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A study of microblogging data**

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Initial adoption of technology is examined. Initial adoption refers to the point at which the decision to adopt a technology is made, before the user has formed perceptions of - for instance - how easy it is to use or how useful it is. Adoption behaviour is explained in terms of information cascades. An information cascade exists when a potential technology adopter ignores their private information about the technology and is influenced by the adoption decisions of others. Data were drawn from a microblogging service. Microblogging is a form of social networking where short messages are sent from one blogger to many readers. The system is voluntary and unlike many information systems, gives potential adopters the ability to clearly see the adoption decisions of others. Two empirical analyses support the notion that an individual's decision to adopt is influenced by the decisions of others. A third study examines a possible alternative explanation – that some individuals are lurking, thereby adopting the system although not in the way intended by the developers – and discounts it. We found strong support for the importance of the adoption decision of others in an individual's decision to adopt. A general model of these ideas is one which recognises the importance of what might be termed buzz around a technology and how this can influence adoption decisions.

Keywords

Information cascade, Microblogging, Technology adoption.

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Initial adoption of technology is examined. *Initial adoption* refers to the point at which the decision to adopt a technology is made, before the user has formed perceptions of—for instance—how easy it is to use or how useful it is. Adoption behaviour is explained in terms of information cascades. An information cascade exists when a potential technology adopter ignores their private information about the technology and is influenced by the adoption decisions of others. Data were drawn from a microblogging service. Microblogging is a form of social networking where short messages are sent from one blogger to many readers. The system is voluntary and unlike many information systems, gives potential adopters the ability to clearly see the adoption decisions of others. Two empirical analyses support the notion that an individual’s decision to adopt is influenced by the decisions of others. A third study examines a possible alternative explanation—that some individuals are *lurking*, thereby adopting the system although not in the way intended by the developers—and discounts it. We found strong support for the importance of the adoption decision of

others in an individual’s decision to adopt. A general model of these ideas is one which recognises the importance of what might be termed *buzz* around a technology and how this can influence adoption decisions.

1 Introduction

The information systems discipline has a long history of studying technology acceptance. Current theories model acceptance as being determined by user attitudes, beliefs and perceptions (for instance the Technology Acceptance Model (Davis, 1989); Diffusion of Innovation theory (Rogers, 1995); Theory of Planned Behaviour (Ajzen, 1991); Unified Theory of Acceptance and Use of Technology (Venkatesh et al., 2003); Theory of Reasoned Action (Ajzen and Fishbein, 1973); Model of Adoption of Technology in Homes (Venkatesh and Brown, 2001)). As examples: the Technology Acceptance Model (Davis, 1989) sees acceptance being determined by a user’s perceived usefulness of, and perceived ease of use of, the system; diffusion of innovation theory (Rogers, 1995) models acceptance based on perceived characteristics of the innovation: its relative advantage, compatibility, complexity, trialability and observability. The current paper adds to this literature by considering *initial adoption*, with the aim of gaining an understanding into how initial adoption decisions are made before the user has had the chance to form perceptions of—for instance—how easy the technology is to use or how useful it is. By initial adoption (henceforth simply referred to as *adoption*) we mean an individual’s decision on whether or not to ‘give the technology a go’.

In this work, adoption is modelled not on characteristics of the user or of the technology, but on the information users have about the adoption decisions of others. The system considered is a microblogging technology. Microblogging is a form of blogging where users publish brief text messages or multimedia such as photos or audio clips, either to be viewed openly or by a restricted group chosen by the user. The purpose of microblogging is similar to that of traditional blogging—one writer communicating to multiple readers—with the only difference being the size of the posts (Barnes and Böhringer, 2009).

The data used in the current work were taken from Yammer, a microblogging service similar to the more popular Twitter but aimed

at professional rather than social use. Yammer networks are tied to Internet domains which means members of a domain—as determined by email address—are able to join one Yammer network and see the posts of others within the same network. The network used belongs to a UK university. Use of the technology within this network was initially enthusiastic, but faded after about a year. The system can therefore be considered a technology fad. Microblogging data are particularly suited to studying adoption as they show a detailed time sequence of users who considered the technology, and which of them then did and did not adopt it.

