

Fostering Social Interaction Between International Students: An ICT Implementation for Information Sharing

Danny E. Morales-Briones

Faculty of Technology, Policy and Management, TU Delft, Jaffalaan 5, 2628 BX Delft, Netherlands, E-mail:danny_dmb@yahoo.com

Abstract

The city of Delft in the Netherlands has an international population of students attending TU Delft. This heterogeneous population is composed of several nationalities. In heterogeneity, participation is difficult to achieve. This case is no different with limited interaction among international students of these groups and the rest of students. This research study an online platform to stimulate information sharing and improves the sense connectedness among students. The platform is based on four main principles: 1) information, 2) activities & space, 3) multicultural approach, and 4) key actors. Moreover, the platform includes and aim for students to use narratives to promote information sharing. Furthermore, the platform includes features that allow the generation of activities and the connection with physical spaces in the city. The process starts with a survey to collect the perspective of different student groups and elaborate the requirements of the platform. After the elucidation of the requirements, the next step is designing and developing the platform. The platform has international master students as users and collects information about its use. Furthermore, to complement the data, interviews helps to understand the motivation behind the information posted and the use of different services of the ICT artifact. The results show that narrative is not as relevant as useful information to stimulate interaction. On the other hand, information including physical references of the city generates more interesting interactions. Finally, features resembling social network platforms prove to be effective to stimulate users' interactions.

1 Introduction

The city of Delft in the Netherlands considers itself a student city [GemeenteDelft, 2019]. The number of students attending TU Delft is 23.461 [TUDelft, 2018] which is 23% of the total population of the city. According to TU Delft official statistics, in 2017 the number of international students in the master's program was 3.676 students. The three major minorities are from India, China, and Greece representing 41.9% of the international student population [TUDelft, 2018].

Master programs at TU Delft have a duration of 2 years for full-time students independent of their nationality. TU Delft provides support to students for finding accommodations. The most common option for the first year or exchange students is using the University service provided by DUWO. The services consist of self-contained and non-self-contained units in new or renovated buildings [DUWO, 2018].

The result is a group of international students

living abroad for a relatively short period of time in private accommodations, and between them, three major groups are present. The configuration mentioned resembling a heterogeneous group with homogeneity inside different subgroups. For example, Figure 1 shows a group composes from different subgroups, and each subgroup shares a common language. Previous research about heterogeneous groups shows that participation is difficult to achieve, and homogeneity among these groups reduce their motivation to participate [Shoji et al., 2010]. This effect found in the literature is palpable in DUWO residencies where almost no interaction among the different tenants is the norm, except for groups of tenants from the same nationality.



Figure 1: Heterogeneous group with homogeneity in each subgroup

Fragmented groups in a student city create a societal problem that requires attention. One societal issue is isolation, which leads to loneliness and at the same time can result in feelings of sadness or depression [Cacioppo and Cacioppo, 2014] [De Jong Gierveld et al., 2006]. Another problem is the lack of willingness among residents to support each other in case of emergencies due to a lack of community sense. Therefore, this segment of the population is not resilient. People that feel isolated have the motivation to seek connectedness but at the same time experience an increase of vigilance for social threats [Cacioppo and Cacioppo, 2014]. One way to reduce the levels of loneliness is improving the opportunity of interaction by removing barriers or bringing people together [De Jong Gierveld et al., 2006]. One factor that affects the interaction among heterogeneous groups is information sharing [Singletary Walker et al., 2019]. Improving information sharing in heterogeneous groups can positively affect inclusion resulting in a sense of community.

Living in the information age requires abilities linked to the use of Information and Communication Technology (ICT), the lack of knowledge and using computers or the Internet create obstacles to engage members of society [Gardner et al., 2012]. The range of services that ICT offers allow researchers use mobile technologies for language learning [Petersen et al., 2008], areas like health care uses ICT for creating feeling of presence, connectedness, and awareness [Heidari et al., 2015], companies like Facebook uses social media to enable connection among users [Alias, 2013], and it is impos-

sible to overlook the use of ICT in organization supporting operations and innovation [Koskinen and Luomala, 2012]. Therefore, it is not difficult to consider the use of ICT in daily activities. Therefore, it is expected that international students in Delft to be in contact with ICT (applications and devices) on a regular basis and for different uses.

Literature provide some insights about stimulating social interaction from different perspectives. Four main principles are distinguished: 1) information, 2) activities & space, 3) multicultural approach, and 4) key actors. First, information. There are different types media channels and their use and effectiveness are also different. Part of the success of using social media comes from the information presented and the way it is presented. Furthermore, the information should come with a narrative that provides the correct message needed to communicate through the community network since a credible story can resolve issues and gather people together [Goldstein et al., 2015]. Moreover, the language used must be in line with different social groups in the community [Pascua et al., 2017] [MacDonnell et al., 2017].

Second, activities & space. In order to stimulate participation, one strategy used is given ownership to the activities directly to the community [Kitagawa, 2019] [Kelkar and Spinelli, 2016] [MacDonnell et al., 2017]. Co-creation of activities or space increase inclusion, engagement and the sense of belonging [Kelkar and Spinelli, 2016] [Sacchetti and Campbell, 2015]. Furthermore, connection with a place is important to resilience [Goldstein et al., 2015] [Sacchetti and Campbell, 2015].

