mechanisms. These results corroborate prior studies that have emphasised the importance of creativity for software developers (Crawford et al. 2012; Mohanani et al. 2017; Tiwana and Mclean 2005). In particular this study contributes to previous research on the importance of knowledge sharing for creativity. For example, Tiwana (2005) argues that knowledge and expertise sharing influence software developers team creativity. The current study argues that knowledge sharing and acquisition beyond the organisational borders can influence software developers' individual creativity.

Based on their review of IS research, Orlikowski and Iacono (2001) suggest that most IS studies treat IT artefacts nominally. They advocate that IS researchers should place specific emphasis on the technology itself. They propose a research direction for the IS field that begins to take technology as seriously as its effects, context and capabilities.

The current study moves beyond the nominal treatment of the technology. Rather than treating social media as a black box that somehow affects the cognitive mechanisms, this study delineates the two properties of social media and their impact on cognitive mechanisms. This study explicitly focuses on visibility of knowledge and association as two properties of social media and their relation to cognitive mechanisms.

Moreover, the conceptualisation of social media in this study is based on individuals' perceptions about social media properties. Orlikowski and Iacono (2001) categorise this as the 'proxy' view with a conceptualisation of 'technology as perception'. They also suggest that the

phenomenon investigated and questions addressed in a research study should help articulate the technology (e.g., social media). In this study, the investigation of cognitive mechanisms in social media places emphasis on an individual's perception of social media properties in their work settings.

This study also contributes to the literature on the value of public social media for individuals' cognitive mechanisms (Liu and Liu 2008) and creativity (Perry-Smith, 2014). The findings demonstrated that public social media is a space for developers to advance their cognitive mechanisms and creativity. The threaded nature of associations and the visibility of the knowledge that experts share on social media make it possible to access heterogenous knowledge that can inspire fresh thinking and creativity among developers.

In addition, although visibility of knowledge in social media is an important concept in IS (Treem and Leonardi 2013), the review of the relevant literature revealed that there is a lack of validated items for measuring users' perception about the visibility of knowledge provided by social media. The current work addresses this issue by providing a context-specific conceptualisation of perceived visibility of knowledge in public social media and offering a reliable and valid instrument for this construct. This will advance the existing body of knowledge in several ways.

This study's instrument development exemplar contributes to measurement theory. Mackenzie et al. (2011) provided comprehensive validation guidelines for IS in particular and behavioural and social sciences research in general. This study applied their recommendations and did not encounter major issues by following Mackenzie et al. (2011). In some steps, I had to deviate from Mackenzie et al.'s (2011) recommendations due to practical considerations. For example, during the content validity check, I initially followed their preferred Hinkin and Tracey (1999) content validity assessment approach. Given the feedback obtained during the face validity

check, I decided to employ Anderson and Gerbing's (1991) approach after realising that ranking all item-construct pairs would overburden raters. Future research aiming to develop instruments could also consider this option.

7.3 Practical contributions

The insights from this research offer practical implications for firms and individuals involved in software development. In particular, software developers are encouraged to develop the ability to search, categorise and read knowledge available on social media as well as share, discuss and co-create knowledge with others. In addition, firms should cultivate an organisational climate and culture that supports the use of public social media to assist software development activities.

The results of this study provide software project managers with a better understanding of how the participation and engagement of software developers in social media can provide them with access to various types of knowledge and perspectives, thereby enhancing their ability to be more creative. Therefore, software development organisations and project managers can influence the creativity of software developers by encouraging them to use social media tools (e.g., GitHub) that facilitate their cognitive mechanisms beyond their organisational borders.

In addition, the findings from this study provide managers of social media tools (Stack Overflow, GitHub) with insight into the influence of developers' perceptions of two properties of social media (visibility of knowledge and association) on their use of social media for cognitive mechanisms (internal individual and external collaborative mechanisms). Therefore, managers of social media tools may strive to improve such properties (visibility of knowledge and association) to increase the use of such social media tools by software developers.

Moreover, using the newly developed instrument, organisations will be able to maintain and monitor the visibility of knowledge provided by their newly developed or existing social media

tools. Organisations can use the newly developed instrument to evaluate their individuals' perception of the degree to which the existing information systems (e.g., enterprise social media) provide them with visibility of knowledge that enables them to easily search for and quickly access a variety of information that is complete, up-to-date, reliable and relevant to their tasks.

Perceived visibility of knowledge is conceptualised as users' perception of the degree to which social media provides them with visibility of knowledge which enables them to easily search for and quickly access a variety of information that is complete, up-to-date, reliable and relevant to their tasks.

One concern of many business executives is what social media tools (e.g. Facebook, Twitter or Yammer) they need to use to support employees' knowledge sharing and acquisition (Kane 2015). The newly developed instrument can be useful in this regard. Managers can evaluate which social media tools provide their employees with better visibility of knowledge in terms of easy and timely access to a broad, up-to-date, diverse, trustworthy and appropriate information for their tasks.

Also, software development companies that develop either public or enterprise social media tools can use this instrument especially during the application maintenance and review stage where the system is evaluated by final users. Once potential users have tested the prototype, the newly developed instrument can be used to obtain feedback from them about their perceived visibility of knowledge provided by the system.

