Process Differentiation and Information Systems Development

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Abstract

This paper presents the results of a study to determine if and how the use case model (UCM) could be used by strategists in small businesses. The reason for wanting to use the UCM in this way is to get problem domain experts, that is top management, more involved in systems development by creating a requirements model which can be used by systems developers as a starting point for analysis. The use of the UCM by developers and strategists should facilitate communication between the two parties. The application that was found for the UCM in strategy planning was to use it to generate ideas of how the organisation's business processes could be differentiated. An idea generating technique, based on established idea generating techniques, was developed to do this. The results of testing the technique by experiment are presented. An attempt to measure the creativity of ideas that subjects generated was made in a similar way to how Getzels and Jackson [19] measured creativity in their study of gifted children. The technique has also been tested during a series of case studies which were performed on small businesses. The results of part of one of the case studies are presented as an example of the technique.

1. Introduction

A use case model (UCM), mostly used in object oriented development, is created at the beginning of systems development to capture system requirements. A use case is defined by Jacobson [1] as a sequence of events that achieves a measurable result for an actor, or put simply, it is an example (a case) of how someone or something uses the system. Figure 1 shows what a use case model might look like. The system being modelled need not be computer based. Use cases have been used to model organisations for business process reengineering [2]. The big advantage the UCM has over other requirement models is that it is an excellent tool for communication between developers and users as it is written in the user’s language and requires little or no knowledge of a modelling notation to understand [3],[4],[5]. The study reported here was conducted to determine if the UCM could be used by strategists in organisations for strategy planning. The study concentrated on small businesses where strategists, that is top management, would also be end users of the organisation’s information systems. The reason for wanting to use the UCM in strategy planning is to get users (both management and other end users) more involved in systems development and to overcome a lack of communication between developers and users. A lack of communication has always been a stumbling block for systems development [6]. The UCM would be created by problem domain experts, the top management (or more likely, a team led by the top management), so it should be accurate and could be used by developers as an initial requirements model and a starting point for analysis. Other end users would be involved in validating the models and this should mean that users would be less likely to resist the new system as they have been involved in its development [7]. The application that is being proposed for the UCM in strategy planning is to use it to generate ideas of how the organisation’s business processes, modelled as use cases, could be differentiated (changed to be different from competitor’s processes). An idea generating technique, based on existing techniques, was developed to do this. This paper presents the technique and the results of testing it.

The idea generating technique, called keyword analysis, is based on the focused object idea generating technique [8] and in line with numerous other techniques makes use of Osborn’s four rules of brainstorming [9]. Using the focused object technique, idea generators try to combine elements that are related to the problem at hand (fixed elements) with randomly selected element, unrelated to the problem at hand. So for example, consider trying to generate ideas of how to improve a notice board. The notice board is the fixed element. The random element could be anything, for example a light bulb. This might generate the idea of illuminating the notice board from behind or making the board in the shape of a bulb. These are called first order ideas. The idea of making the board in the shape of a bulb might lead to the second order idea of putting a floral design on the board.
Like focused object, keyword analysis is designed to encourage divergent thinking. The steps, assuming a group is generating ideas, are as follows:

1. Individually, work through the use case and pick out keywords; important words and phrases.
2. Using the first keyword that any group member has chosen, free associate on words or phrases that could replace that keyword.
3. By forcing the replacement words into the use case, free associate on how this could perform the use case differently.
4. Repeat this for each replacement word.
5. Repeat the process for the next keyword.

An example is given in section 6. The technique has been tested to determine if it has any effect on the numbers of ideas generated and the creativity of ideas generated.

2. Research Method

Fifty one subjects were assigned to teams of three and each team was randomly assigned to one of the experimental conditions. The experimental group were given instructions on using keyword analysis and asked to differentiate a business process modelled as a use case. It was a fictitious business process designed to have plenty of room for improvement. The control group were given the same task using no particular idea generation technique. All the teams were asked to follow Osborn’s four rules of brainstorming [9]. The ideas were written down on a board as the subjects called them out and it was the subjects themselves who decided when to stop. Subjects were all computing students with similar backgrounds and intelligence, mostly aged between nineteen and twenty two although there were some mature students.

In the classic experimental design, one measurement, the pre-test, is taken before exposure of the experimental group to the independent variable. A second measurement, the post-test, is then taken after exposure has taken place [10]. For this experiment, a post-test-only design was used. This means both groups were measured once, after the experimental group had been exposed to the independent variable. A post-test-only design has implications on the internal validity of the experiment [11] and controls for sources of internal invalidity such as changes to the subjects over the time of the experiment or changes in the measuring instrumentation.

The results were analysed along two dimensions. The first was idea fluency, that is, the number of ideas generated. The null hypothesis, $H_0$, that was being tested was the number of ideas generated will be the same when the technique used to generate ideas is keyword analysis as when the technique used to generate ideas is not keyword analysis. The alternative hypothesis, $H_1$, was the number of ideas generated will be different when the technique used to generate ideas is keyword analysis and when the technique used to generate ideas is not keyword analysis. The dependant variable was idea fluency and the independent variable was the technique used to generate ideas.

