Categories:

Findings	Codes:	#	Representative quotes to support the findings
Developer Issues:			
Distractions and interruptions from communication channels negatively impact developer productivity			
	Distractions	30	"reddit can be a source of information, as well as a major time-waster" [P368]
			"The News overload via Aggregators (Hackernews, Reddit, Digg, Slashdot, ...) affects productivity. I dont use too much of social networking (facebook or twitter) as they are a huge time-sink and sheer noise as far as technical development work is concerned." [P1144]
	Interruptions	11	"It is difficult to balance the benefits of talking to another developer with the harm done by interrupting that developer." [P1340]
Keeping up with new technologies and project activities can be challenging, but social tools help			
	Keeping up with new technologies	8	"focusing on which technology is most important because there is much available and so much that I want to learn. " [924]
			"Staying cutting edge is a never ending task" [P625]
	Keeping up with activities on projects	7	"Keeping track of contributors, issue writers etc. I often find myself wanting a 'CRM' for the public projects I help maintain." [P54]
Collaboration and coordination hurdles:			
Sharing and explaining code lack adequate tool support			
	Sharing code	4	"There are no advanced way of share code snippets. The best example would be paste bin web sites, e.g. http:\/\/lpaste.net\/" [P349]
			"Pasting code to people via something like Hangouts or Skype or any IM program is never pretty. GitHub Gists are a nice solution to this, but they are also an additional step to perform." [P549]
	Explaining code	6	"How to share screenshots and highlighted code easily." [P1038]
			"Its very difficult to have detailed discussions about how software should work along with each of its expected components and interfaces." [P1265]
			"A fairly minor issue - but many communications tools (email, IM, etc) are not especially good for talking about code. Generally in any given conversation I'll end up using several tools, eg IRC + a paste-bin (GitHub Gists) to effectively communicate ideas." [P1416]
Getting feedback on development activities is challenging			
	Getting feedback	8	When it comes to getting feedback from users, I often wonder\/worry about which channels have the least friction. [P934]
			"It's difficult to share small new projects that aren't very far along and get feedback" [P751]
	Proprietary projects	3	"Finding good usage examples of internal code - Getting quick feedback for internal technology because you cannot ask on stack overflow - Staying up to date with new company internal technology because it is not on twitter/ hacker news - I guess there is a theme here, if its open source help is plenty and readily available, not so much for internal tools. " [P706]
Collaborative coding activities need improved tool support			
	Collaborative coding	1	"Live collaborative coding tools. For example, we can currently edit a document collaboratively in google doc. If we can have a IDE \/ tool like that for coding too, that would be useful." [P1154]
Barriers to community building and participation:			
Geographic, cultural and economic factors can pose barriers to participation through social channels			

Time zones	11	"Time zone since I live in Melbourne (Australia not Florida), so I often have to wait hours for replies." [P711]
		"Time zone differences, The lead developer is on the other side of the world." [P1105]
		"It can be difficult to have real discussions when you work with someone in another continent, when you can't have discussion logs, because you've to talk live and it can be difficult when you've a big jetlag." [P1249]
Access to the internet	2	
		"Unemployment and poverty brings challenges, in that I am not always able to participate, because of ramifications like not being able to pay for Internet connection." [P1035]
		"I live in a third world country. Our internet connection sucks! It makes it hard for me to talk to people overseas, or even locally." [P429]
Language barriers	18	"poor english skills, especially writing :(" [P1605]
		"Colaborate in different languages" [P157]
		"Language - many of our collaborators do not have English as their first language. IRC helps this a lot." [P362]

Despite using social channels, finding developers to participate can be difficult

Finding right people	7	"I'm working on my own project and haven't gone looking for collaborators as I don't know a good place to look for them, and not sure I'm ready to introduce more type A personalities into my project yet. :)" [P173]
Convincing others (to participate)	2	"I used to think that publishing application code with an open source license would attract collaborators with an interest in using V improving that application, but now I feel like most users of code hosting sites are more interested in collaborating on tools they can incorporate into their own projects, and almost no one is interested in working on application code. I guess the challenge here is convincing developers that your application is interesting even if your code is not." [P1285]
		Another challenge is dealing with the sense of entitlement felt by some users of open source projects. Encouraging them to find ways to contribute without alienating these users can be difficult. Making them understand that open source projects are (usually) unpaid volunteer efforts and everything that implies can be difficult." [P1388]

Social and human communication challenges:

