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Exploring Individual Trust Factors in Computer Mediated Group Collaboration: A Case Study Approach

Xusen Cheng · Linda Macaulay

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Abstract Trust has become more and more important in the context of mixed use of longitudinal face-to-face and computer mediated group collaboration using Group Support System tools. Previous research has investigated trust factors in different dimensions. This paper takes the perspective of individual trust and aims to explore the new trust factors and also their detailed second level trust sub-factors in computer mediated collaboration over time. We have taken the interviews using the student groups during the two year-long collaboration project based case studies. We have validated the previous factors and found seven new trust factors and thirty one sub-factors which are associated with the main factors. Furthermore, based on the new factors, this paper has also designed an innovative trust traffic light model with suggested steps which could be easily used to help analyze the trust factors development over time for future longitudinal studies.

Keywords Trust · Trust factors · Collaboration · Traffic light model · Teamwork

1 Introduction

More and more people are using the updated technology for communication and collaboration online. Collaboration support is always very important for organizations and business for sustainable collaboration over time (Kolfschoten et al. 2012). Group Support System (GSS) has been considered as an information communication and sharing technique for enabling efficient and effective communication (Bajwa et al.

X. Cheng (✉)
University of International Business and Economics, Beijing, China
e-mail: xusen.cheng@gmail.com

L. Macaulay
Manchester Business School, Manchester, UK

2003). From the purpose of a professional collaboration, many researchers choose GSS software such as GroupSystems^{TM} (ThinkTank) for computer mediated collaboration research (Bragge et al. 2007; Kolfschoten et al. 2007; Kolfschoten and Vreede 2009).

Nonetheless, social factors, such as trust, have already been identified as critical to the success of computer mediated teams (Ebner 2007; Weinela et al. 2011). However, building trust in computer mediated collaboration teams is always a complicated topic (Powell et al. 2006). Trust has its importance to individuals working as part of a virtual team (Costa 2003; Jarvenpaa et al. 2004; Suchan and Hayzak 2001). There are many studies about trust between each other in a team and also trust in an online environment (Meyerson et al. 1996; Carmel 1999; Costa 2003; Nandhakumar and Baskerville 2006; Wilson et al. 2006; Lewicki et al. 2006; Piccoli and Ives 2003; Nolan et al. 2007). There are also various kinds of trust. For instance, individual trust is based on factors which represent conflicting priorities of the individual (Nolan et al. 2007).

The previous studies have investigated trust from different dimensions and in different contexts. The longitudinal collaboration using GSS support usually requires face-to-face (f2f) support rather than purely virtual in order to have better results. Nonetheless, there is little trust research in the context of computer mediated collaboration using GSS tools with face-to-face support over time. Moreover, the previous trust studies are also limited to higher level of main trust factors with models and theories, but have not investigated trust in a lower level into their more detailed sub-factors which are in the second level categories. In addition, there is little research from the perspective of individual trust factors and in the context of computer mediated collaboration over time.

Therefore, in order to answer the first question to fill the research gap, our research will first dig out some new trust factors and also the detailed list of sub trust factors that occur in the collaboration process from the perspective of individual trust and development over time in the context which is computer mediated collaboration with f2f support. Moreover, after finding out the sub-factors, how to measure trust development by using the newly found sub-factors that could be easily understood and lead to open-and-shut perception becomes the another research question. Thus, we also aim to design an innovative model for measuring trust development using the newly found sub trust factors for future research. In order to answer the two research questions, we have chosen a case study approach which takes 2 years.

In this paper, Sect. 2 will conduct the literature review, research method and design will be given in Sect. 3, followed by Sect. 4 which will show the case study and data collection. In Sect. 5, we will analyze the results and have the discussion. The final section reveals the conclusion, implication, limitation and future work.

2 Background and Literature Review

2.1 Trust in F2F and Computer Mediated Collaboration

According to Friedman et al. (2000, p. 36), “People trust people, not technology”. Dafoulas and Macaulay (2002) have also stated that a high level of trust is required in order for virtual teams to perform effectively in order to avoid any delays and conflicts.

Researchers have looked for an alternative theoretical lens to understand the interplay of teams and communication media, particularly when attempting to solve business problems with little or no face-to-face communication (Webber 2002). Nonetheless, building trust in computer mediated teams is complicated because time and geographical distance precludes most synchronous communication which is needed (Powell et al. 2006). DeLuca and Valacich (2006) have reported that the same-time-same-place communications, such as face-to-face communications, are highly synchronous. Beise et al. (2004) have also claimed that face-to-face meetings in virtual teams are needed to produce commitment, accountability, and to increase urgency. Drawing on case-based research, Lee-Kelley et al. (2004) highlighted that better performance in virtual teams was achieved through face-to-face meetings for team development. In addition, Nandhakumar and Baskerville (2006) have argued that the long-term virtual team working without face-to-face social interactions would lead to a gradual dissipation of personal trust relationships, and subsequently loss of impersonal trust relations. They have also stated that the computer mediated team working technologies alone have limited scope in reproduction and reinforcement of commitment and personal trust relationships. In order to obtain a higher trust, computer mediated collaboration with face-to-face support will enable better results and have been adopted by many business and organizations. On the other hand, in practical, such as the company employees in the business meeting, they usually use online platform for sessions but also with face-to-face interaction support. This mode is usually used by many companies. Therefore, we also decide to conduct the trust case study on this collaboration context.

2.2 Trust Factors

In order to answer the research questions, we need to investigate the individual trust factors in computer mediated teams in the perspective of trust development over time.

2.2.1 Trust Factors in Trust Development

When looking into the trust factors in the perspective of trust development over time which is associated with the collaboration going on, we can find the factors exist in different dimensions. Lewicki et al. (2006) have organized the existing work on trust development into four broad areas: the behavioral approach and three specific conceptualizations of the psychological approach (unidimensional, two-dimensional, and transformational models).

In the behavioral approach, trust is viewed as rational-choice behavior, such as cooperative choices in a game (Hardin 1993; Williamson 1981). In the definition of trust by Deutsch (1958), it is also based on individual behavior. From this behavioral perspective, the trustee's intention, motives, and trustworthiness are usually inferred from the frequency and level of cooperative choices made (Lewicki et al. 2006). The essence of trust in this tradition is the choice to cooperate or not to cooperate (Flores and Solomon 1998; Lewicki et al. 2006). It is also reported by Lewicki et al. (2006) that trust is operationalised as the level of cooperative behavior, shifts in the individuals'

level of cooperation. Therefore, we can find one trust factor from this approach which is "cooperative".