7.4 Limitations of the study

While the results of this study provide insightful implications for research and practice, these results need to be interpreted with caution.

The cross-sectional design in the data collection process may limit the implications of the findings. The reason is that trends and technological specifics of professional online communities (e.g., Stack Overflow) change at a rapid pace, and users' perceptions about the properties may also change accordingly. Moreover, since the empirical data of the current study was collected at a specific time rather than through a longitudinal study, readers are encouraged to exercise caution in extending the findings from this study to understand software developers' perception of social media properties over time. Furthermore, it may be difficult to conclude suitable casual relationships based on the cross-sectional data (Rindfleisch et al. 2008). Hence, further longitudinal studies are needed to observe any changes in software developers' perceptions of social media properties, as well as developers' cognitive mechanisms and creativity over time. By applying a longitudinal study design, the casual relationships between perceived social media properties, cognitive mechanisms and creativity can be strengthened.

In addition, this study is based on self-reported measures of creativity. Although several studies have found self-reported creativity to be associated with objective measures of creativity (Furnham et al. 2005; Kaufman et al. 2010; Park et al. 2002), it cannot be said that the results of this study are necessarily indicative of the same model derived from objective measures of creativity. Future research is needed to examine if the same research model derived from objective measures of creativity has the same outcome as the results of the current study using self-reported measures of creativity.

In addition, this study measured software developers' perception of visibility of knowledge and association in New Zealand, which is an English-speaking country. It is likely that non-English speaking developers may have lower perceived visibility of knowledge in social media. One reason could be the fact that most information on social media, especially technical information, is in English. Hence, further research is needed to test the same instrument in non-

English speaking countries to see whether and to what extent there is a difference between the two groups.

Also, this study focused exclusively on the two components (domain-relevant knowledge and divergent thinking) of the componential theory of creativity and did not focus on intrinsic task motivation as the third component of the componential theory of creativity. The reason was that intrinsic-task motivation is more dependent on the characteristics of the task itself and not on external factors such as knowledge. One limitation of this study is that this research did not control for intrinsic-task motivation.

7.5 Future studies

The findings of this research open up a few interesting areas for future research.

Future IS studies could expand the results of this study by evaluating the influence of cognitive mechanisms on the creativity of IS professionals working in other areas than software development. For example, future research could apply the proposed model to examine the creativity of data scientists and compare their results with the results of the current study.

In addition, the current study focuses on software developers' perceptions of social media properties and their creativity at the individual level; future IS research could evaluate if perceptions of social media properties influence software developers' creativity at the team level during the development of new information systems.

In addition, the findings related to instrument development open several directions for future research.

The newly developed measures of perceived visibility of knowledge could be used as a springboard for future research. Researchers could replicate this work in a new context (Johns 2006). For example, future studies could investigate the perceived visibility of knowledge offered by other platforms, besides social media, such as knowledge management systems. It

would be interesting to investigate how users differentiate visibility of knowledge in different social media tools such as blogs versus wikis (or alternative social networking sites, such as Stack Overflow versus GitHub). The finding of such studies would be particularly useful for improving knowledge management in organisations.

Moreover, future research could use the newly-developed instrument to empirically investigate the influence of perceived visibility of knowledge provided by social media on related phenomena (e.g., employees' performance, productivity or other work-related outcome variables). For example, the newly developed instrument could be used to study how visibility of knowledge in social media affects individual performance by allowing individuals to find and access the right digital content at the right time.

Finally, future studies could also use the newly developed instrument to measure the visibility of knowledge in social media as perceived by individuals working in different contexts such as musicians, artists, writers and chefs. It would be interesting to measure how individuals working in other contexts rate visibility of knowledge in social media in terms of the criteria (e.g., broadness, timeliness) identified in this study.

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Appendices

Appendix A – Ethics application approval

AUTEC Secretariat

7 February 2017

Antonio Diaz Andrade
Faculty of Business Economics and Law

Dear Antonio

Ethics Application: 17/8 **Social media properties and employee's creativity in information systems development**

Thank you for submitting your application for ethical review to the Auckland University of Technology Ethics Committee (AUTEC). I am pleased to confirm that your ethics application has been approved for three years until 7 February 2020.

As part of the ethics approval process, you are required to submit the following to AUTEC:

- A brief annual progress report using form EA2, which is available online through http://www.aut.ac.nz/researchethics. When necessary this form may also be used to request an extension of the approval at least one month prior to its expiry on 7 February 2020;
- A brief report on the status of the project using form EA3, which is available online through http://www.aut.ac.nz/researchethics. This report is to be submitted either when the approval expires on 7 February 2020 or on completion of the project;

It is a condition of approval that AUTEC is notified of any adverse events or if the research does not commence. AUTEC approval needs to be sought for any alteration to the research, including any alteration of or addition to any documents that are provided to participants. You are responsible for ensuring that research undertaken under this approval occurs within the parameters outlined in the approved application.

AUTEC grants ethical approval only. If you require management approval from an institution or organisation for your research, then you will need to obtain this. If your research is undertaken within a jurisdiction outside New Zealand, you will need to make the arrangements necessary to meet the legal and ethical requirements that apply there.