Miscommunications on text-based channels are common

Miscommunications	20	"With the increasing amount of communication being done with social tools and IMs/Chat, the amount of misunderstanding and bad/incomplete briefs grows in the same rate." [P385]
		"Written communication is very limiting: emotions and emphasis is not transmitted and, more often than not, parties misread or misunderstand information and clarification is needed" [P828]
		"People in general have a general lack of awareness when communicating. This is exacerbated by the fact people are using more and more slang which provides more ambiguity and thus slowing down communication. Or people are lazy or assume too much from the other person in the conversation and thus spiral a miscommunication war of back and forth trying to figure out what's being said." [P1331]

For many developers, face-to-face communication is best

	(Not) Face-to-face	17	"Often collaboration tools are still not as good as face-to-face communication. Many software companies have moved to having all of their staff on-site full-time, because the communication is just better. Especially when two or more developers are collaborating on the same code in real-time (pair programming) or "whiteboarding" on a design... being there in person is just different. " [P176] "Often times it is difficult to get ideas across in written communication. This is where tools such as Google Hangout and Skype can be beneficial, but they are not always an option." [P206] "I've always found it slightly more difficult to work over email, instant messenger or a not in person code review tool than working face to face with someone. When working apart people aren't always at their computer or responding to messages, and in the case of code review they have to summarize their thoughts into a few paragraphs. In person it's much easier to convey a thought, have a discussion and come to a resolution." [P319] "We use skype a lot to chat with our developers but to be honest, skype stinks and seems to only be getting worse as time goes on. if I had any complaint about our stack or our methodologies it would be skype." [P1218]
People are challenging, no matter which channels are used			
	Poor attitude	9	"Misinformation is easy to communicate and propagate. People can be rude or obnoxious on social mediums, distracting from a discussion. The asynchronous nature of social media interaction can often lead to missed information or incomplete contexts for understanding information." [P187] "Yes. Personal restraint w\/ people who are mean (or, dicks). Otherwise, amazing area for learning and sharing." [P421]
	Intimidated	12	"I often times feel I'm not smart enough." [P174] "The biggest thing I fear in my work is that I'll say something that is not 100% technically accurate or could be misinterpreted. Other developers are utterly merciless, and I have thin skin. Whenever I post something on HN or StackOverflow I find that I feel anxious that someone will tear me a new one over some oversight in my analysis." [P302] "I find it hard to find projects that really interest me and need my help. Most stuff is created by guys that are more productive and more proficient than me and their software is already in a state where I can hardly add any real value." [P435] "You are contacted by people who considers you a good developer, and that's a challange for oneself to prove one's skills and abilites." [P640] "Nearly all my development work is out in the open. However, in addition to the positive responses, it also leaves me open to attacks from people as well." [P847] "It's difficult to apply an hierarchy in an OpenSource project. And you don't want to talk against other developers because of the fear the may just fork the project\r\nand develop on their own version of the project." [P1103] "…With open source, I think there's social issues around etiquette and a certain... apprehension to participate for fear of looking like a n00b. " [P1385]
Communication channel affordances, literacy and friction:			
Developers need to consider channel affordances			
	Private vs public	9	"Yes some information that is distributed via private email should be made public for traceability and awareness purposes." [P806] "Very few new developers are learning how to use old tools such as email and are tending toward using social networks and other tools. It can be frustrating when you want to collaborate and they insist on proprietary software or technology, or insist on using privacy invasive tools such as Skype or Facebook. " [P897] "People complaining about their privacy tend to slow down development." [P1399]
	Synchronous vs asynchronous	9	"I want realtime communication" [P596] "I try to use asynchronous communication. so i can decide the time when to communicate and i wont be disturbed when im programmin or learning!. On the other side i have the possibility to talk face to face to to the other developers in the team, which is the most effective way to learn, coordinate etc. But it is not asynchronous." [P927]

