Communication tools used by distributed teams in a BIM learning project

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Abstract

The constant changes in the world market demand flexible and fluid organizational structures, such as rotating and engaging human effort, to provide high performance. Therefore, organizations make use of distributed multicultural teams, meetings, and online lead projects. However, these social categorization processes can become a disadvantage if trigger potential conflicts during task performance. Distributed teams can also be difficult to manage, and their members can face extra adversities in communication. Architecture, Engineering and Construction Industry (AEC), is a context where the use of distributed teams is growing significantly, particularly through the enabling features of Building Information Modelling (BIM) methodologies. This paper was aimed at the diagnosis of communication behaviour in distributed teams in the context of a PBL methodology that requested students to work in distributed teams on two distinct locations. For that, the authors managed a workshop on Lean Project Management and Collaborative Tools in the European Master in Building Information Modelling (BIM A+) using a Lego for Scrum activity, adapted to a team of students distributed in Portugal and Slovenia. After that, nine distributed teams of students had to design exposition pavilions in BIM platform and using collaborative tools. At the end, each team had to present the project for the entire body of students and faculty, located in Guimaraes (Portugal) and Ljubljana (Slovenia).

Keywords: Distributed teams; Communications tools; Agile Project Management; Lean project management

1 Introduction and Motivation

Projects, as a temporary endeavour developed by a team to deliver a new result or product, may be managed with different approaches, from more predictive models to more agile models (PMI, 2017). The agile models are related to the need to cope with fast changing requirements and the desire to satisfy the client during those changes. Lean Production is an organizational approach that resulted from the Toyota Production System (Escudeiro, Escudeiro, Barata & Lobo, 2011), which main goal is "doing more with less", where less means less human effort, less stocks, less resources, less space, less product development time. This paradigm evolved to a set of concepts and tools that were one of the inspirations of Agile Project Management approaches (Sutherland & Sutherland, 2014). Thus, agile and lean can be seen as similar approaches to project management, developed with similar goals. In some way, it can be said that, if a project is planned to deliver the product while minimizing waste, it's directed to be a 'lean' project. Wastes are all activities that do not add value from the client's point of view (Escudeiro, Escudeiro, Barata & Lobo, 2011). This is the first principle of Lean Thinking: Value that derives from Lean Production (Georgios, 2014).

In the BIM (Building Information Modelling) environment, the concept of lean management is one of the factors that allows to increase efficiency and improve the quality of projects (Koskela, 2000). According to (Gupta & Moon, 2019) and (Alizadehsalehi, Hadavi & Huang, 2019), lean construction approach allows project management at their early stages, which facilitates their control and quality.

Today's world with constantly changing organizational structure requires flexibility and fluid teams with rotating and evolving team memberships (Moe et al., 2015). While organizations aim to utilize multicultural distributed teams to achieve better performance, that social categorization processes may render diversity a disadvantage as it increases the potential for relational conflicts that are detrimental to task performance

(Harush, Lisak & Glikson, 2018). Distributed teams can be difficult to manage, and their members can face extra difficulties in communication (Da Silva, Costa, França & Prikladnicki, 2010).

To mitigate these impacts, there are several aspects to consider for lean project management applied in distributed team. Therefore, it is very important to implement tools for systemizing communication in distributed teams.

In order to study this theme, this article intends to evaluate how project management tools can be used to foster collaboration in distributed teams, through the implementation of BIM learning projects with teams distributed in two different countries while developing the same project.