To enable us to provide you with efficient service, we ask that you use the application number and study title in all correspondence with us. If you have any enquiries about this application, or anything else, please do contact us at ethics@aut.ac.nz.

All the very best with your research,

Kate O'Connor
Executive Secretary
Auckland University of Technology Ethics Committee

Cc: Narges Safari; Angsana Techatassanasoontorn

Appendix B – Participant information sheet - Interview

Participant Information Sheet

This information sheet is for academic experts and practitioners who have experience in the field of social media and information systems development (ISD).

Date Information Sheet Produced: 17 November 2016

Project Title: Social media use and employee creativity in information systems development.

An Invitation

My name is Narges Safari. I am a doctoral student at Auckland University of Technology (AUT). I invite you to participate in this study, which is part of the requirements for my doctoral degree. Your participation is at your discretion. You can withdraw from participating in this study up to the end of data collection.

What is the purpose of this research?

The purpose of this study is to develop an instrument that specifically and directly measures the construct of visibility of knowledge, which is related to social media use. The likely outputs of this research are a thesis, conference paper and journal article.

How was I identified and why am I being invited to participate in this research?

You are invited to this study because you have experience in the field of social media and ISD. I have identified you by receiving an email from you in response to the advertisement on the university notice board or on academic professional portals.

How do I agree to participate in this research?

You have responded to the advertisement by emailing me, whereupon the Participant Information Sheet and Consent Form have been sent to you by email. Once you read the Participant Information Sheet, you can agree to participate in this research by signing the Consent Form and send it to me by email. Your participation in this research is voluntary (it is your choice) and whether or not you choose to participate will neither advantage nor disadvantage you. You are able to withdraw from the study at any time. If you choose to withdraw from the study, then you will be offered the choice between having any data that is identifiable as belonging to you removed or allowing it to continue to be used. However, once the findings have been produced, removal of your data may not be possible.

What will happen in this research?

This study involves a multi-stage procedure in order to develop an instrument that measures the construct of visibility of knowledge, which is related to social media use.

What are the discomforts and risks?

I do not foresee any possibility of discomfort or risks experienced by you. In any case, you do not have to answer questions that you are uncomfortable with. You also can withdraw your data up to the end of the data collection.

What are the benefits?

This research is a requirement to obtain the researcher's PhD qualification. Moreover, this research will benefit the researcher by giving her the opportunity to develop an instrument for measuring visibility of knowledge.

The findings of this research will benefit the wider community by introducing validated items for measuring the visibility of knowledge offered by social media.

How will my privacy be protected?

This study does not involve any sensitive questions that may harm you. In addition, you will only be involved in this study if you are interested and you volunteer. Your identities will be protected as your name will not occur in the data and also will not be used in the dissemination of findings. Also, your privacy will be managed by not identifying you in the process of data analysis. This research will not use any identifiable information in the resulting publications. You are not pressured to answer any questions during interview discussion. All queries from you will be answered using common language and in truthful manner. All the obtained information/data will remain confidential both during and proceeding the project.

What are the costs of participating in this research?

The only cost in this research is that you will be required to give about 30 minutes for the interview.

What opportunity do I have to consider this invitation?

You will have two weeks to consider the invitation.

Will I receive feedback on the results of this research?

If you are willing to receive feedback on the result personally, please tick the following option in the attached Consent Form as:

I wish to receive a summary of the research findings.

In this case, I will provide you with the feedbacks on the result via email.

Also, a copy of the executive summary of this research will be posted on the AUT website Thesis Link (Thesislink.aut.ac.nz) and it can be publically accessed.

What do I do if I have concerns about this research?

Any concerns regarding the nature of this project should be notified in the first instance to the Project Supervisor, *Assoc. Prof. Antonio Díaz Andrade, antonio.diaz@aut.ac.nz, 0064-9-921-9999 – ext: 5804*.

Concerns regarding the conduct of the research should be notified to the Executive Secretary of AUTEC, Kate O'Connor, *ethics@aut.ac.nz*, 921 9999 ext 6038.

Whom do I contact for further information about this research?

Please keep this Information Sheet and a copy of the Consent Form for your future reference. You are also able to contact the research team as follows:

Researcher Contact Details:

Narges Safari, nsafari@aut.ac.nz, 0064-9-921-9999 – ext:5896.

Project Supervisor Contact Details:

Assoc. Prof. Antonio Díaz Andrade, antonio.diaz@aut.ac.nz, 0064-9-921-9999 – ext: 5804.

Approved by the Auckland University of Technology Ethics Committee on *type the date final ethics approval was granted*, AUTEC Reference number *type the reference number*.

Appendix C – Participant information sheet - Survey

Participant Information Sheet

This information sheet is for software developers who are currently working on information systems development (ISD) projects.

Date Information Sheet Produced: 18 November 2016

Project Title: Social media use and employee creativity in information systems development.

An Invitation

My name is Narges Safari. I am a doctoral student at Auckland University of Technology (AUT). I invite you to participate in this study, which is part of the requirements for my doctoral degree. Your participation is at your discretion. You can withdraw from participating in this study up to the end of data collection.