In the unidimensional approach, trust is deemed to be a single, superordinate factor, with cognitive, affective, and behavioral intention sub-factors (Lewicki et al. 2006). According to what Lewicki et al. (2006) have stated, the cognitive factor encompasses the beliefs and judgments about another's trustworthiness and it is the most emphasized in prior research on trust. A complementary aspect of trust assessment historically overlooked by researchers is the emotional/affective factor (Lewicki et al. 2006). It is reported that there is often an emotional bond between parties, especially in close interpersonal relationships and this factor is likely to affect the cognitive "platform" (Lewis and Weigert 1985). It is stated by Lewicki et al. (2006) that to trust behaviorally involves undertaking a course of risky action based on the confident expectation which is cognitively based, and feelings, which are emotional based, that the other will honor trust. Mayer et al. (1995) also argued that the outcome of trusting behavior provides information that will reinforce or change cognitions about the other party's trustworthiness. There are also some other studies have examined whether trust can be empirically distinguished into cognitive, affective, and behavioral components (Cummings and Bromily 1996; Clark and Payne 1997).

In the two-dimensional approach, there are also some trust factors. Cognitive factor here is divided into three characteristics identified by Mayer et al. (1995) which represent important ways that one party depends on the actions of another party as ability, benevolence, and integrity. Affective factor here is emphasized as emotions (Lewicki et al. 1998, 2006). Behavior trust factor could draw on the work of Gillespie (2003), which could be identified as "reliability".

In the transformational approach, there are three different transformational models which are Deterrence-Based Trust (DBT), Knowledge-Based Trust (KBT), and Identification-Based Trust (IBT) (Shapiro et al. 1992). Lewicki and Bunker (1995, 1996) have renamed the DBT to Calculus-Based Trust (CBT), and the trust is developed from CBT to KBT and then to IBT, Rousseau et al. (1998) have developed transformational approach into CBT and relational trust (RT). However, from KBT we have found the factors as "reputation", "reliability", and "integrity". From the CBT we have found the factors as "vulnerabilities", "risk", "predictability", "reliability" and "benefits". From the IBT we have found the factors as "reliability" and "honesty". From the RT, we have found the factors as "reliability", "dependability" and "emotion" which have been mentioned by in the previous research.

2.2.2 Trust Factors in Computer Mediated Teams

Trust in the computer mediated teams is different with trust in other context although in the perspective of trust development. Trust has been identified as the defining issue in understanding the effectiveness of distributed groups (Handy 1995; Poole 1999). With the advent of distributed teams, trust becomes a more salient issue (Lawler 1992; Mayer et al. 1995). A research on trust development over time on computer mediated teams by Wilson et al. (2006) has shown that it takes longer for trust to develop in computer mediated groups because it requires more time for members of those groups to exchange social information.

Wilson et al. (2006) has focused on the cognitive trust and affective trust in their experiments of trust development over time in computer mediated teams. Three scales from the McAllister's (1995) which are cognitive trust, affective trust, and monitoring/defensiveness are taken into the measurement. "Risk" factor is also highlighted by Ebner (2007) in e-negation. Two critical elements for trust which are "risk" and "reliability" are considered by Wilson et al. (2006) as the trust factors to measure the trust in computer mediated teams. Another factor which is "cooperation" is also considered in their measurement.

2.2.3 Individual Trust Factors

Individual trust is an important type of trust in computer mediated teams and with the perspective of trust development over time. The individual trust factors represent conflicting priorities of the individual. It is defined by Deutsch (1958) that trust is an expectation by an individual in the occurrence of an event such that expectation leads to behavior. The behavior of individual is also mentioned in the trust definition of Frost et al. (1978). It seems that individual trust may also rely on behavior approach. There are various trust factors which can be allocated according to different perspectives, however, only some of them could be considered as individual factors.

Reliability Reliability could be considered as an individual trust factor. Whether this person could be reliable to others is important in individual trust measurement. It is mentioned by researchers that in individual terms, trust is conceived as the extent to which people are willing to rely upon others and make themselves vulnerable to others (Frost et al. 1978; Rotter 1967).

Cooperation Cooperation, which is also measured as a behavior outcome of trust, could also be considered as one individual trust factor, and it is also mentioned that cooperation was a binomial measure at the individual level (Wilson et al. 2006). Whether an individual is good at cooperation with others or not will also influence his individual trust. Cooperation on individual levels is also an important trust factor in the behavior approach (Lewicki et al. 2006).

Reputation Reputation could also be considered as an individual trust factor. Drawing on Tschannen-Moran and Hoy (2000), a reputation of trustworthiness is a valuable asset to individuals and businesses alike. A good reputation will definitely increase the individual trust. When many people perceive that an individual has a good reputation, it is more difficult for a negative event to significantly reduce a high level of trust in that individual (McKnight and Chervany 1996).

Six factors in online individual trust development Nolan et al. (2007) have conducted research on individual trust development on online communities where they deconstructed individual trust into its six component parts:

- *Risk* which is associated with providing information to unknown recipients and acting upon information received from them;

- *Benefit* which an overall perception that involvement will provide individual gain;
- *Utility value* which is measured by high information quality such that it can be absorbed into immediate practice;
- *Interest* which indicates an inherent interest in the system and the information available;
- *Effort* which is exerted to acquire information;
- *Power* which is an individual's ability to influence others by means of his/her superior knowledge and/or access to information.

It is also proposed by Nolan et al. (2007) that each element is evaluated by individuals which are relative to one or more of the others as such the "balance" between them dictating an individual's readiness for collaborative behavior. Here we also count the *risk, benefit, utility value, effort* and *power* as the individual trust factors which are main trust factors in the online environment for measurement.

3 Methods

3.1 Research Method

Considering the approach used in other similar studies (Wilson et al. 2006; Piccoli and Ives 2003; Nolan et al. 2007), case study was chosen as the research methodology to exploring the factors. We also follow the case study approach of Yin (2003, 2009). In this research, in-depth interviews were used to collect data for the case study.

For the purpose of this study, Nolan et al. (2007)'s six individual trust factors have been used in the investigation and design of the interviews. At the same time, by considering the trust factors from Tschannen-Moran and Hoy (2000), as well as the Tuckman (1965), Tuckman and Jensen (1977) four stages of team building, Adair (2004) team building theories and many other scholars' previous research, the semi-structured interview protocol was designed. Students who come together for a group project are a frequently used sample for researchers testing or evaluating techniques and models in the group decision and collaboration research area (Gipps 1994; Kwok and Ma 1999; Ma 1996; Richards 2009; Chiu et al. 2010). Thus, we decided to use student groups in the year long project based case study. It is also indicated by McConnell (2006) that smaller groups make group meetings outside class time easier for students to organize. Furthermore, McConnell (2006) recommends groups of five students if teams are to meet in class. Nicolay (2002) also asserts five as a convenient group size. Thus, we decided to design the case into five participants per group.

3.2 Measurement Instrument

Interview is also a vital part in this research and will extend the research with exploratory findings into trust factors and development over time. It will collect the qualitative data from the case studies in this research during the 2 years' longitudinal research. The initial guideline for designing the interview questions is based on the six trust factors and other individual trust factors found in the literature. Additionally,

the Tuckman (1965)'s four stages of team building and Adair (2004)'s team building theories are also considered in the interview design process. The interview questions have also been discussed in collaboration sessions with several experienced facilitators. The preliminary version of interview questions has been sent to the case study ITMB programme director for more feedback. Moreover, the interview questions are tested by some students and then approved by the programme director for final authorization.