The object of study is the project "BIM A+", an international Master's Course in Building Information Modelling (http://www.bimaplus.org). The Master offer an advanced education programme on BIM integrated design, construction, and operation processes, with a strong focus on the collaborative practices that are the cornerstone of such integration. The Master combines the diversity of expertise at leading European universities in the relevant fields, offering education oriented to a multidisciplinary understanding of virtual construction through the involvement of experts from complementary fields (engineers, architects, programmers and others). BIM A+ has three main consortium partners that hold responsibility for teaching: (i) the University of Minho in Portugal (UMinho, which is the coordinating institution); (ii) the University of Ljubjana in Slovenia (UL); and (iii) Politecnico di Milano (PoliMi) in Italy. The Master has two semesters of duration, comprising a 1st semester of coursework (October to March), and a 2nd semester for dissertation preparation (March to July). The coursework comprises six modules (5 ECTS credits each), delivered in sequential manner, and labelled from BIM A+1 to BIM A+6:

- BIM A+1 Management of Information and Collaboration in BIM
- BIM A+2 Modelling in Architecture and Engineering
- BIM A+3 Parametric Modelling in BIM
- BIM A+4 Advanced BIM Data Systems and Interoperability
- BIM A+5 4D, 5D, 6D Modelling and Applications
- BIM A+6 BIM based Rehabilitation and Sustainability analysis

In the school year 2019/2020 (the inaugural year of the Master), the coursework of the first semester was delivered in synchronous manner at two coursework locations: UMinho and UL. A total of 42 students were attending the course, with 27 of them located at UMinho and 15 located at UL. Synchronous teaching was assured with the support of videoconferencing and mobility of staff, as to ensure that all students had personal contact with the teaching staff. The background of students was diverse, but most of them were either Architects or Civil Engineers. Nationalities were very diverse as well, with students coming from most continents: Europe, America, Africa and Asia.

The object of analysis of this article is a common assignment requested from students in the scope of BIM A+2, which comprised distributed teams with students from both UMinho and UL.

2 Literature review

The literature review will present the concepts, management, communications, methodologies and tools mainly used for distributed teams. Finally, provides an overview of transversal competencies in a teamwork environment.

2.1 Distributed teams

Distributed Team is a team which has members dispersed across globally and collaborate together to achieve a common goal, also have the characteristics of both a virtual and a multicultural team (Seshadri & Elangovan, 2019). With a high level of interdependence and cooperation among the team (Moe et al., 2015), the members have different working style, time orientation and cultural differences which can interfere in their teamwork quality (Seshadri & Elangovan, 2019).

While organizations aim to utilize multicultural distributed teams to achieve better performance, that social categorization processes may render diversity a disadvantage as it increases the potential for relational conflicts that are detrimental to task performance (Harush, Lisak & Glikson, 2018).

2.2 Management of distributed teams

In distributed teams, the typical project manager is responsible for defining and managing work (Srivastava & Jain, 2017). Work effectiveness and a constructive team climate have to be maintained using performance management strategies; leadership is therefore a central challenge (Moe et al., 2015).

Today's world with constantly changing organizational structure requires flexibility and fluid teams with rotating and evolving team memberships (Moe et al., 2015). Karhatsu (Karhatsu, et al.,2010) demonstrated that team orientation is supported by allowing the team to participate in iteration planning and goal setting and prioritize clearly. This gives team members a possibility to choose tasks on their own.

In this context, language and culture of team members represent a major challenge to the managers, especially if English is not the first language of all members (Seshadri & Elangovan, 2019). It is important for distributed teams to communicate effectively to resolve such risks in a systematic way (Alontani & Qureshi, 2014). Conflicts between distributed teams bring high risk of failing a development project due to poor communication. Therefore, it is important for distributed teams to communicate effectively to complete a successful project (Alontani & Qureshi, 2014).

Son and Park (Son & Park, 2011) studied how the communication frequency impacts team's performance. Their study concluded that the communication frequency was a major factor to manage and reduce conflicts. It is found that frequency of communication is fluctuated by each conflict type and it has an impact on performance of team. Team performance will be reduced by decreasing the frequency of communication.

The team manager activity employing member's talent to achieve synergy and synchronization of communication in an effective way, therefore managing such team require a different set of competencies than for a collocated team (Seshadri & Elangovan, 2019).