Third, multicultural approach. Active involvement has been identified as a factor to create community engagement [Kitagawa, 2019] [Burkhart-Kriesel et al., 2019] [MacDonnell et al., 2017]. The idea is providing as many opportunities for the community to get involved and form social bonds. These activities should aim for including a cultural approach in order to empower the community [Wali et al., 2017]. Moreover, presenting activi-

ties that can be identifiable with more than one group could be beneficial to stimulate inclusion between the groups.

Fourth, key actors. One of the main factors for the success of community engagement the presence of key actors [Kitagawa, 2019] [Burkhart-Kriesel et al., 2019] [Bach et al., 2015]. These actors create a link between different stakeholders, moreover, the role of the actor is not only establishing the connections but assume the role of leader and stimulate trust.

1.1 Research Gap and Research Questions

The result of the literature review also provides gaps in previous research addressing community engagement and social interaction. There are three gaps address in this study. The first gap identified is related to time, (1) most of the studies focus on improving resilience for communities for a long period of time and assumes a stable community presence. However, the case presented in the Delft needs to deal with an international community that changes almost completely in 2 years, which could affect the willingness in the case of the bigger minorities dampening the chances of forming a resilience community as a result. Therefore, the classical approach of integration may not be applicable and new solutions are needed.

The second gap is related to physical space. The relation between participation and physical space is only present in built-environment studies. However, (2) the benefits of having a physical space that reflect the identity of different groups in other fields are not present.

The third gap is related to the inclusion of multiple perspectives. Community integration cases that include different perspectives usually address only a binary approach (i.e. gender, adults and children, or residents and developers). However, (3) it is unusual to find literature with more than two different perspectives at the same time. In the present study, the traditional approach to gathering local students and inter-

national students as two groups is not a viable option. Therefore, the international student community requires a self-organization scheme. As a result, it is necessary to include multiple minorities inside the student international community.

In order to address the gaps identified in the literature, a research question has been formulated:

- How can information-sharing apply in an IT artifact foster connectedness between individuals from different nationalities in Delft’s international student community?

The main research question can be answered by breaking down different elements of the research into several sub-questions:

1. What are the main requirements for an IT artifact to stimulate information sharing?
2. What type of information shared using the IT artifact change the perceived level of connectedness among their users?
3. What functionalities of the IT artifact are necessary to stimulate communication apart from the shared information?

This research addresses the problem of connectedness between different international students in the city of Delft and proposes as one solution to the creation of a community using information sharing via an ICT artifact. The second chapter presents the methodology, the research uses five methods to find answers to the main research questions. The third chapter presents the requirements of the system. The fourth chapter introduces the design and development of the artifact. The fifth chapter shows the process of evaluation of the ICT artifact. Finally, the sixth chapter presents a discussion based on the results of the previous chapters.

2 Methodology

The research approach selected for this case is design research [Johannesson and Perjons, 2014]. Knowledge and understanding of a problem domain are achieved by building an application or designing an artifact in a way that the application or artifact contribute to finding a solution of a problem or

general interest [Johannesson and Perjons, 2014] [Hevner et al., 2004].

Johannesson and Perjons [2014] present a framework with five main activities: 1) explicate the problem, 2) define requirements, 3) design and develop artifact, 4) demonstrate artifact, and 5) evaluate artifact. Therefore, there is a need for different methods during the execution of the five main activities of design-research science. Figure 2 show the activities and methods of the research.

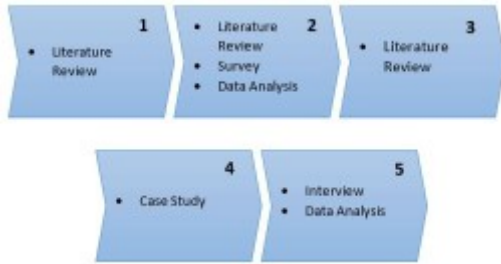


Figure 2: Activities and methods

2.1 Literature Research

The purpose of the literature review is analyzing the problem and its context. Furthermore, permits the analysis of previous research to find possible solutions and gaps. The second activity uses literature to analyze previous attempts and extract general requirements. Finally, the third activity requires literature review to have adequate knowledge to transform the requirements into design elements.

The literature research uses Google Scholar as a search engine. The first research uses as parameters: *"community elements"*, *"community resilience"*, *"information grounds"*, *"heterogeneous groups"* + *"information sharing"*. The parameters used for the selection are connections between community and networks, resilience in cities, and social capital in communities. The second research uses: *"digital platforms"*, *"community engagement"* + *"ICT"*. The selections parameters are 1) Requirements to create a community sense. 2) Best practices used in different scenarios to promote community engagement. 3) Principles for the creation of ICT artifacts in community participation and information shar-

ing. The next research uses: *"platform ecosystem"* + *"platform architecture"*. The selection is based on the relevance to the context of the research.

2.2 Survey

The second activity of the research uses not only a literature review but survey as methods. The main purpose of the survey is collecting information from international students in the city of Delft to elicit the requirements that the ICT artifact requires to share information and foster connectedness. Therefore, the survey and literature review permit answering the first sub-question after the finalization of the first two activities.

The questionnaire has four sections that aim to collect information for elicit requirements, and gain insides to understand the problem. Therefore, the sections address: 1) Identification of possible causes for not sharing, 2) assessing perceived connectivity outside academic circles, 3) identification of viable IT artifacts and metrics, and 4) identification of preferred information and activities for sharing.

