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A Study of Elicitation Techniques in Market-Driven Requirements Engineering

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ABSTRACT

Context. Compare with bespoke RE, market-driven requirements engineering (MDRE), has many classical requirements engineering activities of bespoke RE. Elicitation is one of these activities. This process is to capture, extract and obtain needs from stakeholders. And there are many techniques to guide MDRE elicitation, and some techniques for bespoke RE are also used in MDRE context nowadays. However, not all of these techniques are suitable for MDRE due to the difference between MDRE and bespoke RE, for example, in MDRE context, there is no specific customers' participation. Meanwhile, there is a lack of studies that compare elicitation techniques by evaluating their competence of mitigating MDRE challenges.

Objectives. In this study, we investigate and collect techniques which can be used for MDRE elicitation. We also identify challenges of MDRE elicitation practice from literature as evaluating criteria. Then, we evaluate elicitation techniques' competence of mitigating these challenges. Finally, we discuss with some interviewees to validate our result with real-world MDRE context.

Methods. We use literature review and snowball sampling to investigate and collect MDRE elicitation techniques and challenges. Next, we summarize elicitation techniques' advantages and limitations from literature and compare these techniques by evaluating whether they can mitigate MDRE challenges we find. Next, we conduct interview with 8 interviewees who are practitioners or have developing experience in order to find out and discuss the difference between academic and real-world MDRE.

Results. We identify 6 elicitation techniques which can be used in MDRE to compare. We also collect 6 challenges which may happen in MDRE elicitation process. We compare them by literature study and interview with practitioners and find that although some interviewees' opinions are similar with literature, there are still many different cases we need to consider before choosing elicitation techniques.

Conclusions. In this research, we fill the gap that there is a lack of studies about the comparison of elicitation techniques in MDRE context. We also find 4 factors which should be studied in-depth in the future MDRE elicitation techniques research, and validate our result with practice and discuss the reason of differences. Our result can help requirements engineers to choose suitable elicitation techniques in MDRE projects.

Keywords: Market-driven Requirements Engineering,
Elicitation Technique, Challenges

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1 INTRODUCTION

Nowadays, more and more software products are developed for a mass market with many customers rather than a specific one. Regnell et al. [1] defined this type of software development as market-driven software development, and the requirements engineering in market-driven area is also called market-driven requirements engineering (MDRE). Compared with bespoke requirements engineering (bespoke RE), market-driven requirements engineering covers classical requirements engineering activities, such as elicitation, specification, and validation [1]. Meanwhile, MDRE also includes some special activities and elements, such as release management, MDRE repository and market analysis [1]. According to Regnell et al. [1], requirements engineers of market-driven software projects should consider above classical activities in market-driven context, because MDRE focuses on an open market rather than a specific customer [2].

For MDRE elicitation, requirements are elicited from open markets, which contain lots of customers [1]. However, some problems of MDRE elicitation were stated by researchers. Toci [3] illustrated that one of the most important challenges in MDRE is finding adequate requirements. Gorschek et al. [4] pointed out that requirements elicitation in MDRE is access to customers. However, Gorschek also said access to customers in MDRE context is limited, because it's impossible to consider all customers in the market but only some key customers. As a result, this situation will lead to inadequate and inaccurate requirements elicitation in MDRE. And inadequate requirements elicitation processes will lead to improper, ambiguous and inconsistent requirements, which may contribute to project failure [5]. Thus, an adequate and accurate elicitation is really significant for an effective and successful MDRE process [1]. This MDRE process will result in an effective, clear and consistent market-driven software project.

There are many different methods or techniques which concentrate on different aspects to guide requirements elicitation. Choosing appropriate techniques can help elicitation process more accurate and effective. Therefore, selecting a suitable elicitation technique is necessary before elicitation. In MDRE context, Both Regnell et al. [1] and Gorschek et al. [4] stated that elicitation process focuses on eliciting requirements from a combination of market analysis and generating new ideas based on opportunities provided by new technology instead of insufficient customers' participation. It means that the selection of elicitation techniques in MDRE could be different with bespoke RE. So analysts should consider totally different factors to select suitable elicitation techniques in MDRE context.

In order to improve elicitation process, various elicitation techniques have been put forward to be used in elicitation process depending on the nature of projects, Regnell et al. [1], Sharma et al. [6], Gorschek et al. [7] among others identified many elicitation techniques, such as interviews, surveys/questionnaires, brainstorming, Joint Application Design (JAD)

workshops, etc. However, because of the reason above, some of them may not be suitable for MDRE context. For example, interviews and surveys rely on the intervention of customers, while organizations can only discuss with key customers, and these customers may not represent whole market [4]. Hence, in MDRE elicitation, these kinds of techniques may lead to biases in requirements identification. However, there are still other techniques which may be useful for MDRE context, for instance, Regnell [1] and Gorschek [4] suggested elicitation techniques such as JAD, workshops, focus groups etc. Because they pointed out that in JAD and workshops, companies can organize all kinds of stakeholders through group meeting [6]. Hence, although they cannot listen to all customers' opinions, they still can obtain requirements from as many as possible stakeholders.

Even though some MDRE elicitation techniques are studied, for example Regnell et al. [1], Gorschek et al. [4] and Sharma et al. [6], there is still a lack of studies about elicitation techniques in market-driven context. In the present study, seldom studies compared these techniques in MDRE context. Therefore, we want to fill this gap. In our study, based on the differences of elicitation techniques, we conduct a comparison study of them and evaluate these techniques by criteria we define. The comparison result will be more specifically help developers understand these MDRE elicitation techniques better and may help them choose appropriate techniques for MDRE projects.

In order to compare these elicitation techniques, from our previous work, different elicitation techniques focus on mitigating different MDRE challenges, so we choose challenges as comparison criteria. We choose snowball sampling to identify challenges in MDRE elicitation process. In this study, we identify 6 challenges in MDRE as criteria, include no specific customers' participation, requirements change (or volatility), target group selection, writing understandable requirements, short time to market and easy to use. And then, we conduct a literature review to collect MDRE elicitation techniques, and use snowball sampling to complement them. We collect 6 MDRE elicitation techniques; include prototype, analysis of existing document, scenarios, focus groups, workshops, and market research. After identifying, we collect their advantages and limitations from literature. Then we compare and evaluate these techniques by ourselves. Finally, we conduct interview with 8 interviewees from China to validate our result and record their opinions. And all of these interviewees are practitioners or have developing experience. After interview, we find some differences between literature and practice, and discuss the reason in discussion section.

Finally, we fill the gap that there is a lack of studies about the comparison of elicitation techniques in MDRE context. And our study can guide developers to choose suitable elicitation techniques in MDRE context. After interview, we validate our result with practice and discuss the reason of differences. Based on above, we find 4 factors which were seldom considered in many studies and should be studied in-depth in the future MDRE elicitation techniques research.

In section 2, we discuss our previous work of this study and collect other researchers' related work. In section 3, we illustrate our research methods; include literature review, snowball sampling, and interview. In section 4, we report our result; include challenges, techniques and their advantages and limitations, and interview result. In section 5, we analyze interview result and our result and illustrate limitations. In section 6, we discuss our conclusion and future work.

Terminology

Terms	Definitions
MDRE	Requirements engineering of market-driven software projects.
Elicitation techniques	The methods or techniques are used for eliciting requirements in requirements engineering

2 RELATED WORK

2.1 Requirements elicitation

The elicitation process is to capture, extract and obtain needs from stakeholders. It has a high influence on subsequent activities [9]. Thus, effective requirements elicitation is crucial to the success of software development [8]. According to Liao [9], RE activities are independent, iterative and run through the whole requirements engineering phase. As the initial stage of requirements engineering, requirements elicitation is regarded as one of the most important activities in software development [10].

2.2 Market-driven elicitation Vs Bespoke elicitation

Market-driven and bespoke are different contexts of requirements engineering. Bespoke plays a major role in traditional requirements engineering. In bespoke, the customer is clear and definite. Software products are developed for specific customers. However, in market-driven, the customer is usually not specific. Software products are developed for a mass market with many customers rather than a specific one [1]. In other words, the costs and the revenues of product development are not related to a specific customer, but to the market including a large number of potential buyers [4]. This difference between market-driven and bespoke highly influences the requirements elicitation process. In bespoke, developers only need to elicit requirements which are specified by customers. Thus, requirements can be gathered and elicited with the help of communication between developers and customers [2]. But in market-driven, requirements are invented and elicited based on market information, strategic business objectives and domain knowledge [11, 12]. Requirements elicitation cannot only rely on the needs of several potential customers. It means that elicited requirements need to satisfy the market needs. Thus, in market-driven context, requirement eliciting is more complex than bespoke elicitation.

There are many different methods or techniques can be used to guide requirements elicitation process. Considering the difference between MDRE and bespoke RE, the selection of elicitation techniques will be different. Various elicitation techniques have been put forward to be used in elicitation process depending on the nature of projects, Regnell et al. [1], Sharma et al. [6], Gorschek et al. [7] among others identified many elicitation techniques, such as interviews, surveys/questionnaires, brainstorming, Joint Application Design (JAD) workshops, etc. However, not all of them are suitable for MDRE context. For example, interviews and surveys are not better choice because they rely on the intervention of customers. Although organizations can discuss with key customers, these customers may not represent whole market [4]. Hence, in MDRE elicitation, these kinds of techniques may lead to biases in requirements identification. However, there are still other techniques which

may be useful, for instance, Regnell [1] and Gorschek [4] suggested elicitation techniques such as JAD, workshops, focus groups etc. They pointed out that in JAD and workshops meetings, companies can organize all kinds of stakeholders through group meeting [6]. Hence, although they cannot listen to all customers' opinions, they still can obtain requirements from as many as possible stakeholders.

2.3 Challenges of Market-driven

When developing market-driven software products, mean time to market and insufficient initial requirements are two significant challenges for managing requirements [11]. Especially, how to elicit requirements is a particular problem posed by market-driven software [13]. These two significant challenges are often discussed in studies. The first one is about eliciting adequate requirements without specific customer and the second one is about the limited time to market.

Firstly, developing products in market-driven context is for an open market rather than for a specific customer [33]. Nevertheless, companies can still obtain opinions from some key customers or end users [39]. Moreover, for companies, it is difficult to identify key customers if there are too many potential customers [37, 67]. Even so, it is worth noting that the consumers' needs are generally uncertain and these needs also cannot represent the whole market [68]. Thus, it is a challenge to elicit accurate and adequate requirements without specific customers' participation.

