

Agile Software Development Diffusion: Insights from a Regional Survey

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Abstract The agile approach to software development is now standard practice in many organisations. In innovation diffusion terms, its uptake seems to be well into the majority adoption phase, with a large number of organisations now claiming some level of agile activity. Confirming adoption progress requires appropriate periodic surveys of industrial practice. The purpose of this paper is to present and comment on the results from such a survey, performed in Northern Ireland in 2010, with thirty-seven software development companies. The work is distinctive in aiming to provide comprehensive coverage of the region. The paper describes the design of the survey and comments on the insights it has provided. The results show that approximately 50% of companies are now running agile projects routinely, with over 80% of those using Scrum as their agile framework. The wider extrapolation of the results is also discussed.

1 Introduction

The social science literature contains a substantial body of work on *innovation diffusion* [1-3], which is the process by which new ideas become established. The pattern of adoption is typically summarized by two curves (Figure 1), one showing market share growing to saturation (S-curve) and the other classifying the type of adopters involved in each phase (bell-shaped Gaussian curve): *innovators*, *early adopters*, *early majority*, *late majority* and *laggards*. Further, in considering technology innovation, such as agile development, Moore argued that for adoption to

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occur, a transition has to be made from the early adopters who explore new technology routinely to the early majority who wait pragmatically until there are clear advantages to adoption. This transition he calls “crossing the chasm” [4].

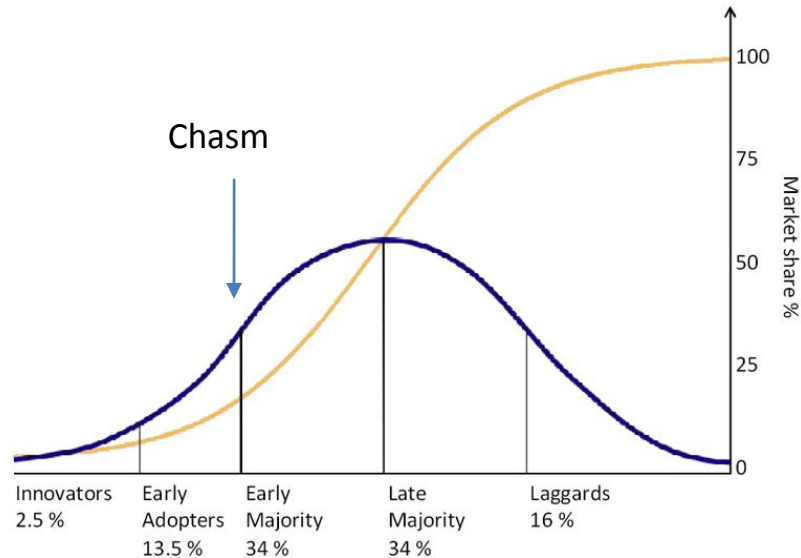


Fig 1 Innovation Diffusion Curves

In estimating progress along the adoption curve, it seems safe to suggest that agile development is now comfortably on the other side the chasm. Arguably, this began ten years ago, with the collaboration that led to the ‘agile’ concept, the development of the Agile Manifesto, and the definition of the associated twelve Agile Principles [5]. The growth of agile use has been substantial since then but estimates of adoption levels remain surprisingly low. Vijayasarathy and Turk, for example, describe their survey in 2008 [6] as a contribution to “*bridging the chasm*”. Also, while Ambler has been asserting that the chasm has been crossed since 2006 [7], his conclusions about the current extent of adoption seem modest [8]. The underlying issue here is that most surveys are based on self-selecting participants, so the results cannot easily be generalized to the full population of software development organisations. For example, Vijayasarathy and Turk note that their respondents were “*knowledgeable and/or interested in agile development...more representative of early adopters and not of all developers*”.

The purpose of this paper is to present the results from an agile survey that is distinctive in attempting to provide comprehensive coverage of a single geographic region, rather than using volunteers from a wider area. The survey was commissioned by Invest Northern Ireland (INI), an economic development agency, to analyze the capability and capacity of the Northern Ireland software industry to engage in agile software development. In addition to clearer adoption information, the survey was also expected to provide insights into the current practice of agile

development. The next two sections of the paper describe the design of the survey and make observations on the results obtained. The paper concludes with some general comments on agile diffusion and suggestions for future work.