The paper progresses as follows. Section 2 describes the theory underpinning our work. Section 3 describes our dataset. Sections 4 and 5 describe the two empirical studies. Section 6 offers a third study undertaken to discount one possible explanation of the data, with Section 7 offering a discussion of the work.

2 Information cascades

The current work attempts to model technology adoption not on characteristics of the user or the technology, but on the information users have about the adoption decisions of others. Our underlying theory is that of information cascades. An information cascade (Bikhchandani et al., 1992) is said to exist when an individual’s action is based not upon their private information but on their observation of the actions of others. In the following explanation we use the notation introduced by Bikhchandani et al. (1992).

An information cascade—within the current context—is explained as follows. A new technology is introduced. Individuals in a sequence $i = 1, 2, \dots, n$ assess the technology and decide whether to *adopt* or *reject*. The order of the sequence is unimportant but is known to all. An individual i observes the set of decisions A of those who came before, $A_{i-1} = (a_1, a_2, \dots, a_{i-1})$ where a_i is the decision of individual i . All individuals have a cost, C of adoption, and gain value V from adoption. A correct adoption is made if its value equals or outweighs its cost; it is incorrect otherwise. An information cascade exists if an individual ignores their private information and instead makes their choice based on the decisions of those before them.

For instance, if an individual’s private information is negative toward the technology, but they observe that the previous—say—three

people to consider the technology have adopted it and then choose to adopt because of this fact, that individual is in a cascade. This may in turn influence the decision of the next individual. Alternatively, the individual might be positive about the technology but be persuaded to reject by the people coming before them. A cascade may lead individuals to the correct or incorrect choice.

3 The data

To model adoption using information cascades, use of the system must be voluntary as individuals must have an adoption choice. Individuals must also see the adoption decisions of those who have considered the technology before them. There are few systems where this second condition exists. We would imagine that a general model of this theory for IS adoption would see the set of others' decisions A_{i-1} as coming from word of mouth *buzz*, where a potential adopter gets a feeling for others' decisions from Internet fora, review websites and social networks. These data—even if they were readily available—would be insufficient for a rigorous study. However the Yammer network from which the current data were drawn is one where use is voluntary and—as now explained—the sequence of individuals and their adoption decisions are known to all who consider adopting the technology.

When a user creates a Yammer account they are presented with the existing feed of posts in the network they have just joined, in reverse chronological order. At the same time, a post is added to the feed informing all members of the fact that a new user has joined. Therefore the feed will contain introductory posts such as *UserName has joined the network*. We define a non-adopter as an individual who registers for an account but then fails to post, and an adopter as one who registers and posts. Therefore if there are no posts from *UserName* (which would appear above their introductory post) a new member can infer that *UserName* rejected adoption. If they have posted messages, a new member can infer *UserName* has adopted. The rejection inference of course will be made subjectively based on the current date compared with the date *UserName* joined. If they are the same, a new member may infer that *UserName* simply has not posted yet. However if *UserName* joined over a certain time ago (decided subjectively), then a new member will infer rejection. (The implications of this issue for the results are considered at the end of

Number of individuals	65
Number of adopters	29
Total number of posts	1936
Minimum number of posts per adopter	2
Maximum number of posts per adopter	466
Average number of posts per adopter	68

Table 1: Summary statistics

Section 4.) If the feed is large, then we would not expect the individual to be able to properly process the full sequence of adoption/rejection decisions. In this case we would expect them to scan a subjective number of recent posts.

The data contain 1936 posts from 65 individuals (Table 1). The number of posts against time is shown in Figure 1. The initial response was enthusiastic but eventually faded just over one year later. For all users therefore adoption was incorrect – the value of adoption was less than the cost of adoption. (Note that we are not saying the technology had no value to the users; we are saying that whatever value it had did not outweigh the cost of use, which in this context does not mean financial cost but ‘effort’.)