2.3 Communication management framework for distributed teams

Distributed teams can be difficult to manage, and their members can face extra difficulties in communication (Da Silva, Costa, França & Prikladnicki, 2010). Therefore, it is very important to implement tools for systemizing communication in such teams. One of proposed solutions (Alontani & Qureshi, 2014) is divided in 2 parts:

- Management of distributed teams
- Communication tools

2.3.1 Management of distributed teams

The idea is to have several special roles in the team: team leader, communicational coordinator and technical support.

Team leader can represent the whole team during online meetings with other teams or management. Communication coordinator is the person, responsible for scheduling meetings, so that all the team members, who need to attend the meetings could do it with minimal inconveniences. Technical support is responsible for providing communication tools and dealing with problems, related to them, faced by the team members.

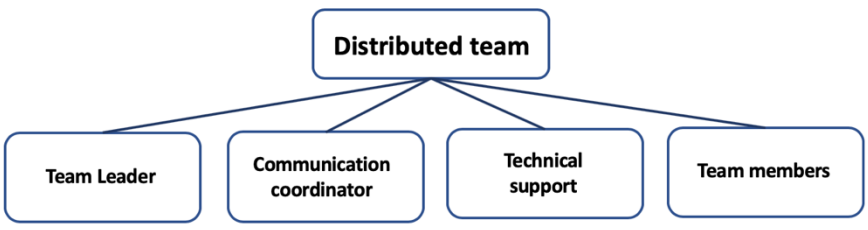

Figure 1. Roles in distributed teams.

In small teams, it is not necessary to choose a special person for a particular role.

2.3.2 Communication tools

There are many types of communication tools for different purposes those can be used for improving management of distributed teams. In study (Alontani & Qureshi, 2014) a combination of 3 types was proposed and tested: project portal, technical support and instant messaging. Project portal is used for keeping, sharing and managing all the information and documents, related to the project and for online meeting among teams. Technical support is a used for direct help with technical issues, that team members can face. Instant messaging used for one-to-one communication and preferable than email.

2.4 Distributed team transversal competences

Nowadays, in dynamically changing times, work in distributed teams is becoming more and more important (Schleutker, Caggiano, Coluzzi & Luján, 2019). Transversal competencies have an impact on team efficiency and quality. This applies not only to communication between departments in a certain company but also to distributed teams around the world (Nilugal, Thaker, Molugulu, Andrew, Ugandar & Chittur, 2015) and (Escudeiro, Escudeiro, Barata & Lobo, 2011). There is a noticeable gap in engineering environment between soft and hard skills. Currently, the lack of soft skills is one of the challenges for coherent work in distributed teams (Razdan, Polanco, Ackerman, Vidot & Razdan, 2019). According to (Sievi-Korte, Richardson & Beecham, 2019) in the architectural environment, where distributed teams are usual, the emphasis is on accurate selection of practices that support their communication and understanding of the objectives and activities. This approach aims to develop not only technical competences but also transversal competences.

There are many methods for developing transversal skills. For example, in distributed teams, agile and scrum methods allow for effective communication and collaboration of teams. According to (Berczuk, 2007), which defines the benefits of the previously mentioned concepts also draws attention to problems resulting from misunderstanding them.

The need to communicate by distributed teams means that transversal competences need to be developed. This is the result of the constant need to provide information and feedbacks (Weilkiens, Lamm, Roth & Walker, 2015).

3 Context

The work reported herein is performed within the scope of the group assignment of module BIM A+2 "Modelling in Architecture and Engineering". This module took place in the last week of October and during November 2019, with 13 contact days (generally comprising lectures in the morning and free time for assignments in the afternoon). The following main learning objectives/outcomes are envisaged: (i) be able to differentiate the requisites and uses that are of interest for each construction specialty (Architecture and Engineering); (ii) identify and describe adequate modelling practices in view of intended uses for the models; (iii) list, apply and criticize the several modelling recommendations that exist at international level; (iv) capability to understand and perform BIM models for the specialties of Architecture, Structural Engineering and MEP Engineering; (v) understand further particular cases of modelling, targeted for monitoring and management. The lectures of BIM A+2 were led by the team of UMinho, with teaching staff having mobility towards UL (1 week of the module). All morning classes were synchronous, with students witnessing the same teacher deliver the same content (some receiving the content 'in-person' and others through videoconference). An example of this setting can be seen in Figure 2.