2 Survey Design

Pfleeger and Kitchenham [9] define a survey as “*a comprehensive system for collecting information to describe, compare or explain knowledge, attitudes and behavior*”. The aims of the Northern Ireland survey were to (i) *describe* the extent of agile software development among organizations in the region; (ii) *compare* the position in Northern Ireland with other parts of the world; and (iii) *explain* any apparent anomalies in the findings that emerged.

The first step was to identify the companies that might participate. The goal, as indicated, was to have comprehensive coverage of the region. This was achieved by building the survey list around the software development companies that had either engaged with INI (the economic development agency) or who had joined Momentum, the trade association for the ICT industry in Northern Ireland. Fifty-six companies were identified in this way.

The next stage was to decide how the survey would be performed. Given that there were three researchers involved (the authors) and the companies to be surveyed had a relatively narrow geographical spread (many in the larger Belfast area), it was a straightforward decision to gather information face-to-face, through structured interviews. The direct contact approach would also make the size and wording of the associated questionnaire less critical and help achieve (i) a high response rate; (ii) the full completion of each questionnaire; and (iii) consistency in the interpretation of each question.

A number of research questions influenced the design of the questionnaire. The first was the overall driver for the study, namely: *what is the capability and capacity of the Northern Ireland software industry to engage in agile software development?* A set of related secondary questions included:

1. *What does it mean to adopt an agile approach to software development* (to clarify what is expected in the software process and detect any evolving changes in the concepts and practices involved)?
2. *To what extent is agile adoption in Northern Ireland indicative of agile adoption worldwide* (to assess the significance and generality of the results)?
3. *What are the main inhibitors and accelerators for agile adoption* (to assess likely changes in adoption levels)?
4. *To what extent does the agile approach help or hinder individual aspects of the software development process* (to clarify the specific contributions of the agile approach to the development process, identifying any current inhibitors)?

5. *In what ways is the quality of the software product affected by an agile approach* (to clarify the specific contributions of the agile approach to software quality, identifying any current inhibitors)?

The resulting questionnaire had two main sections: one gathering summary information about the organization and the other capturing details of its experience with agile software development. The questions on the organization asked how long the company had been in operation, its business area (including types of software produced), its autonomy (independent or part of a larger organization), its size (technical staff and overall numbers), and any conformance to external standards, such as ISO 9001 or CMMI [10].

The number of technical questions posed depended on the agile experience of the organization. Four categories were defined: A. *no direct experience so far*; B. *some experimental use*; C. *routine use for some projects*; and D. *general approach taken across the organization*. For Category A companies, with no direct experience of agile development, it was simply a matter of documenting the reasons for non-involvement, with some prompts offered, such as: (i) satisfaction with current practices; (ii) no one having sufficient interest; and (iii) pre-existing negative impressions of the approach. The third response was followed up with additional questions to clarify the issues involved. Similarly, for Category B organizations, with just experimental experience of agile development, the focus was simply on determining details of the experiments and their results.

Twenty questions were posed to those companies in Category C or D, which used agile development routinely. The first twelve questions established when agile use began, why and how it was introduced, the extent of its use, involvement in specific methodologies (e.g. Scrum [11], XP [12], DSDM [13]), selection of team members, team sizes and locations, and the number of projects completed so far. More detailed questions then followed. These covered:

- An assessment of the advantage or disadvantage in using agile development across over 30 individual software engineering activities, including aspects of requirements analysis, system design, project management and the satisfaction of developers, clients and managers.
- The perceived impact of agile development on the software attributes cited in the ISO 9126 Quality Model (Functionality, Reliability, Usability, Efficiency, Maintainability, and Portability) [14].
- The level of agreement or disagreement with the 12 Principles of Agile Development (e.g. 7. *Working software is the primary measure of progress*) [5].
- The level of experience, if any, with the 12 practices of XP [12].
- Details of any specific tools used in the support of agile development.

As is evident from the description above, a substantial amount of information was gathered at each interview. It was estimated that for a company involved in agile development, completing the questionnaire would take roughly an hour; for others it would be much shorter. It was recognized that having a questionnaire of

this length would be daunting for some organizations, which could lead to non-participation. This seemed particularly likely for organizations that had yet to consider the agile approach in detail. For those actively engaged in agile development there was some evidence from earlier informal interactions that they would be relatively enthusiastic about presenting what they had achieved. Additional incentives included:

1. Emphasizing the confidentiality of the study: *“Please note that all information supplied will be held in accordance with the data protection act 1998. The information will be used and published in the form of consolidated statistical survey data only.”*
2. Making clear that although INI was interested in the detailed responses from each company, the front page of the questionnaire allowed for an opt-out from this arrangement.
3. Offering those participating in the survey a full copy of the resulting consultancy report, which would not be made public for at least a year.