Finally, the semi-structured interview which is composed of 16 questions is designed. The questions are also associated with different team building stages which are forming, storming, norming, performing and adjourning, whereas the last stage is not the main research aim but could provide optional complementary data to answers from previous stages. Although the questions allocated into different team development stages show the relationship in four/five different stages, some questions/trust factors exist throughout all stages. Therefore, the questions allocated in different team development stages may not relate to this stage exclusively. This means it may either be introduced from this stage or its main performance is on this stage, but could also relate to others stages. The interview will be conducted in the end or near the end of the case study ITMB project which is also the end of the computer mediated collaboration.

A justification of the trust factors, team building and development stages and interview questions with reference is shown in the Table 1.

By using the template of the interview questions, the data collected in the semi-structured interviews will be better transcribed, coded and analyzed with target to different trust factors based on this template.

4 Case Study and Data Collection

We have two longitudinal year-long case studies selected for this research. In each of the case study, eight facilitated student groups were chosen from a UK university in which each of the groups aimed to do the same team project in the same lab sessions for one whole academic year. In total, we have sixteen groups in the two cases. They are two similar cases. Each case lasts for 1 year following the same settings, but it is repeated again for another year. The case study was conducted in the background of their "integrated team project" course module. There were five students in each collaboration group, they are all first year fresh students and are not familiar with each other. They are all novice to the task and project. The project which we named "ITMB" was conducted in the Collaboration Laboratory. The computers in the lab were all available to access the professional Web based online GSS collaboration software GroupSystem^{TM} (ThinkTank) which was the main collaboration tool for the students. At the start of the project, the students in the ITMB project were randomly allocated into different teams which they will be working with for the whole project period. They were doing the same project, but in teams.

The project lasts for one academic year. In the case project, each team of the students is required to collaborate using the GroupSystem^{TM} (ThinkTank) which has been integrated with thinkLets in the computer lab in order to create a solution (Briggs and Vreede 2001). Typically, they have lectures and lab sessions every week. They can

Table 1 Justification of the trust factors and questions in the interview

Team stages	Trust factors	Interview questions	References
Forming	*Motivation*	1. Is each team member motivated enough to want to achieve the best results possible in all the collaboration process?	Adair (2004)
	Risk	2. Are there any troubles or risk in your team, what are they? Have them been solved? And how do they change in the collaboration process? Why?	Lewicki and Bunker (1995), Lewicki and Bunker (1996), Lewicki et al. (2006), Wilson et al. (2006), Nolan et al. (2007), Ebner (2007)
	Interest	3. Are you interested in your team project and working with others all the time? Or why you increased or lost your interest?	Nolan et al. (2007)
Storming	*Reliability*	4. Are the team members reliable and have their reliability changed over time?	Butler and Cantrell (1984), Hosmer (1995), Tschannen-Moran and Hoy (2000), Rotter (1967), Hoy and Kupersmith (1985), Baier (1986), Gambetta (1988), Bradach and Robert (1989), Coleman (1990), Fukuyama (1995), Mayer et al. (1995), Cummings and Bromily (1996), Mishra (1996), Rousseau et al. (1998), Gillespie (2003), Shapiro et al. (1992), Wilson et al. (2006)
	Reputation	5. Do you think your team members have a good reputation?	Shapiro et al. (1992), Tschannen-Moran and Hoy (2000), McKnight and Chervany (1996)
	Power	6. Do you think you have a superior knowledge or ability to influence others? Have you increased this ability or lost this advantage? Why?	Nolan et al. (2007)
Norming	*Cooperation*	7. How do you value your team members' cooperation over time?	Hardin (1993), Williamson (1981), Lewicki et al. (2006), Flores and Solomon (1998), Wilson et al. (2006)
	Benefit	8. Do you think you have obtained benefits from your team work? And with the work going on, you get more benefit, or you get less benefit? Why?	Lewicki and Bunker (1995), Lewicki and Bunker (1996), Nolan et al. (2007), Ebner (2007)
	Utility value	9. Do you think you can get utility value from the information you gained in your teamwork? Do you get more of these in the later work, or in the beginning work?	Nolan et al. (2007)

Table 1 continued

Performing	*Achieving the task*	10. How do you think you and your team members' ability and performance in achieving the task over time?	Adair (2004)
	Effort	11. Have you spent lots of hard effort in your team work? You spent more in the beginning or in the later stages? Why?	Nolan et al. (2007)
	Friendly	12. Is each team member capable of working closely with the others in a friendly and personable way?	Adair (2004)
Adjourning	*N/A*	13. What are the main advantages and disadvantages in your team?	Own
	N/A	14. Do you like your team and your team members? Why?	Own
	N/A	15. What factors do you think is important in building high level of individual trust in your team?	Own
	N/A	16. What others you want to say, or other suggestions to your team collaboration?	Own

discuss with each other in the lab sessions and they may also have offline discussions and communications. However, some teams may also work after class in their own time. They may also have face-to-face meetings or virtual meetings in their own time. For instance, they can have group meetings and they also use social networking communication tools such as facebook, twitter or online chatting tools like Skype to communicate with each other in their own time. The purpose is to finish the collaboration project. Finally, they have to implement their solution into a detailed Web design. From the project which is started in September, they have to define a problem, analyze user requirements, have scope of solutions, and do high level of design before the Christmas break. After that, they will do detailed design, implementation, testing and evaluation, followed by Demo and final report. However, in the November and April they will have employer events where they will show the employers their up to date work. In the November and April events, the employers from business come to university to review their process and give suggestions. The students need to do their presentations in front of the enterprise mentors. In addition, the student teams have professional facilitators from the university to advice them in the collaboration process of their projects. Outside the lab, in some seminars of this module, the students also have university mentors to help them with the collaborations. There will also have funded cash prizes for the first three highest score team in their ITMB project. See Fig. 1.

In the case study, all participants have to record their own perceptions including trust change for the collaboration in their weekly report throughout project in order to make sure all perceptions and ideas are recorded in time. Interviews were designed to be carried out at the end of the project. The process was repeated in another academic year for another eight groups of students in a similar case. The same case study is with

