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The application of group consensus theory to aid organisational learning and sustainable innovation in manufacturing SMEs

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Abstract: This paper investigates the exploring of situated knowledge within manufacturing organisations, with employees from a four-tier supply chain utilising a form of Group Consensus Theory (GCT). The implementation of GCT through focus groups as well as individual interviews with participants and observation of group dynamics allowed the authors to characterise the dynamics of learning and application of innovation projects and, identifies the types of innovation strategies in relation to organisational dynamics and knowledge. The aim of the work is to identify the underpinning issues relating to organisational dynamics and organisational learning in relation to innovation. Direct feedback from the SMEs will inform the analysis of how and in what way manufacturers can meet the challenge of increasing the attitudes towards improving innovative activities in companies. This paper extends the theoretical development around organisational learning towards understanding how companies within supply chains learn and innovate. This work therefore focuses upon inter-company learning and innovation which is largely under-developed from a research viewpoint. The method developed is practical, and may be used by organisations for themselves to aid the development of group as well as individual reflection, to stimulate the consideration of change. The results suggest that a clear connection exists between how companies are managed and led and, the resulting organisational learning capabilities of the collaborative team.

ABOUT THE AUTHORS

Professors Thomas, Francis and Fisher and, Haven-Tang, PhD, and, Mason-Jones, PhD, are researchers at Cardiff Metropolitan University. Their research interests include supply chain management, tourism management and quality management. More specifically their interests include innovation management, knowledge management and understanding the issues around value and the perceptions of value in business. Dorrington, PhD, is a senior lecturer at Swansea University. His research interests include innovation, creativity and design process management. More specifically, his research focuses upon knowledge management, the use of technology in assisting the creativity process, and user-centred design processes.

PUBLIC INTEREST STATEMENT

This research investigates whether the Group Consensus Theory Technique (GCT) provides an effective approach towards identifying the early stage markers of inter-company collaboration when applied to a collaborative innovation project. Through a case study approach, the paper analyses the GCT technique and determines its impact on the organisational learning capability (OLC) of the participant companies. The study showed that there is a clear connection between the GCT profiles obtained for each company and, the respective OLC profiles thus indicating that the GCT technique can be used to predict the level of performance of each company prior to the collaborative project taking place. It is believed that the GCT will provide guidance and structured support to practitioners who intend to implement innovation based action learning in to their companies and supply chains.

Subjects: Business, Management and Accounting; Production, Operations & Information Management; Management of Technology & Innovation; Leadership; Industry & Industrial Studies

Keywords: organisational learning; organisational dynamics; group consensus theory

1. Introduction

The field of organisational learning (OL) has been well developed by both practitioners and academics over the years. The link between organisational learning and manufacturing performance (and in particular supply chain performance) is identified in the work of Azadegan and Dooley (2010) in which they posit a strong positive link between the use of OL theory and resulting supplier innovativeness and manufacturing performance. Furthermore, academics have undertaken studies to explore the dimensions of organisational learning capability (OLC) and, whether these dimensions impact upon organisational innovativeness (OI). The results of their work indicated that OLC dimensions significantly and positively influence OI within companies (Onağa, Tepecib, & Başalpc, 2014; Thomas et al., 2017).

Academic theory around learning in organisations has traditionally been divided into two theoretical areas of literature namely: organisational learning (OL) literature and, the learning organisation (LO) literature (Chiva, Alegre, & Lapiedra, 2007). The former has focused on the learning process of an organisation and the latter on the factors that facilitate the process of becoming a learning organisation (Chiva, 2004). Focusing on the OL area, the literature around this subject attempts to analyse and determine whether and how a certain process of learning is being accomplished in organisations. OL thinking has developed over time and many perspectives have appeared. Chiva and Alegre (2005) identify two OL perspectives namely: the individual and, the social perspective. Chiva (2004) further explains that the individual perspective considers learning as an individual phenomenon and consequently understands that organisations learn through individuals who learn (Senge, 1990), the social perspective however, considers learning as a social phenomenon and as such understands that organisations learn through communities and groups (Lave & Wenger, 1991). Advances in the area of OL showed that organisations, and the people in them need to learn constantly through facilitating learning for all members of the company which in turn continuously transforms the company by way of its services, products and innovation which emerges from this learning process (Kumpikaite, 2008).

The impact of OL on SMEs more specifically, is identified through the work of Michna (2009). Michana's study identified and defined a number of empirical dimensions of organisational learning namely: dialogue and empowerment of the employees, collaboration, team learning, leaders' attitudes and suggests that there is an empirical relationship between organisational learning and organisational performance where SMEs reaching a higher level of organisational learning probably achieve higher performance. A further perspective of OL on SME performance is shown through the work of Matthews, MacCarthy, and Braziotis (2017) in which they show how OL provides new insights to conceptualise the nature of process innovation as a multi-level practice in SMEs. Effective process innovation practices within SMEs are shown to be consistent with OL concepts, enabling firms to translate individually identified improvement opportunities into organisational-level changes that result in sustained benefits.