To help ensure that there was sufficient reflection on the answers provided, it was decided to send those who agreed to take part in the study the questionnaire (electronically) in advance of an interview, with a request to draft responses as far as possible. At the interview, the answers would then be confirmed, additional notes taken, and any missing sections completed.

As a check on the suitability of the questionnaire, it was piloted with three companies with whom the authors had worked previously. No significant changes were required.

3 Survey Implementation, Results and Observations

This section describes the implementation of the survey in more detail and comments on both the process involved and the results obtained.

3.1 Survey Implementation

The survey was carried out over a 4-month period, leading up to the production of a consultancy report in March 2010. To give authority to the survey, the initial invitation to participate was issued by INI, using email directed at the CEO, CIO or senior representative in each organization. Participation was, however, optional. About half of the 56 companies invited agreed to be interviewed. Some made it clear that they did not want to take part and others simply didn't reply. For the latter group, further attempts were made to establish contact. In some cases there had been organizational changes and a new contact had to be found. A small number of organizations agreed to complete the questionnaire by telephone and two returned the questionnaire without an interview or discussion. One of the companies

that failed to respond had moved its main software development activity out of Northern Ireland so they were excluded from the study. Another large public body argued that they developed all significant systems through third parties and so could not contribute to the survey. This was agreed, though later it was recognized that such bodies have a significant effect on agile adoption in the companies where they place contracts because, typically, the projects are fixed-term and specify project management processes (usually Prince2)—both of which tend to inhibit agile use.

3.2 Survey Results

In the end, 37 questionnaires were completed in a form suitable for analysis. The companies contributing ranged in size from 7 to 770 development staff, and covered a wide range of business areas, including aerospace, finance, telecommunications, oil & gas and government. One characteristic of the region is that it has a relatively large proportion of SMEs, with about two-thirds having fewer than 50 staff.

The broad level of experience with agile development reported by the 37 companies surveyed is summarized in Table 1, using the four categories explained in Section 2.

Table 1 Broad levels of experience in agile use

Response	No of Companies
A: No direct experience so far	6
B: Some experimental use	7
C: Routine use for some projects	15
D: General approach taken across the organization	9

The six companies in Category A had no experience of agile techniques. In each case the company was satisfied with its current development approach and had no plans to change in the foreseeable future. One of these companies felt that their current approach to requirements development, approval and change was better suited to the fixed-price contract work in which they were involved; also, it was not necessary to demonstrate the ‘product’ to their customers on a regular basis in order to show project progress. Two of these companies did employ prototyping: one to help clarify requirements and the other to aid proof of concept within the development team.

Across the seven companies in Category B that have experimented with agile techniques, the main reasons given for considering an agile approach were (number of responses shown in brackets):

- Client requests to integrate with their business/project processes (2)

- Issues with requirements (2), either to reduce the pressure of voluminous detailed requirements up-front; or be better able to cope with an anticipated large volume of change requests
- To support frequent releases to help manage the product strategy (product roadmap) (1)
- Reaction to the heavyweight traditional approaches and desire to operate more efficiently (2)

Four of these Category B companies had started experimenting with agile techniques during late 2008 or 2009, while for the other three the experiments were conducted much earlier in the period 2000–05. In all seven cases, routine or widespread adoption of agile approaches had not yet happened. For two of the companies, the main reason given was that as their customers became more engaged, so their ability to change and extend their requirements increased in often undesirable ways. Interestingly, one of the fully adopting companies found it difficult to experiment with agile techniques on a small scale, arguing that a whole-hearted commitment and high level of discipline was required to realize the main benefits from the approach, necessitating a more complete adoption strategy.

For Category C and D companies, reporting routine use of agile techniques, the main reasons cited for adoption were:

- Driven by developer interest (8)
- Influence from a partner/parent/sister organization and in some cases to facilitate better interaction between these co-operating groups (6)
- For competitive advantage, such as a need to meet tight deadlines or provide frequent releases—some companies could see competitors using agile techniques able to release new features in a much shorter timeframe (6)
- To improve requirements development (2)
- Client demand (2)

The main factor was ‘developer interest’, which has been a significant influence in the rise of the agile movement. The role of large organizations is also important in spreading the approach globally: directly, across their own structure and indirectly, in influencing competing organizations and sub-contractors.