	Ephemeral vs archival	3	"…Face to face seems easier, but in many cases it's less efficient because there is no record of the communication that can be referenced later unless the parties involved take very detailed notes. If you consider video conferencing to be \"face-to-face\" then this can be resolved by recording the conversation." [P1250]
	Anonymous vs identified	1	"I disklike not knowing a communication partner personally. It is similar to anonymous statement. I cannot really judge a anonymous statement. Unless you do scientific statistics, I see no big value in anonymous statements." [P397]
	Text-based vs verbal	5	"When you write, context and expression is lost. There have been so many times when something I wrote did not come across to the other person as intended. This causes problems all the time. You must be careful and spend time on the words and phrases you use when communicating in text. If you can pick up the phone, then use IM and at last resort, email." [P126] "Textual communication with long distance teams doesn't work well. Things are lost and missed." [P966] Clarity of intent (it can be hard to get a point across through text-based media) - It can be difficult to see the big picture, or even the pieces, without talking face-to-face" [P1241] "Language is sometimes a problem. Not all people - including me - are native English speakers and writers. Direct communication via (Video-)Phone (or Skype or ...) would sometimes be better than just written text." [P1459]
	Face to face (vs not)		*This code was already presented above.*
No single tool fits all *			
	No one tool fits all	10	"none of the technical channels/tools/methods is rich enough or responsive enough (nothing comes close to co-location and face-to-face); when using on-line tools, there is often a problem on "completeness" (I'd like feature X from one tools and feature Y from another)" [P43] "The closest thing that my ideal setup is Google Hangout + Trello + GitHub + Nitrous.io. The biggest challenge in soft-dev for me is four-fold: communicating the idea (Hangout), managing the idea (Trello), logging the implemented idea (GitHub), and explaining the implemented idea with the team (Nitrous.io). The first three solutions are pretty solid. It's the fact you can't always sit right next to someone and show them the code and explain how everything works that is the most challenging part. Cloud9, Koding, Nitrous, etc are all trying to solve the last problem. So far, Nitrous works best for me but that's still where the biggest pain point is for me (translation: Nitrous is still pretty far from where it should be)." [P445] "Each tool has its own strengths, weaknesses, and modes of use. It's tough when other developers don't use tools well or use the wrong medium." [P888] "Different people have different communication preferences, plain and simple." [P1296]
	Communication with users	9	"I'm developing SARAH a framework to connect Internet of Things. So coding si 30% of time ! I also have to manage a community of 700 users and doing markting, talks, video, tutorials, etc ..." [P146] "…When it comes to getting feedback from users, I often wonder\/worry about which channels have the least friction. E.g., most non-coders don't have Github accounts. Do they have Google accounts? And then I have to copy bug reports from elsewhere into Github issues.\r\n\r\nAnother concern (especially in my day job) is user privacy. We want to be able to hear from users and respond to them, and for them to talk with each other, but we don't want to see their email addresses or have them see each other's addresses. Nor can we trust third parties with their addresses. (Our users could be in danger in their home countries if they reveal they use our tool. We're not a normal case.)" [P394] "Users often do not express the problem they are having concisely or in a way that makes it clear what the problem is. This makes it more difficult for myself or others to debug the problem and fix it." [P631] "Users of my open source software often feel entitled to free technical support. Because it's so easy to reach me, they can be a nuisance sometimes." [P700]
Developers need to be literate with communication channels			

Literacy	17	"The tool matters less than how people use it. Biggest problem is people not using tools the way it was agreed upon." [P253]	
		"Lesser-skilled developers (typically designer-developers) sometimes struggle to use the common tools like git\/github, screensharing, text-based communication and to configure their own development environment. This makes collaborating remotely get bogged down in stupid troubleshooting sessions." [P488]	
		"Developing filter skills to pick out the important things from the noise." [P729]	
		"Each tool has its own strengths, weaknesses, and modes of use. It's tough when other developers don't use tools well or use the wrong medium." [P888]	
		"The main challenge for me is the interaction with people who are not literate enough to use the tools I consider 'standard'" [P1005]	
Lack of documentation	6	"The time a new technology spend on develop a good and strong documentation, and the time developers get used and experienced. This is key for social tools during software development." [P12]	
		"The lack of information and documentation about these tools sometimes makes it harder to learn to use them, and this makes them require a lot more time to be mastered." [P981]	
		"Learning how to use them. I still don't understand how to do simple things in IRC and often don't bother because of the perceived effort involved - much easier to post on Stack Overflow. With tools like GitHub, there's similar issues (like how to submit patches) although documentation is improving. [P1385]	
Learning tools	8	"The biggest challenge from social tools during development is when a new one is adopted into the mix, the learning curve associated with a new tool eats time unless the program is intuitive and pointed."[P404]	
		"Basically a very different way to communicate compared to face-to-face comm. It simply has to be learned." [P1317]	