Then, time to market is an important part in MDRE process [74]. However, the time to market is usually very short since it needs to ensure that the release of the product is ahead of other competitors [40] [37]. And a short time to market is the main challenge [66]. It requires companies to have a higher productivity and agile processes [38].

2.4 Elicitation techniques in Current research

In order to effectively elicit requirements, the use of elicitation techniques is necessary. Until now, there are many techniques have been put forward. The paper [14] presented some techniques are more widely used. And 20 techniques were introduced in detail. Furthermore, the authors also explained how to use these techniques and how to select them under different circumstances.

The paper [15] was about comparison study of elicitation techniques. The authors provided an overview of different elicitation techniques which described their characteristics, advantages, and disadvantages. These techniques were classified into traditional techniques, contextual techniques, collaborative/group techniques and cognitive techniques. Traditional techniques mean earlier used and the most commonly used techniques, which include interviews, questionnaires/surveys, and document analysis. Contextual techniques are used for gathering requirements at the working environment, which include observation, ethnography and protocol analysis. Collaborative/group techniques are used for eliciting

requirements from groups of stakeholders by applying their individual expertise, which includes prototyping, Joint Application Development (JAD), brainstorming, and group work. Cognitive techniques are used for analyzing and obtaining information from the human thinking level, which can understand the problems in depth. This category includes laddering, card sorting, repertory grids and class responsibility collaboration.

In paper [16], the authors systematically reviewed the effectiveness of elicitation techniques from literature. After aggregation analysis, the authors pointed out that interview is the most effective technique for eliciting requirements.

In paper [17], the authors surveyed existing elicitation techniques along with challenges faced in a global environment. And these techniques were evaluated according to their competence in different challenges. And then, the authors proposed an Iterative Requirements Elicitation (IRE) approach in Global Software Development.

Hickey and Davis [8] proposed a model for elicitation technique selection which matches techniques to different RE situations.

At present, many studies about elicitation techniques focus on their comparison. The comparison results provide an important reference to the selection of techniques. Yousuf and Asger said [15], there is no ideal technique which is useful for all situations. Different techniques are suited for different situations and one technique's weakness can be neutralized by some other technique [15]. After comparing, the characteristics of techniques will be more clearly. This is also helpful for developers to better understand these techniques. Furthermore, suitable techniques are the key to the success of the elicitation process. Thus, the comparison study of elicitation techniques is very necessary.

2.5 Research gap

In our related work part, we illustrate the requirements elicitation process, discuss the difference between MDRE and bespoke RE, show two main significant challenges and discuss elicitation techniques in Current research. From the literature above, we can find detailed elicitation techniques comparison in bespoke RE, but seldom can give us a detailed and thorough study about comparing elicitation techniques in MDRE context. Thus, the comparison study of elicitation techniques in MDRE context is also necessary, so we aim to fill this gap in this study.

3 METHODOLOGY

Our study aims to explore elicitation techniques which can be used in MDRE context, and propose a comparison result of these techniques based on the analysis of the advantages and limitations. And then we validate our result and identify whether the results are consistent with practice. To achieve our aims, we formulate following research questions, and literature review, snowball sampling and interview are selected for answering our research questions.

In section 3.1, we identify our aim and objectives, and in section 3.2, research questions are presented. In section 3.3 and 3.4, selected research methods and motivation of selection are presented. And more details about the implementation of research methods are shown in section 3.5 and 3.6. At last, we discuss the validity of our study in section 3.7.

3.1 Aim and Objectives

The purpose of our study is to explore MDRE elicitation techniques, compare these techniques in MDRE context and to evaluate them.

To meet these aims, we should achieve the following objectives:

- To identify elicitation techniques which can be used in MDRE.
- To explore advantages and limitations of these techniques.
- To collect MDRE challenges which are related to elicitation process
- To compare the mitigating challenges competence of elicitation techniques in MDRE context.
- To evaluate these techniques and validate our result in practice by interviewing practitioners.

3.2 Research Questions

To achieve our aims, we define the following research questions:

RQ1: What elicitation techniques are reported in literature relevant for MDRE?

RQ1.1: What advantages and limitations of these techniques are reported in literature?

RQ1.2: To what extent can these elicitation techniques mitigate challenges of requirements elicitation in MDRE context?

RQ2: To what extent is the literature consistent with practice in terms of mitigating MDRE challenges?

In this study, firstly we aim to investigate and collect elicitation techniques which can be used in MDRE context in RQ1, and we have a deep research on the main advantages and limitations of these techniques in RQ1.1. Then we compare and evaluate the competence of these techniques in different MDRE challenges in RQ1.2. After that, we validate our

comparison result. We want to know whether our result is different in practices and complement it in RQ2.

3.3 Chosen research methods

In order to answer RQ1, we select literature review method to collected elicitation techniques that can be used in MDRE from previous literature. The literature review can help us to summarize the available documents related to our topic. We conduct this method according to Kitchenham’s guidelines [18]. For complementing our literature review, we not only use the keyword searching but also conduct the forward and backward snowball sampling to solve RQ1.1 and RQ1.2, due to the keyword searching leads to a narrow and shallow literature background [19]. According to Wohlin [20] described, snowball sampling can help us to find more relevant research articles to extend the literature study. This method also can help us to conduct our literature review efficiently and reliably. For solving RQ1.1, we aim to use the snowball sampling to complement the description of techniques with respect to advantages and limitations. For solving RQ1.2, we aim to use this method to find challenges relate to MDRE elicitation process, and use these challenges as criteria to compare techniques’ competence of mitigating challenges.

For RQ2, we choose interview to solve this question. Interview is suitable for collecting data about the investigation [21]. For validating our research result, we need to obtain more professional opinions to solve this question. Hence, interview can solve our research question directly. We interview practitioners who research relevant area or have relevant development experience in China. These practitioners can help us to complement and evaluate our comparison result. After interview, we use the content analysis method [75] to analyze collected data. And based on the data, we will compare whether our result is consistent with the practice. If not, we also will discuss why these differences occur. The mapping of research questions and methods are shown in the table.

Table 3.1 Mapping of research questions and methods

RQs \ Methods	Literature Review	Snowball sampling	Interviews
RQ1	√		
RQ1.1	√	√	
RQ1.2	√	√	
RQ2			√

3.4 Discussion of Alternative Methods

Compared with other methods, the literature review will give us much relevant knowledge which is validated by experts. And this method is flexible. Systematic mapping also can be conducted. But mapping study focuses on providing an overview of research trends and the scope of the area [22]. For our goal, we need to collect evidence to support

our evaluation result. Thus, we do not choose systematic mapping method. Moreover, systematic literature review method is also not suitable because when we start to research this topic, we find a lack of research on elicitation techniques in MDRE context. Thus we cannot find enough evidence to support us to conduct this method.

For solving RQ2, survey or experiment also can be conducted to validate it, but the survey is really hard to control and hard to check the genuineness of answers. We may get many inaccurate opinions. And the experiment is more complicated for us. First, it is difficult to find open MDRE industry source to support us conducting controlled experiment. Second, we don't have enough industrial experience to design the details of experiments, like how to choose experiment scale, how to control variables, and so on. Thus interview is more suitable for us to obtain professional opinions in RQ2.

3.5 Literature review

We conduct a literature review combined with snowball sampling to solve RQ1, RQ1.1, and RQ1.2. In order to conduct the literature review for higher quality, we defined a protocol as below. And we use Zotero tool to manage the references in our study.

3.5.1 Search Strategy

Firstly, we identify a process of search strategy according to Kitchenham's guidelines [18]. It is more effective to guide us into review research. The process is shown in the figure below.

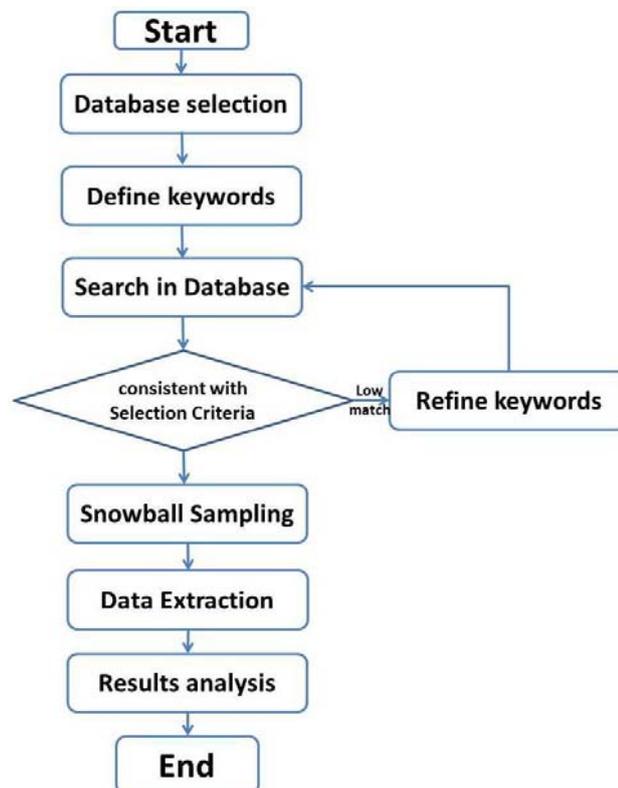


Figure 3.1 Search strategy process

3.5.2 Database Selection

For retrieving relevant studies, we will select the databases which cover comprehensive sources relevant to software engineering papers. And it also needs to be easier for us to conduct advance searching. Based on the above considerations, we select Inspec and Scopus database.

3.5.3 Search String Identification

To conduct our literature review, we need to determine some appropriate keywords for searching databases. In our research, we use literature review to collect MDRE elicitation techniques, so our keywords should be based on this topic.

According to our previous research [1, 4], some elicitation techniques are not suitable for MDRE. We aim to study elicitation techniques in Market-driven context. So one of our keywords is “Market-driven”, and then studies which are not related to MDRE will not be searched. In order to search Market-driven studies fully, we will search this keyword in “All context”.

Next, many studies are relevant to “Market”, but they are not relevant to “Requirements engineering” or “Software engineering”, so we narrow down the search scope by using keywords “elicitation” and “requirements engineering”, and use these keywords in “Title, Abstract, and Keywords”

Thus, we define search string as following: (Market-driven) AND ((Elicitation AND Technique) OR (Requirements AND Elicitation) OR (Requirements engineering)). Then we will use these search string when we search in databases.

