The nature of IT use in temporary organizations

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Abstract

Temporary organizations (TOs) are organizational forms characterized by finite-life duration, novel tasks, heterogeneity of organizational members, and different phases of work. They have a greater proportion of emergent processes than more enduring organizations do. This poses particular challenges in the use of IT because it is difficult to foresee all IT applications that are required. This paper examines how IT is used to support the execution of processes in TOs. The empirical setting for our study is a particular and exemplar temporary organization: the 2016 Olympic Games Organizing Committee. Through immersive, in depth and qualitative fieldwork, based on participant observation, interviews, and internal documents, we find that TOs have a

dynamic mix of operational processes in different phases of work. Accordingly, they have four patterns of IT use: (1) planned use - of formal IT, (2) planned use - of informal IT, (3) emergent use - of informal IT as a substitute for formal IT, and (4) emergent use - of informal IT combined with formal IT. We develop a theoretical explanation for how the patterns address the distinctive conditions facing TOs (i.e. a novel task done in a finite time, by multiple and heterogeneous people, across different phases of work) and its dynamic mix of processes through both planned and improvised use of IT. Practical implications include the impact of improvised IT use on aspects such as security, compliance, integration, and traceability.

Keywords

Temporary organizations, IT use improvisation, Patterns of IT use, 2016 Olympic Games, IT Use.

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Declaration of Interest Statement

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The nature of IT use in temporary organizations

1. INTRODUCTION

Temporary organizations (TOs) are time-limited organizational forms designed around a particular task/purpose (Lundin and Söderholm, 1995; Söderlund, 2004), such as sports events, disaster relief projects, movie sets, and task forces (Bakker, 2010). Both their structure and the organizational affiliation of those who work in them may be temporary (Bakker et al., 2016). They have key distinctive characteristics – limited duration of existence (not necessarily short), heterogeneity of organizational members, accomplishment of novel tasks, and different phases of work (Lundin and Söderholm, 1995; Maylor, 2010; Meyerson et al., 1996). The study of TOs is relevant and interesting because TOs are essential for tackling disruptive and humanitarian situations such as emergencies and disasters, and staging socially and culturally significant global events, such as the Olympics or the World Cup (Bakker, 2010). Flexible and ad hoc ways of organizing are needed to deal with such temporary tasks (Burke and Morley, 2016; Bakker, 2010; Bakker et al., 2016).

The literature shows that IT (Information Technology) is widely used in TOs, and describes the use of different applications. For example, in disaster relief operations, data exchanges facilitate creation and sharing of data among humanitarian organizations, partners, and volunteers (e.g. Haavisto et al., 2016). Geographical information systems and social media applications help humanitarian agencies to map and prioritize communities to provide aid to (Ling et al., 2015). For construction projects, RFID and logistics/supply chain management applications enable transparency of information among members (Cus-Babic et al., 2014; Shin et al., 2011). Studies hint that IT is used in unanticipated ways, especially to deal with unexpected contingencies. For example, in crisis response, operating staff and volunteers under time pressure spontaneously use applications such as Twitter and Facebook to quickly share information and coordinate activities (Li et al., 2014; Tatham and Christopher, 2014) – the use of these applications is not planned in advance. Similarly, in megaprojects, Ninan et al. (2019) found that project team members and external stakeholders (e.g. communities and public bodies) spontaneously use social media applications for governmentality and branding.

TOs' distinctive remit is to accomplish novel tasks within a limited time, through the work of people from heterogeneous specialties. To do this, TOs need to gather information from different sources, interpret and share it, and apply it to execute organizational processes – quickly and often in real time. TOs are also dynamic; they operate through different phases of work that require different processes over time. These characteristics create particular information-processing challenges. First, because of their limited duration, TOs might not have enough time to gather and share relevant information, leading to an inability to execute processes. Second, the heterogeneity of interdependent team members may lead to multiple interpretations of information. Third, the novelty of TOs' tasks means that the information required to execute them may not be standardized or clear. Fourth, information requirements are different over different phases of work. Taken together, these lead to high and dynamic levels of both 'uncertainty' (Galbraith, 1973) and 'equivocality' (Daft and Lengel, 1986) which, if not addressed, can lead to TOs not accomplishing their central task.

Therefore, merely knowing what applications TOs use is not enough: we also need a theoretical explanation of how IT use can tackle these challenges and thus support TOs' processes. Primarily, it is important to understand how IT use evolves over time in order to address the dynamic nature of TOs' processes. Existing studies, which mainly describe what applications are used in TOs, fall short. In particular, they do not reveal how TOs' processes transition over time and how IT use evolves to support the changes. Such an explanation also has practical value; it can help TOs' members to understand how IT can help them deal with their operations' complexity over time. Indeed, studies report that TOs' operations are often plagued by bad decisions stemming from inconsistent and unreliable information, confusion, misinformation, and rumours (Day, Junglas and Silva, 2009; Li et al., 2014) because of lack of clarity regarding how IT can support the processes. This can lead to failure to accomplish the TO's task, and to delays, cost overruns, lack of quality, reputational damage, and even loss of lives or prolonged hardship (e.g. Fulford and Standing, 2014; Haavisto et al., 2016; Tatham and Christopher, 2014).

Thus, our study examines the following research question: *"How does use of IT support the execution of processes in temporary organizations?"* Given that the literature indicates both planned and unanticipated use of IT in TOs as noted above, we draw from the concept of improvisation in IT use as the sensitizing theoretical lens for this study (Ciborra, 1996; Orlikowski, 1996, Weick, 1998). We investigated a particular TO – the 2016 Olympic Games Organizing

Committee (OGOC) – conducting immersive, real-time, and qualitative fieldwork during the 2016 Summer Olympic Games in Rio de Janeiro[1]. Data collection involved participant observation, analysis of internal documents, and interviews with 28 organizational members from multiple departments, functions, and hierarchical positions within this TO. Specifically, we examined how and why IT was used across different phases of work. The OGOC was a particularly appropriate empirical setting because it is a typical TO, presenting finite-life duration, novel tasks, heterogeneity of organizational members, and different phases of work.

Our theoretical contribution is to explain how TOs tackle the information processing challenges of a changing mix of processes over time, through four patterns of IT use. The patterns address distinctive conditions facing TOs and their dynamic mix of processes, through both planned and improvised use of IT. We thus develop a novel theoretical explanation of how use of IT supports TOs' processes.

Section 2 of the paper presents the literature on information processing in TOs, IT use in TOs, and on IT use improvisation. In Section 3, we describe the study's methods and data. Section 4 analyses the findings, Section 5 discusses the theoretical insights, and Section 6 presents theoretical contributions, future research, and implications for practice.

2. LITERATURE REVIEW

In this section we first examine information processing in TOs, particularly elaborating on specific information processing challenges faced by such organizations. We next lay out the literature on IT use in TOs. We then present the theoretical lens for this study, that of IT use improvisation.

2.1 Information processing in TOs

Organizations process (i.e. gather, interpret and synthesize) information (Tushman and Nadler, 1978) to accomplish processes, coordinate activities, and interpret the external environment (Daft and Lengel, 1986). Information processing is influenced by two characteristics of information: uncertainty and equivocality (Galbraith, 1973; Daft and Lengel, 1986). Uncertainty is an absence of sufficient information to execute a specific activity. Equivocality is the presence of ambiguous information leading to its multiple and potentially conflicting interpretations. High levels of

[1] Hereafter, we refer to the 2016 Summer Olympic Games as the Olympic Games.

uncertainty and equivocality in TOs create distinctive information processing challenges. We use four central concepts from the literature on TOs - *time*, *task*, *team*, and *transition* (Lundin and Söderholm, 1995) - to theoretically frame these challenges

Because TOs have finite and limited duration, *time* is perceived as scarce and valuable (Bakker et al., 2016; Lundin and Söderholm, 1995; Söderlund, 2004). Hence, a TO may lack the time and resources to develop formal information processing mechanisms and IT applications, and organizational members may lack sufficient information to execute their activities, leading to high levels of uncertainty.

The *task* is the main purpose of a TO (Lundin and Söderholm, 1995), such as the creation and delivery of a building or an event, or a response to a natural disaster (Burke and Morley, 2016). The task is generally novel and complex, leading to uncertainty and equivocality in information processing. Novelty implies potential lack of information because the task has not been done before. Complexity means that more information may be needed to measure and control for a greater number of parameters. Such tasks are also associated with ambiguous information processing because interdependent activities need to be coordinated (Daft and Macintosh, 1981; Daft and Lengel, 1986; Tushman and Nadler, 1978).

TOs accomplish tasks in multi-disciplinary *teams* rather than through mono-disciplinary departments. Team members are brought together in both planned and emergent ways (Bakker, 2010; Lundin and Söderholm, 1995). They have diverse skills, come from different functional specializations and have varying levels of expertise (Bechky, 2006; Grabher, 2002; Meyerson et al., 1996). Further, they may work in sub-teams, often for short durations, to execute interdependent activities. The heterogeneity of team members working interdependently together for short durations implies that several people may collect and process information differently and in a decentralized way. This may lead to information that is of low accuracy and quality. Further, such information may lend itself to multiple interpretations, increasing equivocality.

TOs have different phases of work. For example, in humanitarian operations there are the phases of mitigation, preparedness, response, and rehabilitation (Kovács and Spens, 2007), and projects in general have the phases of conception, planning, development, and evaluation (Maylor, 2010; Meredith and Mantel, 2008). The *transition* aspect relates to changes between these phases (Lundin and Söderholm, 1995). Because each phase has distinctive objectives, they have different information processing requirements. If the TO's information processing capabilities do not adapt

accordingly, information could be missing or unclear, making high levels of uncertainty and equivocality likely.