The second dimension was an attempt to measure the creativity of the ideas. The null hypothesis, $H_0$, for this part of the experiment was the creativity of ideas generated by keyword analysis will be the same as the creativity of ideas generated without using keyword analysis. The alternative hypothesis, $H_1$, was the creativity of ideas generated by keyword analysis will be different from ideas generated without using keyword analysis. The dependant variable was a score given for the creativity of ideas, which is described in the next section, and the independent variable was the technique used to generate ideas.

3. Measuring creativity

Several models have been proposed to explain creativity, although it remains an elusive thing to understand. Many explanations of where creative thoughts come from revolve around the combination of two or more related or unrelated ideas or objects. One such explanation comes from Mednick [12] who suggested an associative theory whereby creative ideas are generated when two or more ideas already in the thinker’s mind are brought together. The ideas may be combined in the thinker’s mind by accident or because the thinker perceives them to be similar or because in the thinker’s mind they both have something in common. If the ideas that are being combined are only weakly related, then the idea that is generated will be more creative or original.

One characteristic that creativity exhibits, that has been agreed by psychologists, is that it involves escaping from conventional modes of thought [13]. Simpson [14] defined creativity ability as the initiative which one manifests by one's power to break away from the usual sequence of thought into an altogether different pattern of thought. Concepts such as curiosity, imagination, discovery, innovation and invention are often found in definitions of creativity [15].

Problems have been encountered when psychologists have tried to measure creativity. A creative response is by definition unpredictable so correct answers to tasks cannot be specified in advance [16]. Some psychologists believe that divergent thinking is equivalent to creativity [17]. Since there are tests that measure divergent thinking, it is convenient to take a measure of divergent thinking as a measure of creativity [18], although there is certainly more to creativity than divergent thinking alone. Divergent thinking does little to explain the creativity demonstrated by, for example, a great composer or an
artist. Despite this, a number of tests have been developed that claim to measure creativity.

Psychologists Jacob Getzels and Phillip Jackson [19] were trying to examine the relationship between intelligence and creativity among gifted children. They used tests for divergent thinking to measure creativity. They used five tests to give each child a creative score. This score came from measuring the number, novelty and variety of responses to a stimulus task. The measure of creativity in this experiment was based on the scoring method of one of the tests they used, the fables test. The fables test involved subjects reading four fable stories in which the last lines were missing. Subjects were asked to complete the fable with a moralistic, a humorous and a sad ending. The last lines that subjects suggested were scored on two criteria. The subject scored a one for each line if it was judged to have the appropriate emotional tone; moralistic, humorous and sad. The second scoring criteria was relatedness which measured if the last line related to material given in the fable and followed on logically from it. The fact that this test is open ended allows for the use of original ideas. As a check for reliability of scoring, two judges rated the responses of twenty subjects and ranked them in order of their total score. These were compared and a high correlation was found.

For the experiment, three criteria were used. These came from an analysis of characteristics common to some famous successful strategies and were called relatedness, newness and usefulness. Each idea was given either a one or a zero against each criterion so the top score for creativity was three and the lowest, zero. Relatedness means that the strategies followed in each case were related to what the companies were doing prior to the implementation of the strategy. The newness criteria means the ideas involved new ways of doing things or new ways of solving problems. One thing that psychologists agree on is that creativity involves something new [15]. The usefulness criteria was the most difficult to quantify. For the purposes of the experiment, usefulness was defined as any action that improves or at least does not deteriorate the business process.

4. Results

The point biserial correlation coefficient, \( r_{pb} \), was used as the correlation measure [20]. This measure was chosen because the independent variable was in the form of a dichotomy, that is it could be one of two values; either keyword analysis or not keyword analysis. The point biserial correlation coefficient is calculated the same way as the Pearson correlation coefficient. The point biserial correlation coefficient between the technique used to generate the ideas and the number of ideas was calculated to be 0.58 which is significant at the 5% level of significance when \( n = 17 \) (51 subjects in groups of 3).

This allowed the first null hypothesis to be tentatively rejected and the alternative hypothesis to be accepted; using keyword analysis significantly increased the number of ideas generated. However, no correlation was found between the technique used to generate the ideas and the creativity of ideas. This meant the second null hypothesis could not be rejected; keyword analysis had no effect on the creativity of ideas.

5. Problems with experimentation

One problem with these results is that the subjects taking part in the experiment were students. There are well known problems with using students as surrogates for business people [21],[22].