Individuals are in an information cascade if they ignore their private information and make their decision to adopt or reject based on the decisions of others. In the case of microblogging, an individual’s private information would come from—for example—previous experience with social networking technologies and reviews they have read of Yammer and microblogging. These data are unknown to us. Anderson and Holt (1997) who studied information cascades in the laboratory state that even in the lab it is *‘very difficult for a researcher to infer what people think about the quality of others’ sources of information’* such as a third party review. The following therefore seems to be a sensible approach. When the university Yammer network was created, an email was sent to all staff alerting them of this fact. The majority ignored it thereby revealing themselves to have negative private information, perhaps because they were already users of Twitter or similar, or perhaps because they had read negative reviews, or perhaps through a feeling of ‘latest technology fatigue’. (Note that ‘negative information’ need not mean ‘negative attitude’ toward the technology. A person could feel positively about microblogging but think they do

Figure 1: Number of Yammer posts against time

not have time to contribute, which is part of their private information. In this case their private information tells them to to react negatively i.e. reject the technology without examining it.) In any case, 65 people did not ignore it. They registered for an account and joined the network.

At this point these 65 individuals examined a technology they had never used and decided whether or not to ‘give it a go’. Twenty nine of them choose to start posting messages i.e. adopt, and 36 choose to not post messages i.e. reject. We assume that the private information of these 65 were not negative toward the technology, otherwise they would not have registered in the first place. In fact in Study 1 we will start by assuming their attitude was indifferent.

4 Study 1

Figure 2 shows the number of individuals who adopted and rejected the technology against time. As estimated from the data, the probability that an individual’s decision to adopt or reject Yammer will match the decision of the person before them is 0.73. The probability

Figure 2: Adoption decisions against time

that it will match the decision of the two people before them is 0.59. Assuming indifference to the technology as described at the end of the previous section—that is assuming the probability an individual will adopt Yammer is 0.5—then the expected probability that an individual’s decision will match the decision of the person before them would be 0.5, and the expected probability that it will match the decision of the two people before them would be 0.25. In fact this provides strong evidence against adoption decisions being made indifferently and lends support to the notion that adoption decisions are related to the decisions of others. This finding holds even when we relax our indifference assumption and model individuals as apriori positive (setting a probability of adoption as 0.6 or 0.7) or negative (probability of adoption as 0.4 or 0.3) about adopting the technology. See Table 2 for full details of the statistical test; also considered are matching the previous three decisions and matching the mode of the previous 3, 5 and 7 decisions.

In addition, we ran two regressions of individuals’ decisions made against the number of adopt decisions by the previous two people to consider the technology (a_{i-1} and a_{i-2}) and by the previous three people (a_{i-1} , a_{i-2} and a_{i-3}), controlling in each for the sex and role of the

Event	Null distribution	Observed n	p	95% CI
$a_i = a_{i-1}$	$B(64, 0.50)$	47	0.000	(0.609, 0.837)
$a_i = a_{i-1} = a_{i-2}$	$B(63, 0.25)$	37	0.000	(0.456, 0.710)
$a_i = a_{i-1} = a_{i-2} = a_{i-3}$	$B(62, 0.13)$	27	0.000	(0.310, 0.567)
$a_i = \text{mode}(a_{i-1} : a_{i-3})$	$B(62, 0.50)$	50	0.000	(0.686, 0.896)
$a_i = \text{mode}(a_{i-1} : a_{i-5})$	$B(60, 0.50)$	45	0.000	(0.621, 0.853)
$a_i = \text{mode}(a_{i-1} : a_{i-7})$	$B(58, 0.50)$	42	0.001	(0.591, 0.833)