3.5.4 Selection Criteria

We define inclusion criteria and exclusion criteria for selecting articles after searching in databases. For answering RQ1, we aim to include articles about MDRE elicitation with the identified usable techniques. The details of select criteria are shown as below:

Table 3.2 Criteria of literature review

Inclusion criteria	Exclusion criteria
<ul style="list-style-type: none">• Papers which are written in English;• Papers relate to MDRE area and relate to the elicitation techniques for MDRE;• Papers should be journal articles or conference articles;• Papers cover one or more of our research questions;	<ul style="list-style-type: none">• Not relevant to software engineering area;• Not relevant to market-driven area;• Repeated or redundant research;• Not peer-reviewed.• Written in other languages.

3.5.5 Selection Procedure

Based on our selection criteria, we will tabulate our search result as following steps, and then we will summarize our selection results in a table.

- Include studies by Inclusion criteria;
- Exclude studies by Exclusion criteria;

- Read abstracts, introduction, and conclusion, since abstract standard for software engineering is poor, so conclusion is also important to read [18], then exclude not relevant studies and repeated studies;
- Record source, title, author and other information of papers;
- Record the number of papers, candidate papers, and selection papers;
- Record the reason for exclusion.

3.5.6 Snowball sampling

Due to the above limitations of keyword searching [19], for answering RQ1.1, we need to conduct a forward and backward snowball sampling to collect more relevant studies to complement our results. These studies should cover more explicit description of advantages and limitations or analysis of characteristics in terms of MDRE elicitation techniques. And for answering RQ1.2, we need to find MDRE challenges relate to elicitation as our criteria to compare these techniques. Thus, in order to complement this part, we decide to use this method.

- **Start set**

As a complement, we conduct the snowball sampling method after the literature review. We use papers of the literature review as start set for answering RQ1.1. And for answering RQ1.2, we define new keywords to search in Google Scholar and Summon@BTH in order to avoid publisher bias. Through observing the research questions, we will put following words into these 2 databases: market driven, challenge or problems or issues, elicitation. And then we will scan the title and abstract of papers in the database and select relevant papers as tentative start set, and we will finalize the start set after reviewing full-text.

- **Inclusion and Exclusion**

Due to the purposes of snowball sampling are different with literature review, we redefine inclusion criteria and exclusion criteria for selecting papers in snowball sampling. For answering RQ1.1, we aim to include studies that provide a detailed description of advantages and limitations or analysis of characteristics about MDRE elicitation techniques. For answering RQ1.2, we aim to include studies that provide the analysis of MDRE challenges. The details of select criteria are shown as below.

Table 3.3 Criteria of snowball sampling

Elicitation technique snowball sampling		MDRE challenges snowball sampling	
Inclusion criteria	Exclusion criteria	Inclusion criteria	Exclusion criteria
<ul style="list-style-type: none"> ● Papers which are written in English; ● Describe characteristics, advantages, 	<ul style="list-style-type: none"> ● Not relevant to software engineering area; ● Lack of explicit description of elicitation techniques characteristics; 	<ul style="list-style-type: none"> ● Papers which are written in English; ● Describe challenges relate to 	<ul style="list-style-type: none"> ● Not relevant to software engineering area; ● The challenges identified in papers unrelated to MDRE. ● Repeated or redundant research;

and limitations of elicitation techniques	<ul style="list-style-type: none"> • Repeated or redundant research; • Not peer-reviewed; • Written in other languages. 	MDRE.	<ul style="list-style-type: none"> • Not peer-reviewed; • Written in other languages.
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3.6 Interviews

3.6.1 Interview design

For answering the RQ2, Based on the guideline of [23], we conduct a semi-structured interview to validate whether our results is consistent with practices. The semi-structured interview is a qualitative research method [23]. It can help us to obtain more detailed information about elicitation techniques with practitioners' experience in the real-life environment. Moreover, before we evaluate these techniques, we conduct a pre-interview to select them because we find too many elicitation techniques after literature review. And it is impractical to compare all of them. In pre-interview, we let these 8 practitioners to identify which techniques they used in practice.

After interview, we use the content analysis method [75], because it is suitable for our qualitative data collection method.

3.6.2 Selection of Interviewees

We aim at looking for interviewees who have rich industrial experience in MDRE. Firstly, we choose convenience sampling method to select 2 professors in China. It is more convenient for us to contact them. Then, we let these 2 professors help us explore more sample. Finally, we conduct interviews with 8 interviewees; two of them are professors with practical experience and six of them are practitioners. In our study, in order to obtain sufficient result, we want to cover different scales of companies, so we contact interviewees from different companies, and the number of employees of companies from 50 to 40000. We use Table 3.4 to show the roles of participants, working experience and the number of employees. Due to the confidentiality requests, we will not describe more details about the interviewees and their organizations.

Table 3.4 Interviewees Features

ID	Job /Role	Working experience (years)	Number of employees
A	Professor/ Project Manager	22	N/A
B	Professor/ Project Manager	20	N/A
C	Product Manager	5	50
D	Product Manager	5	300
E	Product Manager	8	500
F	Product Manager	6	800
G	Product Manager	8	5000
H	Project Manager	10	40000

3.6.3 Interview Process

The interview is designed to last about 50-65 minutes. Due physical distance of the interviewees we use WeChat application to make video-calls with them online. The video calling also can help us more clearly understand behaviors and words of participants. The specific interview process is showed in Table 3.5. All the content of interview will be recorded. After completing the interview, we will translate the interview notes into English.

Table 3.5 Interview Process

Step	Activities	Description of Activities	Approximate time (min)	Comments
1	Introduction	1.1 The interviewers and the interviewees Introduction. 1.2 Topic introduction	5	
2	Propose questions	2.1 Which of the techniques mentioned above you have used in practice? 2.2 What techniques you have used the most? 2.3 When face these challenges, which techniques in your experience mitigate each challenge? And why? 2.4 When face these challenges, which techniques are better? And which techniques are general? 2.5 How to combine these techniques in practice?	40	
3	Discuss	After answering above questions, we discuss differences between our evaluate results and interviewers' opinions.	15	
3	Supplement and comments	3.1 Is there something missed? 3.2 Do you want to add something in this interview?	5	
4	End and thanks			

3.7 Validity

We use structure proposed by Runeson et al [24] to discuss potential validity threats of our study, we discuss them through 4 aspects, construct validity, internal validity, external validity, and reliability. We discuss these threats as following:

3.7.1 Construct Validity

Construct validity is concerned with the operational measures, such as techniques selection and different understanding between interviewers and interviewees,

Firstly, for literature study methods, we use literature review and snowball sampling to perform our literature studies of MDRE elicitation techniques and challenges, because we cannot find enough evidence to support a systematic literature review. Hence, although we

cover as many elicitation techniques and challenges as possible and definite a quality assessment process, there are still some techniques or challenges we cannot find probably.

Secondly, we collect many techniques from literature study, and many of them may not popular in real-world development. On the other hand, if techniques are not frequently used by interviewees, we will not obtain sufficient information from them. In order to avoid this threat, we conduct a pre-interview with our interviewees to select frequently-used MDRE elicitation techniques to research.

Thirdly, we collect many challenges from literature, and we select 6 challenges as our criteria. However our selection may be subjective. So there may be other challenges that can also be used as criteria.

Finally, we may face that our definition of techniques and challenges are not completely same with interviewees' opinions, so we illustrate our definition in detailed, and show them examples in order to let them understand our definition and objectives.

3.7.2 Internal Validity

Internal validity is concerned with causal relations in the study.

In the interview, our opinions of techniques evaluating may mislead interviewees' opinions. In order to avoid these disruptive factors, we only introduce necessary information to interviewees, such as a description of techniques and challenges, research aims and objectives. We don't show them our opinions of techniques when we propose questions.

However, for interviewees' nationalities, in order to organize enough interviewees, we have to contact them from China, because we don't have so many resources in Sweden. So our result may reflect MDRE situations in China. Due to different culture between China and Sweden, our results may not be able to reflect MDRE situations in Sweden completely.

Meanwhile, our experience of software engineering studies may mislead our result. Firstly, we select 6 MDRE elicitation challenges based on our literature study. However, some other challenges may be ignored, because we are not sure if these challenges will happen in elicitation process. Secondly, our evaluating result is also based on literature study by our experience, so our evaluate result and reasons may not reflect these authors' opinions.

3.7.3 External Validity

External validity is concerned with the confidence of findings generation, such as population and coverage of interviewees.

If our interview cannot cover as many kinds of companies as possible, it may not represent all market-driven software companies. In order to deal with this problem, we organize interviewees from companies of different size (from 50 to 40,000 employees). We also contact two interviewees from college, so we can obtain academic opinions from them.

In our study, we want to study techniques which are often used by interviewees, so we select 6 techniques to study by our pre-interview. Although we have 8 interviewees

according to the description above, these interviewees may not enough to cover all popular techniques, so maybe some other techniques are ignored.

3.7.4 Reliability

Reliability is concerned with to what extent the other researchers can obtain same result by conducting same study.

Our research objective is comparing MDRE elicitation techniques by evaluating their competence of mitigating challenges. We record interviewees' opinions by words and discuss these reasons in result part. However, this form is not easy to repeat, because different interviewees have different idea to express their opinions. In order to provide a repeatable form of our interview, we design a table with techniques and challenges. When we conduct the interview, we also write down interviewees' rates (Y or N) in the table, and we count up all interviewees table and draw statistical graph to show our result.

4 RESULTS

4.1 Results of Literature review

4.1.1 Selection Results

We define the following string for searching in the database, and the search results are shown in the table. After searching, we obtain 599 papers from these two databases. And then, after reading the abstracts, introductions, and conclusions of these articles, we exclude irrelevant articles and get 53 candidate papers. Finally, we review full-text of these 53 candidate papers and select highly related 20 papers.

Table 4.1 Search and select results

Database	Search string	Total papers	Candidate papers	Selection papers
Inspec	((((Market driven) WN ALL) AND (((Elicitation) WN KY) AND ((technique) WN KY)) OR (((requirements) WN KY) AND ((elicitations) WN KY)) OR ((requirements engineering) WN KY))))AND(({ca} OR {ja}) WN DT) AND ({english} WN LA)	211	23	8
Scopus	((ALL ("Market driven")) AND ((TITLE-ABS-KEY (elicitation)) AND (TITLE-ABS-KEY (technique))) OR ((TITLE-ABS- KEY (requirements)) AND (TITLE- ABS-KEY (elicitation))) OR (TITLE- ABS-KEY (requirements AND engineering)))) AND (LIMIT-TO (DOCTYPE , "cp") OR LIMIT-TO (DOCTYPE , "ar")) AND (LIMIT- TO (LANGUAGE , "English"))	388	30	12

4.1.2 Data Extraction

After the literature review, we find 20 papers. As the table in Appendix I show, we can see most of them focused on MDRE context. Many studies selected case study as their research method, others used interview, questionnaire, experiment and literature study to answer their research questions. Summary of paper study methods is shown in Figure 4.1.