Similarly, Gomes and Wojahn (2017) identify the significant importance of OL in terms of innovation in SMEs. The results show that the organisational learning capability influences the innovative performance of small and medium-sized enterprises, however, the influence of the learning

capability in organisational performance was not significant. The study provides evidence for these relations and shows that they are significant and positive in the context of small and medium-sized textile enterprises. Therefore, on this basis, this study will focus on the innovative performance of manufacturing SMEs.

A key component of OL is that of Situated Knowledge (SK). SK encompasses the established skills and competencies which are available, intellectual know-how, processes and procedures which have evolved over time, along with rules and roles, and with which an enterprise exists (Holman, Pavlica, & Thorpe, 1996). These include product/service aspects, as well as supplier, customer and competitor knowledge. Equally, SK involves less tangible aspects concerned with how company members and groupings relate to each other, regard each other, and interact with each other, in sharing power and knowledge, making decisions and enacting leadership. Also, and most crucially, situated knowledge is concerned with how these activities can both engender, and drive, a range of emotional states in the minds of individuals and groupings, which is emotional knowledge. These forms of knowledge are the creation of people working together in some cooperative and purposive way, which is how this type of knowledge acquires meaning (Holman et al., 1996). What constitutes knowledge in some context only has relevance and value in that context. Because this knowledge exists as a result of joint activity, it requires activities which are intrinsically social and collective to surface its existence, and open up the possibilities of individual and organisational level learning (Jerez-Gómez, Céspedes-Lorente, & Valle-Cabrera, 2005).

This paper investigates the exploring of situated knowledge within manufacturing organisations, with employees from a four-tier supply chain utilising a form of Group Consensus Theory (GCT). The implementation of GCT through focus groups as well as individual interviews with participants and observation of group dynamics allowed the authors to characterise the dynamics of learning and application of innovation projects and, identifies the types of innovation strategies in relation to organisational dynamics and knowledge. The aim of the work is to identify the underpinning issues relating to organisational dynamics and organisational learning in relation to innovation.

This study is in two parts. Part 1 of the study details the application of a technique known as Group Consensus Theory (GCT). This technique is applied in order to identify the early stage markers of group dynamics and identifies its potential to predict individual and overall team performance prior to undertaking innovation projects. Being able to characterise early stage group dynamics will assist in the establishment of correct group composition and fit as well as being able to identify the drivers required to effectively manage the team at the project phase. It is argued that GCT is a form of social activity involving "conversational learning" (Jensen & Kolb, 2002; Turner, Gear, & Read, 2009) and is applied to address the contextual nature of situated learning (i.e. the learning that occurs through undertaking the work in this innovation project). The approach which is described is designed to identify the cultural relationships that exist within the companies (those of; culture, power, leadership, management, responsibility and innovation, etc.), which are usually difficult to explore openly because staff may be "uncomfortable" or potentially threatening to individuals or groupings. The approach is designed to be participative and interactive, limiting the threat to individuals, whilst providing the environment and potential for learning and change.

Part 2 of the study goes on to detail the development and execution of the innovation project. The overall OLC profiles are calculated as part of the study with the resulting individual team performances measured. The OLC profiles are then compared with the GCT profiles in order to identify whether there are any tangible links between the profiles i.e. how the culture and relationships developed in the four companies taking part in this innovation project affect the resulting performance on the collaborative innovation project. Figure 1 shows a schematic of the research process adopted in this study.

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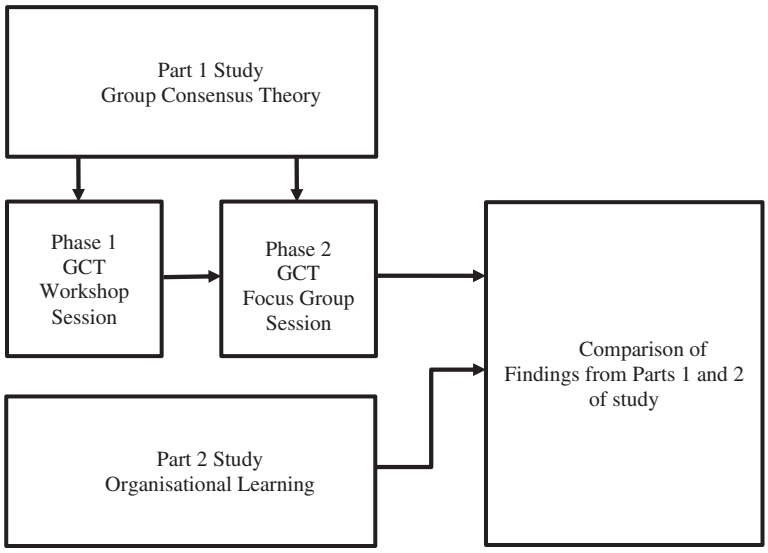
Figure 1. Schematic diagram of the research adopted for this study.