The nature of the client contract appears to have an important bearing on whether or not an agile approach is used. Many companies (at least 5) in Category C used an agile approach if the client contract permitted it. In some cases, even on fixed-price contracts an agile approach was taken, with internal iterative development but no release of intermediate products.

From the 24 companies using agile development routinely (Categories C and D), 11 were using Scrum, 8 a combination of Scrum with XP, and the remaining 5, various mixtures of Scrum, RUP and DSDM. Overall, Scrum emerged clearly as the dominant framework for the agile approach.

The level of experience with agile development varied significantly across those using it routinely. Two companies had taken an agile approach in one form

or another for over 10 years but over a third of the respondents were still in the first 18 months of routine use. Reflecting that range, roughly 10% of companies had completed over 50 agile projects while 40% had 5 or fewer.

Project teams ranged in size from 2 to 30 developers, with an average size around 5 to 6. Ten companies reported development teams located in the same room, while 14 had some teams that were separated within a building or distributed geographically across different regions of the world.

To assess the effectiveness of the agile process, each company was asked to rate, on a scale of -2 (much worse) to +2 (much improved), various process related aspects of their agile approach against previous experience with non-agile development. The questions related to activities with requirements, design, coding, testing, maintenance and overall developer productivity. The results, summed across all 24 respondents (value range -48 to +48), are presented in Figure 1.

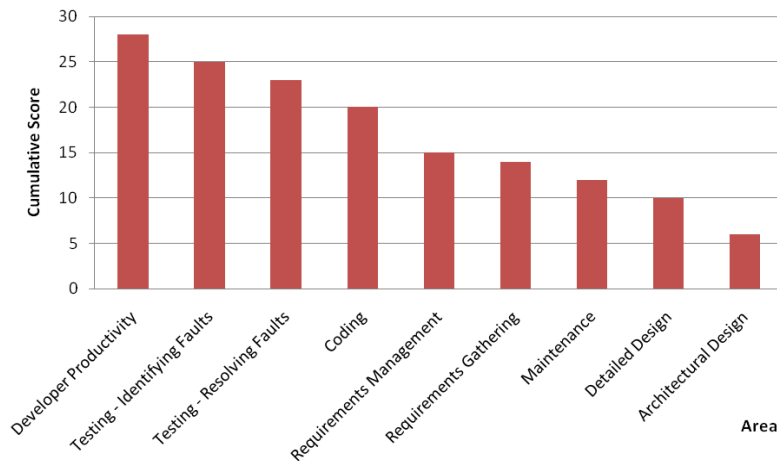


Fig 1 Perceived process benefits of agile approach

It is significant to note that all of the cumulative totals are positive, meaning that agile approaches are considered an improvement over non-agile approaches in all of process areas assessed. These benefits were shared by developers, customers and management. The highest ranked aspect is developer productivity but agile approaches also assist testing, particularly through test-driven development. Several companies commented that this had been their area of greatest gain.

The lowest ranking activities related to design—particularly architectural design, where 13 companies felt that there was no improvement over traditional approaches, with some reporting that teams found design more difficult.

A similar pattern emerged in the assessment of perceived improvement to the software product through agile development, as summarized in Figure 2. As might be expected, product functionality and usability are the two qualities most often enhanced through the use of highly iterative agile approaches, where the focus is very much on the value of the developed product.

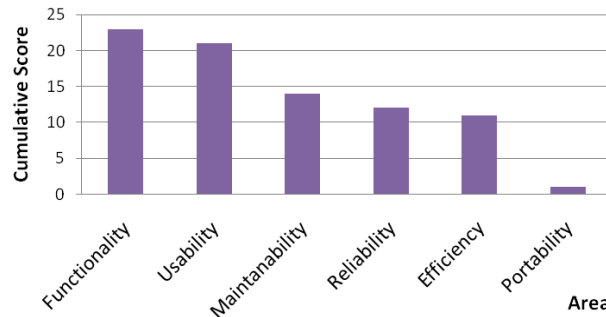


Fig 2 Perceived product benefits of agile approach

3.3 Observations

This section presents a number of observations on the survey results in relation to the general question of the level of agile adoption in Northern Ireland.