Indeed, studies show that TOs are often plagued by inconsistent and unreliable information, confusion, misinformation, and rumours (Day et al., 2009; Li et al., 2014), leading to delays, cost overruns, reputational damage, and even loss of lives (e.g. Fulford and Standing, 2014; Haavisto et al., 2016; Tatham and Christopher, 2014). We suggest that the time, task, team and transition characteristics create high levels of both uncertainty and equivocality (Galbraith, 1973; Daft and Lengel, 1986). We further suggest that understanding how IT can be effective for TOs thus requires a theoretical explanation of how IT can address these information processing challenges.

2.2. IT use in the context of TOs

IT can compensate for the limitations of organizational structures, formal procedures, and the lack of well-developed processes that arise from the TO's finite duration (Haavisto et al., 2016; Mesa et al., 2016). In disaster relief operations (Day et al., 2009; Haavisto et al., 2016; Tatham and Christopher, 2014), IT enables relief workers, affected communities and volunteers to create, collect, share and use information during emergency responses. IT is used to assess the progress of response (e.g., number of people rescued from a flood), coordinate activities among relief agencies, government agencies, firms and volunteers, and provide briefings and appeals for donors (Haavisto et al., 2016). In construction projects, computer-aided design tools and 3D design applications speed up the link between design/prefabrication and on-site construction processes (Cus-Babic et al., 2014), RFID applications support just-in-time delivery of materials (Shin et al., 2011), and real-time data enables integration, transparency, and logistics related collaboration among project partners (Cus-Babic et al., 2014; Mesa et al., 2016, Fulford and Standing, 2014). In complex infrastructure projects, delivery systems improve supply chain integration (Mesa et al., 2016) and data analytics tools facilitate real-time decision-making (Whyte et al., 2016).

In addition to these more planned types of IT, other IT applications such as Twitter and Facebook have been used in temporary settings in unanticipated ways (Haavisto et al., 2016; Li et al., 2014). In crisis response, humanitarian agencies use social media 'on the ground' to facilitate information sharing and coordination of activities among multiple stakeholders (Ling et al., 2015). Such impromptu use, however, is characterized by a lack of control over the disseminated information (Li et al., 2014; Tatham and Christopher, 2014; Ninan et al., 2019). Besides social

media, open domain IT applications such as Google spreadsheets prove useful in temporary settings for information sharing and coordination because organizational mechanisms and reporting structures are not always in place (Landgren, 2015). Their use is not planned but emerges during the course of the TO's life.

Even though TOs execute their work in several different phases, most studies examine IT use only in one specific phase. The literature shows that various IT applications are used, but does not explain how the use of IT addresses the specific information processing challenges arising from the distinctive characteristics of TOs. Therein we find the theoretical motivation for our research question. Further, the distinctive characteristics of TOs create the need for quick information processing in circumstances of high uncertainty and equivocality, meaning that information processing and therefore IT requirements are emergent and cannot be completely foreseen. Consequently, because TO operations are time-sensitive, it is likely that individuals will improvise in their use of IT as well as use applications in planned ways, to achieve their aims. We therefore adopt improvisation in the use of IT as our theoretical lens, and examine this next.

2.3. IT use improvisation

Improvisation in organizing deals with the unforeseen; it works without a prior stipulation, producing something on the 'spur of the moment' (Ciborra, 1996; Weick, 1998). "We can observe phenomena such as: plans keep being diverted, surprises arise constantly, opportunistic adjustments must be carried out on the spur of the moment, so that planning is espoused while circumstances compel managers to improvise" (Ciborra, 1997, p. 72).

Improvisation is an important aspect of the use of IT (McGann and Lyytinen, 2010; Njenga and Brown, 2012; Ciborra, 1997). In particular, Ciborra's (e.g. 1996, 1997) ideas on bricolage, tinkering, care-taking, and technology drift are central in framing IS improvisation. Bricolage involves combining and applying known IT applications and tools to solve new problems by people close to the operational level, and is used by Ciborra to discuss situated and experience-based improvisation (Shantz, 2005). The concept of tinkering keeps IT close to the ongoing contingencies in local practices (Ciborra, 1992). Care-taking (Ciborra 1997) involves IT users taking an active role in their use of IT applications through continuous commitment and involvement in needs analysis, system development, training, implementation and deployment, and subsequent modification. Technology drift (Ciborra, 1997) happens when implementation

processes move beyond original system design intentions, involving unexpected outcomes of technology and requiring adaptations and reinventions of initial applications (Shantz, 2005). Despite planning, control and risk management, IT infrastructures can 'drift' as a result of improvised use, unforeseen technical interdependencies, idiosyncratic design choices and unexpected user resistance (Ciborra, 2004).

Although improvisation deals with a new situation each time, it can be a patterned and deliberate activity that can be enhanced with practice (e.g. Moorman and Miner, 1998; Weick, 1998). Improvisation is "simultaneously rational and unpredictable; planned but emergent; purposeful but opaque; effective but irreflexive; discernible after the fact, but spontaneous in its manifestation" (Ciborra, 1999, p. 137). This paradoxical nature of improvisation has been discussed in the improvisation literature through paradox pairs, such as planned-serendipity, rehearsed-spontaneity, and learned-improvisation (Mirvis, 1998; Molnar et al., 2017; Zheng et al., 2011). Successful improvisations draw on learning, creativity, flexibility, and expertise (Cunha et al., 1999; Molnar et al., 2017; Shantz, 2005) and can be enhanced with practice (Pavlou and El Sawy, 2010). Positive outcomes of improvisation include innovation (e.g. Cunha et al., 1999).

Conditions that trigger improvisation include: (1) uncertain circumstances that cannot be addressed with existing plans, (2) there not being enough time or finances to engage in formal planning, (3) a need to act outside formal plans to cope with novel situations, and (4) situations of time pressure to solve problems and address opportunities quickly (Cunha et al., 1999; Moorman and Miner 1998; Pavlou and El Sawy, 2010). All these conditions are true for TOs (Lundin and Söderholm, 1995). The concept of improvisation has often been used to critique IT use studies that do not take into account environmental surprises and uncertainties (Ciborra, 1996; Njenga and Brown, 2012; Orlikowski, 1996). TOs not only face uncertain and changing processes, they also face dynamic information processing requirements: to tackle these, IT improvisation may need to change with time, an aspect that current IT improvisation studies do not consider. For all these reasons, we draw on this concept as the sensitizing lens for our study.

3. METHODS

We conducted an immersive, in depth, and qualitative study using longitudinal real-time fieldwork and participant observation (Walsham, 2006). Specifically, we investigated the 2016 Olympic Games Organizing Committee (OGOC). The OGOC is a TO, deployed especially to organize the

2016 Summer Olympic and Paralympic Games, and then disbanded. It was a particularly appropriate empirical setting because it had finite-life duration, a novel task (i.e. to conduct the Games), heterogeneity of organizational members, and different phases of work. We studied the OGOC across four different phases of the Olympic Games: *Planning, Venueization*[2], *Operation,* and *Dissolution*. The OGOC started its activities as a small organization in 2009 with around 50 employees and grew massively, especially during Games-time, having more than 6,500 employees in 2016. We longitudinally assessed changes in its operational processes, the related information processing requirements, and in the IT applications used. By being embedded in the empirical setting, we were able to observe how IT use evolved over time.

To keep the scope manageable, we conducted our fieldwork in one operational area of the OGOC: the transport operation, which transported around 50,000 clients[3], by vehicles and buses. This operation was selected for a number of reasons. Firstly, it was critical and central to the Games, given the significant urban road travel, congested transport systems, and geographical dispersion of venues. Secondly, its processes and activities changed very frequently to accommodate requirements of different sports events (e.g. some roads were blocked during the marathon days, meaning that alternative routes had to be used). This provided a rich empirical setting to study the dynamism and complexity associated with TOs. Thirdly, this operation, given its physically dispersed nature, was a decentralized one. Thus, connectivity was required between the Transport department's members and other departments within the OGOC, and with multiple external organizations (e.g. public bodies, suppliers, and partners) in order to deliver the transport services. This provided fertile ground for analysing the use of IT applications.

3.1 Data collection

3.1.1 Data sources

Data were collected through participant observation, semi-structured interviews, and internal documents (Walsham, 2006). The first author[4] worked as a full-time volunteer of the Transport

[2] Venueization refers to the phase immediately before the Games, when the venues are made ready to operate.
[3] 'Client' is the term used by the OGOC to refer to different members and participants of the Olympic Games (including athletes, members of National Olympic Committees and the International Olympic Committee, media, and dignitaries), to whom Transport staff needed to provide transport services during the Olympic Games.
[4] Hereafter referred to as 'author'. We note that she was one among 50,000 volunteers and did not influence the use of IT in the TO in any substantive way.

department within the OGOC from July to September 2016, which enabled real-time and immersive data collection during and immediately before and after the Olympic Games.

The participants involved in our study were top managers, middle-level managers, operational staff, and volunteers, from the Transport department and from other departments within the OGOC. In total, 28 people from multiple departments and hierarchy levels of the OGOC were interviewed, including people who had been involved since 2009, to ensure the representativeness of data. The interviews were recorded, corresponding to about 26 recording hours. Interviewing people from various departments provided a comprehensive picture of the transport operation and related challenges. The interview questions focused on identifying the main operational processes and challenges, IT applications used (e.g. systems, applications, and tools), and how they supported the OGOC to achieve its objectives across the Olympic phases. The interview schedule and questions are provided in Appendices A and B, respectively. Most of the interviews were carried out in person and a few via Skype, depending on the interviewees' location and availability. All interviews were recorded and transcribed. Because we assured anonymity to the research participants, we use pseudonyms when referring to specific quotes. In addition to the interviews, information on how processes were executed and IT applications used were captured daily through observations.

Further relevant data were collected within the Transport department in the form of internal documents, such as reports, maps, daily schedules, operational plans, and IT systems descriptions. These documents were part of operational procedures developed by the OGOC, based on the International Olympic Committee's guidelines and on the clients' needs and preferences. These were valuable sources of data that helped us better comprehend operational processes as well as specific features and applicability of IT solutions.