BIM A+2 comprised two assignments for students to perform. The first assignment was individual and pertained to the preparation of a class of objects, apt for use in BIM modelling (not of interest for this paper). The second assignment was a group assignment in which students were supposed to gather in groups of 4-5 to develop the BIM model of exhibition halls in a real terrain in Guimarães (neighbouring the campus). The terrain was divided in 9 plots, and students were requested to form 9 groups.

Figure 2. Classroom setting at UMinho during a lecture broadcasted from UMinho to UL (projection allows to witness the classroom setting on the classroom at UL). Image taken from the Facebook page of BIM A+.

As there were more students at UMinho (27) than at UL (15), it was not possible to ensure distributed teams in all groups. Therefore, the following strategy was followed: 9 students were randomly selected to act as 'seeds' of groups #1 to #9. Groups #1 to #7 had to be mandatorily composed of 4-5 students, with a minimum of 2 students from each coursework location, whereas groups #8 and #9 where composed of 4 members located at UMinho (not distributed teams). The 'seed' students were supposed to communicate with other students and assemble a team that would need to comprise several independent roles to carry out the assignment. The roles included BIM Manager, Architect, Structural Engineer, MEP (Mechanical Electrical and Plumbing) Engineer, other relevant roles for design (or duplication of some of the previous roles with due differentiation of work). It is noted that the 'seed' student did not have any particular role assigned to begin with, so the choice of roles had some degree of freedom. It is also worth to highlight the role of BIM Manager in the assignment, who operates as team manager, and was supposed to lead the collaborative work and communication (this was part of the assignment and was an item under evaluation). It is further noted, that regardless of the communication strategies used by the teaching staff (e.g. using ZOOM for videoconferencing platform), students were given full freedom to elect their collaborative means, platforms, and workflows of choice.

The teams were formed without the need for intervention of the teaching staff. For the scope of this paper, only the distributed teams #1 to #7 were considered. Teams #1 to #5 had 5 members each (3 members in UMinho and 2 members in UL). Team #6 had 3 members in UL and 2 members in UMinho. Team #7 had 2 members in UL and 2 members in UMinho.

4 Methodology

The purpose of this study consists in providing relevant understanding about communication between distributed teams in learning BIM projects. Within this goal, an overview of how the communication goes throughout the BIM phases will be described, including problems faced and solutions founded. Thus, this study went through the following steps:

1. Observe the working process in distributed teams.
2. Interviewing the participants about their difficulties and problems in communication and project management faced throughout it.
3. Consult and share ideas on improving the communication flow between the teams.

Each of these teams was interviewed separately to collect the data about their ways of communication, tools and problems related to it. Only the members of each team in UMinho were interviewed. All the data collected is presented in the paper. The interviews were semi-structured: we had a list of questions that we asked all the teams, but depending on their answers, we sometimes asked some extra questions

5 Description and analysis of the communication tools

Audio/video calls were necessary for virtual meeting and discussing plans in SCRUM-like methodologies every day, what helped them significantly (Kumar & McArthur, 2015; Sakikhales & Stravoravdis, 2017). Several teams have reported difficulties in agreeing and setting up efficient communication strategies that would fit their personal hardware and work style (teams #1, #2, #3, #4, #6). Software tools originally used by the teams for audio calls are Skype, Google Hangouts and WhatsApp. Teams using Google Hangouts did not report any occurrence of very bad connection, whereas one of the teams even reported very good connection. The most problematic tool was Skype. Indeed, none of the teams reported adequate degree of satisfaction when using this tool.