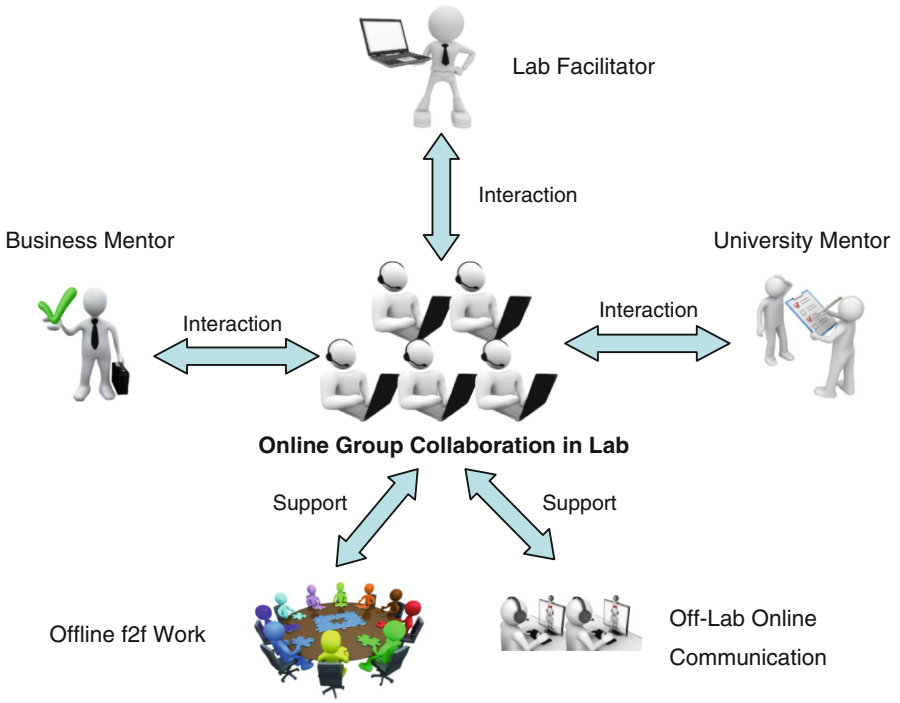

Fig. 1 Case study project map

a different Web design re-engineering topic, but with the same number of first year students and the same experiment settings.

At the end of each year long project we interviewed some students individually. The interviewees were all volunteered to be interviewed. They all had good archive of the project collaboration process and perception record. Semi-structured audio-taped interviews were used in data collection. Monetary compensation was given as an incentive to the interviewees. In the interview, questions were answered, problems were mentioned and feedback was given. Finally, twenty in-depth interviews have been successfully conducted for the two cases over 2 years.

5 Results and Discussion

5.1 Six Trust Factors and Their Sub-factors

The six individual trust factors proposed by Nolan et al. (2007) are validated in our case studies. Furthermore, we found many sub-factors in the second level which are related with them. According to the semi-structured interviews, the initial coding results of interview data have been categorized into associated trust factors including the main trust factors and their sub-factors. There are numerous trust factors existing in the 2 year's two cases.

Table 2 Risk interview comments example

Case	Sub-factor	Interviewee ID	Comments example
1	Communication skills	I12G1S1	*Communication probably was the probably one of the biggest problems within the group; Communication was another important thing*
	Meet up problem	I16G7S2	*Finding the time when we can all meet up that was one of the major things…*
	Conflict of option	I3G3S3	*We have conflicts of interest in communicating an idea*
2	Technical problems	I20G8S1	*Have got quite a lot of technical problems*
		I19G6S2	*Technical knowledge to achieving the group's goals*

5.1.1 Risk

In the first case, three sub-factors which are communication skills, meet up problem, and conflict of option have been frequently indicated in the interviews. Better communication skills means there will be less risk where as the opposite is found with regards to the meet up problem and conflict of option sub-factors. In the second case, technical problems will lead to more risk. According to the interview data, the sub-factor of *technical problems* is the main trust sub-factor for this case two which is different from the first case. We also categories the interviewees into IGS form, for example, I12G1S1 means the interviewee is given number 12 which is an unique number and he/she is in group 1 in the case and the assigned student number is 1 in this group. See Table 2.

In the three stages' development, *conflict of option* in first case was mentioned less by the interviewees in the middle stage and final stage. However, other sub-factors relating to *risk* still maintained an unchanged importance over time.

5.1.2 Benefits

For the first case, according to the interview data, *learning things, communication skills*, and *team building skills* are frequently mentioned benefits by the interviewees. For the second case, there are also some similar sub-factors with case one frequently mentioned as benefits by the interviewees. They are *learning things, team management skills*, and *team working skills*. For instance: Table 3

In the development over time, *learning things* and *team working skills were* mentioned less in the middle stage and final stage. However, *communication skills* have

Table 3 Benefits interview comments example

Case	Sub-factor	Interviewee ID	Comments example
1	Learning things	I12G1S1	*It increased my learning from initially*
	Communication skills	I12G1S1	*Communication is probably the biggest and most important thing in the team and it was a benefit for me to understand what was needed*
		I5G7S2	*Communicating or people giving me the confidence to talk in a team*
	Team building skills	I5G7S1	*We kept a really good team morale*
2	Learning things	I20G8S1	*I have learned a lot from doing the report*
	Team management skills	I15G7S1	*Develop my team management skills and organising timetables and contacting everybody*
	Team working skills	I14G3S1	*Picked up skills like how to work with teams and how to manage all the people within a team*

Table 4 Utility value interview comments example

Case	Sub-factor	Interviewee ID	Comments examples
1	Team working skills	I17G4S1	*Team working is obviously valuable skills*
	More work	I4G3S4	*Deadlines became closer and closer and you have got more work to do*
2	Communication skill	I20G8S1	*I think the communication skills might be one of the most important utility values*

been mentioned more in the middle stage but mentioned less in the final stage. For second case, those sub-factors all stayed at the same level.

5.1.3 Utility Value

For the first case, there are two factors, which are *team working skills* and *more work* are considered as the sub-factors of utility value in this case. In the second case, *communication skill* is considered as the main sub-factor of utility value. See Table 4.

For the first case, in the development of the project over time, however, *team working skill* is only mentioned in the beginning stage but seems of little importance as a utility

Table 5 Interest interview comments example

Case	Sub-factor	Interviewee ID	Comments examples
1	Learning things	I4G3S4	*I had learned quite a bit*
	Team working	I6G7S2	*It was really interesting working with team members*
	Don't know anybody	I12G1S1	*At first it was interesting because I did not know any of the group members*
	Task completion	I20G8S1	*There was the time to get our project done and all and our interests went up again*
	Whether contributing	I1G3S1	*Frustrating when you're working in a team and say if someone doesn't do their work*
2	Team working	I20G8S1	*I am interested in working with other people*

value in the later stages. *More work* only emerged as a sub-factor of utility value in the final stage. For the second case, *communication skill* as a utility value doesn't changed over time.

5.1.4 Interest

For case one, there are a few sub-factors which have been mentioned a lot by the interviewees which are *learning things, team working, don't know anybody, task completion* and *whether contributing*. If other people contribute, it will increase the interest of other individuals. For the other four factors, they are all positively related to interest. For case two, *team working is* highly considered as a sub-factor of interest which is also positively related (Table 5).

In the development, for the first case, the factor of *don't know anybody* only exists in the beginning stage. *Learning things* as an interest is found more in the middle stage but gets prominent as an interest in the final stage again. *Team working* as an interest is mentioned more in the final stage rather than the first two stages. *Not contributing* is mentioned in the middle stage. In the final stage it is mentioned more than the initial stage. For the second case, *team working* as an interest is decreasing to a standard in the later stages.