The combination and complementarity of multiple sources of data and inclusion of diverse research participants enabled triangulated (Miles et al., 2014) and in-depth understanding of the operational processes, information processing requirements and use of IT applications within the Transport department. It also provided relevant insights regarding the OGOC in general. Table 1 provides an overview of the participants' profile and of the activities observed.

Department	Main objectives	Pseudonyms of participants interviewed and observed	Activities observed

Transport	Provision of diverse transport services to around 50,000 clients (e.g. athletes, dignitaries, and media).	Top manager: George General managers: Christine, Paul, and Mark Managers: John, Jenny, Roger, Claire, Philip, Nicholas, Bryan, and David Supervisor: Anna Analysts: Emma, Rosie, and Mathew Volunteer: Mary	Operational meetings, training, allocation of cars to clients, information provision, and use of IT applications supporting operational processes.
Information Technology	Development of IT solutions, maintenance of hardware and software, and assistance to users.	Managers: Margaret, Peter, Robert, and Steve Analyst: Adam	Use and maintenance of IT applications. These activities were executed by an IT team dedicated to the Transport Department.
Human Resources	Development of HR processes (e.g. recruitment, selection, and training).	General manager: Valerie Manager: Sarah	Training, motivational and engagement programs (especially for volunteers)
Logistics	Provision of logistics solutions.	Top manager: Jimmy	Distribution of goods
Procurement	Procurement of goods and services.	Top manager: Carl	Bidding processes through a web portal, management of contracts
Security	Provision of security services.	General manager: Alex Manager: James	Access control, security of dignitaries

Table 1: Participants' profile and activities observed

3.1.2 Researcher roles

During the observation period, the author observed and participated in some operational processes[5] undertaken by the Transport staff and volunteers. These included access control to ensure that only accredited vehicles could access the venues, allocation of cars to clients, information provision to clients about transport services, training for new volunteers, and use of IT applications supporting operational processes in multiple, physically dispersed Olympic venues (e.g. Olympic Park, Olympic Village, stadiums, and garages). She audio-recorded relevant observations, impressions, and perceptions daily.

[5] Operational processes are defined as a series of activities undertaken by the staff of the Transport department across different Olympic phases in order to provide transport services during the Olympic Games.

Initially, the author's role was that of a *volunteer*. Her role in the field was to undertake the operational tasks as directed, similar to other volunteers. As she got to know people better, she made the research objectives known to other volunteers and managers. Therefore, her role was augmented to that of a *researcher*. People knew that she was there to work as a volunteer, but also to understand the operations of the Transport department. The managers then assigned her to more diverse duties and positions so that she could execute and observe different activities and, therefore, learn as much as possible, as well as being introduced to key managers who became the respondents for this study. In executing the volunteer work, she was also seen as a *team member*. She attended important team meetings and was asked to help solve problems and train newcomers. This enabled an insider's perspective and contextual embeddedness (Tracy, 2013), which allowed her to appreciate and 'live through' the TO's complexity and understand interviewees' perceptions.

We make a note here about researcher reflexivity (Langley and Klag, 2019). The author's embeddedness enabled an intimate approach to and deep understanding of the TO's operations and IT use, not only through interviews and observations, but also through direct experience. She was able to access relevant people, departments, meetings, and venues that would not normally be accessed by researchers, which enabled understanding of how IT use was rooted in the operational processes of the Transport department. However, it also raised the possibility of researcher bias. To mitigate potential biases, findings were sent to key research participants for validation (Langley and Klag, 2019; Miles et al., 2014). This was done 'on the spot' during the fieldwork, wherein the author summarized key aspects of the data (e.g. specific operational processes or IT applications features) and verified them with respondents on a daily basis to check for accuracy and resonance with their experiences. Additionally, it was done during analysis, when we sent drafts to some research participants for feedback on our interpretation.

3.2 Data analysis

Data analysis followed Miles et al. (2014) recommendations on data classification and reduction, in combination with temporal bracketing (Langley, 1999). We examined situations in which IT applications[6] were used to process information and support the execution of operational processes. Data analysis comprised three main steps, conducted iteratively: *data reduction*, *data coding*, and

[6] The term IT applications in this study includes hardware and software, such as applications, systems, and tools.

longitudinal analysis. Each step involved an iterative process of data exploration, comparison between theoretical ideas and empirical data, discussion, and reflection.

During *data reduction*, all sources of information (interview transcripts, documents, and field notes) were combined and summarized, using the research objective as overarching guide first, then focusing on specific features and challenges related to IT use over the different phases of work.

Data coding then allowed the identification of the main categories, based on the literature and on the empirical data. We used content analysis to classify the data, generating broad themes (Walsham, 2006) that were progressively refined, combined, and detailed. In the first round of coding the interview transcripts, documents, and field notes were first classified into initial broad categories, based on the literature on TOs and on IT use. In subsequent rounds, these categories were revisited and compared again with the literature and with one another. Based on this, some were reclassified into new codes. Through this iterative process, new categories emerged, others were combined and modified, and others were abandoned (Walsham, 2006).

Regarding the role of theoretical ideas – those related to TOs' features, information processing, and IT use for organizational processes – they initially shaped the data analysis in a mostly deductive manner. We then compared these theoretical ideas with the empirical data (Walsham, 2006). In the process, we identified initial codes, which were then refined and detailed considering contextual specificities. In order to understand various empirical evidence, inductive reasoning was then applied. This led to the emergence of new codes from the data, such as the patterns of IT use that pointed to improvisation (e.g. Ciborra, 1996; Orlikowski, 1996) as an appropriate and relevant sensitising lens. Finally, based on theoretical ideas of the improvisation approach, we conducted a final round of coding.

In this way, we identified a combination of literature-driven and data-driven themes, which are presented in Table 2. For example, the overall theme of 'information processing challenges' was derived from the literature (e.g. Daft and Lengel, 1986; Lundin and Söderholm, 1995) and denotes particular characteristics of TOs that make information processing difficult. However, aspects of the theme specific to the particular TO we studied emerged from the data. The theme 'operational processes' emerged from our data and refers to different types of processes executed by the Transport staff. 'Types of IT applications' originated from the data and characterizes the types of IT applications used by the Transport staff. Also emerging from the data, 'Patterns of IT use' refers

to the ways in which IT was used to support information processing and execution of organizational processes. 'Improvisation' and related sub-themes were literature-driven (e.g. Ciborra, 1992, 1996, 1997; Orlikowski, 1996; Orlikowski and Hofman, 1997), emerging as we applied ideas from this theoretical framing to our findings.

The third and last step consisted of *analysing data longitudinally* through the temporal bracketing strategy, which provided the means to structure and describe events in different periods (Langley, 1999). This strategy allowed us to break down multiple events into periods of interest (in our case, the Olympic phases) and analyse how IT use evolved in each of them. This enabled us to compare and understand changing processes, related information-processing requirements, and the dynamic use of IT.

To assure accuracy (Miles et al., 2014), our findings were sent to key research participants for validation in two different ways, as explained above – 'on the spot' during the fieldwork and later on after the findings were partially written. These interactions allowed a clearer understanding of the research outcomes. They also enabled triangulation and thus served to guard against respondents' and investigators' biases (Miles et al., 2014), thus serving as particularly valuable ways to bolster study rigor. In sum, the data analysis process took place through a constant interaction among data, literature, reflections, and discussions, as is recommended in interpretative research (Walsham, 2006). The author's embeddedness allowed her to reflect further, based on discussions with research participants, thus enabling rigor in analysis and interpretation.

Further details on the data and on the analysis process can be found in the Appendices C, D, and E. Appendix C presents additional examples of codes, including some illustrative quotes from the data, Appendix D exemplifies how the data were organized, and Appendix E provides examples of IT applications used.

Themes	Sub-themes	Definition
		1st round of data coding
Information processing challenges	**Time pressure*	The degree to which people's activities are constrained by time spans (e.g. Goodman and Goodman, 1976; Lundin and Söderholm, 1995).
	**Uncertainty*	The degree to which people are unable to predict environmental conditions. This is caused by unknown conditions such as novel and varied tasks (Lawrence and Lorsch, 1967; Thompson, 1967).
	**Heterogeneity of team members*	The degree of difference among people in terms of skills, background education, previous experience, organizational 'home bases', and training levels (Bechky, 2006; Goodman and Goodman, 1976; Grabher, 2002; Meyerson et al., 1996).
	**Changing requirements*	The extent to which organizational requirements need to change in order to cope with dynamic environments and unexpected/novel events (Lawrence and Lorsch, 1967; Thompson, 1967).
		2nd round of data coding
Operational processes	*General*	General processes are foreseen and continuous; they are present in most or all phases of work.
	Phase-specific	Phase-specific processes are foreseen, planned, and focused on a specific task; they are present in one or few phases of work.
	New unforeseen	New unforeseen processes are unplanned and focused on a specific task; they can emerge in different phases of work.
Types of IT applications	*Formal IT*	Formal IT refers to IT applications that the organization develops or purchases. Usually, the use of these applications is defined in procedures. Some examples from our data include formal systems, such as the vehicle tracking system. People and resources are necessary for the development of a formal IT application.

	Informal IT	Informal IT refers to IT applications available in the open domain that the organization does not develop or purchase. Usually, the use of these applications is not defined in procedures. Examples from our data include instant messaging applications, such as WhatsApp and Facebook Messenger. Informal IT applications are usually free of charge for the organization.
Patterns of IT use	*A*	**Planned use of formal IT** applications to process information and support the execution of processes.
	B	**Planned use of informal IT** applications to process information and support the execution of processes
	C	**Emergent use of informal IT applications instead of formal ones** to process information and support the execution of processes.
	D	**Emergent use of informal IT in combination with formal IT** to process information and support the execution of processes.
		3rd round of data coding
Improvisation	**Bricolage/Tinkering*	Bricolage/Tinkering involves combining and applying known tools and techniques to solve new problems by people close to the operational level (Ciborra, 1992).
	**Triggers to improvisation*	Triggers to improvisation are events encountered in IS use where information cannot be properly processed through existing IT functionality or process design, thus leading to improvisation (McGann and Lyytinen, 2010).
	**Technology drifting*	Technology drifting refers to situations in which implementation processes move beyond original system design intentions involving unexpected outcomes of technology given unpredictable behaviours of both systems and humans, which require frequent adaptations and re-inventions of initial applications (Ciborra, 1997).
	**Care-taking*	Care-taking captures the idea that actors do not limit themselves to interacting with technological applications but, rather, they take an active role in relation to them – they take care of them (Ciborra, 1997).