2. Group consensus theory

There is an increasing amount of empirical research that supports the fact that GCT has been successful in reducing communication barriers and facilitating decision-making activities by increasing participation and providing increased opportunities to influence the opinions of others in groups (Fjermestad, 2004). Group decision support has also been developed to help identify the core knowledge created by an organisation (Lin, Liu, Hsu, & Wu, 2007). The approach to characterising organisational dynamics (OD) which is described in this paper is based on a form of "group inquiry" (Read, Gear, & Devold, 2004). This paper presents the authors experience of extending the "group inquiry" concept in to companies forming part of a four-tier supply chain. Features of this work as outlined by Read et al., (2012). The Research Question asked in this paper is therefore: "Is the GCT technique effective in identifying and predicting group dynamic behaviours of company teams *prior* to the start of innovation projects?". If it is possible to predict future behaviour of teams within an innovation project, then it may be possible to construct more cohesive team groupings which in turn may increase the level of innovation emanating from the work whilst systematically reducing the chances of project failure.

The GCT method is underpinned by a social perspective of the process of organisational learning, focusing on the experience and validation abilities of groups of people in a workplace (Higgins, 2009; Read et al., 2012). From this perspective, learning emerges from the interactions of the group and, learning itself is concerned with characterising and defining local knowledge about given working practices. The method described in this paper represents one approach, a designed intervention into "normal" practice, intended to give the members of the supply chain an opportunity to understand the emotions and politics which have come to shape their companies, and its practices. Such understanding can lead to reflection on, and questioning of existing assumptions, with the possibility of making strategic changes, to the benefit of the companies. GCT will therefore identify the underlying learning cultures in the companies and will investigate if there is a connection between these cultures and their resulting OL performance.

It seems that little academic study has been undertaken that demonstrates the usefulness of GCT as a tool to support innovation development in SMEs. This paper presents the authors experience of extending the "group inquiry" concept in to the SMEs. Features of this work as outlined by Read et al., (2012) and applied here are:

- Characterising the group dynamics and group learning around Innovation implementation in manufacturing SMEs where there have been few previous empirical studies.
- A field study on how this form of group analysis can aid the innovation teams to access their own knowledge and share best practice.

From this perspective learning emerges from the interactions of the group and, learning itself is concerned with characterising and defining local knowledge about given business improvement practices. Development of the method was based on a pilot study of "situated knowledge" in a collaborative innovation project involving four manufacturing SMEs. The authors use the approach adopted by Read et al., 2012 for this study. The reason for adopting such an approach is twofold. Firstly, the authors wanted to understand whether the work developed by Read et al. could be implemented in a different social setting and context (i.e. in the assessment of Innovation implementation in SMEs) and secondly, using the same question set as developed by Read et al., enabled the authors to use the previous data to be used as a benchmark and sense check for the outputs from this study. A detailed application of the technique is now outlined.

3. Methodology

The focus of this project was to bring together four companies to form a unique supply chain configuration and, to use their core competencies and technical knowledge to co-create a new product. This paper therefore presents an applied research project which focuses on the development of a connected supply chain network of companies that work towards a shared vision; this vision will be to design, develop a new product whilst simultaneously creating a resilient and sustainable supply chain capable of breaking into a new market sector (Thomas et al., 2017).

The companies had never worked with each other previously and so the focus was to identify whether the cultural issues present within each team that formed the supply chain innovation project (i.e. leadership styles employed in company, company structures and the resulting staff motivation and capabilities) have a direct effect on the group dynamics when operating as part of the supply chain innovation project (i.e. attitudes to learning and collaborating, innovation and, whether teams took ownership of problems and emerging innovation from the project). The companies were targeted and selected by the project team as being a potential "good fit" with the project aims and objectives. However, what the project team were unable to determine in any sound way was whether the companies would be effective contributors to the project and were capable of developing appropriate learning strategies and leadership roles during the project.

Therefore, Part 1 of the project involved the application of the GCT technique as a pre-cursor to the main project implementation programme. GCT was employed to identify whether the companies had the cultural capabilities and internal infrastructure to support the team approach towards collaborating effectively on this innovation project. If the GCT technique enabled the author team to identify a close correlation between SK and OL then it may be possible to use GCT as a precursor to measuring and identifying collaborative partner selection on future projects as well as identify the key OD and OL markers in an attempt to assess the potential company contribution to this particular project.