For papers' sources, 10 papers are journal articles and 10 papers are conference articles. And the published years of them were distributed widely, from 1998 to 2016. Summary of published years is shown in Figure 4.2, and summary of paper types is shown in Figure 4.3.

For research questions, 7 papers focused on developing new techniques to support MDRE [4, 25, 26, 27, 28, 29, 30], 10 papers focused on introduction of process or problems

of MDRE [11, 13, 31, 32, 33, 34, 35, 36, 37, 38], and some of them provided techniques to mitigate these challenges, 3 papers validated some MDRE techniques [39, 40, 41].

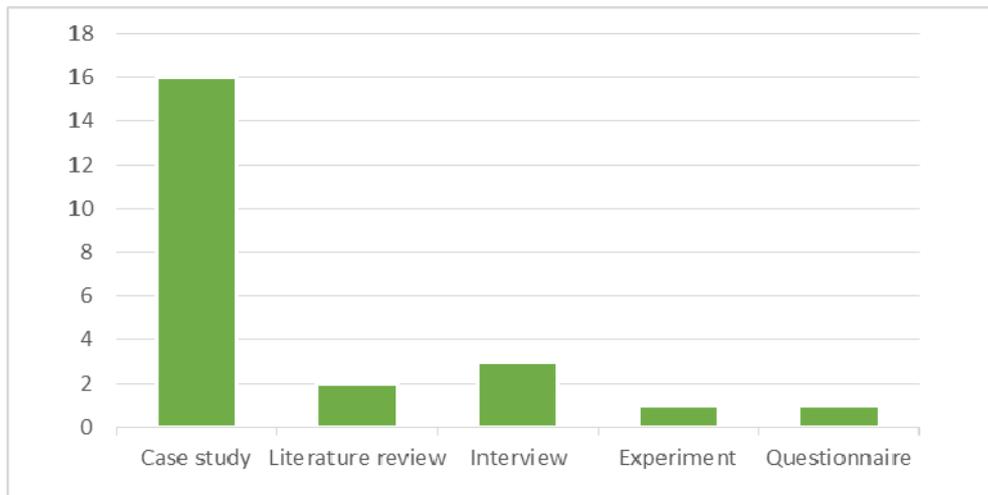


Figure 4.1 Research methods distribution

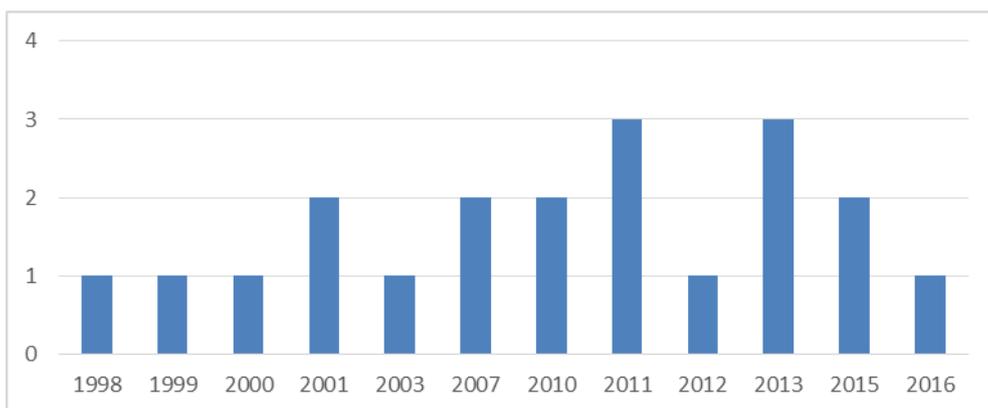


Figure 4.2 Published years distribution

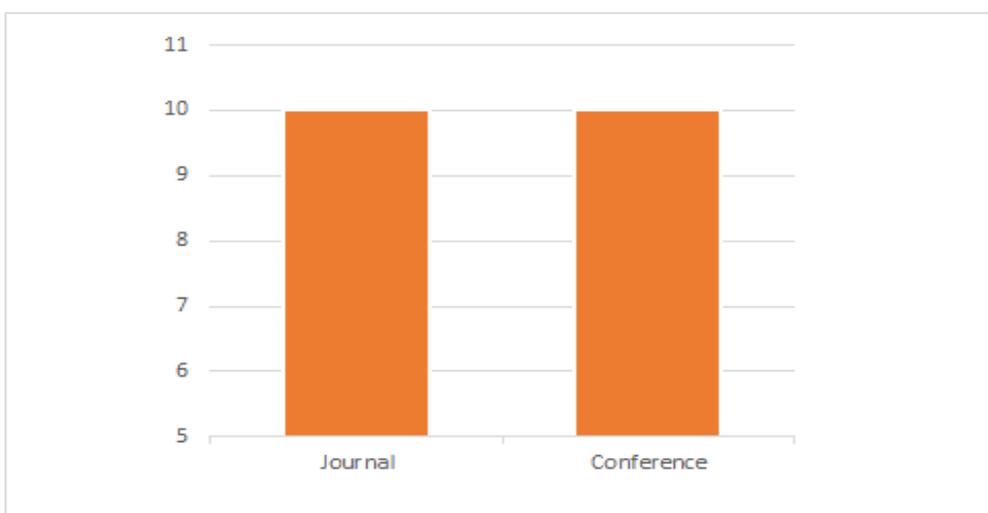


Figure 4.3 Literature sources distribution

4.1.3 Quality Assessment

Based on quality assessment criteria in the protocol, we discuss literature review quality in this section.

- These papers researched MDRE context clearly:

Most of these papers studied about MDRE context, some of them contained “market driven” in their titles [4, 11, 13, 25-27, 34, 37, 38, 40, 41]. One studied about cloud service [35], but it was relevant to market-driven development. One studied about very large-scale requirements engineering [33], but in this paper, the authors defined MDRE as a dominant context in very large-scale requirements engineering, so it also studied about MDRE indeed. Others studied techniques in MDRE context or quality requirements of the market-driven domain [28-32, 36, 39]. Hence all 20 papers in our literature review studied MDRE context clearly.

- One or more elicitation techniques were discussed in every paper clearly:

Most of these papers were relevant with MDRE elicitation techniques, but many of them just mentioned these techniques, for example, some papers studied about challenges, and they suggested using one or more techniques to mitigate challenges [31, 34, 35], but they didn't illustrate techniques in detailed. Some papers conducted an interview about which techniques were the most popular in the industrial context. They mentioned some techniques but didn't explain their advantages or limitations. Hence we need more papers to complement these techniques.

- These papers can cover all relevant studies on MDRE elicitation techniques:

In these 20 papers, we find 22 techniques in total. Many of them were discussed in at least two papers, and some techniques were designed specifically [4, 28-30, 36, 39]. Another technique called market research, it was not a technique in many papers, and its definition was different in papers. We read these papers and their reference, and don't find other techniques which can be used in MDRE context clearly. So these papers can cover most relevant studies.

According to these quality criteria, we find many techniques which can cover most relevant studies on MDRE elicitation techniques, but some of them didn't explain techniques in detailed. So our literature review quality is acceptable if we only identify MDRE elicitation techniques. However, we need to collect their advantages and limitations and link these characteristics with challenges, so we need a snowball sampling process to obtain more papers to complement this shortage.

4.2 Snowball Sampling Results of Elicitation Techniques

After the literature review, we conduct a snowball sampling to complement the shortage of keyword searching. We collect more papers about the description of techniques by using this method.

4.2.1 Start Set

According to the guidelines of snowball sampling [20], 20 papers are chosen from literature review results as our start set. The papers of start set are shown as below, and we obtain the number of cited from Google Scholar.

Table 4.2 Elicitation techniques snowball sampling start set

NO.	database	Year	Title	References	Cited	Reference
1	Inspec	2011	Introduction of a process maturity model for market-driven product management and requirements engineering	91	34	[4]
2	Inspec	2011	Requirements Engineering Process Improvement: An Industrial Case Study	32	6	[31]
3	Inspec	2003	Market Driven Requirements Elicitation via Critical Success Chains	5	4	[25]
4	Inspec	2013	Uni-REPM: validated and improved	39	12	[39]
5	Inspec	1998	A Market-Driven Requirements Engineering Process: Results from an Industrial Process Improvement Programme	13	105	[26]
6	Inspec	2000	Requirements Lifecycle Management and Release Planning in Market-Driven Requirements Engineering Processes	12	111	[40]
7	Inspec	1999	Improving Market-Driven RE Processes	17	72	[13]
8	Inspec	2010	Managing requirements in market-driven software project: Agile methods view	40	5	[11]
9	Scopus	2001	Exploring bottlenecks in market-driven requirements management processes with discrete event simulation	16	89	[41]
10	Scopus	2012	Managing Software Quality Requirements	27	8	[32]
11	Scopus	2013	Managing constant flow of requirements: screening challenges in very large-scale requirements engineering	31	6	[33]
12	Scopus	2007	Requirements engineering challenges in market-driven software development-An interview study with practitioners	35	142	[34]
13	Scopus	2016	Understanding big consumer opinion data for market-driven product design	62	3	[27]

14	Scopus	2011	A prototype tool for QUPER to support release planning of quality requirements	30	4	[28]
15	Scopus	2013	How cloud providers elicit consumer requirements An exploratory study of nineteen companies	26	19	[35]
16	Scopus	2015	Uni-REPM: a framework for requirements engineering process assessment	88	7	[29]
17	Scopus	2010	Videos vs. Use Cases Can Videos Capture More Requirements under Time Pressure	22	15	[36]
18	Scopus	2001	An Industrial Case Study on Distributed Prioritisation in Market-Driven Requirements Engineering for Packaged Software	18	222	[37]
19	Scopus	2015	A case study evaluation of the guideline-supported QUPER model for elicitation of quality requirements	33	3	[30]
20	Scopus	2007	Preliminary Results from an Empirical Study in Market-Driven Software Companies	25	16	[38]

4.2.2 Iterations

After defining start set, we first scan the title of these references and citations to find papers which titles include “technique” or “method”. Then, we select them through reading full papers before entering iteration. Based on our inclusion and exclusion criteria, we exclude papers which are repeated, unrelated and not have an explicit description of these techniques. The snowball sampling process is shown as Figure 4.4. The number in red means the included number of papers in each iteration, and the final results is the sum of these red numbers. The meaning is the same as Figure 4.5. And finally, we collect 47 papers after 3 iterations. More information about these papers is shown in Appendix II.