What is the purpose of this research?

This research aims to examine the effects of social media use on employee creativity in ISD projects. In order to explain the relationship between social media use and employee creativity, a knowledge management (KM) approach is adopted. Drawing on the KM approach, this study explains how the use of social media can affect employees' creativity through opportunities of social interactions for knowledge exchange beyond the organisational borders. The likely outputs of this research are a thesis, conference paper and journal article.

How was I identified and why am I being invited to participate in this research?

You are invited to this study because you are a software developer who is currently working on ISD project. You have been initially invited to this study through an advertisement posted on software developers' portals. This advertisement includes a link for Participant Information Sheet and a link for online survey. I do not collect the contact details from you. Once you read the participant information sheet, if you agree to participate in this study, you can complete the survey.

How do I agree to participate in this research?

By completing the survey, you will be indicating your consent to participate in this research. Your participation in this research is voluntary (it is your choice) and whether or not you choose to participate will neither advantage nor disadvantage you. You are able to withdraw from the study at any time. If you choose to withdraw from the study, then you will be offered the choice between having any data that is identifiable as belonging to you removed or allowing it to continue to be used. However, once the findings have been produced, removal of your data may not be possible.

What will happen in this research?

This research involves an online survey in order to assess the relationship between social media use and employee creativity. As a potential participant, by competing the survey, you will share your perception about social media use, your knowledge management activities and creativity. Your participation in this research is voluntary.

What are the discomforts and risks?
I do not foresee any possibility of discomfort or risks experienced by you. In any case, you do not have to answer questions that you are uncomfortable with. You also can withdraw your data up to the end of the data collection.

What are the benefits?
This research will benefit the participants by offering them the opportunity to reflect upon how the use of social media can facilitate their creativity.

This research is a requirement to obtain the researcher's PhD qualification. This research will also benefit the researcher by giving her the opportunity to understand the effects of social media on employees creativity in ISD projects.

The findings of this research will benefit the wider community by advancing the understanding of the role of social media use in employee creativity in ISD projects.

How will my privacy be protected?
This study does not involve any sensitive questions that may harm you. In addition, you will only be involved in this study if you are interested and you volunteer. I do not obtain any contact details of you. Since the online survey is anonymous, the identities will not be collected in this research and the anonymity can be achieved. The data collected from you will be sorted in Excel file in a shared drive on AUT's network. Only the primary researcher and supervisors will have access to the data and there will be no identification of you. You will not be pressured to answer any questions during the survey. All the obtained information/data will remain confidential both during and proceeding the project.

What are the costs of participating in this research?
The only cost in this research is that you will be required to give about 20 minutes for completing the online survey.

What opportunity do I have to consider this invitation?
You will have two weeks to consider the invitation.

Will I receive feedback on the results of this research?
A copy of the executive summary of this research will be posted on the AUT website Thesis Link (Thesislink.aut.ac.nz) and it can be publically accessed.

What do I do if I have concerns about this research?
Any concerns regarding the nature of this project should be notified in the first instance to the Project Supervisor, Assoc. Prof. Antonio Díaz Andrade, antonio.diaz@aut.ac.nz, 0064-9-921-9999 – ext: 5804.

Concerns regarding the conduct of the research should be notified to the Executive Secretary of AUTEC, Kate O'Connor, *ethics@aut.ac.nz* , 921 9999 ext 6038.

Whom do I contact for further information about this research?
Please keep this Information Sheet and a copy of the Consent Form for your future reference. You are also able to contact the research team as follows:

Researcher Contact Details:

Narges Safari, nsafari@aut.ac.nz , 0064-9-921-9999 – ext:5896.

Project Supervisor Contact Details:

Assoc. Prof. Antonio Díaz Andrade, antonio.diaz@aut.ac.nz, 0064-9-921-9999 – ext: 5804.

Approved by the Auckland University of Technology Ethics Committee on *type the date final ethics approval was granted*, AUTEC Reference number *type the reference number*.

Appendix D – Initially developed items

Constructs	Items
Broadness	I can get additional information to what I originally searched for
	I can learn about any particular problems from basic to advanced level
	I can access comprehensive information related to problems at hand
	I can click on hyperlinks to access further information
	I can see many comments on particular posts
	I can access a wide range of information
	I can access all the required information to complete a certain task
	I can get access to heaps of information
	I can see details about every job-related matter I have
	I can come across information that can be useful in the future
	I can access a sufficient amount of information for my needs
	I can access information that covers all my needs of my tasks
	I can access complete information
	I can access supplementary information related to what I was looking for
Up-to-datedness	I can access brand-new information
	I can access recently released information related to the problem
	I can access first-hand information
	Information is current
	I can access up-to-date information that I need for my work
	I can access newly released information
	The information is up-to-date and not obsolete
	I can learn about new topics
	I can catch up with recently released information
Diversity	I can see a variety of information regarding my problems
	I can access information in different formats
	I can see a variety of information
	I can obtain a variety of information about how software developers solved their problems
	I can observe how software developers exchange ideas about a subject related to my task
	I can compare information provided by different social media platforms (e.g. blogs, wikis and social networking sites)
	I can see different ideas and approaches about one subject
	I can obtain multiple approaches for solving a specific problem
	I can see different options and choose which one is the best to apply in my task
	I can read others' multiple experiences about the same problem I have at hand
	I can find diverse content
	I can access information about how different solutions worked on a specific problem
Timeliness	I can quickly browse the required content
	I do not have to waste time finding the information that I need
	I can access information very quickly
	I have direct access to the content
	I can access the required information immediately
	I can readily access the information that I need
	I can save time gaining the required information compared to obtaining the same information offline
	I can find information at the time I need
	Information can be retrieved rapidly without delay
	Information is delivered on time
	I can find the solution for my job-related problems quickly
	It does not take too much time for me to get the required information
Easiness	I can easily browse through social media applications
	I can easily search for others' experiences
	I have different easy ways to search for the required information