Part 2 of the study involved the process of innovation and discovery through running the project and then profiling the respective OLC profiles to determine whether there is a connection between the levels of innovation which emerge from the project and, the respective OLC profiles achieved by the new supply chain. As part of the project, a four-tier supply chain system was developed. This required the active involvement of four companies which had not previously worked together and who had very different skills and knowledge attributes. Outline details of each company and their tier within the supply chain are as follows:

Tier 1 SME (1)—An engineering department with a knowledge of patient physiology and assisted living devices.

Tier 2 SME (2)—A specialist assisted living device manufacturer with a knowledge of design and manufacture of various assisted living devices. Frames, lifts and slings, etc.

Tier 3 SME (3)—A specialist equipment building supplier to the automotive industry with a skillset in systems integration, robotics and sensor integration systems.

Tier 4 SME (4)—A specialist equipment tracking company with knowledge and skills in the design and development of asset tracking and Active IR tracking systems.

The application of the GCT technique in Part 1 of this research programme is to initially identify the organisational learning dynamics of each company by discussing the current management approaches adopted by each individual company. Furthermore, the authors are particularly interested in understanding the issues around the organisational dynamics and the acquisition, integration and application of learning and knowledge about innovation projects in order to sustain Innovation implementation projects in SMEs.

In order to fully investigate the cultural dimensions and organisational dynamics present within each company, Part 1 of the research study consisted of a two phase programme of research. Through the application of a questionnaire, Phase 1 consisted of a practical approach to investigating and characterising the dynamics of learning and implementing innovation projects in SMEs is undertaken through Group Consensus Theory (GCT). Secondly, through face to face interviews and focus groups, Phase 2 consisted of a detailed study and analysis undertaken to determine the levels of autonomy and power relationships that existed within each company so as to determine the early stage issues around the organisation dynamics of each SME in the team. The study in to the organisational dynamics and knowledge management is shown next.

3.1. Part 1: Phase 1 study workshop session

A single workshop run over a day involved two representatives from each company, a manager responsible for innovation within the company and, an engineer with the responsibility for product realisation and development. The group of eight company representatives (two from each SME involved in the study) were joined by the project team and this formed the focus group for this study. Prior to the workshops and focus group phases of the study, the authors reviewed the question sets provided from the work of Read et al. in order to contextualise the questions and to reduce the ambiguity surrounding what was actually being asked in each question. Since the question sets were generic in nature and were focused upon understanding the organisational and group learning dynamics within each company, there was not a need to reduce the number of questions but, to just contextualise the questions somewhat so that a common understanding amongst all participants was achieved. Table 1 (identified as the Workshop session).

3.2. Part 1: Phase 2 study focus group session

Phase 2 involved a more detailed focus group discussion about each question (identified as the Focus Group Session). Two stated aims were given to each participant within the groups before staring the Workshop and Focus Group sessions. These were:

- To generate collective reflection on how the companies lead and manage innovation projects in their own environments.
- To initiate a dialogue on how the institutions are led and managed more generally in order to identify any key cultural and OD issues that would make the respective institutions more or less capable of implementing innovation projects.

The workshop session lasted 2 h and this consisted of the authors outlining the rationale for the study, establishing the aims and objectives of the work and, introducing the participants to the questions (see Table 1). The focus group (FG) was then run immediately after the workshop. The FG session lasted approximately 3 h, and was facilitated by a facilitator, who was not one of the authors in

Table 1. Questions asked to the focus group

1	Decision-making power is widely shared throughout the organisation	11	Conflicts and disagreements are dealt with openly	21	Important issues are not avoided
2	The predominant management style is participative rather than "top-down"	12	There is generally a high level of trust between members of staff	22	We have regular meetings to review progress and discuss issues
3	I feel able to participate in decisions which are important to the organisation	13	I feel comfortable expressing my feelings in the organisation	23	I would welcome more responsibility within my job
4	Senior managers commonly delegate decision-making to others	14	Important issues for the organisation are discussed readily	24	I am satisfied with the way I am managed by my immediate boss
5	It is easy for me to raise awkward issues with managers	15	Staff rarely feel anxious	25	We learn from mistakes, and are not blamed for them
6	Staff are encouraged to speak out	16	Staff rarely behave defensively	26	I enjoy my work
7	Difficult issues are not normally brushed under the carpet	17	We do not have a blame culture in the organisation	27	I trust the information I get from senior management
8	Staff are "open" in their communications (e.g. there are few "hidden agendas")	18	Staff are encouraged to reflect on the organisation's processes	28	I receive open and honest feedback about my performance
9	When the going gets tough, people help each other	19	I rarely feel threatened when things are going wrong	29	I have the opportunity to influence the way I work
10	People are willing to admit when they make mistakes or errors of judgement	20	I rarely feel powerless in the organisation	30	The organisation needs to change

order to limit bias and intervention. The facilitator was asked to stay out of the dialogue as much as possible, with the exception of occasions when it was potentially insightful to ask participants to provide an example to illustrate the point they were making. A member of the author team observed each session but did not participate or contribute in any of the sessions.