Table 2: One proportion test of a Bernoulli probability

Variable	Estimate	SE	p
Adopt decisions of previous two people	0.77	0.23	0.001
Sex	0.25	0.37	0.500
Role	0.42	0.46	0.371
Pseudo R^2 : 0.29			
Adopt decisions of previous three people	0.56	0.16	0.000
Sex	0.14	0.37	0.703
Role	0.19	0.45	0.683
Pseudo R^2 : 0.29			

Table 3: Study 1 probit results

individual (Table 3). Role refers to job within the university and was categorised as either academic (lecturer or researcher) or support (IT technician or librarian). These additional dependent variables were largely included speculatively in that we had no theory to suggest that sex or role might impact on the decision to microblog. The regressions used a probit model to specify the binary response variable adoption decision (adopt or reject). Analyses were carried out in R (R Development Core Team, 2009). Sex and role had no impact on the decision but the number of acceptances did, $p = 0.000\%$ in each case. Pseudo R^2 was calculated using a formula taken from Maddala (1983).

To check whether a time delay between a user joining and posting might have an impact on the results by causing an adopter to be confused as a non-adopter, we analysed the delay for each individual in the sequence i . The majority of users (22 out of 29) sent their first post on the same day they joined the network. Three others sent their first post the day after they joined. We therefore conclude that the

223 delay could not have any substantial impact on the results reported.

224 5 Study 2

225 Rather than being influenced by the adoption decision of those who
226 assessed the technology immediately before them, it is possible that
227 an individual’s decision is influenced by the *messages* posted immedi-
228 ately before they joined, which is subtly different. For instance, after
229 the previous individual registered and considered the technology—
230 whatever their decision—their *UserName has joined the network* post
231 and possibly their first genuine posts may have been superseded by
232 new posts from existing members. Individuals influenced by the se-
233 quence of posts rather than the sequence of adoption decisions are
234 still considered to be in an information cascade. This is because even
235 though in this case the order of the set of decisions A will not appear
236 to new users to be the true order of adoption, in our definition of
237 information cascades, the order of the sequence is unimportant.

238 To test for this we examined the posts that were created immedi-
239 ately before each individual joined the network. Specifically we looked
240 at the structure of the sequence by counting the number of real (versus
241 *UserName has joined the network*) messages in the previous 1 up to
242 10 messages posted to the network. We ran a series of regressions of
243 adoption decision on the number of real messages, again controlling
244 for sex and role. The structure of the previous one and two posts
245 (i.e. whether the previous message was real and the number of real
246 posts in the previous two messages) was significant (Table 4). Beyond
247 this—that is, looking at the structure of the previous three to ten
248 posts—the structure was insignificant.

249 6 Study 3

250 The data demonstrate the potential importance of the adoption de-
251 cision of others in an individual’s decision to adopt. So we can say
252 that information cascades are consistent with the data although we
253 cannot say that they are the sole explanatory factor. However we can
254 only think of one other possible explanation, which is examined in this
255 study.

256 If individuals come to the technology with extremely positive or
257 negative prior probabilities of adoption, this would explain their ob-

Variable	Estimate	SE	p
Previous post (real versus new user message)	1.38	0.60	0.022
Sex	0.18	0.36	0.611
Role	0.46	0.46	0.322
Pseudo R^2 : 0.16			
Number of real messages in the previous two posts	0.73	0.38	0.055
Sex	0.25	0.36	0.481
Role	0.41	0.45	0.359
Pseudo R^2 : 0.02			

Table 4: Study 2 probit results

served behaviour. We discount this with the reasoning that if an individual is extremely negative they would not register for an account, and if they were extremely positive they would use their account and adopt, that is there would be no non-adopters. However, it is possible that the people we have labelled as non-adopters did in fact adopt the technology, just not in the way the developers intended. People often register on Internet fora to *lurk*, never intending to contribute to them (Preece et al., 2004). If that was happening here, people would register, not post, but would be using the technology to keep abreast of what is happening in the organisation. We discount this by a survey of the Yammer network. A link to the survey was emailed to all 65 individuals in the dataset, with a request to participate in a study about microblogging. An incentive of two £25 iTunes vouchers was offered to increase the response rate, and subjects were ensured that the study had ethical approval and that their data would be stored securely and independently of their identity. Contact details of the researchers were included and precautions were taken to prevent someone completing the survey more than once.