The target group of the survey is the international student community in TU Delft. In order to be consistent with the heterogeneity of the community, the survey identifies the three main nationalities and a fourth group from the rest of nationalities. Finally, the participants are first- and second-year international master students.

The online survey uses email as distribution media and the selection of potential participants uses the snowballing technique. The email list with the addresses of the potential participants has a 20-80 distribution. The 20% of participants of each group have a connection with the researcher. The remaining 80% of participants in the list are the result of their connections with the initial participants. This process permits the reduction of bias in the responses of the survey. In order to have a confidence interval of 95% from the universe selected, a minimum of 10 participants per each group is necessary. The nature of the survey is anonymous and confidential. The content of the survey does not collect

personal or identifiable information of the participants. Therefore, it is necessary to protect the information via controls or manually anonymizing data and forcing the platforms to collect no metadata [MIT, 2011].

2.3 Case Study

The fourth activity is the demonstration of the artifact. The method selected to test/monitor/understand the final ICT artifact and its application in a real scenario is a case study. A case study focusses on one instance of the situation and offers rich, in-depth information about the instance [Johannesson and Perjons, 2014]. The case study selected for this research is an explanatory case study.

In this research, the case study considers the artifact as a black box since the important is the inputs and outputs of the artifact. A black box analysis can use for testing, experimenting, or monitoring depending on the control over the inputs. In our case, the inputs provided by the participants are outside of our control. Therefore, in cases where there is no control over the inputs, the correct analysis is monitoring [Tschantz et al., 2015].

The instance of the case study has a fix duration in which is possible to analyze the results of the ICT artifact use. The instance has three stages: 1) Invite participants, 2) monitoring interaction, and 3) interviewing participants. The case study involves the presentation of the solution to a group of students, the participants are free to create the information or interact with the different functionalities of the ICT artifact. Finally, it is necessary to analyze the results of the interactions recorded in the artifact and the data collected from the participants as well. Figure 3 shows the stages of the case study.

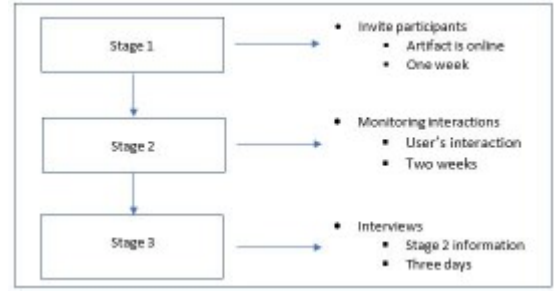


Figure 3: Stages of the Experiment

The monitoring uses an automatic collection of the data, which means that the researcher does not waste resources. The collection of data includes the type of device used to access the service (i.e. mobile or fixed devices), the number of visits, the number of members, the type of information shared (i.e. based on pre-determined categories extracted from the survey), the interaction between users, and reactions to the information.

2.4 Interview

The fourth method used in this research is interview. Interviews are effective to collect complex and sensitive information (i.e. attitudes, emotions, opinions, experiences, behaviors) [Rowley, 2012] [Johannesson and Perjons, 2014] [Gill et al., 2008] because permit the collection of rich and meaning-making data [Frels and Onwuegbuzie, 2013].

The main goal of the interview is collecting responses of international students about three main topics: 1) the literature research concepts applied in the artifact, 2) the motives behind the information shared between participants, and 3) features of the artifact.

A semi-structured interview (SSI) requires the definition of the interview schedule. The interview schedule has the primary questions, sub-questions and their order [McIntosh and Morse, 2015]. The first section has 7 open questions. Each question address one of the main principles to stimulate social interaction and connectedness in an ICT artifact. These answers are in the results and support answering the main research question. The second section

has 4 open question. The topic of these questions addresses the information shared by the participant in the ICT platform, the motivations, and topics for sharing. The responses contribute to answering the second sub-question. The final section has 4 open questions. The questions address the different functionalities of the platform, their use and reasons for using parts of the platform. The results are going to support the answer of the third research sub-question.

After the main questions of the interview are complete, it is advisable to conduct a pilot to test and improve the questions, their clarity, and order [Hannabuss, 1996] [McIntosh and Morse, 2015]. Refining the questions of the interview uses the input of master students. Furthermore, two master students that do not participate in the interview process review the questions to test their clarity. Finally, to test the protocol, one of the participants took the interview. This interview forms part of the results and helps in the process of tune the interview protocol for the rest of the interviewees.

2.5 Data Analysis

Data analysis is the last method used in this research. However, this method is present during different stages of the study. Furthermore, the survey, case study, and interview collect data that require analysis. Data analysis derives valuable from collected data to explain or describe the event under investigation [Johannesson and Perjons, 2014].

The survey delivers data in the form of categorical variables as responses from different questions. The case study monitors numerical data from the users of the ICT artifact linked to the key performance indicators (KPIs). Finally, the interview delivers data in the form of text that requires classification and the identification of relations.

2.5.1 Survey

The results of the survey require analysis to extract the information necessary to elucidate the requirements. Figure 4 shows the data analysis

process used to get information from the data of the survey.

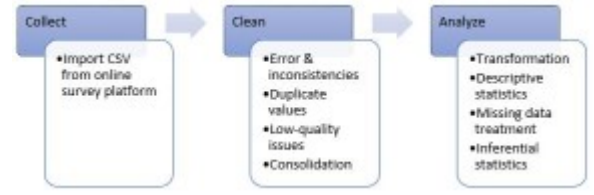


Figure 4: Survey's data analysis process

2.5.2 Case Study

The data analysis of the case study considers the results monitoring the ICT artifact. The results of the interaction between the participants and the platform include the count of interaction and other features defined in the next chapters. Therefore, the data analysis of the case study uses descriptive statistics only.