Table 2: Data coding

*Note: the codes marked with an asterisk are literature-driven; the rest are data-driven.

4. FINDINGS

We present our findings in four sub-sections. The first describes the Olympic phases and information processing challenges in each. The second discusses the nature of operational processes executed by the Transport staff in each phase, particularly the use of various IT applications that supported the processes through the different phases; this allowed us to identify four patterns of IT use. The third sub-section describes these four patterns. The fourth sub-section discusses the application of the patterns of IT use over time across the different phases of the TO's work to support the changing mix of processes.

4.1 The Olympic phases and related information processing challenges

The Olympic Games took place in August 2016 and involved thousands of athletes competing in 306 events for 306 medal sets. The organization of this mega-event proceeded in four distinct phases, namely Planning, Venueization, Operation, and Dissolution, which are described in manuals developed by the IOC. The manuals define the various tasks and timelines of the OGOC in terms of when they should do strategic planning and operational planning, achieve operational readiness, and actually operate. The Transport Department worked in accordance with the four Olympic phases and was divided into two main operational areas: bus and fleet (cars and vans). The buses were provided by a bus consortium formed by 32 small and medium-sized local firms and the vehicles were provided by Nissan, one of the main sponsors. While the bus operation had dedicated drivers provided by the consortium, the fleet operation relied mostly on volunteers, who were not necessarily from Rio de Janeiro, but came from different parts of Brazil and from all over the world.

The Olympic phases were more than chunks of time and milestones; they involved distinctive goals with different sets of operational processes and information processing requirements. The Planning phase lasted from 2009 to March 2016 and included the understanding of the clients' needs, numbers, behaviours, and preferences, and of the numbers and types of events and locations, based on historical data, reports, and meetings. The Transport staff used this information to develop forecasts and plan the overall operational capacity (e.g. number of buses, cars, workforce, and infrastructure) necessary to meet the IOC's requirements. Activities in this phase also included hiring firms and defining the operational strategy for each transport service, which varied according to the

client (e.g. athletes, media, and dignitaries). During this phase, the OGOC used a centralized management structure; most departments were based in the same office.

'Venueization' is the term used by the International Olympic Committee (IOC) for the phase in which the venues are made ready to operate; it lasted from March to July 2016. General plans developed centrally were applied to operational units (venues). It was found that substantial changes were needed to be made to the plans at the point of execution. For example, planned check points had to be redefined or reduced in some venues in order to avoid traffic jams. During this phase, the staff were distributed across and worked from about 45 different physical locations. This phase was characterized by emergent conditions and thus new activities, as local teams tried to implement centralized plans and then modified them as necessary. There was also increased heterogeneity of team members as public and private organizations joined the OGOC to prepare the venues for actual operation during the Games.

The Operation phase was the one during the Games (July to September 2016). In this phase, processes that were planned in the previous stages were actually executed and put to work. For some of the interviewees, this phase represented a relief; for others, a great achievement; for yet others, chaos. One of the interviewees reported his experience from the 2012 London Olympics Organizing Committee. He was told: "*Be prepared for chaos! No matter how good your plan is, someone else's plan will not be that good and will impact your good plan*". Numerous and heterogeneous team members worked interdependently in this phase, leading to high levels of uncertainty in how to execute operational processes. Thousands of people from different departments of the OGOC, from public and private organizations, and volunteers from all over the world needed to work in synchronization to deliver different transport services for around 50,000 clients. The increase in the number of people compared to the Venueization phase was massive. "*An operational team of 10 people in May will have 2,500 in August*" (Paul – Transport General Manager). The distinguishing characteristic of this phase was the enormous time pressure for solving problems, for attending to changing requirements, and for tackling unforeseen demands – all in real time as the Olympic Games unfolded under the eyes of the entire world.

The Dissolution phase involved the 'disassembly' of the OGOC's structure as a whole (e.g. workforce, infrastructure, contracts, and technology). This phase lasted until the end of 2016, when the OGOC's operations as a private organization came to an end; i.e. legal, material, and financial dissolution. The management structure was centralized as people

returned to the central office. This phase was subject to strict deadlines to conclude all the activities of the Transport staff.

Based on interviews and fieldwork observations, we note that across the different phases, the main information processing challenges were caused by: (1) uncertainty due to task novelty; (2) time pressure because of the fixed deadlines; (3) heterogeneity of team members working interdependently; and (4) changing requirements in different phases. These challenges, together with the different Olympic phases, exemplify the dynamic nature of temporary organizations; i.e., they illustrate how TOs change over time as a result of changing organizational objectives. Consequently, the related operational processes also change. The next section examines these dynamics.

4.2 Operational processes

The OGOC executed different processes to accomplish the objectives of the different phases of work associated with providing transport. Three types of processes were evidenced: general processes, phase-specific processes, and new unforeseen processes (Table 3).

	Planning	**Venueization**	**Operation**	**Dissolution**
Phase-specific Processes			Client management	
		Logistics	Fleet management	
	Development of partnerships	Commissioning	Venue management	Decommissioning
	Development of IT solutions	Quality control and operational improvement	Quality control and operational improvement	Management of after-Games problems
	Rehearsal (macro-level)	Rehearsal (venue-level)	Security/Access control management	Reporting
General Processes	Training (in person and online)	Training (on-site)	Training (on-site)	
	Route planning	Route planning	Route planning	
	Risk management	Risk management	Risk management	Risk management
	Coordination	Coordination	Coordination	Coordination
	Budgeting	Budgeting	Budgeting	Budgeting

New Unforeseen Processes	Transportation of infrastructure staff	Hiring of drivers

Table 3: Exemplar processes related to the transport operation

The *general processes* were foreseen and planned ones, such as risk management and coordination, which were present in most or all phases. However, their nature changed over time to meet specific requirements in each phase. Consider the route planning process as an example. During the Planning phase, the routes were planned taking into account the IOC's guidelines, clients' needs in terms of volume and types of services, the locations of key hubs and garages, and the transport infrastructure and road system in the city and surrounding areas. In the Venueization phase, the planned routes were adapted and even redefined according to the specificities of each venue (such as size and number of sporting events held) and their surroundings. In the Operation phase, route planning involved adjusting and rethinking daily activities of signage and traffic diversion, as they happened, to take into account 'on the ground' emergent situations involving, for example, traffic conditions, protests, and accidents. Thus, general ongoing processes changed over time to meet specific requirements of the phases.

The *phase-specific processes* were foreseen and planned ones executed in one or a few phases, in order to accomplish the objectives of those phases. They included, for example, rehearsals in the Planning phase and commissioning (e.g. assembly of temporary physical structures) in the Venueization phase. During the Operation phase, examples of phase-specific processes included fleet management and venue management. During this phase, the number and variety of operational processes executed by the Transport staff increased significantly. The Dissolution phase involved specific processes such as decommissioning and management of after-Games problems.

In addition to the foreseen and planned processes (general and phase-specific), there were *new unforeseen processes* that could not be anticipated and planned for. The complexity and uncertainty of everyday contingencies (e.g. failures and new demands) gave rise to these processes, predominantly in the Venueization and Operation phases. During Venueization, last-minute infrastructure problems (e.g. water leaks and power failures in the Olympic Village, and damaged paving in the competition venues) created the need for immediate and substantial infrastructure work to make the venues ready to operate. As a result, a new process of planning and delivering transport services for third-party infrastructure staff (e.g. plumbers, electricians, and cleaners) emerged. During the

Operation phase, absenteeism among volunteers gave rise to a new process for hiring additional drivers through a third-party company to meet the urgent need for staff.

Emergence in processes happened in two different ways. The first was the *emergence of new unforeseen processes*, as described above. The second was the presence of *emergent elements in the planned general and phase-specific processes*. For example, in Venueization, it was found that airport signals interfered with the planned radio communication among staff and volunteers in the garage located near Rio de Janeiro's International Airport. Although the process of venue-level communication had been planned, this contingency could not be anticipated until the process was actually tested in the Venueization phase. Thus, alternative applications were used (e.g. Facebook Messenger and WhatsApp) by operating staff to share information about issues such as access rights to the garages, giving rise to an emergent way of using IT for communication at that particular venue.

From the examples presented in Table 3, we note that each Olympic phase had a *different* mix of processes – over time, some processes were continued, while others were discontinued, included (in planned or emergent ways) and/or adapted to meet the requirements of the phases of work. "*The Transport department is one of the most technology-dependent areas of the OGOC. It needs connectivity, telecom, systems, and IT in general mainly due to the dynamism involved in their processes. IT tools that enable rapid and accurate information-sharing are essential to support decision-making in real time*" (Robert – IT manager). Such interviewee insights together with fieldwork observations helped us understand that the dynamicity combined with emergence gave rise to varying information processing requirements over time, resulting in the use of different kinds of IT applications. We next examine the patterns of IT use observed.

4.3 Patterns of IT use

We found four patterns of IT use in the OGOC. These patterns reflect how IT was used by the TO's members. We describe these as: (A) *planned use - of formal IT*, (B) *planned use - of informal IT*, (C) *emergent use - of informal IT as a substitute for formal IT*, and (D) *emergent use - of informal IT combined with formal IT*. Planned use refers to foreseen and intended use defined by the organization's top managers centrally (i.e. top-down). Emergent use refers to unforeseen use defined by individuals on the ground locally (i.e. bottom-up). *Formal IT* refers to IT applications and tools that the OGOC developed or

purchased. Examples from our data include a vehicle tracking system and a GPS application. *Informal IT* refers to free-of-charge IT applications and tools that were not developed or purchased by the OGOC, such as WhatsApp and Waze.