The company members entered their personal response to each of a series of questions that were presented on a screen, without any discussion or feedback. The question set consisting of 30 questions was used and was designed around three key issues which are centrally concerned with organisational learning, following a theoretical framework presented by Vince (2001) and developed by Read et al., (2012). The questions were designed using a five-point Likert-type, agree/disagree scale. The question set is shown in Table 1 and as stated previously, is taken from the work of Read et al. (2012) in which they employed a similar study in a manufacturing organisation to investigate situated knowledge acquisition and development. The questions have direct applicability to our study and so have not been changed or modified although the context for each question has been changed slightly to focus upon Innovation project implementation.

The outputs from group sessions were recorded for analysis in two ways. The inputs from the questionnaires provided a quantitative record of all judgements. The quantitative information obtained from the workshop session gave an understanding of the feelings and opinions from the workshop members whereas, the ensuing dialogue and discussion provided insights into the reasons why these views were held. Each member of the FG marked each question using the Likert scale. All participants were requested to provide their opinions for each question asked. Once complete, the facilitator collected the paper responses. The authors then fed the information into a spreadsheet and then fed the aggregated score to the FG for further discussion. This enabled the FG members to have a level of anonymity around their personal response and, the FG were then able to discuss the aggregate scores rather than focusing upon individual scores. During the FG session, the

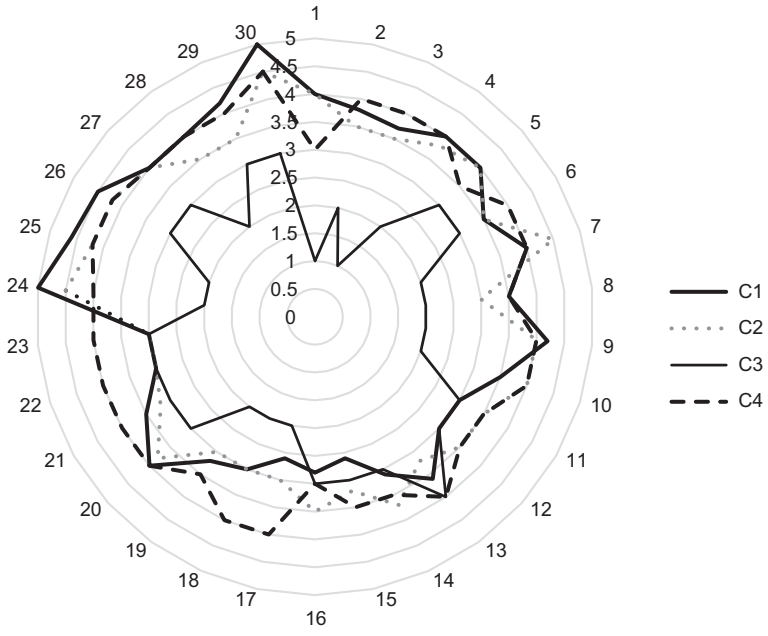


Figure 2. Group consensus theory profiles.

aggregate feedback score to each question was used as a means of stimulating a conversation focused on the range of responses (i.e. range of perceptions). A low-level form of facilitation, which simply summarised each display, was found sufficient to generate conversations focused on the reasons for differences. It was found that individuals sometimes declared their own input, and sometimes preferred to maintain their anonymity. The particular usefulness of the Radar plots to display the aggregate score to each question maintained a collective focus. The discussions that emerged from responses to the question set were transcribed to provide the researchers with insights into SK within the group and then later, the scores were disaggregated to identify the level of SK in each company. Figure 2 shows the GCT profiles of each company taking part in this project.

3.3. Part 1: Research findings

Figure 2 provides the output of the first phase of the GCT technique. This provided important initial information on the potential of each company to contribute effectively to the innovation project and, to develop the necessary OL skills and knowledge that will drive the correct ODs during the project. What was particularly important here is the identification that SME 3 underperformed significantly when compared to the other three companies.

Further discussion in the second phase of the study (the FG phase) further identified the problems SME 3 had in developing a culture of innovation and learning. The company representatives identified a difficult working environment where innovation and new products are demanded but the environment was not conducive to creativity taking place. In particular, the GCT profile highlighted the key issues around decision-making and added that the company was driven too much from the managing director (MD) and that no decisions could be made without MD involvement and frequently, decisions were made only when the initial innovation or solution had been adjusted and changed significantly often to a less innovate and "safer" option. Low scores were posted for other key areas such as job satisfaction, etc.