The monitoring of the interactions should happen in the ICT artifact. Therefore, the collection of data happens in an automatic way; however, the process does not consider exporting the data to any repository. As a result, the first step of the data analysis is the collection of information from different sections of the artifact. The complications presented in the survey around cleaning the data are not present in this method. Therefore, the second part of the analysis is performing a descriptive statistic to obtain percentages and frequency.

The result is going to provide information for understanding which features of the artifact are the most used. Also, the selection of potential participant for the interview comes from the results of the interaction with the ICT artifact in the case study.

2.5.3 Interview

The amount of information resulting from an interview is considerable [Hannabuss, 1996]. The analysis of an interview makes a comparison of the responses by item [McIntosh and Morse, 2015]. After the comparison, it is possible to make a numerical trans-

formation and perform a quantified analysis [McIntosh and Morse, 2015].

The first step for the analysis is by preparing the data. The preparation of the data includes a transcription word for word of the audio files to text [McIntosh and Morse, 2015]. However, the confidentiality of the responders is a priority. Therefore, data that can identify any subject is removed from the transcription. The second step is content analysis. The data is sorting in similar categories and subcategories [McIntosh and Morse, 2015] [Rowley, 2012]. Finally, since the number of SSI is small. It is possible to compare participants and tabulate the categorical data. The analysis allows the presentation of results in percentages and frequencies.

3 System Requirements

In this chapter present the outlining of the artifact and its requirements. The resulting artifact will tackle the main problem [Johannesson and Perjons, 2014]. In order to accomplish this task, it is necessary to explore even further the causes of the problem and propose a solution to the issues that start appearing. The process to construct the outline and requirements can be seen in Figure 5.

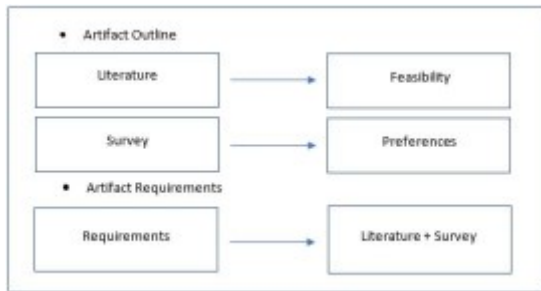


Figure 5: Process of artifact outline and requirements elicitation

3.1 Artifact Outside

In order to have a proper artifact outline, it is necessary to review if an ICT artifact can be a good fit to create a community and address the four principles from the research gap (in-

formation, activities & space, multicultural approach, and key actors) to be successful in foster social interaction and connectedness among different groups. Also, it is necessary to introduce the preferences of the community expressed in the survey. Therefore, this chapter analyzes the feasibility of an ICT artifact to the main principles and survey's preferences. Finally, the resulting ICT artifact will be outlined in general terms based on the survey's participants desires.

3.1.1 Main Principles

There is a constant influx of newcomers into Delft and DUWO buildings stimulate by new acceptances to TU Delft. Initial communication and participation reduce the social distance between individuals [Shoji et al., 2010]. The use of an ICT artifact (i.e. social media, messaging platforms, websites) to establish first contacts is a good fit since the information exchanged can be easy and fast to communicate and understand.

The results of the questionnaire reveal that the participants identify as their major obstacle the time spend in academic assignments. Also, limited physical space and cultural differences mark high as obstacles. Therefore, an ICT artifact can allow students to create their own events according to their necessities or interest. These events can have a positive impact on the collaborative spirit of the members and help them perceive their role in the community [Shoji et al., 2010] [Koh et al., 2007]. The ICT artifact can allow a central place for international students living close to each other to share information about useful places in the neighborhood to interact. Therefore, the solution is a good fit and can contribute to help people to interact outside their groups and increase the social capital in the neighborhood [Paulos and Goodman, 2004] [Hampton and Wellman, 2003].

The ICT artifact can allow different digital spaces under one platform depending on the interest of the users. The newcomers can choose to participate or contribute to an existing digital space or can create a new category. Apart from allowing the expression of multiple voices

an ICT platform can help to create an appropriate bonding space for multiculturalism. Meetings in free-space without a central control can allow participants to create social bonding outside of an existing social structure and develop specifically shared norms [von Krogh, 2011]. The benefits are twofold: 1) The cultural differences should decrease, fixing one of the barriers for communication found in the survey, and 2) prevent community failures due to the lack of recognition of diverse and multiple interests of the actors in the community [Sacchetti and Campbell, 2015].

There are individuals that are part of several social networks and are easily recognizable among other members. These key individuals are known as sociometric stars [Chapin, 1950], and are important to stimulate the diffusion of information among members and lower the resistance to interact or start conversations. ICT platforms also allow the exitance of well-known individuals or influencers. Therefore, a platform that allows the rise of this key actors is a suitable fit as a solution.

3.1.2 Online Platform

The proposed solution based on the information collected from the literature and the responses of the sample group of Delft international student community is the creation of an online platform. The platform must connect the International student community in Delft. The online platform must be designed and tested to operate on a web-based environment to allow compatibility with different devices, operational systems (OS), and web-browsers. The platform must allow a sense of membership, two-way communications, incorporation of a positive narrative, and create benefits from its use. Finally, the platform must incorporate different communication channels, support different sharing format for send information and permit the creation of events and posting useful information.