	I do not need to ask for help from others to search for information
	I can search for information easily
	I can easily search for an answer to my questions
	I can easily navigate through available information
	I can search for others' experiences easily
	I do not need to put a lot of effort into searching for the information that I need
Trustworthiness	I am confident that the retrieved information is reliable
	I can find information that is trustworthy
	I can find workable solutions for my task-related problems
	There are a few errors in the information I obtain
	I can access information that is free of error
	Information is valid
	Information does not contain a substantial amount of bias
	If I apply the retrieved information in my tasks, it will work for me
	I am confident that the retrieved information is true
	I can find solutions that have been verified by experts
Appropriateness	I can retrieve specified information for my tasks
	I can exactly find the information that I am looking for
	I can access information that fulfils my job needs
	The information that I retrieve addresses my need
	I can find detailed information about how to solve a problem
	Information that I find is applicable to my work
	Experts write their ideas about inaccurate information shared by others
	I can find appropriate information for my work
	I can find information that is highly relevant to my work
	Information is dependable
	I can obtain information that helps me solve the problems at hand
	I can apply the retrieved information to my task
	The information that I retrieve, addresses my needs
	I can access information about particular problems

Appendix E –Instructions used for content validity check - Hinkin And Tracey's (1999)

Approach

Dear Participant,

Thanks so much for your participation.

I am a doctoral candidate in Business Information Systems at Auckland University of Technology (AUT), Auckland, New Zealand.

I am in the process of designing a questionnaire to measure the extent to which software developers perceive that social media makes knowledge visible to them. I have come up with seven definitions that explain different aspects of visibility of knowledge in social media. I also have several statements for each of these definitions. As part of my research, I need to evaluate how well each statement is related to the proposed definitions.

To complete the survey, please read each statement (row) and indicate to what extent it relates to each definition (column). For example, if you believe that the statement "In social media, I can see different solutions to my problem" is highly related to the definition "Social media contain a variety of information", you can check its related box and choose number 7.

Please contact me on nsafari@aut.ac.nz for any questions.
I really appreciate your input!
Narges Safari

Items	**Construct Definitions**						
When I use social media for software development activities, I believe that:	Social media provides **information that is large in scope**	Social media provides **up-to-date information**	Social media contain **a variety of information**	In social media, it is **easy to search for information**	In social media it is **fast to locate information**	In social media, **information is free of error and correct**	In social media, **information is specific to the task**
In social media, I can see different solutions to my problem	5	2	7	1	1	1	6

	Social media provides information that is large in scope	Social media provides up-to-date information	Social media contain a variety of information	In social media, it is easy to search for information	In social media it is fast to locate information	In social media, information is free of error and correct	In social media, information is specific to the task
In social media, I can see different solutions to my problem							
I can access information in different formats (e.g. text, video and image)							
I can get additional information to what I originally searched for							
I can learn about any particular problems from basic to advanced level							
Information that I find in social media is reliable							
I can access cutting-edge information							
I can retrieve information that fulfills specific needs for my tasks							
I can easily search for others' experiences							

	Social media provides information that is large in scope	Social media provides up-to-date information	Social media contain a variety of information	In social media, it is easy to search for information	in social media, information can be located quickly	In social media, information is free of error and correct	In social media, information is specific to the task
In social media, I can quickly go through content until I get information that I need							
I can see a variety of information							
I can exactly find the information that I am looking for							
I can access comprehensive information related to problems at hand							
I can find information that is trustworthy							
I can click on tags (hyperlinks) to find related content on other pages							
I can be an observer of how software developers exchange ideas about a subject related to my task							

	Social media provides information that is large in scope	Social media provides up-to-date information	Social media contain a variety of information	In social media, it is easy to search for information	in social media, information can be located quickly	In social media, information is free of error and correct	In social media, information is specific to the task
In social media, I can access recently released information related to the problem that prompted my search							
I can access information that fulfills my job needs							
I can find detailed information about how to solve a problem							
I do not have to waste time to find the information that I need							
I can find information that is highly relevant to my work							
I can compare information provided by different social media platforms (e.g. blogs, wikis and social networking sites)							
I can access all the required information to complete a certain task							
I can see many comments on particular posts							

	information that is large in scope	provides up-to-date information	contain a variety of information	easy to search for information	can be located quickly	is free of error and correct	information is specific to the task
In social media, I can have readily access to the information that I need							
I can obtain multiple approaches for solvi a specific problem							
I can obtain information that help me solve the problems at hand							
I can read others' multiple experiences about the same problem I have at hanu							
I can save time to search for the required information compare to obtaining the same information offline							
I can find the solution for my job-related problems quickly							
I can access a sufficient amount of information for my tasks							
I can access information that is free of error							