Companies SME 1, SME 2 and SME 4 shows an altogether improved set of responses with their overall scores reflecting the energy and enthusiasm emanating from the FG phase of the study. The willingness to discuss differences in the GCT scores and to accept the other group's opinions were evident in the FG phase. Also, through discussion with the company members, it was possible to identify that the company cultures were very different to company SME 3 in that much more

individual responsibility was given to the team members of SME 1, SME 2 and SME 4 where it was possible for them to make local decisions due to their more decentralised leadership and management system within their respective companies

3.4. Part 2: Innovation workshops and OLC profiling

Following the application of the GCT, the companies embarked on the innovation project. The project ran for one year and consisted of five innovation workshops delivered to the participants during this time. Following each workshop, OLC curves were plotted for each company in order to monitor their growth and learning profiles. Details of the workshops can be found in the work of Thomas et al. (2017). However, a very brief synopsis of each are shown below:

3.4.1. Workshop 1: Introduction and new product development process

The first workshop was centred around building trust and understanding between the partner organisations (which now became the innovation group), and the facilitation team. Champions and senior managers from the design and engineering departments of each SME were invited to the workshop. The project aims and objectives were recapped, and the SMEs presented a background to their company operations and their expertise. An expectation mapping session was conducted and discussions were started around the area of future Intellectual Property (IP). At the end of the workshop, the facilitation team explored a number of themes and challenges faced by members of the innovation group in their daily operations. Each member highlighted a particular challenge and all members present considered the challenge with the innovation team then working to developed ideas of how their competencies and skills could address the issues raised.

3.4.2. Workshop 2: Creativity and innovation workshop

This workshop focused upon the principles of creativity and specific techniques were delivered, including the factors and processes which affect creativity at an individual, team and organisational level. Common barriers to creativity were discussed, such as time, finance, skills, fear of failure and motivation. The importance of giving employees "permission" to be creative were also emphasised when fostering a creative culture. An integral part of the workshop was the introduction of the "Listen, Connect, Do (LCD)" model (Loudon & Deininger, 2014) which aims to support sustained creativity. Particular aspects of this model were emphasised such as: "empathising" with the end user; "listening" to what they have to say; observing how products are used *in situ*; connecting and engaging with others; listening and observing. During this workshop, a number of collaborative idea generation techniques were introduced and put into practice with relevant exercises, leading to the investigation of potential products to take forward. The result of this workshop led to the innovation group identifying the need for a workshop which focused upon user-centred design (UCD).

3.4.3. Workshop 3: User-centred design

Workshop 3 reinforced the importance of empathising with, connecting to and observing the user of the products or services under development. Design approaches have traditionally been alleged to fail when it comes to engaging with the end user (Hansen, Percival, Aldred, Brownsell, & Hawley, 2007), and criticism directed towards designers instinctively designing for able-bodied users, being unaware of the needs of users with different capabilities, or not knowing how to accommodate their needs within the design cycle (Keates, Clarkson, Harrison, & Robinson, 2000). User-centred design (UCD) is a design philosophy that looks to overcome this, by placing the needs, wants and desires of users at the centre of the design process, allowing those needs and desires to drive a product, system or service's development. UCD places the end user and their experience of a product, system or service at the centre of the design process and allows the user to contribute to every stage. The innovation group then went on to produce an initial Product Design Specification for the lifting device which would be used for future development and planning. Following this workshop, the innovation group identified the need for a workshop focusing upon prototype development and analysis.

3.4.4. Workshop 4: Prototype development

This workshop focused on the further development of a more detailed Product Design Specification as well as the production of three low fidelity prototypes and their subsequent analyses. The participants were asked to critically analyse the previously taught design and creativity models and to develop and adjust the models to meet the specific project needs. It was here that the double loop learning methodology was applied. The innovation group was asked to critically analyse the previously developed models and approaches and to focus on what was specifically needed to assist them in the development of the prototype models. This included encouraging members to bring in their own design and engineering skill sets and to add these to the existing body of knowledge so that a new process of innovation could be developed. The result of this process enabled the members to modify models to produce three prototype devices. From here, the chosen design was then taken to the final workshop which focused on the detailed design and analysis of the chosen product.

3.4.5. Workshop 5: Detailed design and production planning

This workshop focused upon the delivery of key design process management tools which enabled the innovation group to consider the wider aspects of the chosen design (such as the manufacturability of the product and the systems infrastructures needed to make the product operable in the workplace). Again, the members were asked to integrate the Value Analysis and Value Engineering methodology with their own engineering and design experience and knowledge so as to seek further innovation in the existing design framework.