3.2 Artifact Requirements

The platform's requirements should go in line with the problem that is going to solve

[Johannesson and Perjons, 2014]. Furthermore, the requirements must take into consideration not only theoretical solutions from previous researches but the needs of the stakeholders that the platform serve.

The information previously presented is the base to create the requirements of the online platform. The complete list of requirements of the artifact is next.

The platform must:

- R1. Allow registration of members
- R2. Allow user's roles with access levels
- R3. Include useful information
- R4. Support multiple communication channels
- R5. Protect personal data
- R6. Present a clear interface
- R7. Implement a robust infrastructure
- R8. Incorporate narratives
- R9. Use a positive message
- R10. Manage the number of participants in events or groups
- R11. Allow personalization of user's content
- R12. Allow the creation of user's events
- R13. Support multiple digital spaces
- R14. Support location sharing
- R15. Allow free expressions of users
- R16. Store data from members
- R17. Allow different sharing formats (picture, text, video)
- R18. Create a process to promote the artifact
- R19. Track posting & viewing activity
- R20. Implement web-based tools

4 Artifact Design and Development

Designing and developing an artifact has as end-result an artifact that fulfills the system requirements and addresses the analyzed problem [Johannesson and Perjons, 2014]. Designing the artifact requires to identify the functions and structure of the solution.

4.1 Platforms and Ecosystems

One of the first steps to design and develop a solution is to define what is a platform. This research defines a platform like a product or service based on software that allows external parties to build complementary product or services [Tiwana, 2013]. Furthermore, a platform facilitates interactions between at least two distinct groups [De Reuver et al., 2018]. Finally, a digital product can become a platform if it has a layered modular architecture [Yoo et al., 2010]. On the other hand, an ecosystem is the collection of the platform and software services that interact to extend the functionality of the platform [Tiwana, 2013]. Therefore, the artifact is a software platform that connects master international students from different nationalities and different academic years. On the other hand, the ecosystem is the collection of the online platform and different international students that fulfill the role of end-users and content generators.

4.2 Platform Component

The online platform requires a modular design to reduce the complexity generated by the different requirements of the system. A modular design resembles a Lego-like design [Tiwana, 2013] where different pieces cope with different requirements. Table 1 links the module with the requirements.

Table 1: Modules and requirements of the platform

Module	Requirement
Backbone	R4, R5, R7, 16
Frontend	R6, R7, R9, R14, R15*, R17
Authentication	R1, R2, R5
Membership	R8, R11, R19
Blog	R3, R4, R8, R13
Scheduler	R3, R4, R10*, R12, R13, R14
Forum	R3, R4, R8, R13
Chat	R3, R4, R13
Privacy	R5
Contact form	R4, R5
*partial fulfillment	

4.3 Development and Practical Implementation

The practical implementation deals with the process of putting the platform online and restrictions the system inherit due to practical or social issues. Therefore, this part of the document presents both sides in a complementary form.

4.3.1 Platform and Ecosystem

The platform implementation requires the creation of a modular solution to match the design choices. Since the development of the platform from scratch is not part of this research, the platform and applications/modules use a proprietary solution. The service provider is WIX based on its main features: customizable main structure, application market, and mobile optimization [WIX, 2019].

In terms of connectivity, the platform requires access to a broadband connection and IP requirements to allow the service to be visible on the Internet. On the other hand, the ecosystem requires paying attention to the participants. They are all international students living in Delft and attending a master program at TU Delft.

The implementation of the platform requires capturing information and metrics about the behavior of the participants. Offline interaction is significantly related to posting activity, and usefulness to viewing activity [Koh et al., 2007]. However, the privacy of the participants is a limitation. Therefore, the platform will only provide two types of information: 1) general use of the platform, and 2) information about individual preferences. The first metric can provide information about the number of visits to side, and the number of contributions in the platform (i.e. number of posts, blogs, and events). The second can provide information about individual posting and networking activity (i.e. following activity, views, and likes).

Finally, the ecosystem requires implementing incentives to promote participation. The incentives offered to the participants must be from a non-rival nature [Kitts, 2006], since they can allow the participant to work for a common

good instead of competition. One technical option is implementing a rating system. A rating system is based on reputation and promotes trust [Slee, 2013]. Also, a side effect of reputation systems is that incentive good behavior [Jøsang et al., 2007]. The system is implementing only likes as a rating system since there is no transaction in the system. The goal is to rate the information that users find useful.

4.3.2 Process

Burkhart-Kriesel et al. [2019] propose the next steps to the implementation: 1) Inform, 2) consult, 3) involve, 4) collaborate, and 5) empower. However, practical implementation does not complete the five steps due to time restrictions

The first step involves having all relevant stakeholders involved in the process. In this case, contacted people are the previous participant of the survey that accepted future contact about the research. The second group of invitation includes international students that the researcher has contact and finally, the third group of people includes international students referred from previous participants.

The next part of the process is finding community champions. These champions need to have good writing skill and the willingness to share information with others. Champions post information first to have data in the platform before the rest of the participants uses the platform.

The next step is locating community partners. In the case of this research, community partners are second-year students that have experience and can contribute to the potential questions, or information request in the platform. The invitation includes these participants and first-year students as well.