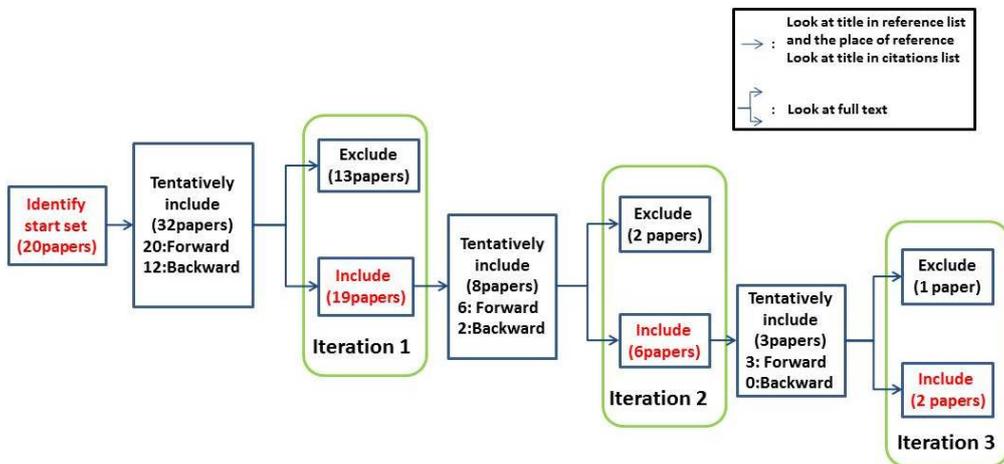


Figure 4.4 Snowball sampling process of techniques

4.2.3 Collection of techniques

After snowball sampling, we obtain 47 relevant papers about these 22 techniques which are shown in Table 4.3.

Table 4.3 Elicitation techniques

NO.	Technique	Description	Reference
1	QUPER prototype tool	Quality PERFORMANCE (QUPER) prototype tool is developed based on QUPER model; it is used for releasing quality requirements.	[28][30][42]
2	MDREPM	The Market-Driven Requirements Engineering Process Model (MDREPM) is a tool for collecting good practices in MDRE. It also is a process assessment framework.	[4][43]
3	Uni-REPM	Uni-REPM is a framework for assessment requirements engineering process.	[29][39]
4	REPEAT	REPEAT (Requirements Engineering ProcEss At Telelogic) is a tool used in Telelogic for eliciting, selecting and managing requirements.	[26][37][40][41]
5	Prototyping	A method for providing prototypes of the system and gathering detailed feedback.	[6][14][15][35][36][44][45][46][47][48][49][50][51]
6	Analysis of existing documentation	A method for collecting useful information from existing documentation.	[6][14][15][32][33][35][38][44][50][52]
7	Scenarios	An approach for specifically describing interactions between the users and the system.	[14][15][35][36][45][46][50][51][53]
8	Focus groups	Stakeholders are invited to groups meetings for sharing their needs and preferences.	[4][15][34][35][44][50][52][54]
9	Workshops	Multiple meetings emphasis on developing and discovering requirements.	[11][14][15][25][33][44][47][50][51][55][56]
10	Market research	A direct approach for capturing market trends and market dynamics	[4][13][38][51][54][57][58][59][60]
11	Storytelling	A method for eliciting requirements through telling logical stories.	[31][46][50][61]
12	Analysis of CR(consumer requirements)	An approach for extracting product features through analyzing big consumer opinion data	[27]

13	Interviews	An approach for collecting data by communicating with stakeholders.	[4][6][11][14][15][28][35][44][45][47][49][50][51][52][53][55][56][59]
14	Questionnaires	Questionnaires consist of some open or closed questions, information can be collected from answers.	[6][14][15][35][47][49][50][51][52][59]
15	surveys	A Similar technique to the questionnaires.	[6][15][35][47][50][51][52][59]
16	laddering	An approach for obtaining knowledge of stakeholders and displaying it by using tree diagrams.	[6][14][15][35][44][45][46][50][62]
17	Card sorting	A series of cards including the names of domain entities will be sorted into groups based on the understanding of stakeholders.	[6][14][15][35][44][45][46][50][53][63]
18	Protocol analysis	This technique provides analysts with specific information and rationale of the system processes.	[6][14][15][35][45][46][50][53]
19	Brainstorming	Stakeholders generate many ideas through informal discussion	[4][6][14][15][35][44][45][47][49][50][51][55]
20	Repertory grids	Stakeholders describe domain elements through matrix assigning and ratings.	[6][14][15][35][46][53]
21	Contextual(ethnography)	An approach for observing the activities of the users from different communities for a period of time.	[6][14][15][35][45][46][50][64]
22	RAD/JAD	Structured meetings involves all the available stakeholders for discussing the needs and desires of the business and users	[6][14][15][35][44][45][46][47][49][50][52][56][60][64]

4.2.4 Selection of techniques

Comparing and analyzing all identified techniques is impractical as it will take too much time from the interviewees. To select the most relevant techniques, we conduct a pre-interview with 8 practitioners. And they identify which techniques they used in practice. Based on their feedback, we exclude techniques which they not mentioned. In the end, 6 techniques are selected. These techniques include analysis of existing documentation, scenarios, focus groups, prototyping, workshops, and market research. And then we will focus on comparing these 6 techniques and analyze practitioners' experience of applying these techniques with respect to MDRE challenges mitigation.

4.2.5 The advantages and limitations of selected techniques

Based on the papers which collected through literature review and snowball sampling, we summarize the advantage and limitations of included techniques as follow.

Prototyping

Prototyping is used for giving ideas to the users by providing them a basic interface design to show what they actually want [15]. Generally, prototypes are provided to stakeholders since it can represent and visualize the actual system parts [45]. It is useful for validating and understanding requirements [44] [46]. It's an effective way to collect user feedback and other detailed information. In general, prototyping is used with other elicitation techniques together, such as interview and JAD [6]. In order to design a prototype, developers need to refer to preliminary requirements or existing similar products [14]. It may be very helpful to illustrate the various possibilities of products [47]. There are many kinds of prototypes which require different effort [48], such as storyboards, executable, and evolutionary, etc. In a word, prototyping is really useful for developing creativity or entirely new products. And it is also useful for developing GUI interfaces of human-computer [6, 50]. The main characteristic of prototyping is that the technique requires a close interaction between customers and developers then obtain user feedback through this process.

Advantages:

- Prototyping can obtain valuable feedback from customers [44].
- Prototyping can encourage stakeholders or users to join the development processes and play an important role. It provides high user satisfaction [49].
- Prototyping is useful for developing greenfield or complicated projects, which are difficult to obtain requirements and user expectations without providing similar models to users [51].
- Prototyping is really effective for representing products in a functional or graphical way. It can help developers to collect details in user interface level [6, 50, 51].
- Evolutionary prototypes can reduce development time and cost [44].
- Prototyping is helpful to verify the system complexity and discover the design problems [44].
- Users and analysts can understand the system better [15].

Limitations:

- Users may become resistant to requirements or solutions change [15].
- It can consume time for complex systems [15].
- The purpose of prototyping may not be clear enough [44].
- It may lead to insufficient analysis [44].
- The practical performance of prototyping is worse than expectation [44].

Analysis of existing documentation

Analysis of existing documentation is an approach for gathering related information from existing documents [15]. In general, existing documents include organization charts that describe users' hierarchy and manager responsibilities, job descriptions of developers, procedure manuals, the forms of input and output, requirements list, the system works diagrams, program codes [6], etc. Reading and studying the relevant content of available

documentation is very useful for gathering early requirements [14]. Meanwhile, it is helpful to understand and capture more domain knowledge [14, 50]. Existing documentations are a good source of product information. It can be effectively used at requirements elicitation initiation phase [15]. Thus, it is necessary to carefully check the availability of documents.

Advantages:

- Documentation analysis is helpful to determine focus domain when stakeholders and users are unavailable [15, 44].
- Before meeting stakeholders, this technique help business analyst understand the organization properly [15].
- This technique can provide useful historical information [15].
- This technique is useful for requirements reuse [15].
- This technique is not expensive [15]

Limitations:

- Not all needs were discussed by users and the availability of documents needs to be carefully checked. [44]
- Requirement engineers need more patience and time consuming to collect available information from huge amounts of existing documentations [15, 52].
- Documents require update periodically [15].
- Incomplete information leads to documents are not available [15].

Scenarios

Scenarios represent the actions and interactions between the users and the system [15, 45]. In general, scenarios are used without considering the internal structure of the system [14]. Scenarios are widely used for eliciting requirements. This is a real example to illustrate how the system is used [15]. It describes the state of the system include specifically describes the details of the current and future processes [45, 50]. The using of this method will provide a wide variety of outcomes [53]. The scenarios are written in a simple natural language, and it needs a basic understanding of performing the tasks by the system and the involvement of users [15]. It is an effective and relatively inexpensive technique to be used for initiating requirements elicitation and validating the requirements [14, 46]. And it is really useful for collecting all the potential exceptions for all processes [14].

Advantages:

- Well-developed scenarios help organizations proactively and specifically work for the desired product [15].
- This technique provides clarifications about the normal flow, exceptional behavior and alternative paths of an activity or event [15].
- This technique is easy to understand since it is written in simple language and people without technical knowledge can also understand it [15].
- This technique can ensure that the system can be designed properly since the perspective of end users is considered for eliciting requirements [15].

- This technique can collect the requirements more flexibly while summarizing and analyzing different sessions and response of users after interacting with the scenarios[51]

Limitations:

- The useful scenarios are difficult to be drawn [15].
- It cannot appropriate for all types of projects even if this technique can capture more requirements [15].
- This technique cannot cover all the processes of the system. In other words, it is not a complete view of the future system [15].