4.3.1 Pattern A: 'planned use of formal IT'

Pattern A refers to situations in which people used **formal applications in a planned way** to process information and support the execution of their processes. An example was the Human Resources (HR) system that supported several HR processes, such as training. This formal application was used in all Olympic phases by staff in the Transport department and other staff in all functional areas within the OGOC. "*For me, this system was essential. Taking into account the size and geographical dispersion of Brazil, the size of the Games, and that we were going to have 40% of our volunteers coming from different parts of the world, I knew that we would need to implement e-learning courses to train people. Another key point was that we were able to integrate this system with other systems and with our portal*" (Valerie – HR General Manager).

Since the OGOC had limited resources, planned IT applications were relatively inexpensive. Interviewees suggested that it was not worth spending too much money on expensive solutions that would not be used for very long. The general approach was to look for existing or free tools available in the public domain, and if these were not sufficient to meet their requirements, to develop or purchase the simplest solutions. "*It does not make sense to spend a lot of money to develop a technological solution to use only for the organization of the Games. We use the tools that are available; we do not want to reinvent the wheel*" (Carl – Procurement Top Manager).

4.3.2 Pattern B: 'planned use of informal IT'

Pattern B refers to situations in which people used **informal IT applications in a planned way** to process information and support the execution of their processes. Such IT applications included WhatsApp[7], Facebook Messenger, Skype, Waze, Moovit, and

[7] **WhatsApp:** freeware and cross-platform instant messaging and Voice over IP (VoIP) service.
Facebook Messenger: instant messaging service and software application.
Skype: software that enables video and voice calls.
Waze: community-driven GPS navigation app that provides information based on user-submitted travel times and route details.
Moovit: public transit app and map service giving real-time public transit information and GPS navigation across different transit modes, including buses, ferries, metro, trains, trams, and trolleybuses.
Google Earth: computer program that renders a 3D representation of Earth based on satellite imagery.

Google Earth. The OGOC's top managers planned the use of these applications for supporting foreseen processes and the local operating staff were instructed, beforehand, to use them.

During the Venueization phase, many operating staff worked at dispersed venues such as streets and parking spaces (managing access) or in the vehicles (testing and adapting routes). They needed to communicate in-the-moment with one another across these venues, about infrastructure conditions, route delays, and necessary adaptations. Often, they did not have access to office email or office computing devices. Therefore, top managers planned for the use of informal IT applications such as WhatsApp and Facebook Messenger to support the process of venue-level communication in some locations. "*We needed technological solutions able to connect many people in different venues and on the streets. Staff and volunteers are usually on the ground, they do not have a computer to send an email, for example. Therefore, we decided to use more informal ways of communication and radios*." (Christine – Transport General Manager).

Another example of Pattern B was the security/access control management in the venues, a phase-specific process in the Operation phase. This process required real time information on traffic conditions and incidents for prompt decision making regarding venue access. The OGOC's top managers centrally planned the use of Waze to help operating staff identify possible traffic problems that could affect arrivals and departures of vehicles carrying athletes and officials to and from the venues. Using Waze, they gathered information from drivers en-route on the streets and, in case of accidents and other traffic disruptions, directed drivers to access the venues using alternate routes.

Interviewees considered the informal applications invaluable because they were free and because they knew how to use them, from experience of using them in their personal activities; people from different backgrounds could thus use them, which was important, because time pressures did not always allow for formal application training.

4.3.3 Pattern C: 'emergent use of informal IT as a substitute for formal IT'

Pattern C refers to situations in which people used **informal IT applications instead of formal ones in an emergent way,** to process information and support the execution of their processes. This is in contrast to Pattern B, where the use of informal IT applications was centrally planned by the OGOC's top managers.

In the Operation phase, there was a massive increase in the number and variety of processes and people, and a need for real-time response to situations. Furthermore, many

situations themselves were unpredictable and unanticipated. For example, during the Games, despite the overall planned timetable, clients could make changes in their transport service requirements for a given day, till 5pm the previous day. The formal application developed to support the process of route planning could not handle this dynamicity from last-minute unanticipated requests; the Transport operating staff could not use it to generate transport service orders (SOs). Therefore, they used Google spreadsheets instead, *"The system developed to generate the SOs did not work properly; it was not able to deal with the complexity involved in our operation during Games-time. Most of the time, the SOs had wrong information, especially regarding timetables, which compromised the whole operation. We had to double check every single SO; we could not rely on that system. Then, we gave up and started to produce them manually using spreadsheets"* (Emma – Transport analyst).

Patterns B and C (although both deploying informal IT applications) are distinct. Pattern B refers to the use of informal IT in a *planned way*. That is, OGOC's top managers planned for this use; it was a top-down initiative. Pattern C refers to the use of informal IT by individuals on the ground (i.e. operating staff and volunteers) in an *emergent way* in substitution for formal IT applications. This happened because unforeseen processes arose and also because foreseen processes changed. When the formal IT applications that had been planned by the OGOC's top managers were found inadequate for supporting these processes, individuals on the ground used alternative applications that were at hand. The time-limited duration and dynamicity of the operations did not allow them to wait for formal IT applications to be procured; they had to carry on their activities anyway. Therefore, the emergent use of informal IT was not only observed in support of new unforeseen processes, but also in support of foreseen processes that did not work out as planned.

4.3.4 Pattern D: 'emergent use of informal IT combined with formal IT'

Pattern D refers to situations in which people used **informal IT combined with formal IT in an emergent way** to process information and support the execution of their processes. As an example, the Operation Control System (OCS) was a formal enterprise system developed in house and used by members of the Transport staff to support the processes of communication and coordination of activities during the Operation phase. For example, if there was a disruption because of a protest event against the government that blocked some streets, information needed to be disseminated to various people in

multiple venues at the same time. The Transport staff would then 'post' the issue on the system and 'tag' people (usually managers), who would receive notifications. After seeing this notification, the people in charge, who could be in different locations, would add information about what should be done or simply say that the problem had been solved. The OCS was a rich repository of data; it allowed staff to gather information about several issues important to transport activities during the Olympic Games. Its features and interface were similar to Facebook.

However, access to this system was limited mainly because of security issues – i.e. it was an IT application planned to be mostly used by people at the managerial level. The OGOC's top managers could not foresee everything that would happen during Games-time on the ground; they did not realize how many operating staff and volunteers would need to share information and report situations through the system. To face this, the local team of the Transport department at one of the venues, the Olympic Park, created a WhatsApp group for the volunteers and staff who did not have access to the system so that they could share information. A person in the office within the Park was in charge of monitoring this group. She would then add the information from the WhatsApp group to the OCS. This combination of informal and formal IT facilitated the execution of processes such as coordination and scheduling, by multiple people working in a decentralized way.

4.4 IT use over time

We found that the different phases of work had the presence of different patterns over time (Figure 1). Patterns A and B were present in the Planning phase; A, B and C in the Venueization phase; A, B, C and D in the Operation phase; and A and B in the Dissolution phase. The curved line represents the relative number and variety of operational processes in each phase (presented in Table 3 and Section 4.2). We observe that as the number and variety of processes increased or decreased, so did the number of patterns. We examine these temporal dynamics below.

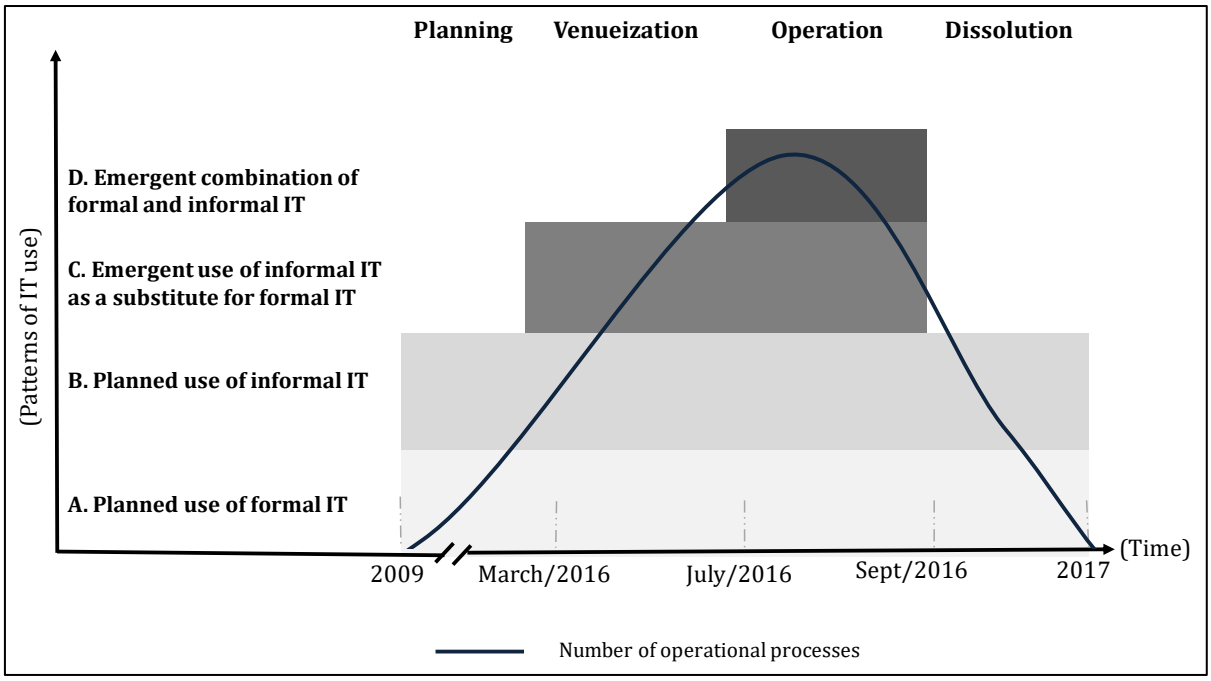

Figure 1: Patterns of IT use over time

In the **Planning** phase, a navigation system, developed by an outsourcing vendor, supported the route planning process. Through this system, the Transport staff analysed information about the city map of Rio de Janeiro and the Olympic route network. Based on this information, they planned the routes, the sites for local garages, parking spaces and loading zones, locations of competitions, timing of routes, and defined special Olympic lanes, taking into account the clients' requirements and the International Olympic Committee's rules. Referring to this system, Adam (IT analyst) said: *"in order to provide information for planning, we needed to map and simulate 4,000 routes at the same time. We would never be able to do it without that system"*. This is an example of Pattern A. One of the Transport managers said that 90% of the activities related to the simulation of routes was conducted in an office using open domain information available through applications such as Google Earth and Open Street Map – this is an example of Pattern B. After completing the operational plans using these tools, the Transport staff only needed to visit the premises to conduct tests and identify necessary adjustments. The use of these informal IT applications reduced massively the time and resources spent in on-site visits, for example. "*Especially the availability of many open and free platforms and technological tools facilitated the planning and the execution of the transport operation in Brazil. In London 2012, for example, many of these tools were not available*" (Mark – Transport General Manager).