Finally, the platform has a section to explain the use of the platform and a preselected category that encourage sharing information with the goal of support others and general topics extracted from the survey. Therefore, the last part of the process is in the hands of the platform itself. The structure aims for participants with more experience to reply to questions from other

participants and in turn, the cycle continues.

5 Artifact Demonstration and Evaluation

After developing the artifact, understanding if the product fulfills the purpose of its implementation requires demonstration and evaluation. Demonstrate the online platform requires choosing the right scenario and determine the way the platform is going to operate in that scenario. Moreover, it is necessary to describe the operation of the artifact. On the other hand, evaluate the artifact requires selecting the type of evaluation and the necessary method to collect the results. The online platform uses a real case scenario with an ex-post/naturalistic evaluation and the collection of data uses interviews and automatic scripts in the platform.

5.1 Demonstrate the Artifact

After finishing the process of development, the online platform needs to show its functionalities in a specific case. Ideally, demonstrating the artifact can probe it can solve some aspects of the problem description [Johannesson and Perjons, 2014]. The online platform design and implementation consider a real-life case from the start. The online platform works with the international student community in TU Delft. Moreover, the target scenario focus on residential buildings in sectors near TU Delft (Wippolder, Voorhof, and City Center) where DUWO have most of their buildings offers [DUWO, 2018]. Targeting international students in a specific area has the intention to limit the information into a more local context.

Based on the operational level of the online platform and the real case scenario, the method selected to demonstrate the artifact is an experiment. The platform is accessible using an exclusive public domain and can be reached using a web browser. Therefore, the environment allows users to visit the site and become members independently of the device they held, location,

and time of the day. However, the platform requires a manual confirmation before granting credential as a member and gain access. This control mechanism is in place to guaranty that only international master students participate during the length of the experiment. The main services that the platform offer to the members and users during the demonstration are: 1) access, 2) blog, 3) forum, 4) events, 5) chat, and 6) members.

5.2 Artifact Evaluation

The online platform evaluation requires determining the extent of how the platform solves the problem and evaluate the requirements of the platform [Johannesson and Perjons, 2014]. Therefore, there is a need to perform two evaluations. The first evaluation uses interviews to collect opinions and experience from platform’ users to understand how the artifact solve the proposed problem. The second evaluation uses the data collected by the platform during the experimentation to understand which features of the platform perform better than others and analysis the requirements behind those features.

The two evaluations require different approaches. The collection of data is automatic, and the users have information about the collection of data as an integral part of using the platform. On the other hand, interviews require coordination to get access to the participants and allocating enough time. The candidates selected have different levels of interaction with the systems, from passive to active users. The first step is to contact them and request their voluntary participation in the interview. The invitation reaches 12 participants and 6 responded affirmatively to the request. The next step is to coordinate as many interviews as possible within three days. Finally, the place selected to perform the interview is TU Delft library or a common room in one of DWUO buildings next to the university to facilitate access to all participants.

6 Results

After the end of the artifact demonstration, several steps have come to an end. Data is the result of each step and the goal is to be able to answer the research questions. This section is going to present the most relevant information with each of the sub-research questions to have a better overview.

6.1 Case Study

International students interact with four services of the platform. Depending on the service, users or members can interact with the content or create new ones. Interactions are the number of ‘views’ and ‘likes’ that other users can provide to the inputs. On the other hand, the members or users can create posts or comments, these two options are inputs. Table 2 show the ranking of services based on inputs and interactions.

Table 2: Ranking of services

Position	Service	Interactions	Inputs
1	Forum	99	24
2	Blog	40	3
3	Event	1	0
4	Chat	0	N/A

The blog service register 2 blogs and 1 comment. These blogs include no pictures and 1 link inside the content. On the other hand, the forum registers 8 posts and 16 comments. The content of the posts or comments includes 2 pictures and 4 links.

In general, the blogs have in average 19 views per post while the forum has 12 views. The posts of the blog address 2 topics: Health care, and restaurants & pubs. On the other hand, the post in the forum address 7 topics distributed in 5 categories: Housing, tourism, bicycles, health care, restaurants & pubs, beers, and sports. Table 3 has the ranking of topics based on the number of views including both services.

Table 3: Ranking of topics based on views

Position	Topic	Views	Comments
1	Sports	35	9
2	Health care	28	1
3	Restaurants & pubs	24	0
4	Tourism	17	1
5	Drinks	14	3
6	Housing	11	3
7	Bicycles	4	0

The interaction with the platform results in different users acting in different roles. The role of moderator has 2 students that participate in the blog. The students writing in the blog or forum is 8 (excluding students in other roles), and the number of other users is 15. The researcher remained in the role of administrator.

The number of communication channels implemented to establish communications is 5 (blog, post, email, electronic form, and instant message). The operation of the platform had no breaches in terms of security or information losses. Also, during the demonstration of the platform, no malfunctions occur. The main atmosphere of the inputs is providing information freely or in reply to somebody else questions. The users can choose to receive information about the platform, receive information from the blog or forum, and receiving information from the interaction of other users.

6.2 Interview

The interview’s question 1 asks about the support of the platform to share stories and find information. All the responses were positive, the users find the interface user-friendly, flexible, and intuitive. Also, the display of the information also incentivizes sharing information. On the other hand, interviewees indicate that introducing categories to organize information improve the location of information.