Another, more serious problem is that the creativity measurement is highly subjective. Even using criteria to judge the ideas, judges did not totally agree. One solution to overcome this was to use idea fluency as the only measure of how well keyword analysis was performing. However it was felt that a large number of bad ideas would not improve any business process so some attempt to measure the 'creativity' of ideas was desirable. (Although according to Osborn [9], a large number of ideas, good or bad, is a reasonable goal for an exercise of this type as the more ideas there are, the greater the likelihood that one of them will be a winner.) Better ways of measuring creativity are still being looked at.

In the meantime, a series of case studies of small businesses were conducted to deal with these problems. Case studies deal with the judgement of ideas problem because a member of top management was able to be assigned to judge ideas generated and their say was made to be final. While still subjective, the judge is at least an expert and if any of the ideas were going to be implemented, it would be the judge who would be making that decision. An example from one of the case study organisations, an art shop, is now given to illustrate the technique.

6. Case Study Example

Figure 1 shows part of a use case model for the art shop. Three ideas that were generated during an idea generation session from this model are now listed. The keyword 'customer chooses' from event C (keywords can be anything, words or phrases), could be replaced with 'we choose'. This suggested the idea to provide a consultancy service to help the customer choose a frame. This would involve house calls to advise on colour and style. The keyword 'customer collects' from event I could be replaced with 'customer stays at home'. This suggested the ideas to provide a delivery service to return pictures and a hanging service to put up the pictures. Incorporating these ideas into the business process gives the use case
shown in figure 2. At least some of the ideas that have been generated during the case studies have been labelled as ‘good’ or ‘creative’ ideas by the managing director of the organisations. However, at present none of the companies are seriously considering implementing any of the ideas. It is assumed that the reason for this is that none of the companies currently perceive a need for change. If the art shop were going to implement these ideas, figure 2 could be used as part of the organisation’s requirements model and a starting point for analysis to create their information system.

Frame a Picture use case description.

A. The use case begins when a customer announces to the shop assistant they have a picture to frame.
B. The shop assistant directs the customer to a display of frame styles and is left to choose one. The shop assistant remains on hand to answer any questions and the give the customer advice.
C. The customer chooses a frame.
D. The price of the frame is calculated from the size of the picture.
E. The customer finalises their selection and places their order. The order includes their name and telephone number, and their chosen style of frame.
F. A copy of the order is filed. The order goes to the workroom along with the picture.
G. The picture is framed through 4 stages, the first 2 of which are optional.
   Mounting
   Dry mounting
   Framing (by this is meant the frame is built)
   Assembly (the picture is put in its frame)
H. The customer is contacted and told to collect the picture.
I. The customer collects and pays for the framed picture.

Figure 1 Frame a picture use case
Frame a Picture use case description.

A. The use case begins when a customer announces to the shop assistant they have a picture to frame.
B. The shop assistant advises the customer that a member of staff can call and give advice on styles of frames and can give a quotation for the framing. If the customer wants to use this service, then a date and time is arranged. The consultant will call with the customer with frame catalogues, samples and price lists and will give the customer the chance to see what is on offer, in the setting where the painting will go. Otherwise, the shop assistant directs the customer to a display of frame styles and is left to choose one. The shop assistant remains on hand to answer any questions and the give the customer advice.
C. The customer chooses a frame.
D. The price of the frame is calculated from the size of the picture.
E. The customer finalises their selection and places their order. The order includes their name and telephone number, and their chosen style of frame.
F. A copy of the order is filed. The order goes to the workroom along with the picture.
G. The picture is framed through 4 stages, the first 2 of which are optional.
   Mounting
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H. The customer is contacted and a delivery time is set.
I. The painting is delivered and is hanged on the wall.
J. The customer pays.
Alternative H: The customer collects their own picture.

Figure 2 Use case model incorporating ideas

7. Conclusions

This study has shown one possible way in which the use case model could be used in strategic planning. The approach builds on the business process reengineering work by Jacobson et al [2] and agrees with Jacobson that the use case model can be created by business people and still be used for information systems development. One important implication of this research is that it will be the end users of the information system (or at least a subset of them) who will create the use case model. Mattingly & Rao [23] advise systems developers against allowing users to create the use case model. They claim that as users are not trained in writing, and are probably not interested in writing, use cases, they should not. The underlying assumption behind this research is that users (in this context, the use case modelling team, who will be end users in a small business) can and should create the use case model. Jacobson [24] states that to do use case modelling properly, it is important to fully understand the problem domain. Who should understand the problem domain better than the organisation’s management? Jaaksi [4] agrees with this, realising it is important to get users more involved in the process of writing and commenting on use cases.

However it is not expected that systems developers will have to work solely from the use case model created by the strategists. Clearly, additional analysis will need to be conducted. However, the model can be used as the basis for that analysis. Developers can discuss the model with end users and perform walk-throughs together as use cases are an excellent communication tool.

To sum up the advantages of using the UCM in strategy planning, problem domain experts are involved in capturing systems requirements, the resulting information system will be geared towards the improved business processes and the use case model will provide a basis for communication between developers and business people.

8. References