

Global Software Development Challenges: A Case Study on Temporal, Geographical and Socio-Cultural Distance

Helena Holmstrom, Eoin Ó Conchúir, Pär J Ågerfalk, Brian Fitzgerald
University of Limerick, Limerick, Ireland
{helena.holmstrom, eoin.oconchuir, par.agerfalk, bf}@ul.ie

Abstract

Global software development (GSD) is a phenomenon that is receiving considerable interest from companies all over the world. In GSD, stakeholders from different national and organizational cultures are involved in developing software and the many benefits include access to a large labour pool, cost advantage and round-the-clock development. However, GSD is technologically and organizationally complex and presents a variety of challenges to be managed by the software development team. In particular, temporal, geographical and socio-cultural distances impose problems not experienced in traditional systems development. In this paper, we present findings from a case study in which we explore the particular challenges associated with managing GSD. Our study also reveals some of the solutions that are used to deal with these challenges. We do so by empirical investigation at three US based GSD companies operating in Ireland. Based on qualitative interviews we present challenges related to temporal, geographical and socio-cultural distance.

1. Introduction

Interest in global software development (GSD) is rapidly growing as the software industry is experiencing increasing globalization of business (Herbsleb & Moitra, 2001). In GSD, stakeholders from different national and organizational cultures and time zones are involved in developing software and tasks at various stages of the software lifecycle may be separated and implemented at different geographic locations coordinated through the use of information and communication technologies (Sahay, 2003). While increasing the scope of organizational operation and opening up for a broader skill and product knowledge base (Baheti et al, 2002), there is little doubt that GSD poses challenges related to project diversity, and complexity (Damian, 2002; Sahay, 2003). Ideally, members of software development teams would have rich interactions and enjoy the opportunity of having real-time collaboration and regular face-to-face

meetings, share a common organisational culture which promotes coordination and facilitates control, and represent a good mix of all required technical skills and relevant experience. Clearly, GSD adds new demands to the software development process by potentially threatening these properties. Especially, temporal, geographical and socio-cultural distance is believed to challenge project processes such as communication, coordination and control (Damian, 2002).

In this paper, we present findings from a case study. Based on workshop discussions and qualitative interviews at three global software development companies, we explore the particular challenges associated with GSD. Our study also reveals some of the solutions used by the companies to deal with these challenges.

2. Global Software Development

Recent years have witnessed the globalization of many organizations and industries. As a consequence, globally distributed collaborations and virtual teams have become increasingly common in many areas such as new product development and information systems (IS) development (Sarker and Sahay, 2004). According to Carmel (1999), globally distributed IS development projects are projects consisting of teams working together to accomplish project goals from different geographical locations. In addition to geographical dispersion, globally distributed teams face time zone and cultural differences that may include, for example different languages, national traditions, values and norms of behaviour. As recognized by Ågerfalk et al (2005), there are many reasons why an organization should consider adopting a GSD model, including access to a larger labour pool and a broader skill base, cost advantage, and round the clock development. GSD is perhaps most evident in the many cases of outsourcing of software development to low-cost countries but is also relevant in the case of utilizing local expertise to satisfy local demands.

Traditionally, literature on GSD has focused on technical aspects (Kotlarsky and Oshri, 2005) and previous research suggests that proper application of

technical and operational mechanisms such as collaborative technologies, IS development tools and coordination mechanisms are the key to successful system development projects (Carmel, 1999). A related stream of studies has focused on issues relating to the dispersion of work and the constraints associated with this. In these studies, constraints such as temporal distance, geographical distance and socio-cultural distance are identified, and while they indeed increase the scope of organizational operation (Sahay, 2003) and open up for a broader skill and product knowledge base (Baheti et al, 2002), there is little doubt that these constraints challenge communication, coordination and control mechanisms (Herbsleb and Mockus, 2003, Damian, 2002).

2.1. Temporal distance

Temporal distance is a measure of the dislocation in time experienced by two actors wishing to interact (Ågerfalk et al. 2005). Temporal distance can be caused by time zone difference or time shifting work patterns and can be seen as reducing opportunities for real-time collaboration, as response time increases when working hours at remote locations do not overlap (Sarker and Sahay, 2004). When organizing work patterns, note must be taken of both temporal overlap of parties, to facilitate communication, and temporal coverage. In fact, time zone difference and time shifting work patterns can work together to either increase or decrease temporal distance. For example, a one hour difference in time-zone within Europe can, because of different routines during a working day, lead to very few overlapping hours and an appearance of higher than expected temporal distance. Conversely, a European liaising with a counterpart in India working a late shift may experience low temporal distance.