Question 2 of the interviews ask participants about the usefulness about having information about locations in the platform. All responses indicate that locations are useful. Participants indicate that this type of information is good for

new students and that its use improves if includes hyperlinks to external sites as a complement.

Question 3 address the relevance/identification of the posts for the participant. All participants responded that the information on the platform was relevant or helpful. Some of the reasons that make participants identify with the information are matching necessities, locality, and timing.

Question 4 addresses the implementation of social network features (i.e. likes, comments) and if these have an impact on the willingness of people to interact in the platform. The responses are mixed, 60% of the participant responded affirmative and the rest did not find these features appealing. Participants that indicate that they will be more willing to interact associated likes with usefulness and a feeling of helping others.

Question 5 asks the participants about the motivations behind their contributions. Each participant contributes to different topics; however, most of the responses are related to experiences that they have/had and how important the information is for them. Also, some participants notice that their selection of the topic and the information posted is in line with their knowledge and a desire for help.

Question 6 of the interview try to find the type of information that international students think that is important, but it was not in the platform. The responses indicate that external information like workshops, the housing situation, and events outside of the city can be a nice complement.

Question 7 looks for the participants to identify the most engaging topic posted on the platform. The responses are varied including health insurance, sports, and events.

Question 8 asks about the selection of different parts of the platform. Participants indicate that they choose the forum since is easy to use. The forum allows participants to reach people, share knowledge and find information (i.e. ask questions). On the other hand, the lack of use of specific sections of the platform is related to lack of interest (blog) or lack of participants (i.e. chat). The event section is not address directly in the answers; however, in different parts of the

interviews it clear that students did not use it or understood this part.

Question 9 asks openly to international students about functionalities that they wish the platform could have. Some users do not mention any extra component. However, others mention that it would be interesting to have videos, temporary chat rooms, and a rolling fee for events.

After question 9, a follow-up question tries to understand if the international students are willing to use the platform to post and find information during their living time in Delft. The responses were all positive except one. Moreover, the reason is the suggestion of other social media sites based on tracking previous interactions.

7 Discussion

This chapter presents discussions about the results in order to answer the research questions, find limitations and future work.

7.1 General Topics

The research presents four main principles from which the requirements and development of the platform are based. These principles are information, activities & space, multicultural approach, and key actors. First, information is address in the survey and the lack of information is one of the obstacles for interaction. The results of question 1 in the interviews confirm that the platform is supportive, intuitive and user-friendly for adding information. Therefore, this principle is one of the most relevant for the creation of a community between international students and properly added to the platform. The second principle is activities & space. Space is related to a location, and the implementation of locations is directly present in the forum. The results of question 2 of the interview indicate that this part of the principle is useful and interesting. Therefore, space is a relevant principle in terms of community creation. The third principle, the multicultural approach, was not part of any question of the survey. However, the design of this principle starts from the moment of the selection of the

main international groups in the study. The implementation of this principle can be seen in the information used in the forum coming from the results of all communities, and in the authentication service and frontend as well. Therefore, a multicultural approach is relevant for the creation of a community between international students in Delft. The final principle is key actors. These actors from the perspective of the platform are second-year students that can collaborate with the platform posting information or answering questions that could appear in different sections of the platform. Therefore, this principle is relevant and closely related to an effective process.

7.2 Research Questions

- The first sub-question is: What are the main requirements for an IT artifact to stimulate information sharing?

The interviews confirm that users are more willing to share information that they consider useful to others and engage in ongoing topics for the same reason. Furthermore, the number of views around this type of information is the highest. Therefore, include useful information in the platform stimulate interaction and encourage new postings.

Some communication channels associated with the forum service has a positive impact. The number of posts in the forum is the highest, followed by blogs. Furthermore, the interviewees found useful that an email reaches them when someone replies to their post. As a result, the exchange of information keeps ongoing. Therefore, having multiple communication channels by itself does not seem to have major impact. However, multiple communication channels working together support information sharing.

The blog is the space more suitable to have narratives. However, the results show that the blog is not the most view section of the platform and the number of interactions with the content is limited in comparison with the forum. Some interviewees indicated that the blog is not as interesting as the forum or does not meet their ne-

cessities quite as well as the forum. Therefore, the use of narratives does not seem to have a major influence on information sharing.

The platform has positive messages in different sections and pages. One of the messages is the idea of bringing support and interaction between members. Interviewee 3 indicate: “this entire platform is mean to help other people” which implies that this type of positive message creates an impact on the users. Also, most interviewees indicate that their reason form sharing information is to provide useful information. Therefore, a positive message promoting support and its benefits have an impact on information sharing.

The platform implements 4 main spaces: blog, forum, scheduler, and chat. The purpose of each service is different, but it is possible to see that the inputs and interactions favor the forum over the blog, and the chat has no input or interactions. Therefore, multiple digital spaces have a positive impact on information sharing. However, the number of digital spaces should be in line with the number of participants. Otherwise, some of the digital spaces would have no participants creating a negative image and disinterest.

The results of the platform test show that students generate 7 different topics by their own and all have views, and most have interactions. Therefore, allowing users to have the freedom to choose their own content stimulate information sharing.

The results show that not all the messages have extra formats apart from the text. However, the interviewees find relevant and useful the information that have images or hyperlinks as complements. Therefore, allowing different formats does not stimulate information sharing directly, but increase the quality of the information and the interest of the participants.