3.3.1 What it means to be ‘agile’

One issue in designing a survey to assess agile adoption is to decide what the term means, as no agreed definition has yet emerged [15]. Ambler, for example, recently proposed five criteria [16] for an agile team to be classified as ‘agile’ but these are debatable and insufficiently precise for use in an empirical study:

1. Produce working software on a regular basis
2. Do continuous regression testing (and better yet, take a test-driven development approach)
3. Work closely with their stakeholders, ideally on a daily basis
4. Be self-organizing within an appropriate governance framework
5. Regularly reflect on how they work together and then act to improve on their findings

Because of this difficulty, it was decided that, rather than produce a definition in advance, information would be gathered in the survey to help create it. This involved seeking each company’s views of the standard principles of agile development and noting their associated activities in pursuit of those principles, prompted by the practices defined for XP. In this way, the survey could contribute to an understanding of what it means to be ‘agile’ and at the same time propose a practical definition to use in the interpretation of the data.

The results, however, suggest that this level of concern was unnecessary. The vast majority of the companies who adopted agile development did so within a standard agile framework, especially Scrum (>80%). The few remaining had their own process but in each case it involved similar rapid cycles of development, and the usual range of associated practices. Interviews provided direct assurance of the depth of agile understanding and activity in each case.

3.3.2 Level of agile adoption in Northern Ireland

Overall, the level of adoption of an agile approach to software development was much greater than the authors were expecting, based on impressions gained from a range of earlier interactions with local companies [17, 18]. The surprise is explained by the fact that over a third of those reporting routine use of agile development had adopted it within a period of eighteen months immediately before the survey.

From the interviews it was clear that for many, agile development had become embedded as standard practice, illustrated by companies having the flexibility to adjust its use according to the type of project involved.

In innovation diffusion terms, adoption in Northern Ireland seemed very close to the middle position of the adoption curve. Specifically, 24 of the original 56 companies contacted seemed to be committed agile users, which approximates to 50%, allowing for (i) the exclusion of some companies because they were not involved directly in software development; and (ii) the possibility that some of those who did not respond had involvement with agile projects. This was known for one (large) company, in which a team had been using an agile approach for at least two years.

3.3.3 Generalizing the Results

Roughly half of the 37 companies surveyed were multinational, though a large number of the remaining indigenous companies operated worldwide, with some having offices and/or development facilities in other countries. This breadth of activity suggested that the results obtained for Northern Ireland could have wider significance. Similar studies in other similar regions would be needed to resolve the matter but in the meantime it was considered useful make some comparisons with other existing survey results. A close comparison with Ambler's surveys [7] is problematic because of the different approach taken in each case, but it is encouraging to note similarities between his latest survey in 2008 [19] and the results obtained here, as summarized in Table 2. The tentative implications are that (i) the level of agile adoption is in reasonable step with the rest of the world and that, in the other direction, (ii) worldwide adoption of the agile development paradigm is at or around the peak level.

Table 2 Comparison with Ambler's 2008 Survey

Observation	Ambler	INI
Respondents with agile projects beyond the pilot project phase	82%	78%
Respondents reporting improved productivity using Agile teams	82%	83%
Respondents reporting improvements in the quality of software	77%	60% ⁴

⁴ This figure is approximate. The precise percentage varies according to the specific 'product quality' considered, with the closest comparison with Ambler's notion of Software Quality likely to be either 'reliability' or 'maintainability'.

Respondents reporting improvements in Business Stakeholder Satisfaction	78%	79% ⁵
Respondents reporting a reduction in the overall cost of system development	37%	29%

4 Conclusion

Getting an idea adopted, even if it is a very good idea, is a slow process. Agile software development is now well established but there is still value in performing regular surveys of its adoption level, both to chart its progress and to monitor any evolving views of its principles, techniques and tools. This paper describes such a survey, covering software development companies in Northern Ireland. The work is distinctive in (i) attempting to provide a comprehensive treatment of a particular region, rather than relying on the voluntary completion of questionnaires from a range of sources; and (ii) using structured interviews to ensure that the information gathered is complete and consistent.

The results suggest that agile development is now a mainstream software engineering practice, with approximately 50% of companies using it routinely in commercial projects and all reporting a range of significant benefits. Comparing the results with surveys by Amber suggests that the Northern Ireland position is similar to that in other parts of the world where software development is a significant commercial activity. The implication is that the adoption of the agile approach now seems to have reached the midpoint of the adoption curve. This has consequences for companies that provide consultancy and training services for industry but also for academic institutions that prepare graduates for employment in the computing industry.

This paper has considered one aspect of the survey data gathered but there are others areas to be analyzed such as adherence to specific principles and practices and the role of tools in the development and maturation processes. Future research will consider such aspects and also return to the companies involved in the survey to monitor their ongoing evolution.

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⁵ This statistic refers to improvements on ‘customer engagement’ which can be correlated with customer satisfaction.

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