The survey collected data on use of Yammer including open ended questions on respondents' behaviour regarding microblogging, how often they posted messages, read messages, their behaviour when reading messages ('When reading messages, would you look at every new message posted to the Yammer network since you last looked at it?' and 'Were you more interested in posting new messages or reading the posts of others?') and items to measure a user's desire to get in-

formation and to give information, taken from Ridings et al. (2006). These items have been demonstrated to vary with whether a user is an adopter or a lurker in a virtual community. Adopters and lurkers have been found to have no difference on their desire to get information, but differ on the desire to give information.

Seven of the 65 individuals had left the university (3 of the 7 were adopters). Fourteen (24%) responses were received which is considered a good response rate for this type of survey although the numbers do not allow for statistical testing. However a content analysis of the responses was still possible. Only two responses were received from non-adopters. Both claimed to have registered with Yammer because colleagues recommended it to them and only one of them logged in again after registering to read the feed. However that respondent claimed not to read through all the posts that had been made since they had last logged in. Neither of the respondents considered themselves to be Yammer users. Comments on the experience included ‘it doesn’t really appeal to me - I’d rather talk to someone face-to-face’, ‘what was posted was not particularly of interest to me’ and ‘I did not have much relevant information to post on the site’. It is impossible to generalise from this to the other non-adopters however what we can say is that none of it is consistent with lurking behaviour. In addition, while we cannot read too much into it, the fact that so few people we classed as non-adopters responded, while so many people we classed as adopters responded, suggests that the non-adopters were genuinely not Yammer users (otherwise we might expect them to have the same interest in the survey as adopters) and therefore were not lurkers.

(As an aside, nothing in the survey results was inconsistent with the assumption of indifference that was made at the start of Study 1. We did not see comments on why respondents registered for an account that were extremely, or even weakly, positive or negative. All but one of the respondents claimed they registered because colleagues recommended it which is itself in line with the theory of information cascades.)

7 Discussion and conclusion

This paper adds to the existing literature on technology adoption by considering initial adoption, the moment at which individuals decide whether or not to start using the technology before they have formed

perceptions of—to take as examples the TAM constructs—how easy it is to use or how useful it is. We have analysed data which support the notion that the adoption decisions of individuals who have passed the point of initial adoption influence the adoption decisions of those following them. This work is within the context of voluntary use and has been performed on a system which—unusually—the adoption decisions of others are highly visible.

Study 1 demonstrates that the behaviour shown in the microblogging data is consistent with the theory of information cascades. Study 2 offers a subtly different view on the data: rather than an adoption decision being influenced by the adoption decision of others, it suggests that adoption decisions may be influenced by recent activity on the feed, which is again consistent with information cascades. If the most recent or the most recent two messages are real messages, individuals tend to adopt, if they are system messages (*UserName has joined the network*) individuals tend to reject. We cannot distinguish between these two explanations with the current data.

Study 3 examined the possibility that the people we have classed as non-adopters in fact accepted the system as lurkers. The data we collected reject this notion, but do not allow us to generalise to all non-adopters.

Study 1 showed evidence of cascades of up three people in length. Study 2 suggested cascades of up to two messages in length. Although these are short, Anderson and Holt (1997) found evidence in the lab of cascades that were 2 and 3 units long, so our data are consistent with this.

Generalising from the microblogging system, we believe our data goes some way to empirically demonstrate the importance of word of mouth—or ‘buzz’—to adoption within a voluntary IS context, something relied on by many software developers. This is not the same as saying individuals are following other users ‘like sheep’, but rather that the information content in the fact that others have adopted the technology is used by individuals when making their own adoption decision. We would encourage adoption researchers to pursue these ideas within their own studies.

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