2.2. Geographical distance

Geographical distance is a measure of the effort required for one actor to visit another and can be seen as reducing the intensity of communication (Ågerfalk et al. 2005), especially when people experience problems with media and have difficulties finding a sufficiently good substitute for face-to-face interaction (Smith and Blanck, 2002). Geographical distance is best measured in ease of relocating rather than in kilometres. Two locations with a direct air link and regular flights can be considered close even if separated by great distance, but the same cannot be said of two locations which are geographically close but with little transport infrastructure. Ease of relocating has several facets,

including ease and time of travel, and necessity for visas and permits. In general, low geographical distance offers greater opportunity for periods of co-located team work.

2.3. Socio-Cultural distance

Socio-cultural distance is a measure of an actor's understanding of another actor's values and normative practices (Ågerfalk et al. 2005). As recognized by Kotlarsky and Oshri (2005), culture can have a huge effect on how people interpret a certain situation, and how they react to it. It is a complex dimension, involving organisational culture, national culture and language, politics, and individual motivations and work ethics. It is possible to have a low socio-cultural distance between two actors from different national and cultural backgrounds who share a common organisational culture, but a high distance between two co-nationals from very different company backgrounds. Certainly, geographical distance may imply increased cultural distance. However, the cultural distance can be great even with low geographical distribution. Similarly, a huge geographical distance does not automatically mean huge cultural difference.

3. Research Method

3.1. Research sites

The focuses of our study are three global software development companies. Each company has headquarters in the US with development teams in Ireland and all three sites coordinate with other remote colleagues in, for example, India, Poland, China and Malaysia. The interviews reported on in this paper were conducted at the Irish company sites. The first company – Intel – is primarily a hardware company, whose secondary software activities support their hardware, providing functionality for their customers. Here, the software development teams work with other teams based at sites including the US, Malaysia, China, India, and Poland. In the past, certain projects included up to eight global sites, however, work is seldom split between more than two sites. The second company – Fidelity – provides financial services and investment resources internationally and is one of the largest private companies in the US. The software products developed are supplied to internal customers in the US, and involve coordinating with several software development teams in the US and in India. The third company – HP – provides desktop support services right through to mission critical service delivery. This

company's approach to GSD can be compared to global virtual teams, with one team effectively split across sites in different continents.

3.2. Research design

Bearing the complex nature of GSD in mind, an interpretivist approach which sought to develop inductively a richer understanding based on case study analysis was deemed appropriate (Yin, 1994; Walsham, 1993).

In January 2005, the first phase of the research began with a workshop seminar on the topic, comprising researchers and industry practitioners, i.e. employees of the three target companies. This workshop was followed by a series of interviews and site visits. The combination of on-site and university-hosted seminars and workshops has been greatly facilitated by the fact that the industry sites and the university are located less than one-hour's drive from each other. The workshops have been hands-on with committed participation by both researchers and practitioners. The workshops and seminars have been complemented with qualitative interviews with managers and software developers at both companies. The interviews were generally of one to two-hour duration. In total, 12 interviews were conducted were conducted with managers, project leaders, technical staff and software engineers, and they were all recorded and transcribed. Informal follow-up telephone interviews took place to clarify and refine emerging issues, and these emerging issues were also presented and discussed at the various workshops.

In terms of data analysis, a primarily qualitative grounded theory (GT) approach was adopted (cf. Corbin & Strauss, 1990; Miles & Huberman, 1994). The GT approach recognizes that social phenomena are complex and seeks to develop theory systematically in an intimate relationship with the data. Interview data was subsequently coded according to the categories represented by the framework factors derived earlier (temporal, geographical and socio-cultural distance), and analytical memos were written as patterns and themes emerged from the interviews.

4. Findings and discussion

In this section, the results from the qualitative interview study are presented. All interviews were conducted between July 8 and August 3, 2005. In accordance with literature in the field, we present our empirical data using three categories – temporal, geographical and socio-cultural distance.