The **Venueization** phase had decentralized operations and new and diverse processes. Formal and informal applications used in the Planning phase could not fully support information processing requirements of this new mix of processes. In addition to Patterns A and B, this triggered the additional Pattern C. For example, the Transport staff, who had all worked in the same central office in the Planning phase, had to move to different locations in the Venueization phase. Further, numerous volunteers and new staff joined the Transport department, which meant that not all new staff and volunteers were included in the formal HR system previously discussed. Thus, there emerged the need for a flexible and easily managed process of rotation planning and control at the venue level. For this, instead of using the HR system, Transport coordinators used Google spreadsheets to facilitate the allocation of staff and volunteers and to control working hours in each venue.

In the **Operation** phase, there was a massive increase in the diversity of processes and number and heterogeneity of both employees and volunteers. *"In the beginning of the Operation phase, we had many changes and adjustments to meet new requirements. We changed processes that had been planned before and we also implemented new processes that had not been planned. These impacted directly in our systems, which required time and joint efforts in order to adjust them properly"* (Peter – IT manager). The IT solutions used in the Venueization phase did not fully meet the requirements of the new mix of processes in the Operation phase, especially because of the increase in the number and type of operational processes that needed to be executed during Games-time. Further, managers did not have enough time to train people, particularly the huge number of volunteers, to use formal applications, to test and adjust the processes properly, and to allow the IT systems to mature. *"Every system needs to be properly configured and parameterized for your needs in order to work well. We did not have enough time to do this and the requirements changed constantly over time. In some cases, the system was running and at the same time, we were setting it up. It was like changing tyres on a moving car."* (Margaret – Transport coordinator).

In this phase, we identified all patterns – A, B, C and D. An example of Pattern A is a tracking application to support the process of fleet management. This application allowed the Transport team to control and access each bus in real time, which also allowed the execution of contingency plans. For instance, if there was an accident and a road needed to be blocked, they would know which buses were around that road and would be affected. They could direct the drivers to alternative routes. Additionally, through alerts (green, yellow, and red) they could assess the travel status of specific routes, which facilitated

routing decisions. An example of Pattern D is the use of the tracking system (formal IT) in combination with Twitter (informal IT) by OGOC's staff and volunteers. This combination allowed them to monitor 7,000 pre-defined Olympic routes and track all the vehicles in real time as well as to gather information about problems reported by drivers on the streets. The use of both types of IT allowed them to tackle the scale and complexity of the Operation phase by identifying problems in real time and taking prompt action.

During the **Dissolution** phase, we observed only patterns A and B, primarily because a number of processes from Venueization and Operation were not present in this phase. The number and variety of processes decreased, as did the number of people executing them. Those processes that remained were foreseen and had already been accounted for during the Planning phase.

5. DISCUSSION

"*How does use of IT support the execution of processes in temporary organizations*?" In studying the OGOC as an exemplar TO, we find three insights. First, individual phases of work in TOs have a different mix of processes – general processes, phase-specific processes, and new unforeseen processes. Second, in order to support information processing for the execution of these processes, formal and informal IT applications are used in planned and emergent ways. This was manifested through four patterns of IT use in our empirical setting. Third, the mix of processes changes over time and so do the patterns. We next discuss these findings and related theoretical insights.

5.1 IT use in TOs is both planned and improvised

The four patterns show planned and emergent ways of using formal and informal IT applications. Pattern A (planned use - of formal IT) is an example of how IT is used to support the execution of typical organizational processes (Tallon, 2008, 2012). OGOC's top managers could foresee the specific processes, for which they planned for IT applications accordingly. Pattern B (planned use - of informal IT) is an example of what we term as 'planned improvisation'. Pattern C (emergent use - of informal IT as a substitute for formal IT) and Pattern D (emergent use - of informal IT combined with formal IT) show how individuals on the ground used IT in a situated way on the spur of the moment (Ciborra, 1996; Weick, 1998); thus we frame them as 'emergent improvisation'

The improvised character of IT use evidenced in Patterns B, C and D, can be interpreted as examples of 'bricolage' and 'tinkering' (Ciborra, 1996), whereby organization members combined their knowledge of known IT tools (informal or formal) and applied it to the processes. While patterns C and D are forms of emergent improvisation driven by individuals on the ground (operating staff and volunteers), Pattern B is organizationally planned improvisation driven by top managers. Given their finite time duration, TOs may not have time and expertise and/or may not want to commit the resources to develop many formal IT applications and train TO members to use them. They may plan for the use of IT applications that are available for free (e.g. Facebook and WhatsApp), which need less time and expertise to deploy and which TO members may already know how to use, in the non-work domain. Thus, Pattern B is planned, because the OGOC top managers planned (in the Planning phase) for open domain and free applications to be used for particular processes and activities. It is also improvised, because this use was triggered by the need to solve problems and address opportunities quickly under time pressure, and, at the same time, by the lack of time or finances to plan for formal applications. Furthermore, the informal IT was not integrated into the planned IT infrastructure of the organization, and thus did not conform to the requirements of formal IT such as integration, interoperability and security. The notion of 'planned improvisation' is in consonance with studies that suggest improvisation can be both an unpredictable (Ciborra, 1999) and a deliberate activity (e.g. Moorman and Miner, 1998; Weick, 1998).

Work in TOs requires substantial levels of ad-hoc task execution and problem-solving which cannot be easily planned for (Bakker, 2010; Burke and Morley, 2016). The active role of people in using multiple IT applications to address this can be interpreted as an example of 'care-taking' (Ciborra, 1997). In our study, care-taking meant that IT users did not passively use the applications provided to them in the way they were trained or asked to. Rather, they proactively and of their volition, engaged with both formal and informal applications, to come up with different ways of use. In particular, the active engagement with informal IT was possible in large part because people used them in their everyday lives outside the OGOC, and thus knew how to use them. Therefore, IT use was partly influenced by the requirements of the operational processes in each phase and partly by the users' previous knowledge of using IT.

5.2 IT use is dynamic

The four patterns identified are shaped by TOs 'distinctive characteristics of *time*, *task*, *team* and *transition* (Lundin and Söderholm, 1995) as we explain below.

With respect to *time*, TOs exist for a limited duration with no expectation of operational continuity beyond that. Therefore, it may not be worth expending resources to develop an expensive IT applications portfolio or to train organizational members. This can lead to the planned use of free/open domain IT – as evidenced through Pattern B. Moreover, it is likely that tasks need to be accomplished quickly, such that if the planned use of either formal or informal applications is not sufficient, emergent use of informal applications, either separately (Pattern C) or together with formal applications (Pattern D) would take place, given the lack of time to plan for and develop new applications.

With regard to *task*, TOs' tasks are complex, novel, and uncertain. There will be emergent processes because not all processes can be anticipated. Even the processes that can be anticipated will not always take place the way TOs planned them. Thus, it is highly likely that the planned use of formal and informal IT (patterns A and B) will not be sufficient to address the information processing requirements of emergent processes (new unforeseen ones) and of emergent elements in foreseen processes, giving rise to the improvised patterns of IT use C and D.

With regard to *team*, the diversity and non-permanence of team members suggests there will be a lack of uniformity in abilities to use formal IT because all members may not have the same technical skills and training. Thus, the use of informal IT, especially those used widely in the non-work domain such as social networking and navigation (e.g. WhatsApp, Waze, and Google Earth) and which team members are already familiar with is likely. Moreover, given their familiarity with such applications, it is also likely that they are able to use such IT in an improvised way, instead of the formal applications that may be harder to use, leading to Pattern C. Further, team members are easily able to find common ground (Srikanth and Puranam, 2011) for improvisation, based on their tacit knowledge of the applications from use in the personal domain. When faced with formal IT applications that partially support or do not support their work, instead of turning to other formal IT, they are more likely to improvise with the informal IT that they are familiar with, leading to Patterns C and D.

IT use in TOs changes over time to address information processing requirements of changing processes. The *transition* (Lundin and Söderholm, 1995) aspect of TOs can

explain this dynamic nature. The use of IT supported the execution of processes in each phase, and over time across phases, as new processes came about from one phase to the next in both planned and emergent ways. This dynamic nature of IT use in TOs was manifested through: (1) **different patterns of IT use** over time; and (2) **different informal applications being added to the formal IT infrastructure** over different phases.