5.1.5 Effort

For case one, the sub-factors for effort are categorized as *motivation, getting to know each other, deadline* and *more work*. These factors will lead participants to dedicate more effort to the collaboration. For the case two, the sub-factors of effort have some difference which is categorized as *easy, reports, business presentations*, and *deadline*. These factors will lead to more effort (Table 6).

With the development of project, in first case, *motivation* is performing less in the middle stage and final stage whilst getting to know each other only exists in the beginning. *Deadline* is starting to emerge in the middle stage with a rapid increase in

Table 6 Effort interview comments example

Case	Sub-factor	Interviewee ID	Comments examples
1	Motivation	I5G7S1	*You don't have to motivate yourself you actually have others around you to motivate you*
	Getting to know each other	I10G4S2	*It was just about getting ideas in the open and getting to know each other*
	Deadline	I5G7S1	*The deadlines were approaching so the work had to be submitted*
	More work	I10G4S2	*From their feedback we got a new surge of work to do*
2	Easy	I18G6S1	*It is easier than at the middle or the end of the project so I put most of my time in at the beginning*
	Reports	I17G4S1	*Writing simple reports and theories*
	Business presentations	I17G4S1	*We have business presentations*
	Deadline	I15G7S1	*Deadlines are coming again… we are stuck on that technical*

the final stage. *More work* only exists in the final stage but is frequently mentioned by the interviewees. For second case, *easy* only exists in the initial stage whilst *reports* and *business presentations* only exist in the middle stage and *deadline* only exists in the final stage as a sub-factor for effort.

5.1.6 Power

In the first case, power such deconstructed into positively related main sub-factors as *organizing meetings, knowledge, confidence, persuasion skills*, and *influencing skills*. There are three main sub-factors of power in the second case, which are *communication skill, unique skills*, and *knowledge* (Table 7).

As the project moved on, in the first case, *knowledge* which is mentioned in the first stage is not mentioned in the middle stage but is emerged in the final stage. *Confidence* decreases in the middle stage and final stage. Persuasion skill as a sub-factor has been increased in the middle stage but decreases towards the final stage. *Influencing skills* and *organizing meeting* stays at the same level of importance during the stages. For the second case, communication skills and unique skills stay unchanged but knowledge seems to have decreased in the later two stages.

5.2 New Factors and Their Sub-factors

In the case studies, we also validated the new trust factors we have adapted from the literature rather than the six individual trust factors and also found many sub-factors associated with them.

Table 7 Power interview comments example

Case	Sub-factor	Interviewee ID	Comments examples
1	Organizing meetings	I1G3S1	*I'm like the leader who organizes the meetings*
	Knowledge	I5G7S1	*I think I have a better knowledge in certain areas*
	Confidence	I8G8S1	*I was assigned the team leader for the project because of my confidence*
	Persuasion skills	I5G7S1	*I believe my persuasion skills were certainly put to the test*
	Influencing skills	I4G3S4	*It has improved by my ability to influence people and motivate people*
2	Communication skill	I19G6S2	*My communication skills have got better*
	Unique skills,	I18G6S1	*I learn more so I have more ability and to use this ability is to influence others*
	Knowledge	I13G2S1	*We have kind of built up our knowledge*

Table 8 Motivation interview comments example

Case	Sub-factor	Interviewee ID	Comments examples
1	Grade	I3G3S3	*I was highly motivated to get a first*
	Deadline	I5G7S1	*The start of the first year was not motivated but then towards the middle and towards the end that when I started to get motivated as the deadlines were coming up*
2	Grade	I15G7S1	*There was competition …want to do the best*

5.2.1 Motivation

In case one, two main sub-factors which are *grade* and *deadline* are frequently mentioned in a relation to the trust factor of motivation. The case two is similar with the first case in this part. It has got aiming for a high *grade* for the project as the main motivation too (Table 8).

In the development over time, in the first case, *grade* as a motivation is frequently cited in the initial stage but gets lower in the middle stage and then disappears in the final stage. Instead, deadline starts to be the main motivation in the middle stage and grows towards the final stage. For the second case, *grade* as a motivation sub-factor is frequently mentioned in the beginning but growing towards a lower rate at the middle and final stage.

5.2.2 Reliability

For case one, according to the data analysis of interview transcripts, three main sub-factors which are *impression, deadline*, and *more work* are related to the reliability.

Table 9 Reliability interview comments example

Case	Sub-factor	Interviewee ID	Comments examples
1	Impression	I7G7S3	*Everyone was trying to give a good first impression*
	Deadline	I12G1S1	*A bit more reliable because they knew we had to complete the task by set deadlines*
	More work	I2G3S2	*Deadlines coming up with more and more work outside of the project as well as inside… increase*
2	Do the share	I17G4S1	*We haven't been able to rely on her for anything*
	Turning up	I19G6S2	*I will not put my whole reliance on them …two people in the group turned up plus me*
	Escape	I20G8S1	*Some people are trying to escape from the problem*

A good impression, closer to deadline, and more work give the individuals more reliability. In the second case, the situation seems different to the first case. *Do the share, turning up* , and *escape* are three main sub-factors relating with reliability. The first two give more reliability whilst the last one decreases reliability (Table 9).

In the development over time, for first case, with the development of the project, *impression* as a sub-factor for *reliability* is frequently mentioned in the beginning stage but disappeared as a main factor in the later two stages. Instead, in the final stage, *deadline* and*more work* which increase the reliability, are frequently mentioned by the interviewees as the main influencing sub-factors. For second case, *do the share* influences *reliability* throughout the project but only in the middle stage is it frequently mentioned. The problem of *turning up* and *escape* are two other frequently mentioned main sub-factors influencing reliability and kept the same importance throughout the project.

5.2.3 Reputation

In the first case, it is related with three main sub-factors which are *know each other, different skills*, and *turning up*. By obtaining those sub-factors, an individual is considered to have high reputation. In the second case, *grade* is the main sub-factor considered in relation to reputation. The more grades, the greater the individual reputation will be (Table 10).

Although the main sub-factors are different in these two cases, the development trend of the sub-factors for *reputation* is the same which keeps unchanged throughout the three stages' project development according to the data. It also means that the main sub-factors in these two cases kept the same importance.

Table 10 Reputation interview comments example

Case	Sub-factor	Interviewee ID	Comments examples
1	Know each other	I10G4S1	*We got to know each other's capabilities so what someone is good at doing and then their reputation increased*
	Different skills	I4G3S4	*Each group member brought their skills set*
	Turning up	I7G7S3	*Gives a bad reputation or if you are late to meetings*
2	Grade	I15G7S1	*Reputation is related with the grade that we get*

Table 11 Cooperation interview comments example

Case	Sub-factor	Interviewee ID	Comments examples
1	Willingness to do	I1G4S1	*He is not willing to talk to each other; they didn't want to cooperate*
	Deadline	I9G8S2	*Forced to finishing…the finishing our group project so we had to do we have to cooperate each other at the end*
2	Communication skills	I15G7S1	*Outside our own free time so I think there should be more communication*

5.2.4 Cooperation

In case one, cooperation is more related to the factors of *willingness to do* and *deadline*. The more willingness to do or closer the deadline, it will have better cooperation. In the second case, cooperation is more closely related to the *communication skills* of the individuals (Table 11).