	Social media provides information that is large in scope	Social media provides up-to-date information	Social media contain a variety of information	In social media, it is easy to search for information	in social media, information can be located quickly	In social media, information is free of error and correct	In social media, information is specific to the task
If I apply the retrieved information in my tasks, it will work for me							
I can search information easily							
I can get access to heaps of information							
I can access up-to-date information that I need for my work							
I can come across information that can be useful in the future							
I can access information about how different solutions worked on a specific problem							
I can catch up with recently released information							
I can find solutions that have been verified by experts							

	Social media provides information that is large in scope	Social media provides up-to-date information	Social media contain a variety of information	In social media, it is easy to search for information	in social media, information can be located quickly	In social media, information is free of error and correct	In social media, information is specific to the task
In social media, I can easily navigate through available information							
I can access sufficient amount of information for my needs							
I can access supplementary information related to what I was looking for							
I do not need to put a lot of effort to find the information that I need							
I can access Information about particular problems							

Appendix F –Instructions used for content validity check - Anderson And Gerbing's (1991) Approach

Dear Participant,

Thanks so much for your participation.

I am a doctoral candidate in Business Information Systems at Auckland University of Technology (AUT), Auckland, New Zealand.

I am in the process of designing a questionnaire to measure the extent to which software developers perceive that social media makes knowledge visible to them. I have come up with seven definitions that explain different aspects of visibility of knowledge in social media. I also have several statements for each of these definitions. As part of my research, I need to evaluate how well each statement is related to the proposed definitions.

To complete the survey, please assign each item (row) to one single corresponding definition (column). For example, if you believe that the item "In social media, I can see different solutions to my problem" is related to the definition "Social media contain a variety of information", then check its related box.

Please contact me on nsafari@aut.ac.nz with any questions.

Many thanks,

Narges Safari

	Social media provides information that is large in scope	Social media provides up-to-date information	Social media contain a variety of information	In social media, it is easy to search for information	in social media, information can be located quickly	In social media, information is free of error and correct	In social media, information is specific to the task
In social media, I can see different solutions to my problem	◯	◯	◯	◯	◯	◯	◯
I can access information in different formats (e.g. text, video and image)	◯	◯	◯	◯	◯	◯	◯
I can get additional information to what I originally searched for	◯	◯	◯	◯	◯	◯	◯
I can learn about any particular problems from basic to advanced level	◯	◯	◯	◯	◯	◯	◯
Information that I find in social media is reliable	◯	◯	◯	◯	◯	◯	◯
I can access cutting-edge information	◯	◯	◯	◯	◯	◯	◯
I can retrieve information that fulfills specific needs for my tasks	◯	◯	◯	◯	◯	◯	◯
I can easily search for others' experiences	◯	◯	◯	◯	◯	◯	◯

	Social media provides information that is large in scope	Social media provides up-to-date information	Social media contain a variety of information	In social media, it is easy to search for information	in social media, information can be located quickly	In social media, information is free of error and correct	In social media, information is specific to the task
In social media, I can quickly go through content until I get information that I need	◯	◯	◯	◯	◯	◯	◯
I can see a variety of information	◯	◯	◯	◯	◯	◯	◯
I can exactly find the information that I am looking for	◯	◯	◯	◯	◯	◯	◯
I can access comprehensive information related to problems at hand	◯	◯	◯	◯	◯	◯	◯
I can find information that is trustworthy	◯	◯	◯	◯	◯	◯	◯
I can click on tags (hyperlinks) to find related content on other pages	◯	◯	◯	◯	◯	◯	◯
I can be an observer of how software developers exchange ideas about a subject related to my task	◯	◯	◯	◯	◯	◯	◯

	Social media provides information that is large in scope	Social media provides up-to-date information	Social media contain a variety of information	In social media, it is easy to search for information	in social media, information can be located quickly	In social media, information is free of error and correct	In social media, information is specific to the task
In social media, I can access recently released information related to the problem that prompted my search	◯	◯	◯	◯	◯	◯	◯
I can access information that fulfills my job needs	◯	◯	◯	◯	◯	◯	◯
I can find detailed information about how to solve a problem	◯	◯	◯	◯	◯	◯	◯
I do not have to waste time to find the information that I need	◯	◯	◯	◯	◯	◯	◯
I can find information that is highly relevant to my work	◯	◯	◯	◯	◯	◯	◯
I can compare information provided by different social media platforms (e.g. blogs, wikis and social networking sites)	◯	◯	◯	◯	◯	◯	◯
I can access all the required information to complete a certain task	◯	◯	◯	◯	◯	◯	◯
I can see many comments on particular posts	◯	◯	◯	◯	◯	◯	◯