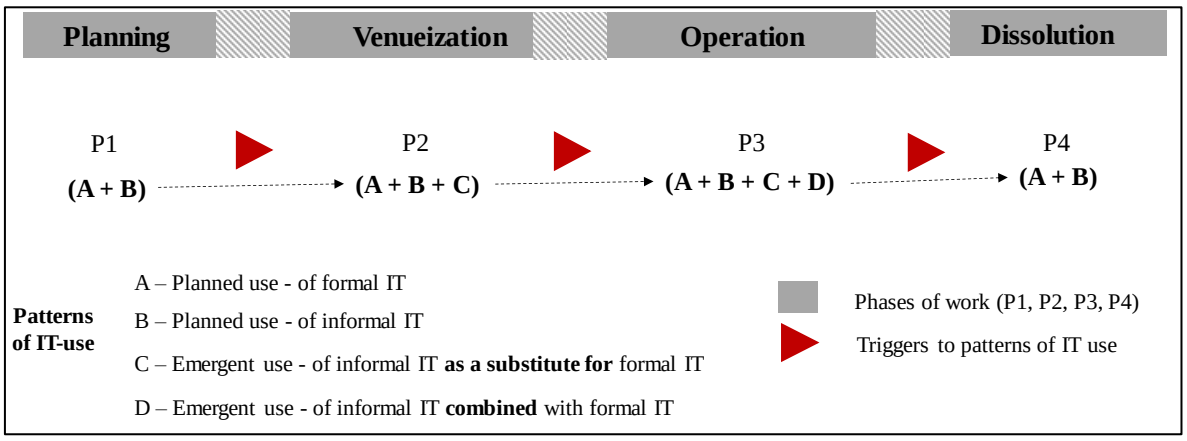

Figure 2: IT use over time

Speaking to (1), seen in the framing of improvisation (Ciborra, 1996; Orlikowsi, 1996; Weick, 1998), IT use in TOs can be seen as difficult to foresee and control, filled with surprise, and tied to the foreseen and unforeseen process changes necessary in TOs. Thus, different patterns of IT use are triggered (Figure 2). Although the OGOC planned to use of formal and informal applications in the Planning phase for general and phase-specific processes (patterns A and B), time pressure and uncertainty created new unforeseen processes. The decentralized nature of the Venueization phase triggered pattern C because the TO's members were dispersed across locations and did not always have access to the planned applications. The transition from Venueization to Operation marked a massive increase in the number and diversity of processes and heterogeneity of TO members (employees and volunteers). Further, because of the time-bound Games' events, operations could not stop. TO members emergently used whatever (formal, informal) applications they found helpful, resulting in patterns C and D. When the Operation phase transitioned to the Dissolution phase, the processes that remained had already been accounted for during the Planning phase. Therefore, patterns A and B were enough to support them.

Speaking to (2), as the phases progressed over time through increasing decentralization and scale, TO members used more informal applications. The IT infrastructure of the

OGOC became a combination of use of both formal and informal IT; it started to 'drift' (Ciborra, 1996). Literature cautions that such drift can lead to lack of, for example, integration, interoperability, compliance, security, and data accuracy/traceability. However, the distinctive character of TOs is to execute a novel task within a limited time. The benefits associated with drift, such as flexibility of application use and timeliness of information processing, may perhaps be more salient than those from a standardized and tightly integrated IT infrastructure. The latter, although efficient, can be expensive and rigid. Indeed, we find in our study that the combination of informal and formal applications enabled the execution of multiple and decentralized processes by a massive number of highly heterogeneous TO members. The acceptance of drift may thus be a pragmatic route for TOs so long as their task is accomplished; they are in any case, of finite duration, to begin with.

5.3 Linking patterns of IT use to processes

TOs can have three different types of processes: foreseen general processes, foreseen phase-specific processes, and unforeseen new processes. The number of these processes varies across phases. Emergence exists in both the unforeseen and foreseen processes. The former, because they are new and unexpected, the latter because even while foreseen, unknown and unanticipated factors might emerge prior to or during their execution. We suggest that different patterns of IT use are linked to different types of processes.

Pattern A (planned use - of formal IT) is more likely for foreseen general processes and for key foreseen phase-specific processes. For processes that will be needed during all phases of the TO's work and for the most important phase-specific processes, it is sensible to purchase or develop formal IT applications to support their execution. In our empirical setting, this pattern was evidenced in all phases of work. Pattern B (planned use - of informal IT) is more likely for foreseen phase-specific processes. For processes that will be needed only in specific phases it may not be possible to purchase or develop an IT application because of time and resources restrictions. Therefore, planning the use of informal applications that are free/open domain is likely. In our empirical setting, this pattern was evidenced in all phases of work. Pattern C (emergent use - of informal IT as a substitute for formal IT) is more likely for new unforeseen processes and for foreseen processes that did not work out as planned. For the first, it is not possible to foresee and plan for all information processing requirements and IT applications. Thus, it is more

sensible to use informal IT applications, especially the ones that may be familiar to users, instead of waiting for formal ones to be developed or purchased. For the second, emergent elements need to be tackled, which the planned formal IT applications cannot always do. TO members on the ground are thus likely to use informal IT applications instead, so that their activities are not interrupted for lack of IT applications. In our study, this pattern was evidenced mostly in the Venueization and Operation phases. Pattern D (emergent use - of informal IT combined with formal IT) is more likely for foreseen processes that do not work out as planned. The planned formal IT applications could not alone tackle the massive and quick increase in the size and complexity of operations during the Operation phase, where this pattern was evidenced. This led to use of informal IT to complement formal IT; the former supported the execution of the processes quickly and at scale.

Based on the above, we suggest a possible generalization regarding associations between the types of processes in TOs and types of patterns of IT use. In the phases with mostly foreseen processes (either general or phase-specific), the patterns A and B are likely to be prominent. In the phases where there is emergence (new unforeseen processes and emergent elements in foreseen processes), the patterns C and D are likely to be present. The emergence can trigger new information processing requirements, which in turn give rise to these more improvised patterns – that of informal IT either in substitution or in combination with formal IT.

6. THEORETICAL CONTRIBUTIONS AND IMPLICATIONS FOR PRACTICE

Our study explains the planned, improvised and dynamic nature of IT use to support TOs' varying processes over time, revealing a complex and nuanced picture of IT use in TOs. We highlight below the study's contributions and implications for practice.

6.1. Theoretical contributions

We explain how TOs tackle the information processing challenges of a changing mix of processes over time, through different patterns of IT use. We go beyond the descriptions of use of various IT applications found in the literature, to identify specific patterns of IT use and to show how they address the distinctive conditions facing TOs (i.e. a novel task done in a finite time, by multiple and heterogeneous people, across different phases of work) and its dynamic mix of processes. The notion of patterns of IT use is theoretically

significant because it focuses not just on use, but on the *nature of applications used* (formal and informal) and *how they are used* (planned and improvised), both of which are necessary to understand and tackle the particular conditions facing TOs. We thus develop a novel theoretical explanation of how use of IT supports the TOs' processes over time.

The *type of application* (formal/informal) is theoretically significant because TOs have time and resource restrictions. The use of applications that the organization did not develop or purchase is necessary in order to balance process needs such as coordination of time-sensitive activities, and the costs of developing formal applications for short periods. The literature describes the use of applications such as WhatsApp and Facebook in TOs (Haavisto et al., 2016; Li et al., 2014; Tatham and Christopher, 2014). We go further by theoretically explaining why and how they are used, as a substitute for and/or in combination with formal IT applications. The use of informal IT implies infrastructure drift (Ciborra, 1997). Perhaps inevitable in TOs, such drift is not necessarily a destructive force. It can help to 'flex' the formal IT infrastructure so that it can accommodate and adjust to the changing information needs associated with the changing mix of processes. The temporal finite-ness of TOs may mean that negative effects of drift such as potential compliance and security breaches may have less of a time-window to occur in, or that the costs of duplication may not be played out over a long time. However, we also note that negative outcomes, if they happen, are also less likely to be resolved.

The *type of use* (planned/emergent) is theoretically significant because of the coming together of TOs' operational specificities such as task urgency and novelty, time pressure, process dynamicity, and organizational members' heterogeneity. In such situations, IT use improvisation increases the TO's capacity to process information quickly and at scale. It helps them deal with uncertainty (Galbraith, 1973) by enabling quick information capture and dissemination, and with equivocality (Daft and Lengel, 1986) by making information available from different sources so that TO members can make sense of it.

We reveal contextual novelties with respect to the literature on IT improvisation. Unlike in enduring organizations where IT improvisation is shaped primarily by learning (Miner et al., 2001), in TOs it is driven by the urgency for accomplishing the final task. Further, 'planned improvisation', evidenced in Pattern B and that incorporates planned use of informal IT, is both planned and improvised. It is planned because the OGOC's top managers organizationally planned the use of informal IT applications for supporting specific processes. At the same time, it is improvised because this use was triggered by

the need to solve problems and address opportunities quickly under time pressure, and by the lack of time or finances to plan for formal applications (Cunha et al., 1999; Moorman and Miner 1998; Pavlou and El Sawy, 2010). Thus, it shows IT use improvisation that is organizationally planned by top managers – a theoretically novel idea with respect to improvisation that is linked to the context of the TO's characteristics such as finite-ness and heterogeneity of team members. This idea complements the notion that improvisation can be both an unpredictable (Ciborra, 1999) and a deliberate activity (e.g. Moorman and Miner, 1998; Weick, 1998), and can incorporate paradox pairs (Mirvis, 1998; Molnar et al., 2017; Zheng et al., 2011). Additionally, we reveal that IT improvisation can be dynamic and evolving in nature to support the changing requirements of different processes across TOs' phases.

The literature examines IT use in TOs in a given phase of work, mostly in the operation phase (e.g. Tatham and Christopher, 2014). Our study of all the phases of the OGOC provides a theoretically more complete and nuanced explanation of the linkages among the changing mix of processes, emergence in processes, and the corresponding evolutions in patterns of IT use over time. To the best of our knowledge, this is one of the first studies that examines contingence with respect to an organization's dynamically changing operational transitions and process characteristics over time, planned use of IT, and IT use improvisation. Examining TOs longitudinally provided this theoretical opportunity.