In the development over time, for the first case, the *willingness to do* seems to become most important in the middle stage of the project compared with less importance in the two ends of the project. *Deadline* doesn't show up until the end of the project when it is frequently mentioned as an important factor influencing *cooperation*. Considering the second case, *communication skill* is the most significant factor throughout the whole project relating with *cooperation*.

5.2.5 Task Achieving

In the first case, *motivation* is considered as the most important factor influencing the task achieving during the stages of the project. More motivation, it will be better to achieve the task. In the second case, there are two factors which are *grade* and *lazy* more related with task achieving. Better grade, better task achieving. But much lazier, it will be worse task achieving (Table 12).

Table 12 Task achieving interview comments example

Case	Sub-factor	Interviewee ID	Comments examples
1	Motivation	I7G7S3	*We were all motivated to get a first*
2	Grade	I20G8S1	*We did it quite well so far from the grades*
	Lazy	I17G4S1	*I am quite a lazy person unless I am given the work*

Table 13 Friendship interview comments example

Case	Sub-factor	Interviewee ID	Comments examples
1	Sociable characters	I12G1S1	*I bonded with team members particularly when we actually socialised outside*
2	Know each other	I14G3S1	*Got to know each other, we got on more*

In the development over time, for the first case, motivation is frequently mentioned in the beginning of the collaboration but the importance in influencing the *task achieving* seems to have dropped in the later stages. For the second case, *grade* is considered as highly important in the middle stage rather the beginning and end whilst *lazy* plays a more important role in influencing task achieving in the final stage.

5.2.6 Friendship

In case one, friendship is mainly influenced by *sociable characters* where an individual is more sociable he will be considered as more friendly. In second case, whether the individual could *know each other* plays a more important role in being friendly (Table 13).

In the development over time, the two sub-factors which are *sociable characters* and *know each other* influencing the *friendship* factor in two cases keep the unchanged importance throughout the collaboration project.

5.3 Discussion and the Categorizing of Trust Factors

In the open questions part of the interview, the interviewees also talked a lot. By analyzing the content, generally, there are some factors frequently mentioned by interviewees in the end of the semi-structured interviews besides the factor based questions. The high frequency factors are indicated as *communication skill, motivation, reliability, turning up*, and*task completion* for the first case, whilst *delegating the responsibilities, communication skills, deadline*, and *know each other* for the second case. Those factors have also validated the factors mentioned in the previous sections.

According to those factors found in the open questions, it is easy to see that *communication skill* belongs to the parent factor of *risk, benefit, utility value, power*, and *cooperation*. *Motivation* itself is considered as a parent factor and it is also related with *effort* and *task achieving*. *Reliability* is already considered as a parent factor. *Turning*

up belongs to the parent factor of *reputation* and *reliability* whilst *task completion* related to the parent factor *interest*. Additionally, *delegating the responsibilities* could be considered belonging to *reliability* and *reputation*. *Deadline* is related with the parent factors which are *effort, motivation, reliability* and *cooperation*. *Know each other* is related with *effort, reputation*, and *friendship*. Therefore, all the parent factors indicated before have been validated again in this level.

Moreover, it could be found that *communication skill, learning things, team working skill, more work, know each other, deadline*, *grade* and *turning up* have multiple relations with more than one parent trust factor. These eight sub-factors are considered to play more important roles than the other twenty three basic sub-factors which are from a single case and only have a single relation to a single parent factor. In the mean time, it is also evident that among the all 31 sub-factors there are 7 skill factors.

Furthermore, the seven "skill" based sub-factors which are *communication skill, team working skill, team management skill, persuasion skill, influencing skill, unique skill*, and *different skills* are influencing *risk, benefit, utility value, interest, power*, *reputation* and *cooperation* which are more than half of all parent factors. Thus, *skill* which includes all the seven skill based factors could be considered as a parent factor which is throughout the *forming, storming*, and *norming* stages of team building.

Therefore, in this research, beside the six factors, we finally define some new found main/parent trust factors in this context as seven factors

(1) *Motivation:* the perception of the individual's motivation in the process of completing the collaboration task.
(2) *Reliability:* the degree of the individual's reliability in the collaboration in the team.
(3) *Reputation:* the individual's reputation with working in the team.
(4) *Cooperation:* the individual's willingness and performance in collaboration with other team members in the common task.
(5) *Task achieving:* the individual's ability and performance in achieving the task in the collaboration team work.
(6) *Friendship:* the individual's impression and attitude to others in the collaborative team work.
(7) *Skill:* the individual's knowledge, abilities and skills to perform in the collaboration task.

By analyzing the data we have collected, a categorized general relationship model of the trust factors and their associated 31 sub-factors can be seen in Fig. 2. We have also categorized the trust sub-factors and selected the two-dimensional approach which is mentioned in the literature review part (Lewicki et al. 2006; Wilson et al. 2006) to categorize them into dimensions of trust using affective factors (AF) and cognitive factors (CF). The AF and CF are presented in the left part of the Fig. 2. The dashed box shows the sub-factors which are only found in the first or second case. The small box numbered 1 or 2 in front of the dashed box shows the unique factors belonging to the first or second case. For instance, the factor behind the small box numbered 1 only belongs to one parent factor and the parent factor is in case one. It could be found that *communication skill, learning things, team working skill, more work, know each other, deadline, grade* and *turning up* have multiple relations with more than one