	Social media provides information that is large in scope	Social media provides up-to-date information	Social media contain a variety of information	In social media, it is easy to search for information	in social media, information can be located quickly	In social media, information is free of error and correct	In social media, information is specific to the task
In social media, I can have readily access to the information that I need	◯	◯	◯	◯	◯	◯	◯
I can obtain multiple approaches for solving a specific problem	◯	◯	◯	◯	◯	◯	◯
I can obtain information that help me solve the problems at hand	◯	◯	◯	◯	◯	◯	◯
I can read others' multiple experiences about the same problem I have at hand	◯	◯	◯	◯	◯	◯	◯
I can save time to search for the required information compare to obtaining the same information offline	◯	◯	◯	◯	◯	◯	◯
I can find the solution for my job-related problems quickly	◯	◯	◯	◯	◯	◯	◯
I can access a sufficient amount of information for my tasks	◯	◯	◯	◯	◯	◯	◯
I can access information that is free of error	◯	◯	◯	◯	◯	◯	◯

	Social media provides **information that is large in scope**	Social media provides **up-to-date information**	Social media contain a **variety of information**	In social media, it is **easy to search for information**	in social media, **information can be located quickly**	In social media, **information is free of error and correct**	In social media, **information is specific to the task**
If I apply the retrieved information in my tasks, it will work for me	◯	◯	◯	◯	◯	◯	◯
I can search information easily	◯	◯	◯	◯	◯	◯	◯
I can get access to heaps of information	◯	◯	◯	◯	◯	◯	◯
I can access up-to-date information that I need for my work	◯	◯	◯	◯	◯	◯	◯
I can come across information that can be useful in the future	◯	◯	◯	◯	◯	◯	◯
I can access information about how different solutions worked on a specific problem	◯	◯	◯	◯	◯	◯	◯
I can catch up with recently released information	◯	◯	◯	◯	◯	◯	◯
I can find solutions that have been verified by experts	◯	◯	◯	◯	◯	◯	◯

	Social media provides **information that is large in scope**	Social media provides **up-to-date information**	Social media contain a **variety of information**	In social media, it is **easy to search for information**	in social media, **information can be located quickly**	In social media, **information is free of error and correct**	In social media, **information is specific to the task**
In social media, I can easily navigate through available information	◯	◯	◯	◯	◯	◯	◯
I can access sufficient amount of information for my needs	◯	◯	◯	◯	◯	◯	◯
I can access supplementary information related to what I was looking for	◯	◯	◯	◯	◯	◯	◯
I do not need to put a lot of effort to find the information that I need	◯	◯	◯	◯	◯	◯	◯
I can access Information about particular problems	◯	◯	◯	◯	◯	◯	◯

Appendix G –Survey used for pre-test

Dear Participant,

Thanks so much for your participation.

I am conducting a research on how visibility of knowledge in social media (e.g. Stack Overflow) affects software developers' information seeking. The survey has 28 main questions and should only take three minutes, and your responses are and will remain completely anonymous. Completion of the survey confirms your consent and willingness to participate in in this study. Information gathered in this study will be only used for academic purposes.

Please read through each question carefully and select the response that best describes you. There is no right or wrong answer. Please do not spend too much time on any one question. Usually, your first reaction to each statement is a good guide. In this survey, you may come across some similar questions. I hope you answer all of them as they are used to examine the statistical reliability and validity of the survey.

Please contact me on nsafari@aut.ac.nz with any questions.

I really appreciate your input!

Narges Safari

Before you take part in this survey, I would like to check to make sure that you meet the criteria to participate in this study.

Please indicate if you use social media platforms (e.g. Stack Overflow, Blogs and so on) to gain knowledge for your software development activities. ○ YES ○ NO

Please provide information about your background below

Please indicate your gender. ○ Female ○ Male Please indicate your age. ○ 29 or younger ○ 30 – 39 ○ 40 – 49 ○ 50 or older

In this survey, you may come across similar questions. The similar questions are used to examine statistical reliability and validity. I hope you will answer them all.

Please choose the option that best describes you.	Strongly disagree	Disagree	Slightly disagree	Neutral	Slightly agree	Agree	Strongly agree
In social media, I can access comprehensive information related to problems at hand.							
In social media, I can access a large amount of information.							
In social media, I can access supplementary information related to what I was looking for.							
In social media, I can access cutting-edge information.							
In social media, I can access recently released information related to the problem.							
In social media, I can access up-to-date information that I need for my work.							
In social media, I can gain new information.							
In social media, I can see different solutions to my problem.							
In social media, I can see a variety of information.							
In social media, I can obtain multiple approaches for solving a specific problem.							
In social media, I can read multiple experiences from others who have the same problem as me.							
In social media, I can access information about how different solutions worked on a specific problem.							
In social media, I can quickly go through content to get information that I need.							
In social media, I don't have to waste time to find the information that I need.							
In social media, I can find the solution for my job-related problem quickly.							
In social media, I can easily search for others' experiences.							
In social media, I can search for information easily.							
In social media, I can easily navigate through available information.							
In social media, I can find information that is trustworthy.							
In social media, I can access information that is free of error.							
In social media, I can find solutions that have been verified by experts.							
In social media, I can retrieve information that fulfils specific needs for my tasks.							
In social media, I can find information that is highly relevant to my work.							
In social media, I can access information about particular problems.							