Focus groups

Focus groups are small structured groups with four to nine participants from different backgrounds and with different skills, these participants discuss and concern the characteristics of the system will be created in a permissive and non-threatening environment [50, 52]. Their needs, individual views, and proper suggestions are shared in group meeting [15]. Generally, the meeting led by a moderator, and the moderator is responsible for keeping the groups focused and encouraging members to interact actively [15]. Interaction within a group is helpful to generate new ideas and have a deeper discussion of every topic [15]. Meanwhile, the participants can also be influenced by each other [52]. Focus groups are helpful to identify actual expectations of users from the system and understand the system scope [50, 54].

Advantages:

- Discussion in group meetings is easy to obtain the best solution [44].
- The use of this technique can collect quality requirements in a shorter time [15].
- This technique can save cost compared with conducting individual interviews of the same number of people [15].

Limitations:

- This technique can consume time and may not come to a conclusion [44].
- This technique may cause argument and misunderstand among groups [44].
- It is difficult to meet stakeholders and experts at the same place and the same time due to the busy schedule of them [15].

Workshops

The workshops include different type of group meetings for collecting requirements from stakeholders and it can provide a complete set of requirements, this method is better in large and complex projects [44, 50]. Similar with JAD, the workshops are structured meetings. The forms of the workshops are various, such as domain workshops and design workshops [14, 47]. Requirements are refined and validated after discussed by stakeholders in multiple sessions and after these multiple sessions [55], the collected requirements are unchangeable [15, 56]. And then these requirements will be reviewed and assigned priorities. This technique needs the active involvement of participants, and expertise of facilitator and

stakeholders' experience is the key to success [15]. Proper planning and well run will elicit high-quality requirements [15]. This technique can also be combined with other techniques, such as interviews, document analysis, brainstorming, etc. [15].

Advantages:

- Participants can exchange knowledge in session [44].
- This technique is useful for obtaining some new business opportunities and valuable feedback [44].
- This technique is useful in the large and complex system [44].
- It needs a relatively shorter time to collect requirements by using this technique [15].
- This technique is helpful to obtain feedback quickly [15].
- This technique is helpful to strengthen trust and understanding between analysts and stakeholders [15].
- The workshops is a formalized and realistic technique to be used for eliciting requirement [51].

Limitations:

- This technique needs to consume more time for preparation [44].
- It is difficult to meet stakeholders and experts at the same place and the same time due to the busy schedule of them [15].
- Too many participants may consume more time and slow down the whole process [15].
- Insufficient participants may lead to incomplete requirements collection and cannot represent proper requirements of users [15].
- Workshops are quite expensive for organizing and conducting [51].

Market research

Market research is an approach for capturing market trends and market information [13]. Market-driven product development needs a strong focus on market, which requires organizations to constantly pay attention to market trends, competitors, and potential opportunities and threats [4]. In the market-driven context, user requirements initially are more or less invented and elicited indirectly based on market research by the developers [13, 57, 58]. For companies that cannot identify real customers in the initial development phases, market research can be seen as common sources of information to help developers invent and elicit requirements [38, 58]. In this environment, it is true to say that market is the customer [4]. We also can identify certain entities in the market, such as key customers, end-users, internal experts, competitors [4], etc. Similar to market surveys, market analysis, and market studies, market research includes conducting a survey/ interview with key customers, end-users, salespersons and marketing professionals, analyzing the competitors, market trends, and market opportunity, etc. [4, 48, 51, 59]. The features of the product can be defined according to the results of market research [38]. And market research is helpful to

define clear targets early and provide large amounts of requirements [60]. And focus groups also can be used as a qualitative research method for marketing purposes [54].

Advantages:

- This method is helpful to define clear targets early [60].
- This method is very appropriate for companies that lack customers and users [38].

Limitations:

- It provides too many requirements [60].

4.3 Snowball Sampling Results of MDRE challenges

After summarizing the advantages and limitations of MDRE elicitation techniques, we also need to compare and evaluate these techniques. According to our project plan, we need to select challenges which are related to MDRE elicitation as our criteria to compare these techniques. Thus, we conduct the snowball sampling to find these challenges of MDRE.

4.3.1 Start Set

According to the guidelines of snowball sampling [20], we define new keywords to search in the Google Scholar and Summon@BTH database. Through observing the research questions, we put following words into Google Scholar and Summon@BTH: market driven, challenge or problems or issues, elicitation. The inclusion and the exclusion criteria are used to filter papers. Through scanning title and abstract of papers, we select 58 papers as tentative start set. Finally, based on our inclusion and exclusion criteria, we select 13 relevant papers as our start set after reviewing full-text. The papers are shown as below and the number of cited obtained from Google Scholar.

Table 4.4 MDRE challenges snowball sampling start set

NO.	Database	Year	Title	References	Cited	Reference
1	Google Scholar	2013	Managing constant flow of requirements: screening challenges in very large-scale requirements engineering	31	5	[33]
2	Google Scholar	2013	How cloud providers elicit consumer requirements An exploratory study of nineteen companies	26	19	[35]
3	Summon @BTH	2007	Preliminary Results from an Empirical Study in Market-Driven Software Companies	25	16	[38]
4	Google Scholar	2012	Challenges in Market Driven Requirements Engineering	9	113	[3]

5	Google Scholar	2011	Introduction of a process maturity model for market-driven product management and requirements engineering	91	34	[4]
6	Summon @BTH	2007	Requirements engineering challenges in market-driven software development An interview study with practitioners	35	142	[34]
7	Google Scholar	2005	Market-Driven Requirements Engineering for Software Products	33	116	[1]
8	Google Scholar	2003	Challenges in Market-Driven Requirements Engineering--an Industrial Interview Study	18	113	[65]
9	Google Scholar	2000	Requirements Lifecycle Management and Release Planning in Market-Driven Requirements Engineering Processes	12	111	[40]
10	Summon @BTH	2002	Elicitation and management of user requirements in market-driven software development	16	13	[66]
11	Summon @BTH	2013	Uni-REPM: validated and improved	39	12	[39]
12	Summon @BTH	2012	Requirements triage-challenges and solutions	38	2	[67]
13	Summon @BTH	2001	An Industrial Case Study on Distributed Prioritisation in Market-Driven Requirements Engineering for Packaged Software	18	223	[37]

4.3.2 Iterations

After defining start set, the similar process with above, firstly we scan the title of these references and find papers which titles included “market driven”, “large scale”, “challenges” or “problems”. Then, we read full papers to filter papers before entering iteration. According to our inclusion and exclusion criteria, we exclude papers which are repeated, unrelated and not have an explicit illustrated MDRE challenges. And finally, we collect 23 papers after 2 iterations. The results and conducting process are shown in Figure 4.5, and more information about these papers is shown in Appendix III.

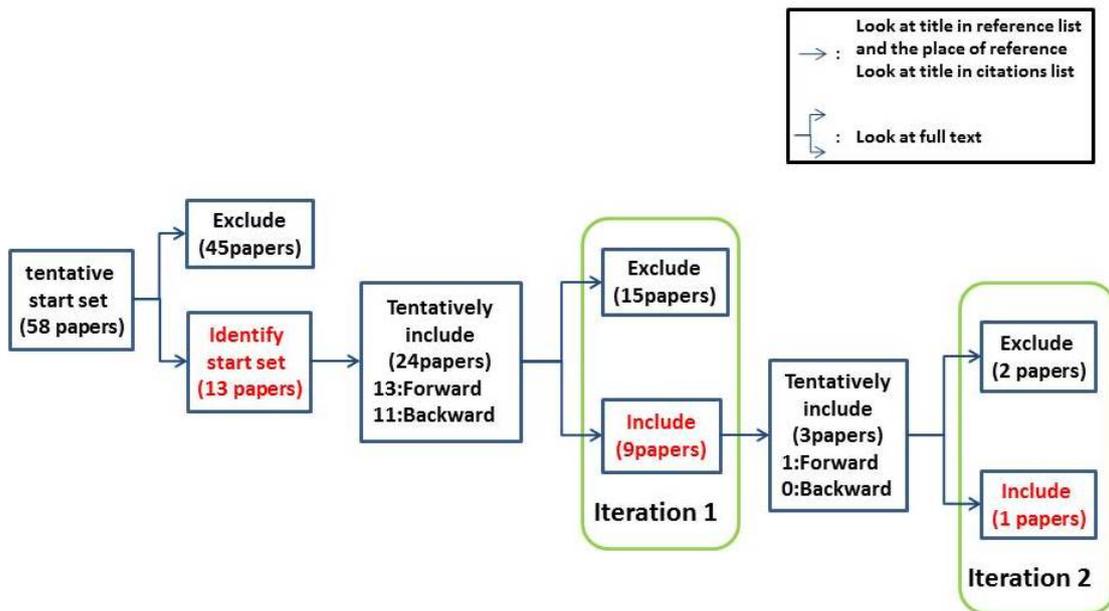


Figure 4.5 Snowball sampling process of MDRE challenges

4.3.3 Selected challenges of MDRE

After reviewing these papers, we find 14 MDRE challenges which are relevant to different MDRE processes, thus we exclude some challenges which are more related to other MDRE processes or cannot use the above techniques to mitigate. For example, in [34], the authors pointed out that uncertain estimated release planning is also a MDRE challenges, but we think it will happen in release planning stage of RE, so we think it is not related to elicitation. Regnell et al. [65] also indicated that requirements overload is a MDRE challenge. However, they thought it would make prioritizing requirements more difficult. So we determine it as a prioritization challenge and it is not relate to elicitation. Finally, we summarize 6 challenges as our compare criteria and shown as below. And more details of 8 excluded challenges can be seen in appendix IV.

Challenge 1: No specific customers' participation (C1)

Typically, developing products in market-driven context means for an open market rather than for a specific customer [33]. Nevertheless, companies can still obtain opinions from some key customers or end users [39]. Moreover, for companies, it is difficult to identify key customers if there are too many potential customers [37, 67]. And it is also important and needed to identify heterogeneous customers or users [35]. Even so, it is worth noting that the consumers' needs are generally uncertain and these needs also cannot represent the whole market [68]. Thus, it is a challenge to elicit accurate and adequate requirements without specific customers' participation.

Generally, in MDRE, some requirements are invented by developing companies [34] [35]. At this point, analyzing market and competitors to gather requirements by themselves is more helpful than communicating with key customers [4, 43, 58].

Challenge 2: Requirements change / volatility (C2)

This challenge happened in both bespoke RE and MDRE. In MDRE, requirements change will cause release plan changing, requirements are postponed to next release [4]. In addition, no customer bears the change cost in an MD project [4], so market-driven development companies need to minimize requirements change cost.