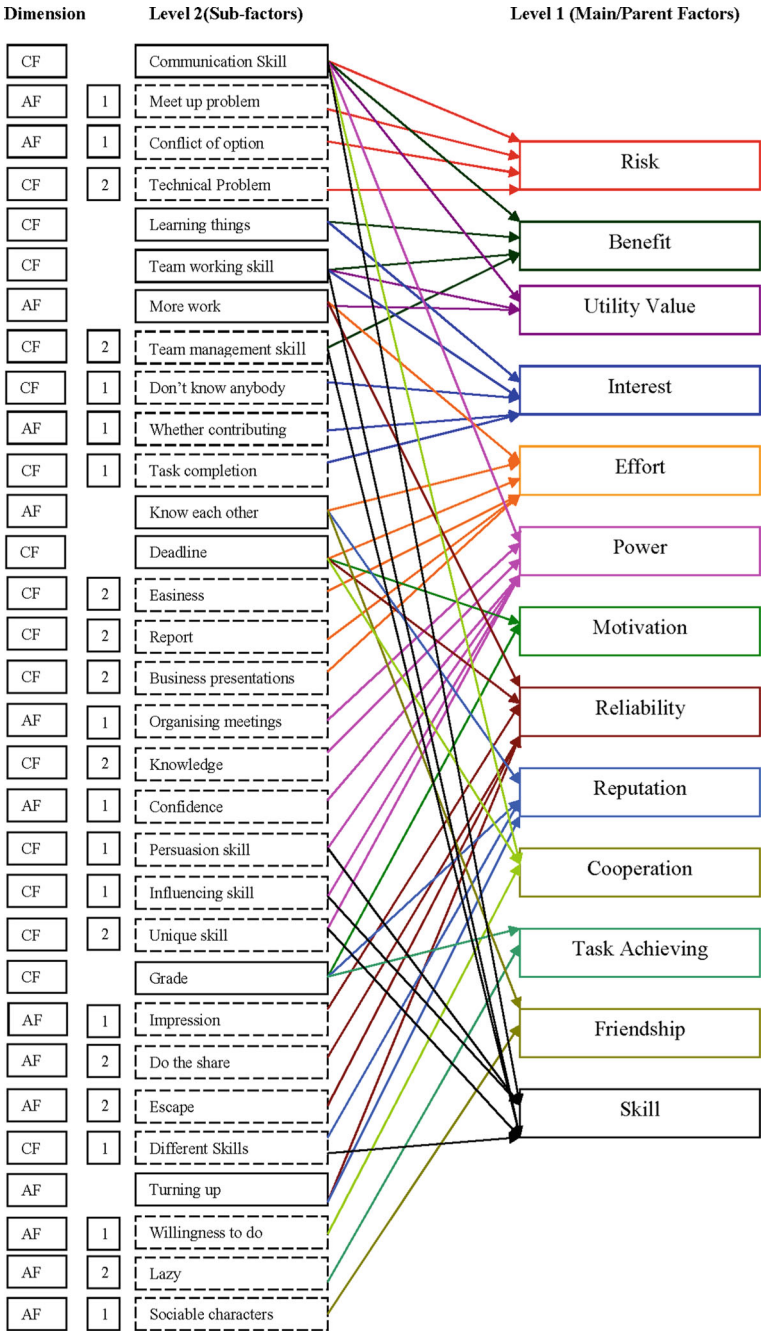

Fig. 2 General relationship model of trust factors in computer mediated collaboration

Table 14 Three color traffic ball table

Traffic ball	Trust factor appearance frequency
	High appearance
	Medium appearance
	Low appearance

parent trust factor. These 8 sub-factors are considered to play more important roles than the other 23 basic sub-factors which are found from a single case and only have a single relation to a single parent factor. Please see the Fig. 2 for the relationship of the trust factors and their sub-factors. The level 2 shows that the sub-factors are second level trust factors that are associated with level 1 main/parent trust factors.

Nonetheless, this is only a categorized general model. We have not investigated the change of the factors relationship in the perspective of development over phases, as we have only conducted the analysis for evidence showing the relationship by using the final stage interview data which is also a limitation of our study. In deed, this relationship model will give clue for the future research and helps better understanding the factors link between first level and second level trust factors. This means, the link may have some difference in different phases as this relationship model is just a general description of the overall link status. Thus, in order to help investigate the development of the trust factors in a more depth which may use our newly found trust factors, we would like to design a trust measurement model which could be used for future longitudinal trust research in the computer mediated collaboration by conducting multi-stages interviews.

5.4 Trust Traffic Light Model Design

Using colors in different stages to monitor the changes have been previously applied in psychology areas (Valois and Valois 1993; Abramov and Gordon 1994). Different colors could give people more direct impression about the changes. In order to better reflect the changes and development among these factors and stages in the collaboration process, a traffic light three color trust model is designed by the authors. Each sub-factor is marked in a color ball. Red ball stands for high (frequently) appearance of the trust sub-factor in the collaboration, yellow ball stands for medium appearance and green ball stands for low appearance. See example Table 14.

In our research, each ball is marked with two unique letters which stand for the detailed sub-factors. See the Table 15.

We have then designed a trust factor traffic light model which is shown in the Fig. 3.

In this model, the users could put the main trust factor in the left box, and case name in the middle box. The trust sub-factors in the case could be put in the right box with the form of traffic light ball (red, yellow or green). There could be many balls which stand for many sub-factors in one box. In addition, the stage N could be the stages the users would like to set up for the trust factors development phases, which means that it could be extended to stage 2, stage 3, stage 4,…stage N. The new stages

Table 15 Abbreviation table of unique letters and detailed factors

Abbreviations	Detailed factors	Abbreviations	Detailed factors
CM	Communication skill	OM	Organizing meetings
MU	Meet up problem	KL	Knowledge
CO	Conflict of option	CF	Confidence
TP	Technical problem	PS	Persuasion skill
LT	Learning things	IS	Influencing skill
TW	Team working skill	US	Unique skill
MW	More work	GD	Grade
TM	Team management skill	IM	Impression
DK	Don't know anybody	DS	Do the share
WC	Whether contributing	EC	Escape
TC	Task completion	DS	Different skills
KE	Know each other	TU	Turning up
DL	Deadline	WD	Willingness to do
ES	Easiness	LZ	Lazy
RP	Report	SC	Sociable characters
BP	Business presentation	MO	Motivation

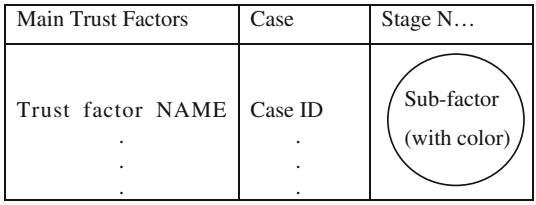

Fig. 3 Trust factors traffic light model

could be put to the right extension of the model. In the meantime, the case ID and main trust factor could also be extended by adding more rows in the behind according to the users' requirement. Thus, the model could be used to not only compare the trust sub-factors development over time in different phases but also compare among different main trust factors and cases.

For example, see Fig. 4. We have done an example traffic light model for three stages using some data from this case study to help better explain this model. However, in this Fig. 4, the data from three stages about the trust factors' appearance frequency, we have only used the data of participants' weekly trust perception document records over phases instead of suggested longitudinal interviews, which is a limitation. We have only taken the main trust factor "risk" and "benefit" for an example. We have divided the case year into three stages. We set up the red ball as frequently mentioned by more than 50 % of the example of sampled participants' records, yellow ball by between 20 and 50 % mentioned records, green ball by below 20 % mentioned records.

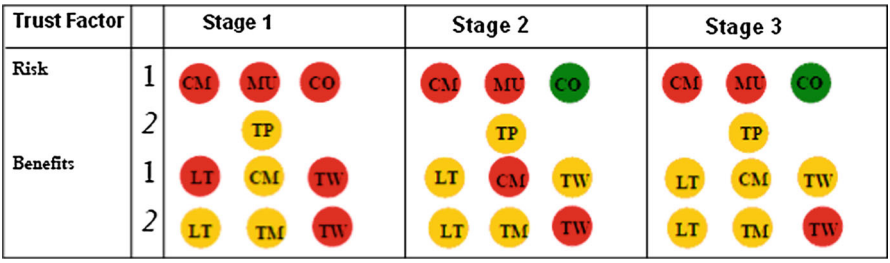

Fig. 4 An example of trust traffic light model

In the Fig. 4 example, 1 stands for first case, and 2 stands for the second case. In the model, we can clearly see the change of sub-factors in the development stages and also can clearly do the comparison between the two main trust factors. However, as just an example, the data used here may also be the best data which we suggested as longitudinal interviews, therefore, we don't go further for discussing the detailed analysis.