Communication channel friction can obstruct participatory development activities

Tool friction	17	"I never used any tool fully based on the communication between the developers team. Social tools are too much 'all-in-one' things..." [P609]	
		"Being made to use overly complex social tools (Jira) vs streamlined services, such as Github." [731]	
		"Never have enough screens. =0p" [P919]	
		"Code review and collaboration tools (Asana, Trello) I mostly find to be necessary to some extent but generally very annoying. Seems like one more thing. Maybe they're necessary evils, but they seem to get in the way a lot. " [P1255]	
		"Hacker News dominates and is terrible." [P1279]	
		"Social software often gets in the way of the programs I use for development or conflicts with the compiler." [P1607]	
Search	11	"Searching in big data collections is hard. For example, Google's review tool has literally millions of entries (with est. half a million being hot data)." [P688]	
		"Finding good usage examples of internal code." [P706]	
Poor mobile support	4	"I don't face any significant challenges. It's not as easy as I'd like to share code on my phone, mostly because it's tricky to write even brief snippets with a smartphone keyboard." [P25]	
		"Lack of attention paid to mobile experience. Lack of persistent/searchable storage for ad-hoc information." [P1116]	
Vendor lockin	5	"Much of the value that we responsible for is now kept safe and maintained by a third party. It's risky... If eclipse.org, stackoverflow.com or github goes away, our team(s) would suffer severe damages. I would love to be able to have my own weekly backup of the social interactions that take place in a format that is machine processable such that in the event of total failure I could migrate our history of communication to another host or another technology." [P334]	
		"Very few new developers are learning how to use old tools such as email and are tending toward using social networks and other tools. It can be frustrating when you want to collaborate and they insist on proprietary software or technology, or insist on using privacy invasive tools such as Skype or Facebook. " [P897]	
Notification issues	5	"Notifications: when used in a moderate way it is fine, but when overused, it is a distraction for developers." [P320]	

Poor channel integration	7	"Yes, many projects use different places for communication (IRC, XMPP, mail list), and even a few. This is a very obstructed. I would like to have some more universal software for interaction." [P369]
		"Scattered communication -- larger projects with more developers and information is on the project collaboration site, in email, in SMS, on Skype -- would love to have a communication funnel so everything is visible in one spot, not spread across so many different media" [P1599]
Channel overload	29	"I am sometimes frustrated that there are too many places to do the same thing; especially when I answer a question privately and want to instead make that answer public." [P137]
		"The explosion of options can be difficult to manage." [P155]
		"Use of numerous tools may be overwhelming. It is usually assumed that it is better to use less tools, and increase the direct communication frequency between developers using face-to-face or chat." [P232]
		"Having so many different avenues of communication essentially divides the community, so depending on who you need to talk to, you may need to add even more communication tools to your already-overflowing communications toolbox." [P580]
Poor adoption	18	"The biggest challenge is to communicate with people not using modern communication and social tools: we must argue enough to make them join." [P40]
		"Usually, the inhibitions come from outdated software and practices, for instance, people who expect patches via email (which I hate) vs using a Pull request on github or similar. " [P191]
		"Employers can (in my case at least) use very outdated or ineffective tools." [P853]
		"Making sure everyone else you're working with also uses the tools." [P1250]

Content and knowledge management:

Use of many channels leads to information fragmentation

Information fragmentation	11	"A lot of the answers and guidance I look for when developing code are scattered all over the internet, it would be nice if there was a place that I could get in touch with an expert developer to ask/discuss questions." [P198]
		"There are many channels that we use for many different things, sometimes you don't remember \/where\/ something was shared regarding a project." [P555]
		"Piece-mail, have to keep herding, centralizing, and distributing to the right stakeholders, info." [P1554]

The quantity of communicated information is overwhelming

Quantity	10	"Trying to control volume and duplicates." [P1293]
		"There definitely is information overload. People think I'm joking when I mention the 'javascript framework of the day'. " [P1409]
(Signal in the) noise	16	
		"Too much noise and repetition. People just reblog or retweet the same stuff.\r\nThere are only a few original content providers, other are just broadcasting their content with a little sugar around it.\r\nIt gets difficult to separate the real content from the shenanigans." [P1100]
		"I believe the main problem I have is the information\/noise ratio. This is easy to notice on discussion lists, where you don't know if you really need to read the email you just received or if there is no problem ignoring it (because it was meant to be answered by some other people)." [P1152]
		"People post lot of waste on social tools. Things which are of no use to me, but which are tempting. So If I log on to social sites looking for some quality material. I end up wasting time commenting on other people's posts, which aren't going to be of any use to me in the future." [P1161]
		"Sometimes large projects have a large signal-to-noise ratio that I find it hard to focus. Lots of pull requests, issues, etc that are not relevant to me, but I still want to stay up-to-date on the project overall." [P1245]