The requirements in MDRE can be elicited from a variety of sources, such as end users, sponsors, markets, standards and government [33] etc. And the requirements change continuously since the markets change, users' feedback change and competitors' improvement, etc [69, 70]. More specifically, customers and retailers' mind change may impact requirements elicitation, and their feedbacks often generate new requirements [71]. In some organizations, it's possible to build incomplete code (always 60%-90%) and show it to customers for obtaining feedback before they implement the function [65]. Otherwise, if competitors improve or add new functions in the product, companies also need to change their requirements quickly. Thus, it is tedious to handle these changes [69].

This challenge happened in both bespoke RE and MDRE. In MDRE, requirements change will cause release plan changing, requirements are postponed to next release [4]. In addition, no customer bears the change cost in an MD project [4], so market-driven development companies need to minimize requirements change cost.

Challenge 3: Target group (C3)

The selection of the target group is the initial stage of requirements elicitation. In MDRE, the target group is often difficult to select, when an organization executes an MD project, they always don't have a clear view of customers. They need to obtain advice from stakeholders and also gather potential requirements and target group from different viewpoints, such as social media, and app store's feedback [3]. Thus, it is essential to select a right target.

Challenge 4: Writing understandable requirements (C4)

Writing quality requirements means that it is traceable and understandable [72]. Requirements have different meanings for different people. In bespoke RE, requirements are elicited by negotiation between customers and developers [2], so both of them can understand requirements directly. However, in MDRE, the resources of requirements are extremely different. For example, these requirements are provided by the marketing department in the companies instead of the development team [1, 2, 65]. Meanwhile, there are many kinds of requirements sources in MDRE, such as customers' feedback of the current release, retailers' inputs and market survey [73]. Requirements from these sources may have a different form, so it is not easy to make sure that all stakeholders can understand these requirements. Hence, people who have different academic background will write requirements in a various way or they may use the same word but with a different meaning [34]. And different levels of abstractions also lead to misunderstanding of requirements [4, 39]. All of these situations will lead to stakeholders' misunderstanding of requirements.

Challenge 5: Short time to market (C5)

Time to market is an important part in MDRE [74]. In order to ensure that the release of the product is ahead of other competitors, the time to market is usually very short [40] [37]. And a short time to market is the main challenge [66]. It requires companies to have a higher productivity and agile processes [38]. Thus, in many organizations, RE process is only a small part of the software development lifecycle. They often start a product development and RE process at the same time. As a result, they spend time on RE is far less than development [34]. In some cases, organizations thought they only spend 10%-15% of total time on RE processes [34]. Therefore, the quality of RE is hard to guarantee and time constraint may cause other problems.

Challenge 6: Easy to use (C6)

In some companies, simple and easy to use techniques are needed for elicitation process [1]. Especially for some small organizations, the product managers think it unnecessary to use complicated elicitation techniques. They mentioned that many developers are reluctant to learn a complicated technique, because it may limit their creativity [65]. Hence, a technique which is easy to learn and use may be better in small organizations. But if the organizations are mature enough, an elaborated process may be more helpful to attain their objective.

4.4 Results of Interview

We interview 8 practitioners from China. They shared their experience of applying these techniques and helped us evaluate and compare these techniques. We use High (H) and Low (L) to categorize their mitigating competence in different challenges. High (H) means techniques can mitigate the MDRE challenges or techniques are helpful to mitigate challenges. Low (L) means techniques cannot mitigate challenges or they are not helpful. More details of this interview are illustrated in section 3.6. After completing the interview, we translate the interview notes into English, the evaluation results of interviewees are shown in Appendix V and the information is summarized as following:

Prototyping

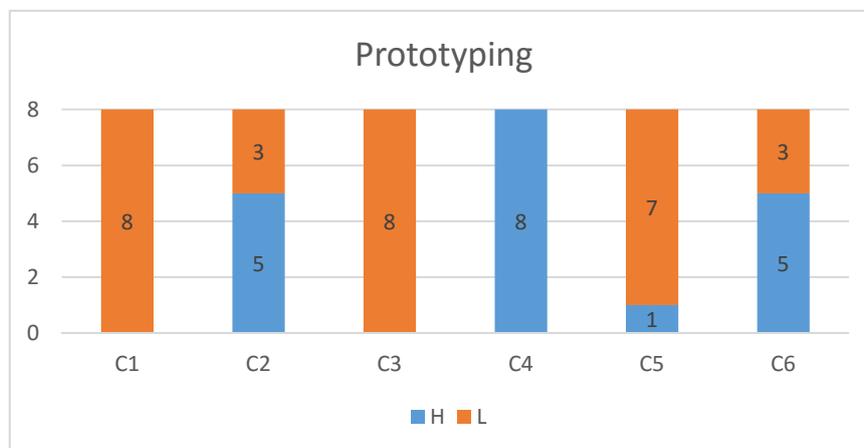


Figure 4.6 Interview result of prototyping

All interviewees agreed that the use of the prototyping is generally based on a certain set of requirements. And they strongly agreed that this technique is not helpful to elicit requirements without specific customers' participation and it is also not useful to identify a target. Requirements change is a process of product update and improve. After product managers put forward the improving plan, a prototype will be designed to test by potential users. So this technique will make requirements change accurately. Thus, it can mitigate the changing of Requirements. However, some interviewees (interviewees A, B and E) thought prototyping cannot mitigate requirements change, because the main purpose of prototyping they used is to validate existed requirements, not elicit new requirements. All interviewees said that this technique is a description tool. It can help analysts to represent requirements to customers in an understandable way. Hence all interviewees agreed that it is very useful for writing understandable requirements. Compared with other techniques in our research, the cost of the prototyping is relatively high since the completion of a prototype requires the assistance of tools. For complex systems, it will consume a lot of time and requires high-level skills of analysts. Thus, all interviewees except interviewee D agreed that the using of this technique not save time. Because, interviewee D thought that if analysts only need to design a simple prototype, it will not consume too much time. And he said in his company, the design of prototype is not very complicated. However, only interviewees A, B and C thought that this technique is not easy to use. They thought that in some small companies, the level of analysts' skills is not high. Thus, for developing complex system, this technique is not easy to use. Moreover, interviewees who are from large or mature companies said that professional interaction analysts will be hired into an independent department in their companies to complete the prototype design work, so in this case, they said that prototyping is easy to use.

In practice, different companies use prototyping in different stages. For some relatively large or mature companies, this technique usually runs through the entire elicitation process. While some companies usually use this technique in the latter stage, that is, after the requirements are basically explicit and product design is generally formed. This technique is used to obtain feedback from stakeholders.

Analysis of existing documentation

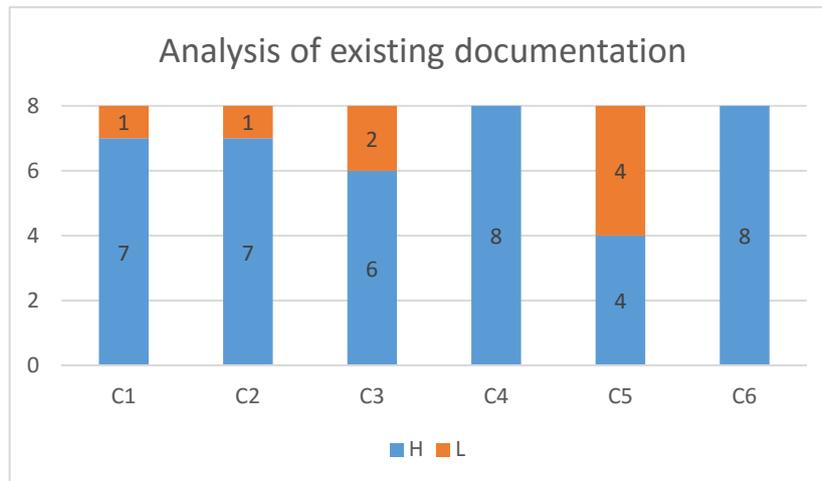


Figure 4.7 Interview result of analysis of existing documentation

Existing documents contain many aspects, but in practice, the most commonly used is the user comments and the user complaint records. Most of the interviewees said that the analysis of user comments and the user complaint records are very useful to elicit requirements without specific customers' participation and capture market information. And some interviewees said they can forecast potential requirements by these kinds of documents, thus, they said that this technique can mitigate requirements change. However, interviewee B said this technique just focus on documents. This is not flexible. And interviewee F said it cannot obtain market information comprehensively. Thus, they thought that this technique cannot mitigate challenges discussed above. Then all interviewees agreed that this technique is helpful to write understandable requirements since analysts can refer existing documents and unify their own writing form. For operation, half of the interviewees (interviewees C, D, G and H) thought that this technique would not waste too much time. Because usually they only focus on the user comments and the user complaint records and they said that existing documents have timeliness. Documents will not be analyzed if they are too old. Thus, in practice, documents that need to be analyzed will not be too many. And these documents generally are sorted in a systematic way. For example, interviewee E said that the members of the department will extract some keywords from these user comments, and the keywords will be used as the tab of classification. So analysts will not consume a lot of time to find useful information through scan the tab. However, the other half interviewees thought that there are still a lot of documents need to be analyzed. Thus, they insisted that this technique will consume a lot of time. All interviewees considered that this technique is simple. They said that analyzing documents is much easier than communicating with potential customers.

In practice, this technique is usually not used for developing new projects. This technique is very useful for updating existing products. And the scope of the documents analysis will be different in different companies. Some companies will only to analyze the

user comments and user complaint records in order to save time. Besides that, some companies will also analyze the requirements documents, bug reports and meeting records, etc.