4.1. Temporal distance challenges

According to our respondents, temporal distance is challenging when it comes to managing projects that constitute different sites. Consider this statement by one of the project managers:

“Time zone distance is the biggest problem when organizing the different parties in projects. There is an unwritten rule...the higher up you are in the organization, the more flexible you're required to be – it is not uncommon to take calls at 10 or 11 at night, at home, but we try to keep this to a minimum”. (Project manager, Intel)

Likewise, the team leader and project manager at Fidelity find temporal distances difficult when managing project resources and describe the decision to move development from India to Ireland:

“There was 0 hours of overlap with US and India and they just found it very difficult to manage the resources. There was a huge turnover of staff and that, I think, was one of the big factors for moving resources to Ireland” (Team leader, Fidelity)

Besides management problems, temporal distance challenges everyday communication within and between teams. In particular, delay of responses is seen as problematic and frustrating for individuals working in the different projects. The issue is highlighted by several respondents:

“If you're trying to progress something very quickly, there can be an issue with the time zones...If there's any need for me to ask something or find an update, I can't really get hold of him [American colleague] until 3pm my time – maybe two o'clock at the earliest” (Team leader, HP)

“I received e-mails this morning from a conversation that kicked off after I left yesterday. Sometime conversation jumps ahead, and you fall a bit behind. Often, I turn it on [Internet connection] and review e-mails at night for half an hour” (Architect, HP)

“It is frustrating...sometimes there is a lag of a day in responses. You send an e-mail today and you get one back tomorrow...People go out of their way to communicate late at night, depending on the intensity of the project at that point in time. It's okay to do that for a while, but it's hard to sustain it, that's the problem. There's burnout of people”. (Manager, HP)

“When some developers are working with people in the US and they are waiting 4 or 5 hours for a response they see themselves as having no control over the entire work process...” (Project manager, Fidelity)

Clearly, everyday communication and coordination is challenged by temporal distance. An obvious disadvantage of being separated by temporal distance is that the number of overlapping hours during a workday is reduced and that team members have to be flexible to achieve overlap with remote colleagues. As noted by one of the managers, the lag in response time leaves with it a feeling of “being behind” and “missing out”, which in the long run make people frustrated and may cause burnout of people. While asynchronous tools are seen as crucial for communication and coordination, and as enablers for non-native English speakers to reflect before answering a question, the use of these tools over temporal distances increases the time it takes to receive a response. As seen in our study, and in accordance with Boland and Fitzgerald (2004), questions received by asynchronous communication overnight can be overwhelming for a developer beginning work in the morning. Also, our study reveals that limited overlap with colleagues – and therefore delay of responses – make people lose track of the overall work process, something that can pose severe problems in distributed, yet time-critical, work. As noted by Grinter et al (1999), problems and responses can drag on over days with increasing vulnerability costs as a result.

4.2. Overcoming temporal distance

In trying to manage the problems related to temporal distance, all three companies have different approaches. At HP and Fidelity, the ‘follow-the-sun’ concept is seen as one alternative, at least for parts of their businesses:

“Generally, it [the ‘follow-the-sun’ concept] is not good for development. However, it works for defect resolution and support. What we try to do is to make use of the time differences. We can do something here [Ireland] and then hand over to them [US] to run something or complete something, and they’ll leave a status note for us, or an e-mail. That works, but it takes time to build up”. (Project manager, Fidelity)

“We have ‘follow-the-sun’ core support during Monday to Friday. Someone should be able to action a call whenever it comes in. A call can be forwarded from site to site to follow the sun...” (Manager, HP)

At HP, the solution is also to have truly distributed teams, something that is commented upon as very ambitious by the manager:

“What I have seen a lot in GSD is to put clusters of people in one location versus another. In HP, we decided to cooperate between locations and to have a truly distributed team. I guess it is kind of ambitious in

one way...not sure that if I had it all over again I’d do that or not...” (Manager, HP)

Despite the recognition of beneficial aspects with ‘follow-the-sun’, this concept is not put in practice at Intel. According to one of the project leaders, the concept is problematic:

“We don’t practice the ‘follow-the-sun’ concept, and we have no intent on practicing it since it is not considered practical for software development”. (Project leader, Intel)

Instead, Intel tries to keep flexible and adjust hours to get a good overlap, and according to the project manager there are few organizational changes as long as the time differences are small. Here, the solution is not to have truly distributed teams as seen in HP, but instead to make time zone differences manageable by dividing work between a limited number of sites, something that is pointed out by the project manager:

“We try to make time zone differences manageable by dividing work between no more than two geographical sites”. (Project manager, Intel)

While it has been suggested that the challenges related to temporal distance would be resolved more efficiently if teams were co-located (Boland and Fitzgerald, 2004, Carmel and Agarwal, 2001), the companies in our study show different approaches for managing temporal distance. For example, at Intel, the solution is to have work divided between no more than two sites which, according to the manager, make time zone differences manageable. At HP, on the other hand, an ambitious attempt is to have cooperation between locations and truly distributed teams. While this might not make possible for concurrent development (Sarker and Sahay, 2004), it opens up for ‘follow-the-sun’ development in which certain tasks can be forwarded from site to site to benefit from temporal distance. In our study, defect resolution and support are activities found suitable for ‘follow-the-sun’, while actual development is considered less suitable for this way of working. In accordance with Sarker and Sahay (2004), our study shows communication technologies as enablers of distributed work but they do not guarantee ‘location transparency’ or work ‘following the sun’.

4.3. Geographical distance challenges

Besides the clear advantage of “intellectual horsepower”, i.e. the ability to recruit the cream of the crop students from top universities in countries where education and employment is more competitive, the organizations in our study all experience problems related to geographical distance. As seen in our

interviews, there are difficulties in establishing a feeling of trust and belonging, i.e. “teamness” within the teams. For example, consider this statement:

“The feeling is that we remain two different teams. However, there is a good cross-site relationship at management level and between certain peers... in general, the developers have not met each other”. (Software developer/team leader, Intel)

As it seems, good cross-site relationships exist at higher levels within the organization while software developers seldom meet. Interestingly, the importance of having developers meeting each other is emphasized by the manager at the same company:

“It’s essential that developers travel and meet each other”. (Manager, Intel)

While the desire of having developers meeting each other is expressed from management level it does not always seem to come true. However, both respondents agree on that the opportunity to meet depends on the specific project – and also, the specific phase of the project.

“The degree of communication depends on the phase of the project. For example, during integration, when things are put together, there can be unexpected behaviour. Usually, we fly people over in critical phases. Mostly, travel happens at front-end and back-end of projects”. (Manager, Intel)

“We try to travel for integration phase and we also fly people over for key features”. (Software developer/team leader, Intel)

Clearly, a major challenge is how to create a feeling of ‘teamness’ among distributed project members. Interestingly, project management seems to have met more often than the developers, and developers in our study mention that they often feel that they remain two different teams. Previous research on distributed organizing shows that people at different sites are less likely to perceive themselves as part of the same team (Kotlarsky and Oshri, 2005) and that interacting face-to-face is indeed crucial for successful distributed work (Orlikowski, 2002). In meeting face-to-face, the aim is to get to know each other and to create social networks that can generate trust, respect and commitment and in the long term facilitate development work across various geographical sites. Our study reveals face-to-face interaction as prioritized in critical phases such as front-end and back-end of projects. For example, the integration phase is considered crucial as there can be unexpected behavior, and also implementation of key features often requires people to be co-located. However, while face-to-face interaction is considered crucial in these phases, the remaining feeling from our study is that extensive travel is carried out by

management and higher level personnel, while software developers and low level project participants in general have usually not met each other. In meeting more often, project members would be able to deal more effectively with some of the temporal and geographical boundaries they encounter in their everyday work (Orlikowski, 2002). Also, a “bridgehead” (Carmel and Agarwal, 2001) or “liaison” (Battin et al, 2001), i.e. a person from one site working in another site and acting as a mediator between sites, may be helpful in situations where geographical distance challenge the feeling of ‘teamness’.

4.4. Overcoming geographical distance

In our study, all respondents emphasize travelling as very important for project success. Most managers spend a lot of time in meetings and one manager pointed out that travelling is indeed a major part of his work:

“I spend more than 50% of my time elsewhere. Travelling is essential”. (Manager, Intel)

Also, the companies work hard on creating structures that facilitate for team spirit and trust. While daily, weekly and monthly meetings are practised at all three sites, there are also additional activities that take place:

“We try to work hard to get team cohesion. For example, we try to keep photos on the website and a profile of everybody to realize that there is actually ‘a human-being at the other side’...we also have some co-located team building activities, especially during project definition work”. (Project manager, HP)