There are some steps that could be suggested to use the model for future longitudinal trust research in group collaboration.

(1) Step 1: Choose the number of phases of longitudinal trust research in the collaboration. For example, the users could choose three stages, or nine stages, according to the detailed requirement of the trust observation.
(2) Step 2: Conduct the longitudinal interviews in different stages. It is suggested to conduct the same amount of individual interviews according to the selected phases. When conducting the interviews, it is suggested that to pay attention to the 31 sub-factors with our interview protocol. However, collaboration participants' perception records over stages could also be suggested to take as support but not as the main data source.
(3) Step 3: Analyze the interview data and set the standards for the red, yellow, green trust traffic light balls according to the requirements.
(4) Step 4: Sort the data into the trust factors traffic light model and do the comparison according to the research requirements.

The model could be used by future study to monitor the development of trust factors and their sub-factors over time with better focus. The results found by using the model could also benefit the trust research in group collaboration and also for team leaders in practice.

6 Conclusion and Implications

Trust is a complicated topic which has attracted many researchers for many decades. Trust factors are also very important in the group collaboration. There are many researches from different dimensions. As the earlier literature suggested that f2f support will help the trust building and better results in the computer mediated collaboration, which is also more similar with the practical cases (Dafoulas and Macaulay

2002; Beise et al. 2004; Lee-Kelley et al. 2004). Thus, we decided to conduct the research by using an f2f and computer mediated collaboration case study rather than purely virtual one as our research context. Following the Nolan et al. (2007)'s research, who has highlighted the individual trust factors and their development, we have taken individual trust factors as a focus as there is little study focused on this perspective in collaboration research. Moreover, many researchers have also showed interest in the development view of the trust research (Wilson et al. 2006; Lewicki et al. 2006; Nolan et al. 2007). In the collaboration research area, drawing on Kolfschoten et al. (2012), team collaboration normally take a longitudinal approach and requires for sustainable use for the collaboration patterns. Therefore, we have decided to conduct this study to explore the trust factors in this collaboration context by using two year-long case studies. In order to reach the aim of the research, this study has focused on exploring the individual trust factors and their sub-factors that exist in the computer mediated collaboration, as well as designing an innovative measurement model by using the trust factors for future longitudinal studies.

In this research, we have taken a qualitative measurement using our designed interview protocols in the two year-long case studies. Each case study is composed of eight groups who are using the GSS tool GroupSystems^{TM} which is embedded with thinkLets as the collaboration software. In the two year-long collaboration project based case studies, we have successfully finished the all the collaboration process with GSS tools over time and have collected data from twenty semi-structured in-depth interviews.

By analyzing the interview data regarding the trust factors and their sub-factors which have affected individual trust development in the collaboration, we have validated the *risk, benefits, utility value, interest, effort, power* factors for previous research (Nolan et al. 2007). Moreover, we have also found and validated the factors of *motivation, reliability, reputation, cooperation, task achieving* and *friendship* as new factors beside the previous six factors. In particular, we find *skill* is another new main trust factor in the research context. In addition, we have found 31 trust sub-factors in the second level with a more depth. Moreover, we have found the main trust factors are linked with numerous different sub trust factors. Furthermore, we have proposed a general relationship model presenting the link of the first level main trust factors and their associated second level sub-factors. Additionally, based on the data of the two cases, we have also designed an innovative trust traffic light model which is easy to use, in order to provide support for future longitudinal trust development studies in collaboration.

Theoretically, first, this research contributes to the trust research in computer mediated collaboration teams. This research has extended the research context from virtual teams from previously researchers, such as Jarvenpaa et al. (2004)'s work and also Piccoli and Ives (2003)'s work, to a mixed computer mediated context. It have also similar interest by paying attention to both the f2f and computer mediated teams such as Wilson et al. (2006)'s work, with a different context which is not to compare them, but with a blended use of both settings. This research not only validates the previous individual trust factors proposed by the researchers such as Nolan et al. (2007); Wilson et al. (2006); Lewicki et al. (2006), but also reveals some new individual trust factors, as well as their associated 31 sub-factors in a further depth view in the second level which

fills the gap for previous researchers. We have also categorized the sub-factors into cognitive factors (CF) and affective factors (AF) by allocating them to the dimensions of trust mentioned by Lewicki et al. (2006) using a two-dimension approach. The many trust factors identified could also provide some theoretical bases of trust factors to future trust researchers according to their requirements for further adoption and development. Additionally, we have linked the 31 newly found sub-factors with their main/parent factors which are at the second level of better understanding trust factors rather than the previous high level only. As previous trust research model has not considered the second level trust sub-factors in the measurement, we have also developed a trust traffic light model and suggested steps, aiming at providing a tool to help future trust researcher design better longitudinal studies which are suggested with more cycles of longitudinal interviews and cases.

Second, to the collaboration research, in the case experiment background, we have successfully used the thinkLets created by Briggs and Vreede (2001), and conducted the case study experiment by using GSS tools and collaboration patterns suggested by Kolfschoten and Vreede (2009), Kolfschoten et al. (2007, 2012), and thus provides a successful implementation for using the GSS tools and techniques. In addition, our trust research in collaboration also fills the gap of the little trust research in group collaboration research field. Furthermore, by understanding the trust factors in collaboration, it could provide clues for collaboration process researchers to better developing the collaboration theories and process from the viewpoint of trust.

Practically, as the research context is more similar to the real business situation, this research helps better understanding trust factors in the collaboration in real project teams. It will also give clues to the trust control, trust development and monitoring for collaboration teams. The business managers and organization team leaders could also consider the factors and use the traffic light model to help monitor the individual trust development in their teams or employees, find out the factors that affect trust development, review and evaluate the team collaboration in the perspective of trust. On the other hand, technically, it will also benefit the collaboration system and process design and evaluation by considering the trust factors.

Nonetheless, this research still has its limitations. Our exploratory research findings, such as trust factors from this research have not been tested in other context and areas. For the trust relationship model among the main trust factors and sub-factors, as currently it is an exploratory process, it is only based on the general categories but not on the point of over phases. As we have not done the longitudinal interviews in this study, the link may be different in different stages. There is also a limitation that we have not used longitudinal interviews over phases in collecting data for this research, thus, not able to test the trust traffic light model with more appropriate data from the collection over phases. In addition, the student context may be different with the real business communities/context, where the results, participants' behavior and performance could potentially be different.

The future work is suggested to include more case studies with longitudinal interviews over phases and maybe more data collection methods. Another point of view which is considering trust development with the associated collaboration pattern in particular stages could also be considered. It is also suggested that to conduct the research in other context and areas in order to comparing the results and testing the

models. Other context is also suggested as cross culture teams, global teams and business teams. Within this process we shall assess the validity of the trust factors and traffic light model we have identified.

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