The quality of communicated information is hard to evaluate

Quality	24	"I sometimes feel lack of quality content on social networks, q&a sites - especially when it comes to incompetent answers to questions I ask. So the challenge is to filter the information you get from all of the sources." [P95]
		``Information is not consistent across IRC, mailing lists, blog posts, etc even within the same project especially re: new features and development changes." [P257]
		"There is so much information out there that as a developer I spend a lot of time trying different approaches because sometimes there is no way to know which one is the best too solve my problem, and worst, when the solution depends on the different versions of my libraries or tools." [P269]
		"Even with the amount of information available, in larger projects, the quality of the information communicated is not very good and leads to much confusion and miscommunication, or a feeling of a lack of important information." [P459]
		"Seeing the truth. It is all too easy for developers to over embellish their skills online via social media. " [P638]
Obsolete information	5	"There is so much information out there that as a developer I spend a lot of time trying different approaches because sometimes there is no way to know which one is the best too solve my problem, and worst, when the solution depends on the different versions of my libraries or tools." [P269]
		"The age of some content can be a problem. As time passes there is a higher percentage of obsolete information that you have to wade through." [P1407]
Spam	4	"Email notification control is very limited which leads to either being spammed or missing everything. " [P671]
		"Recruiters keep spamming me through Github or Stack Exchange looking for web developers, even though I am an electrical engineer, not a web developer. Python != web development." [P750]
Niche technologies	4	"I tend to work alone or with one graduate student. We write our own code and speed and correctness are vital for the problems we are solving: problems that tend to be so difficult that nobody else has been able to find a solution. So communication tools are not so relevant." [P304]
		"It can be hard to find solutions to obscure problems." [P426]
		"Keeping up with technology, niche social communities, and tools." [P1598]
History of information	3	"IRC is particularly difficult to retain saving history unless you go out of your way." [P744]

Strategies: (Discussed when the challenges were presented in the ICSME 2015 submitted paper)		
Developers used a variety of strategies to address their challenges		
Deciding when to use particular channels	3	"I think one needs to exercise self control when using these tools, otherwise it's easy to end up spending more time on them than needed." [P646]
		"Biggest challenge is meta--e.g. *noticing* when I'm feeling overwhelmed or distracted and adjusting to adapt (e.g. closing IRC, taking a twitter hiatus, etc)" [P825]
		"I turn off most communication tools at the right times (ie when I'm not in need of feedback or help). I'll still use GitHub for finding resources and a private messaging tool, HipChat or email, for quick questions. But I don't find that being a part of communication and social tools as distracting to my actual work, they have a time and a place like all tools." [P1336]

	Deciding which channels to use and how	6	"If you have to go to a web browser there is a 10% chance you'll be distracted. I use the project \"howdoi\" to get answers from Stack Overflow on the command line so I can stay out of the browser and keep focus." [P534] "We use HipChat (kind of a private IRC) with HUBOT that watches our github activity. It's wonderful because our entire team can be instantly notified about who's doing what on which repository, and we're all in communication via mobile and desktop with the same feed." [P892] "I try to use asynchronous communication. so i can decide the time when to communicate and i wont be disturbed when im programmin or learning!. On the other side i have the possibility to talk face to face to to the other developers in the team, which is the most effective way to learn, coordinate etc. But it is not asynchronous." [P927] "There are too many sources of communication to monitor, I have been trying to use tools like HipChat and Flowdock to get a more unified communication channel." [P980]
	Encouraging others to use tools	1	"Another challenge is dealing with the sense of entitlement felt by some users of open source projects. Encouraging them to find ways to contribute without alienating these users can be difficult. Making them understand that open source projects are (usually) unpaid volunteer efforts and everything that implies can be difficult." [P1388]
	Unplugging	1	"Sometimes it helps to have a day of development where you unplug in the internet." [P692]

*Notes: * This was presented as a code rather than a finding in the ICSME submission due to lack of space, with the associated codes grouped under "affordances" finding.*
** This finding was omitted from the paper (due to space) and the corresponding codes were grouped with the Affordances finding.