During each of the workshops, the project management team observed each company to ascertain their levels of interaction and contribution to the project. This information was collected individually from each of the facilitation team members and was subsequently moderated and discussed in the post-workshop analysis meeting that was undertaken after each workshop. The scoring of the companies was measured using the Chiva OLC model and in line with the research framework shown in Table 2. Table 2 outlines the OLC criteria and the 14 variables that were measured as a result of

Table 2. OLC criteria and the variables

OLC criteria	Variables
Experimentation	V1. Participants provide support and encouragement to others when presenting new ideas from the team members
	V2. Participants provide and receive favourable responses to new initiatives and feel encouraged to generate new ideas
Risk taking	V3. Participants take risks in the design and processes for the new product
	V4. Participants are seen to venture into unknown territory
Interaction with the external environment	V5. Participants collect, bring back and report information about what is going on outside the company
	V6. Participants use the systems developed for receiving, collating and sharing information from outside the company
	V7. Participants interact with the environment: competitors, customers, technological institutes, universities, suppliers, etc.
Dialogue	V8. Participants are encouraged to communicate
	V9. There is a free and open communication within the project team
	V10. Managers facilitate communication within project teams
	V11. Cross-functional teamwork is in place
Participative decision-making	V12. Managers in this project frequently involve employees in important decision
	V13. Products and processes are significantly influenced by the view of employees
	V14. Participants feel involved in project decisions

the study. Using the 14 variables, the team observed the activities undertaken by the team at each workshop and applied a Likert scale of 1–5 to measure each variable. The companies within the supply chain were scored by the three facilitation team members independently after each workshop session. Alongside this, members of the innovation group were also required to self-assess against the OLC criteria after each workshop in an attempt to garner the widest level of feedback in order to make the OLC analysis meaningful. Where disparities in the marks existed between the facilitation team and innovation group, a discussion was had between the both groups to agree on a given mark for each OLC point. Marks were awarded to each variable by direct observation of the participant's levels of activity and involvement in the project activities.

3.5. Part 2: Findings

Figure 3 shows the composite OLC profiles for all four companies. In all but one case, steady improvement in each of the five OLC elements was made. The workshops were seen as significant catalysts for growth in experimentation and innovation which was brought about from the increase in trust and confidence gained by each company within the supply chain. Impressive results were seen by companies SME 1 and SME 2 where these companies frequently took the lead in the development of new and innovative products. As the workshops progressed, members of these companies became the catalysts for innovation and subsequently developed close, meaningful and sustainable relationships with the other companies in the group. SME 4 was highly influential in the innovation process. Rather than taking a central role in the development of the core product, this company, due to its knowledge and skills base was highly influential and crucial in the development of innovation around systems tracking and mapping. This prevented the project from going down an incremental innovation route and was influential in achieving step changes in product development and, significant innovation from the collaborations.

However, company SME 3 showed problematic signs at an early stage in the project. The OLC plots reflect the lower levels of engagement by the company and, in conjunction with the GCT profiles of company culture and the OLC plots, they became a strong predictor of potential failure of the company which resulted in the company failing to engage in the project after Workshop 3. Early stage intervention by the project team after Workshop 1 ensured that the company continued through to Workshop 3 although its growth and development measured through the OLC continued to be low. The company eventually left the project after Workshop 3.

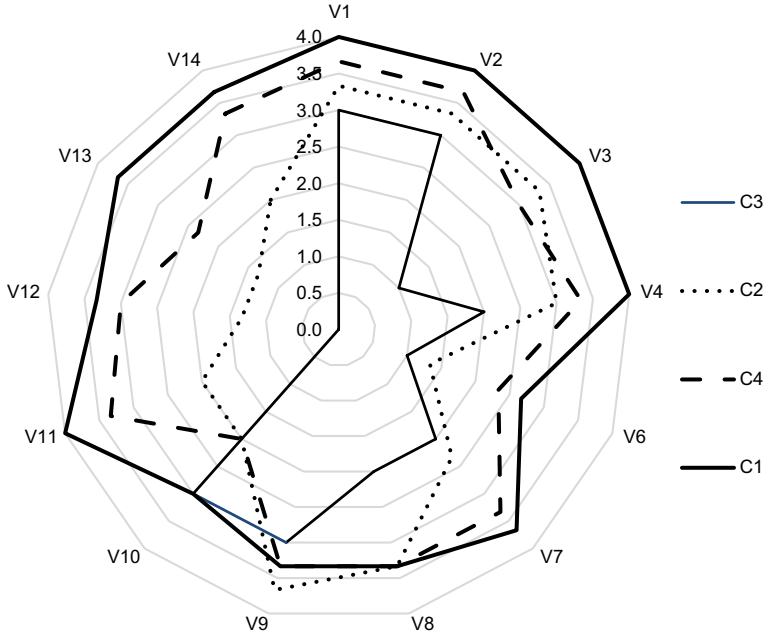


Figure 3. Composite OLC profiles.