One of the interviewees suggests changing the concept of ‘like’ for ‘useful’ or ‘helpful’. Therefore, providing extra information about the value of user’s contributions stimulate information sharing.

- The second sub-question is: What type of information shared using the IT artifact

change the perceived level of connectedness among their users?

The topics have the main characteristics that international students are looking for usefulness, relevance, and interest. Literature indicates that exchanging social support, opinions and asking questions allow users to know each other [Ren and Kraut, 2010]. Inclusion is the result of individuals engaging in task or activities that contribute to the group [Singletary Walker et al., 2019]. Members of a virtual community remain active if they find information sharing, emotional ties [Suh et al., 2015] and the feeling that the community needs their contributions [Ren and Kraut, 2010]. There is a relation between a personal involvement in her/his community and her/his wellbeing [Sacchetti and Campbell, 2015]. Also, care to stimulate trust among members [von Krogh, 2011]. Finally, high-quality interaction among the members of the community creates a shared emotional connection [McMillan and Chavis, 1986]. Therefore, based on literature it is safe to indicate that sharing useful, relevant and interesting information help members of the platform to improve their perception of connectedness and belonging to the community.

- The third sub-question is: What functionalities of the IT artifact are necessary to stimulate communication apart from the shared information?

The forum works perfectly for fast exchange of useful information between members. This module in combination with the blog is the most used functionalities of the platform. Most of the interaction happens in the forum following the blog. However, some participants find the blog not useful or time-consuming to engage. Therefore, the blog must be used as an invitation to share experience and not overlap with the content of the forum to have a better impact. Also, these two functions are important to stimulate communication.

Apart from the main modules, the platform introduces some functionalities in its normal op-

eration. The use of comments is a fast and easy way to communicate with other users on the platform. The result shows that comments stimulate participation and exchange of information effectively. The personalization of notifications and the introduction of categories prove to be useful for the users. Interviewee 4 indicate that personalization is not common in other platforms. Also, it was noted that choosing the type of notification allow the users visiting the site when needed and respond to any questions. Therefore, notifications and personalization stimulate the willingness to communicate in the platform. Finally, external connectivity with other sites using hyperlink had been mention and prove effective to stimulate interaction among users.

- After the analysis of the sub-questions, it is possible to have an answer to the main research question: How can information-sharing apply in an ICT artifact foster connectedness between individuals from different nationalities in Delft's international student community?

Information sharing can foster connectedness between international students from different nationalities in the city of Delft using an online platform. The information in this platform must be useful, relevant, and interesting with the purpose of support other members. Also, the platform must have multiple communication channels working together to reach users and facilitate information exchange. This communication channels must be implemented in different modules with specific functionalities. However, the number of modules should grow according to the number of users to avoid low use and desertion. The platform should have information that transmits a positive message to stimulate students to connect into the platform and share information. Furthermore, the platform must allow the users to share information using a different format like text, videos, pictures, and permit communication with external sites using hyperlinks in forums or blogs that permit fast responses and have recognition for the information. Finally, the platform must have a process to reach experience students that can provide the necessary information.

7.3 Limitations and Future Research

One of the most important limitations of this research is the time and the season of its execution. This constrains have its most impact on the number of participants and the time that the platform is online. Therefore, it is advisable to continue this research in a different season and if possible, extend the demonstration of the platform.

The number of participants in the survey is only 45 which gave a margin of error of 14,6%. Therefore, it is necessary to expand the number of participants in the survey in future research.

Some of the modules of the platform have no interaction (scheduler and chat) which means that some requirements and functionalities related to these modules could not be validated. Therefore, it is recommended that before ruling out some of the requirements or functionalities, future research should address these two limitations and a redesign of modules.

8 Conclusions

This is the last chapter of the thesis and is going to present the conclusions of the research based on the results and the information presented in the discussion.

- The results of this research can be suitable for similar situations and considering the suitable city size. In this case other small student cities with international populations.
- The artifact that suits better the task of stimulating social interaction in a heterogeneous group of international students is a web-based platform.
- After the use of the platform in a real scenario the requirements that stimulate information sharing in a platform are: 1) Present a clear interface, 2) use a positive message, 3) support multiple digital spaces, 4) allow free expressions of users, 5) allowing different sharing formats, and 6) tracking posting and viewing activity.
- The inclusion of narratives in the platform does not make a significant impact in the context of this study.
- The information shared using the platform must be useful, relevant and interesting with the intention of providing help to other members to increase

the perception of connectedness and community.

- The functionalities that the platform must have to stimulate communication are: 1) rewards for the users in terms of notification about usefulness of the information, 2) external connectivity with other sites or platforms using hyperlink, 3) digital spaces like chats with a well-defined topic and a determined time, and 4) a blog and forum functionalities with no overlapping content or topics to improve interaction.
- An online platform can foster connectedness between different groups of international students including relevant and interesting information that benefits other students. The platform should have communication channels that support interaction among users and properly present all its functionalities. Also, the platform must allow the exchange of data with other sites.
- The platform requires more exposure among international students from all nationalities to be attractive, reach critical mass and positioning itself as an alternative to traditional social media in the city of Delft.
- An integral solution requires the implementation of the findings in this research along with the integration of TU Delft and the Municipality of Delft since the factors that interfere with social interaction are related to these two institutions.
- Other universities with similar problems could start programs or services to stimulate participation and create a community spirit to improve the livelihood of students and create positive relations with alumni.

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