Please read through the questions carefully and select the response that bests describe you. Did you know that different software developers follow different paths while trying to find a solution to the same problem?

Please choose the option that best describes you.	Strongly disagree	Disagree	Slightly disagree	Neutral	Slightly agree	Agree	Strongly agree
I use social media to read information related to my task.							
I use social media to search and collect information related to my task.							
I use social media to gather and categorise work-related information.							
I use social media to adapt information to my work-related problems.							

Appendix H –Survey used for data collection

Dear Participant,

Thanks so much for your participation.

I am conducting a research on how software developers' perceptions of social media properties (i.e., visibility of knowledge and association) affect their creativity components (i.e. domain-relevant knowledge and divergent thinking). The survey has 46 main questions and should only take four minutes, and your responses are and will remain completely anonymous. Completion of the survey confirms your consent and willingness to participate in this study. Information gathered in this study will be only used for academic purposes.

Please read through each question carefully and select the response that best describes you. There is no right or wrong answer. Please do not spend too much time on any one question. Usually, your first reaction to each statement is a good guide. In this survey, you may come across some similar questions. I hope you answer all of them as they are used to examine the statistical reliability and validity of the survey.

Please contact me on nsafari@aut.ac.nz with any questions.

I really appreciate your input!

Narges Safari

Before you take part in this survey, I would like to check to make sure that you meet the criteria to participate in this study.

Please indicate if you use social media platforms (e.g. Stack Overflow, Blogs and so on) to gain knowledge for your software development activities. ○ YES ○ NO

Please provide information about your background below

Please indicate your gender. ○ Female ○ Male Please indicate your age. ○ 29 or younger ○ 30 – 39 ○ 40 – 49 ○ 50 or older

In this survey, you may come across similar questions. The similar questions are used to examine statistical reliability and validity. I hope you will answer them all.

Please choose the option that best describes you.	Strongly disagree	Disagree	Slightly disagree	Neutral	Slightly agree	Agree	Strongly agree
In social media, I can access comprehensive information related to problems at hand.							
In social media, I can access a large amount of information.							
In social media, I can access supplementary information related to what I was looking for.							
In social media, I can access cutting-edge information.							
In social media, I can access recently released information related to the problem.							
In social media, I can access up-to-date information that I need for my work.							
In social media, I can gain new information.							
In social media, I can see different solutions to my problem.							
In social media, I can see a variety of information.							
In social media, I can obtain multiple approaches for solving a specific problem.							
In social media, I can read multiple experiences from others who have the same problem as me.							
In social media, I can access information about how different solutions worked on a specific problem.							
In social media, I can quickly go through content to get information that I need.							
In social media, I don't have to waste time to find the information that I need.							
In social media, I can find the solution for my job-related problem quickly.							
In social media, I can easily search for others' experiences.							
In social media, I can search for information easily.							
In social media, I can easily navigate through available information.							
In social media, I can find information that is trustworthy.							
In social media, I can access information that is free of error.							
In social media, I can find solutions that have been verified by experts.							
In social media, I can retrieve information that fulfils specific needs for my tasks.							
In social media, I can find information that is highly relevant to my work.							
In social media, I can access information about particular problems.							
Social media provides various means to support my communications with other software developers.							
Social media supports various online events for me and other software developers to experience together.							
Social media provides various supports for me and other software developers to get together online.							

Please read through the questions carefully and select the response that bests describe you. Did you know that different software developers follow different paths while trying to find a solution to the same problem?

Please choose the option that best describes you.	Strongly disagree	Disagree	Slightly disagree	Neutral	Slightly agree	Agree	Strongly agree
I use social media to read information related to my task.							
I use social media to search and collect information related to my task.							
I use social media to gather and categorise work-related information.							
I use social media to adapt information to my work-related problems.							
I update my personal profile and status in social media.							
I share information to be discussed in social media.							
I become a member of professional networks in social media.							
I identify experts for debating information in social media.							
I use social media to participate in online discussions for creating new knowledge.							
I compare information in social media to come up with new ideas.							

All information will be kept anonymous and confidential. The information that you provide will be used only for academic purposes.

Please choose the option that best describes you.	Strongly disagree	Disagree	Slightly disagree	Neutral	Slightly agree	Agree	Strongly agree
I have a good technical knowledge concerning my tasks in software development projects.							
I have a good knowledge of the applications (e.g., programming apps) that are used in a software development project.							
I can troubleshoot software development-related problems by myself.							

The results of accurate responses to the following questions help managers provide you and your colleagues with a more supportive environment for being more creative. As a software developer, it's hard to keep up with everything. This is true for everybody.

Please choose the option that best describes you.	Strongly disagree	Disagree	Slightly disagree	Neutral	Slightly agree	Agree	Strongly agree
I am interested in everything related to software development projects.							

Logic puzzles fascinate me.							
When I come across a problem in my job, I think it through thoroughly.							
During my work, when I come across a problem that I cannot solve immediately, I try to find out more information.							
I want to know about every detail related to software development.							
I can evaluate a work-related issue from different points of view.							