As in solving the problems with temporal distances, Intel tries to keep dependencies among teams as low as possible:

“Our current tactic is to have as few dependencies as possible on other teams’ work”. (Manager, Intel)

Finally, nearshoring, i.e. offshore destinations that are geographically close to the client country, is mentioned by the manager at HP as an interesting alternative for coming to terms with geographical as well as temporal distances. According to him, it hasn’t happened yet but it will definitely be a solution to consider in the future:

“It hasn’t happened, but I think that’s where we’ll go in the next wave...There are examples – like the east or west coast of the US outsourcing to Brazil. You won’t have the timezone or geographical problem, but you’ll still have the language problem” (Manager, HP).

In our study, all companies try to reduce geographical distance and the challenge of creating ‘teamness’ among distributed project participants. The use of technology in terms of team websites is common

and previous research describes such websites as encompassing all facets of individual- and task-related information – from the programmers’ photos to test documentation (McConnell, 1998). Another approach for alleviating geographical distance, and as mentioned by one of the managers in our study, is ‘nearshoring’. Traditionally, the term nearshore is seen to refer to reducing communication and coordination issues associated with undertaking IT work at a distance and has come to be associated with offshore destinations that are geographically close to the client country (Carmel and Agarwal, 2001). While it has not yet been employed by the companies in our study, it is seen as an interesting alternative in the future for reducing time-to-travel and for increasing cultural similarity.

4.5 Socio-cultural distance challenges

Socio-cultural distance is a complex dimension involving organizational culture, national culture and language, politics, and individual motivations and work ethics. In our study, it is obvious that language can be a barrier in many projects:

“We often experience minor language problems, especially when vocabulary is limited to technical subjects...even going out at night with them [non-native English speakers], conversation can revert back to technical subjects because of their limited vocabulary”. (Software developer, Intel)

Besides vocabulary itself, interpretation and meaning can be different. As can be seen in the statements below, both managers and project participants experience this:

“Difficulties can arise in countries where it is considered impolite in saying ‘no’ even when ‘yes’ would be an inappropriate answer. I have heard people saying ‘yes – no problem, we will have it done by the weekend’ and then 3-4 months later it is still not done and some of the developers might already have left the project...I think it is due to pride – they’ll obey when asked, without saying they can’t do it within the given timeframe”. (Project manager, Intel)

“The general understanding is not too bad. It is often the more subtle ones [cultural issues] that can trip you up the most. They’re the ones that slip through. You interpret it one way, and they interpret it the other way. That gets worse the further away from native English speaking people you go”. (Architect, HP)

Interestingly, there is not only native English and homogenous non-native English groups to deal with. This experience was new to one of the managers in our study:

“One thing that hit me was that when I met the Indians in Fort Collins they all spoke different languages. They are not a monolithic group of people. This was a real revelation to me – I knew there were many different cultures in India, but I couldn’t believe the extent of it. They had to speak between each other in English”. (Project manager, HP)

Besides language problems, there are cultural, political and religious differences that challenge project work. More or less, all companies in our study have experienced this. Consider for example these statements by one of the architects at one company:

“There are a lot of political and religious diversity...if any element of that came into everyday work it could just blow everything apart and create lot of tensions...” (Architect, HP)

“When you have language difficulties initially causing confusion, I think cultural differences can actually drive further awkward situations, and it snowballs...” (Architect, HP)

In relation to socio-cultural distance, the most widely experienced difficulty seems to be related to language and interpretation. In our study, employees from all three companies mention language problems as the primary reason for – if not conflict – but misunderstandings. Often, conversation is focused on technical issues due to lack of vocabulary and even at social activities the topic for discussion is often work-related. While it has been argued that informal communication play a critical role in coordination activities for co-located IS development, it is believed to only increase when size and complexity of IS development increase (Kotlarsky and Oshri, 2005). Informal conversation allows team members to develop working relationships, and allows a better flow of information about changes in the current project (Herbsleb and Mockus, 2003). Consequently, the need for informal conversation in GSD is extensive, yet there is the recognition of far less frequent communication in distributed development teams and that people find it far more difficult to identify distant colleagues and communicate effectively with them (Herbsleb and Mockus, 2003).