Some of the teams explored alternative tools and ways of communication. Teams #3 and #4 used TeamViewer for team audio calls when applicable and found it to have higher quality and allowed facilitating collaboration. Another alternative was Discord. Teams #4 and #6 included the use personal direct calls between team members. This can be perceived as creating extra separation between the teams, as some issues ended up being mostly discussed inside within the sub-sets of team members at UMinho and UL, with communications between these two sub-sets being handled by individual representatives. However, this one-to-one interaction allowed better quality and more focused interactions, and the teams found this helpful for their communication and work.

The teams also used team chats and personal messages for communication between teams. There were no issues in this interaction.

Another important part of communication were file sharing and management. The 3 most popular tools for this were Google Drive, Dropbox and BIM360 (a dedicated platform by AutoDesk in the scope of BIM Collaboration). The latter was more preferred because of better collaboration possibilities for BIM (particularly integration with proprietary formats for BIM models). Google Drive was also found to have synchronization issues that ended up causing difficulties in collaboration. Table 1 shows, which tools were used by each team.

One of the teams (kept anonymous here by choice) deserves special attention. The members at one of the locations had difficulties on using videoconferencing (lack of webcam). Teamviewer was used for most of the communication, together with exchange of photos and videos (mobile phone based). The team admitted that their communication difficulties were significant and represented a conditioning factor for the whole work. On the example of this team we can see, how lack of well-organized/efficient communication (with a bottleneck factor such as hardware being the trigger) can be crucial for teamwork, as it is shown in 2.3. Also, these problems annoyed team members and made the communication between the teams even more difficult, what emphasizes the importance of transversal competences in distributed teams, as it is shown in 2.4.

Table 1. Communication tools used by six distributed teams.

			Team number					
			1	2	3	4	5	6
Tools	Communication tools	Skype	x		x	x		
		Whatsapp	x	x	x	x	x	x
		Google Hangouts		x			x	
		Facebook				x		
		Teamviewer			x	x		
		emails					x	
		Zoom						
	File management	BIM 360	x	x		x	x	
		Google Drive	x	x	x	x		x
		DropBox					x	

As mentioned in section 3, the 'seed' members of each team were chosen randomly, and despite there were no restrictions for changing roles, all team 'seed members' ended up playing the role of 'BIM Manager', except for the case of a single group, in which the 'BIM Manager' was taken by another team member who had some previous professional experience in BIM management. There is a possibility that the team leading role has

been taken in some cases by a person that might not have been best fitting one for the role of the team leader. That may have represented a conditioning factor in some cases.

Some teams reported problems with the language. Since all the members had different levels of fluency in English, the teams needed to spend extra time on some issues to make sure everyone understood everything clearly. Also, sometimes this caused extra diversity inside the teams, when some of the members had the same mother-tongue and tended to communicate more inside this team and not with all the members equally, as it is explained in 2.1 and 2.2.

6 Remarks

Working in distributed teams requires higher level of some skills from team members, for example being open to changes and ability to express yourself, your goals and approach to work, what translates into the lead time of the project. Another challenge of working in multicultural teams is the varied language levels.

An increase in transversal skills is noticeable in distributed teams. Teams are looking for new, better solutions that would allow better cooperation and proper understanding of the project's goals. It allows to know their own competences, strengths and weaknesses, and assign the roles in teams in ways those allow to get better efficiency and results.

The major challenges faced by distributed teams were found to be in the choice of adequate technical solutions that allowed seamless communication both in videoconferencing and synchronized data sharing. When not operating properly, these technical solutions can be the sources of delays and misunderstandings. Management tools, such as scrum, improve communication in distributed teams.

Choosing the correct tools for communication and file management are highly important aspects of work in distributed teams. Properly selected tools translate into decrease in the project lead time and risk of facing potential problems.

Note: this study was entirely done before the CoViD-19 pandemic and many changes in this area happened after this, because many teams around the world started working separately.

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