4. Conclusions

The research question for this study was "Is the GCT technique effective in identifying and predicting group dynamic behaviours of company teams *prior* to the start of innovation projects?". The GCT profiling approach proved in this instance to be an effective predictor of early stage company engagement. SME 3 was identified both through the GCT and OLC profiling to provide lower levels of collaboration and interest in the project. Further analysis of the company found that the company did not allow effective decision-making nor promoted or facilitated trust amongst its workforce. Worker morale was very low and the ability of the workers to effectively interact and provide meaningful inputs in to the project was very low.

It was found that the team members from SME 3 had never participated in an innovation or business improvement project before and, did not have the levels of experience and communication skills to engage fully within the process. The GCT profiling conducted before the project started identified the key OD markers from each company and SME 3 performed poorly on each GCT question. As a result, SME 3 did actually fail to see through the innovation project.

The results of applying the GCT technique at the start of the project in order to identify the relative SK and OL capabilities suggests that was a strong connection between company culture, decision-making and power relationships and, the resulting level of innovative activity undertaken by the team members in the innovation project. Growth in confidence and trust amongst the team members resulted in greater experimentation and risk taking brought on by more effective and frequent communication. Improved participative decision-making driven by the closer communication and trust amongst the team resulted in more innovative designs emerging at each workshop.

Furthermore, it was also observed that there was a clear connection seen between the growth in the level of innovative activity undertaken by the newly formed supply chain company and the corresponding OLC scores calculated. Growth in confidence and trust amongst the team members resulted in greater experimentation and risk taking brought on by more effective and frequent communication between the team members. Improved participative decision-making driven by the closer communication and trust amongst the team resulted in more innovative designs emerging at each workshop. The OLC profiling approach was a good predictor of early stage company engagement. In this instance, the issues around company SME 3 losing motivation and failing to engage was identified very early in the project and whilst the company eventually withdrew from the project, it was possible to identify problems much earlier in the project as a result of the GCT and OLC profiling.

Engaging with a small network of SMEs has its problems. SMEs suffer from resource capacity problems and so the release of staff to attend workshops was a continuous issue, one that required excellent inter-communication skills and working relationships to be established between the facilitation team and the innovation group. However, the motivation created and the excellent team dynamics developed through the workshops meant that the innovation group drove the project forward with key members of the group emerging as natural leaders (Thomas et al., 2017).

This project was seen as a success in part due to the judicious selection of the project partners (Yoon & Song, 2014). The facilitation group undertook a substantial period of time to identify company partners who has both the technical capabilities to contribute effectively to the innovation process but also, the interpersonal skills and the ability to set up trusted relationships quickly. This was achieved through knowing each of the key participants in the companies well and taking a calculated risk in seeing if the team members would gel and function as a coherent group. Also, through a "reverse facilitation" approach, workshop content (and delivery of such content) was defined by the innovation group and delivered by the facilitation team. This allowed for Open Innovation group dynamics to emerge whilst the facilitation team were able to guide and manage the innovation process. The establishment of co-created knowledge delivery and acquisition was a key output of this project.

This project has yielded some interesting and original research outputs relating to GCT profiling and OL and innovation development in supply chains. However, the authors are aware that the research has a number of limitations in both its scope and approach to the research work. It is too early to make clear statements of the GCTs ability to predict every company's OL performance from the application of this method. However, it has provided early stage findings and suggestions that through assessing the political and power relationships that exist in companies, it may be possible to predict their relative OL performance. Further work is required on a wider range of companies and, where GCT profiles are less prominent in order to test the correlation sensitivity.

This paper extends the theoretical development around organisational learning towards understanding how companies within supply chains learn and innovate. This work therefore focuses upon trans-company learning and innovation which is largely under-developed from a research viewpoint. Additionally, the work is considered as having potential in terms of managerial implications, especially in terms of decision-makers' engagement in co-creation and innovation networks, and in offering an understanding of the roles of connected supply chain network of companies that work towards a shared vision.

Since this work is a single case study which involves only four companies, there is still significant work to be undertaken to develop the supply chain / OL theory further in order to understand the deeper and more complex issues surrounding supply chains and how supply chain companies collaborate and learn in the most efficient and effective manner. There will need to be further work with multiple innovation groups in the future in order to develop a body of knowledge that can help enhance the existing body of knowledge in this area. A large scale quantitative study in to identifying and defining the key enablers and barriers to company and supply chain learning is needed in order to establish firmly the theory behind SME supply chain collaboration and learning. Also, further work around knowledge diffusion in companies is needed to provide further and deeper knowledge on the dynamics of OL in supply chains as well as how extended and long supply chains (multiple company networks geographically displaced) could innovate and learn in an effective manner. As for this work, the authors have immediate plans to roll out this work in to other supply chains and innovation groups in order to build up a larger evidence base around implementation of this type of project and to improve and develop a best practice model for implementing a combined GCT/OLC framework.

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