4.6. Overcoming socio-cultural distance

To try to reduce socio-cultural challenges, all companies have their own solutions. For example, language problems can be overcome by using asynchronous communication:

“We try to overcome language problems by making communication more formalized, i.e. written, so that

people with lower competency in English can take their time in reading a document". (Manager, Intel)

Also, creative solutions such as a 'buddy system' seem to work at Fidelity:

"We have a 'buddy system' in which each developer in India was 'buddied up' with a developer in Ireland. That worked very well. We also sent two developers from Ireland to India". (Project manager, Fidelity)

Overall, travelling seems to be the way in which to solve problems. As recognized by one of the team leaders, most employees travel extensively to 'broaden their minds':

"Most of my employees have travelled or have worked in different places. This broadens you as an individual, makes you more open to people coming from different places...that they are not going to do things or think the same way as you do". (Team leader, Fidelity)

Interestingly, our study shows that language and vocabulary itself is not the main problem but rather the interpretation of what is said. Most often, the general understanding of English is very good. However, more subtle issues cause confusion and misunderstanding, and in trying to solve these issues by using communication technologies in which facial expressions and social cues are left out – misunderstandings can "snowball" and get even worse. Here, it is important to recognize that virtual team members are typically drawn from different countries with varying cultural assumptions regarding what to say, how to say it and when to say it. For example, previous research shows that different rhythms around the use of e-mails may lead to communication challenges, particularly in the way 'silence' is interpreted in different locations (Sarker and Sahay, 2004). In addition, different cultures answer in different ways. As recognized by Krishna et al (2004), Japanese professionals take longer time to reply due to their communication culture which values completeness in their mode of replying, while for example Indian professionals reply immediately due to prior work experience with US colleges. However, while a delayed response is sometimes more thought through, and while a fast response is sometimes preferable – the challenge of interpretation remains. Here, the more subtle structures of different cultures have to be understood, allowing distributed project members to internalize and identify with a common way of thinking (Orlikowski, 2002).

6. Conclusions

The objective of this paper was to identify, through empirical investigation at three US based GSD

companies operating in Ireland, the particular challenges associated with GSD. We have identified challenges arising out of temporal, geographical and socio-cultural distance. Our study has also revealed some of the solutions used to deal with these challenges. Interestingly, although the challenges reverberate throughout the three organizations, the ways of overcoming them are remarkably diverse. For example, solutions used to create overlap in time ranged from dividing work between no more than two sites to having truly distributed teams allowing round-the-clock development. So, what are the main challenges associated with GSD, as experienced by the companies involved in our study?

First, and in relation to temporal distance, our respondents emphasize the challenge of creating overlap in time between different sites. Despite flexible work hours and communication technologies that enable asynchronous communication, extensive delay in responses brings with it a feeling of "being behind" and "missing out" – even losing track of the overall work process. The risk for burnout of people is considered high and despite the opportunity for 'follow-the-sun' development which is possible when having truly distributed teams, temporal distance might instead cause companies to limit the number of sites between which work is divided. Second, geographical distance challenge team spirit, i.e. 'teamness', and while all respondents agree on the importance of this, they also recognize the difficulty of establishing and maintaining this in a distributed development environment. While websites with photos and individual profiles indeed serve a purpose, the common solution still seems to be travelling between sites – an activity, that to be successful, must be carried out by high, as well as low-level project participants. Finally, in relation to socio-cultural distance, our respondents emphasize the inherent challenge of creating mutual understanding between people with different backgrounds. Not only is vocabulary limited but different cultures have different ways of interpreting what is being said. Often, the general understanding of English is considered good, but more subtle issues, such as political or religious values, cause misunderstandings and conflicts within projects. In trying to solve this, companies work hard to stimulate informal as well as formal knowledge sharing between project participants. In the end, however, it comes down to individuals and the capacity and interest of understanding other people.

Given how difficult it is to establish a shared frame of reference and mutuality in communication even among those who are co-located, we agree with Schultze and Orlikowski (2001), who contend that

creating and sustaining a coherent connection among distributed individuals occupying a shared electronic space present a major challenge. As identified in our study, a possible solution to this would be to trim down GSD towards nearshoring – thus potentially reducing all three distances (Lapper and Tricks, 1999, Carmel and Agarwal, 2001). While there exists ample opportunity to extend and refine the findings discussed in this paper, we believe that our study will help unravel some of the main challenges associated with GSD and thus, find possible solutions for overcoming – or at least reducing – these challenges.

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