6.2. Future research

Our findings are transferable to TOs that are similar to the OGOC, in terms of particular features, such as temporariness of structure and organizational affiliation of staff, and different phases and processes over time (e.g. task forces, disaster responses, and film sets). We have studied a TO wherein both the structure and the organizational affiliation of staff were temporary. Future research can examine IT use in other types of temporary settings where either of these may not be temporary (Bakker et al., 2016). For example, in-house software project development teams constitute temporary structures but have permanent employees. In contrast, IT outsourcing teams constitute long-term structures and contracts but have people who may be temporary. Studies can also investigate the intended and unintended outcomes of IT use improvisation, including its effects on the TO's performance. Furthermore, in this study we focused on the different phases of work. Future studies could dig deeper into the transitions between the phases, examining the changeovers and triggers vis-à-vis the new patterns in the next phase in

greater detail. Other research avenues include the study of interaction between different patterns of IT use, how TOs can manage the portfolio of formal and informal applications, and how they can leverage the benefits and reduce the risks and limitations of IT use improvisation.

6.3. Implications for Practice

Those managing and working in TOs need to be mindful that the use of IT to support TOs' processes is complex – both planned and improvised use is present and the mix changes over a relatively short period of time. While some IT applications can be anticipated and planned accordingly, organizational flexibility and individual autonomy are necessary to enable and empower TO members to undertake unplanned and improvised use of IT that may or may not have been a part of the TOs' originally planned portfolio of applications at its inception. Although the use of informal IT can facilitate real time information sharing and quick decision making, managers need to be aware of risks associated with such IT such as loss of data, miscommunication, lack of traceability, and security breaches. One way of mitigating such risks is to guide and train users or at least team leaders, especially newly hired staff, on such risks. Additionally, it is worth classifying information in terms of sensitiveness and relevance and framing standard handling procedures. For sensitive information, restriction of access may be necessary. For highly relevant information, compulsory reporting through formal IT may be a way to prevent loss of data and lack of traceability. Those managing the TOs' IT infrastructure should be alert to the effects of drift borne out of improvisation and to the potential lack of compliance and security, which can prevent the TO from executing its task. It is also worth noting that although freely available informal IT applications such as Facebook Messenger and WhatsApp have been around for some time, such applications continually emerge (and fade out) subject to the business models of their providers. There is a trade-off between their low monetary cost and potentially high cost of disruptions of service that are beyond the control of the TO. Thus, there is a need to be vigilant about the extent they are planned to be used. Finally, planners of similar TOs as the OGOC can use our findings to anticipate which patterns of IT use may be needed at different stages of the TO, by identifying the extent of occurrence of the corresponding types of process – foreseen general, foreseen phase-specific, and new-unforeseen.

In conclusion, TOs are distinctive and increasingly prevalent organizational forms – they are created, operate and are disbanded, with the objective of accomplishing a task that is complex. Our study examines how the use of IT complements and resonates with the temporal dynamicity of TOs. In doing so, it develops theoretical and empirical understanding of the planned and improvised nature of the use of formal and informal IT applications in temporary organizational forms.

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APPENDICES

Appendix A: Interviews schedule

Date	Interviewees' pseudonyms	Venues where the interviews took place	Interview duration (min.)
January 11th, 2016	Jimmy	Central Office	28
January 12th 2016	Carl	Central Office	52
April 18th 2016	George	Via Skype	26
April 27th 2016	Mark	Via Skype	37
May 5th 2016	Paul	Via Skype	58
July 28th 2016	Christine	Garages	86
August 7th 2016	John	Central Office	47
August 8th 2016	Jenny	Garages	59
August 9th 2016	Roger	Olympic Park	68
August 10th 2016	Philip	Olympic Park	43
August 11th 2016	Margaret	Garages	45
August 12th 2016	Peter	Central Office	56
August 13th 2016	Robert	Garages	168
August 14th 2016	Steve	Olympic Park	46
August 15th 2016	Nicholas	Garages	126
August 16th 2016	Emma	Garages	44
August 17th 2016	Mathew	Central Office	60
August 24th 2016	Rosie	Olympic Village	51
August 30th 2016	Valerie	Central Office	31
August 30th 2016	James	Olympic Park	16
September 2nd 2016	Bryan	Olympic Park	43
September 2nd 2016	David	Olympic Park	73
September 2nd 2016	Claire	Olympic Park	39
September 4th 2016	Anna	Olympic Village	31
September 4th 2016	Mary	Olympic Park	76
September 4th 2016	Adam	Garages	28
September 5th 2016	Sarah	Olympic Park	45
September 5th 2016	Alex	Olympic Park	43

Appendix B: Interviews questions

Part A: Knowing the organization and the interviewee (general/open questions)

1. Could you tell me about your job during the Olympic Games? For example, what you do, how long you have worked here?
2. If you have previous experience in mega-events or in transport, how does this compare?
3. Please describe the transport operation (e.g. how it is organized, its main clients and services, structure in terms of human and physical resources, and other departments it interacts with).
4. What are its main goals, processes, and activities and how are they achieved?
5. What are the main operational challenges and how do you tackle them?
6. Could you describe the objectives, processes, and challenges of the transport operation before, through and after the Olympic Games?

Part B: Understanding the use of IT (questions based on the literature on IT use)

7. Do you use any IT applications and tools to get your work done? Which ones?
8. For which tasks do you use them? Do they really help? If yes, how? If not, why?
9. Did you know how to use them before or did you learn here?
10. Did you have any kind of training on how to use these IT applications?
11. Do you have the necessary IT applications to accomplish your work? If not, which additional ones would you like to use?
12. Could you describe your IT use across the different phases of work?

Part C: Understanding people's attitudes towards IT-related problems/failures (questions inspired on the IT improvisation literature)

13. What happens when you do not have the IT applications you need? Could you describe a situation when this happened? What did you do to overcome this?
14. What happens when an IT application does not work properly? Could you describe a situation when this happened? What did you do to overcome this?
15. What were the challenges and opportunities you faced with using IT for your work through the different phases of the Olympic Games? How did you overcome the challenges?

Appendix C: Exemplar Codes

Exemplar codes	*Representative quotes*
Uncertainty	*"We do not know exactly what is going to happen in the next day. We have planned everything, but the clients can ask for adjustments until 5 pm in the previous day and they always change everything" (Christine – Transport General Manager).* *"We do not have any control over the demand. We know the maximum number of people that can be in a specific venue (based on the number of seats, for example). However, we will never know if all these people are going or not" (Claire – Transport Manager).*
Time pressure	*"The last months were very intense, everything had to be ready. Sometimes, you can postpone a project deadline, but you cannot postpone the Olympic Games. I used to tell my team: it is not going to start on August 6th nor August 7th; it is going to start on August 5th!"* (Paul – General Manager of a TO). *"Many new demands emerged during the operation. If a problem happens during the operation, you need to solve it immediately; you cannot waste time. Therefore, the transport operation needs flexibility and rapid response"* (Emma – Operating staff of a TO).
Pattern of IT use C (use of informal IT *instead* of formal IT)	*"The institutional system developed to generate order services did not work properly. So, we decided to do it manually in an Google spreadsheet printed file"* (Rosie – Operating staff of a TO).
Importance of IT	*"The Transport department is one of the most technology-dependent areas of the OGOC. It needs connectivity, telecom, systems, and IT in general mainly due to the dynamism involved in their processes. IT tools that enable rapid and accurate information-sharing are essential to support decision-making in real time"* (Robert – Manager of a TO).
Decentralization	*"People are not in their offices anymore; they are on the ground operating and rarely open their emails. Therefore, we have been using WhatsApp a lot to facilitate the work in different operational cells. We have different groups for different purposes"* (Mark – General Manager of a TO).
Transitions	*"During venueization, the venues are prepared for operation. In this phase, we were split into more than 40 operational units around the city. These units had similar structures of functional areas, of course taking into account specificities of some venues"* (David – Manager of a TO).

Appendix D: Example of data organization

	A	C	D	E	F	G	H	I
1				Most used IT applications				
2	Interviewee	Tracking system	Navigation System	OCS	HR system	WhatsApp	Waze	Facebook
3	I1	YES	YES	YES	YES	YES	YES	
4	I2	YES			YES	YES		
5	I3	YES	YES	YES	YES	YES		
6	I4		YES	YES	YES	YES		YES
7	I5			YES	YES	YES		YES
8	I6			YES		YES		YES
9	I7					YES		YES
10	I8	YES	YES			YES	YES	YES
11	I9	YES	YES			YES	YES	
12	I10			YES		YES	YES	YES
13	I11	YES	YES	YES		YES		YES
14	I12					YES	YES	
15	I13		YES	YES	YES	YES	YES	
16	I14	YES			YES			
17	I15	YES	YES	YES	YES	YES	YES	
18	I16					YES		YES
19	I17					YES	YES	YES
20	I18					YES	YES	YES
21	I19					YES		YES
22	I20					YES	YES	YES
23	I21					YES	YES	
24	I22					YES	YES	YES
25	I23					YES	YES	YES
26	I24					YES		
27	I25	YES				YES	YES	
28	I26		YES		YES		YES	
29	I27	YES	YES				YES	
30	I28	YES	YES				YES	YES

"In the beginning of the Operation phase, it was super complex and chaotic... everybody was tense. We had many issues that required fast decision-making. I believe chaos leads to good ideas. So, we had the idea of using WhatsApp, an application that everyone uses nowadays, and it worked pretty well! It allowed us to gather and share information to solve several issues in real time. When there was something more sensitive that needed to be registered, we would formalize it by email later on" (John – Transport Manager).

Appendix E: Examples of IT applications

Formal IT applications (developed or purchased by the OGOC)	Informal IT applications (not developed nor purchased by the OGOC)
Operation Control System	Facebook Messenger
Vehicle Tracking System	Waze
Human Resources System	Moovit
Radios	Google Earth
System to generate service orders	Twitter
Navigation System	Google spreadsheets
Institutional emails and computers	Open Street Map
Procurement Portal	Personal mobiles