Scenarios

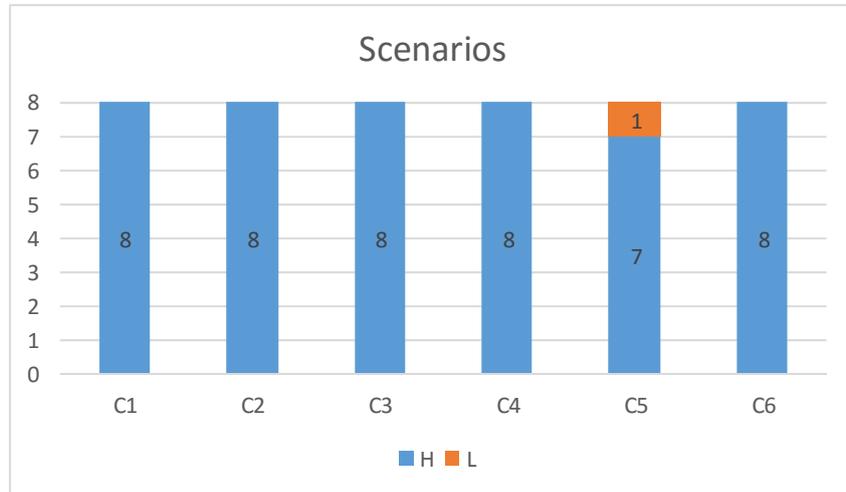


Figure 4.8 Interview result of scenarios

There are two important elements in scenarios analysis: one is the construction of scenes, another is the feeling of users. In the case of no specific customers' participation, analysts will imagine themselves as the users, combined with a scenario to simulate and invent requirements. If product manager can analyze sufficient scenes, the requirements for the product will be adequate. Thus, all interviewees thought that it is useful to elicit requirements without specific customers' participation. Requirements change is often due to scenarios change, through analyzing different scenarios, requirements change will be able to predict and capture, and it is also helpful for identifying a target market, so according to above reasons, all interviewees agreed that this technique can mitigate requirements change and identify a target. In practice, companies can formulate a formal and unified requirements writing form when they use scenarios. So they thought that it is very useful for writing understandable requirements. And most interviewees agreed that this technique is usually simple and cost-saving. However, interviewee A put forward some special cases. For example, if the system is large and complex, or the design and analysis of the scenarios need to be particularly accurate and strict, this technique will consume too much time. So in this case, he disagreed that this technique can save time.

From our interview, scenarios are widely used in practice, and this technique is essential for requirements elicitation process. Especially in a market-driven environment, this technique is very useful.

Focus groups

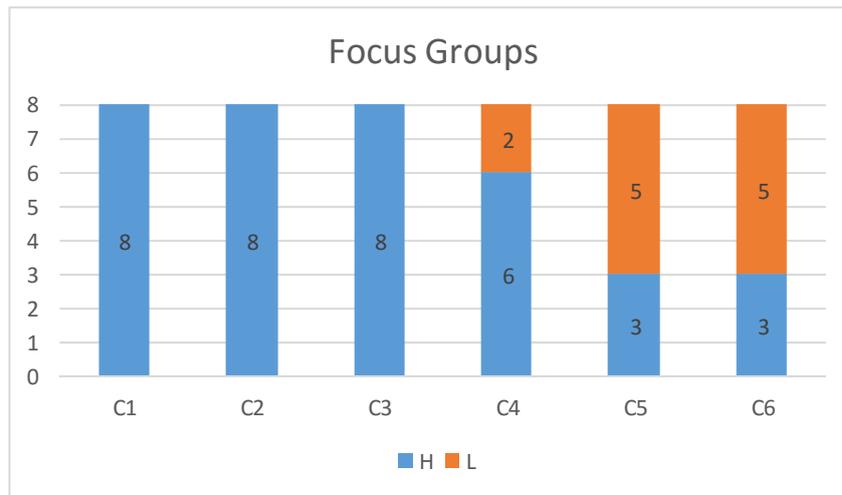


Figure 4.9 Interview result of focus groups

The form of the focus groups is various in different companies. According to the opinions of interviewees, the main differences are participants and outputs. In some mature companies, they often use it as a user research method. Participants are cross-departmental or even external stakeholders; include some potential users (customers), product managers, sales department, etc. The participants will be able to illustrate their own views based on the specific topics and reach consensus in order to obtain new requirements. However, some interviewees thought that it's not easy to reach the consensus from many different stakeholders and it will consume much time to organize. Meanwhile, if these potential users are not clear about their needs, the meeting will also consume a lot of time. Thus, in these cases, interviewees A, E, F, G and H thought that this technique will waste a lot of time. And it is also difficult to ensure that these internal employees and external stakeholders attend the meeting at the same time. Thus they said that this technique is difficult to perform. But, interviewee C said, in her company, they often organize customer service staff and sales personnel instead of external stakeholders to join their meeting, because they usually communicate with customers. So in this case, this method will be easy to use and not consume too much time. However, interviewee D said that some companies use this technique to share information and generate new ideas. Participants are usually internal members. The main purpose of the meeting is to promote product innovation and improvement. The topic of the meeting is not always been defined. In this case, this technique will not consume too much time and it is easy to use. No matter what form it is, all interviewees agreed that the discussion among stakeholders is helpful to elicit requirements without specific customers' participation, mitigate requirements change and identify a target. For writing understandable requirements, many interviewees said that formal meeting records are understandable, but interviewee D and interviewee E said that there will be no formal records during the meeting. Thus, it will be not helpful.

Generally, conducting focus groups meetings require adequate time. The procedure of the meeting is more complex than other techniques and requires participants' enough creativity and imagination.

Workshops



Figure 4.10 Interview result of workshops

There are some differences in the actual use of this technique. In different companies, the forms of workshops are also different. In practice, it is usually a decision-making meeting that requires managers to participate. Some companies organize multiple workshops from beginning to end. And the discussed topic will be different in different processes. So in this case, this method is helpful to elicit requirements without specific customers' participation, mitigate requirements change and identify a target. However, some companies (interviewee D, E and F) hold this meeting only in the latter stages for final decision making. The main purpose of these workshops is to confirm the requirements they are intended to fulfill and discuss the product realization process. Therefore, in this case, this method cannot mitigate the above three challenges. Workshops are structured meetings. Therefore, all interviewees agreed that the formal meeting records are often helpful to write understandable requirements. But some interviewees said that the workshops is generally difficult to implement, because it is difficult to invite everyone to participate in the meeting due to the different working schedule, and many interviewees said if there are too many participants in workshops meeting, it's really difficult to reach a consensus, and it will consume much time. However, interviewee C said that for some small or startup companies, this method will not consume much time and it is easy to implement. Because there won't be many people participate in the meeting.

From our interview, all interviewees said workshops meetings are really necessary, especially for new projects. And they agreed that a high-quality meeting closely associates with decision-making ability and controlling ability of the meeting leader.

Market research

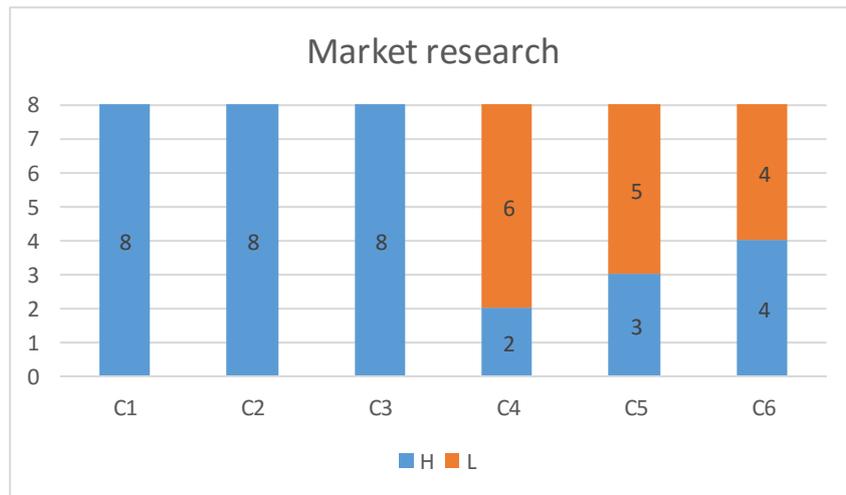


Figure 4.11 Interview result of market research

Market research contains many aspects. But in practice, all interviewees said they always focus on researching market trends, competitor analysis and competitive products analysis. Market research is useful for capturing requirements changing quickly and accurately. Thus, all interviewees agreed that it is helpful to mitigate the above-mentioned first three challenges. Many interviewees said that it is not helpful to write understandable requirements since the source and market analysts are extremely different, so the form of data may be different. However, interviewees D and H said that their companies generally define a unified template for the research report. This report will be helpful to write understandable requirements. Thus, they thought that this technique is helpful. For operation, some interviewees thought this technique is complicated, and it may need more time and resources. On the contrary, some interviewees thought that if product managers have rich experience in market research, then they are able to fully understand the market and competitors. On the other hand, interviewee H from the large company said they usually delegate market research to other external professional organizations to help them obtain the results instead of their own researching. Thus, in these cases, this technique will not consume too much time and it is easy to use.

All interviewees agreed that this technique is used at the initial stage of projects. This technique is essential for whether developing a new project or improving existing projects. A successful market research is objective and comprehensive.

5 ANALYSIS AND DISCUSSION

5.1 Evaluation of techniques from literature

Based on the analysis about characteristics of above 8 techniques and combine with selected challenges, we compare and evaluate them in MDRE context. We also categorize them into High (H) and Low (L) approach according to their mitigating competence in different challenges. There are 2 members in our group, we firstly fill in this table separately, and then discuss different views. And finally we reach a consensus, the comparison results are shown as below.

Table 5.1 Evaluation results of techniques from literature

Challenges Techniques	C1	C2	C3	C4	C5	C6
Prototyping	L	H	L	H	L	H
Analysis of existing documentation	H	L	H	H	L	H
Scenarios	H	L	L	H	H	H
Focus groups	H	H	H	L	L	L
Workshops	H	L	H	H	L	L
Market research	H	H	H	L	L	L

Prototyping: Prototyping is used to obtain valuable feedback from customers [44]. It emphasizes the participation of customer. And the use of the prototyping is based on a set of definite requirements. Thus, we infer that it is not helpful to elicit requirements without specific customers' participation and identify a target. According to the mitigation strategies provided in this paper [2], prototyping is useful for mitigating requirements changing. Because the authors thought that this technique is one way to roughly describe the features of the products and to stabilize the requirements. Generally, prototypes represent and visualize the actual system parts [45]. It is useful for validating and understanding requirements [44, 46]. Thus, we consider that it is useful to write understandable requirements. And sometimes, organizations often start a product development and RE process at the same time. In this case, the using of prototyping may consume more effort. Thus we infer that this technique is not helpful to mitigate challenge 5. Designing a prototype is the basic ability for developers [48], so we infer that this technique is easy to use.

Analysis of existing documentation: Analysis of existing documentation not requires the customer involvement and existing documentation may be helpful to inspire new ideas. Thus, we infer that it is helpful to elicit requirements without specific customers' participation and identify a target. However, based on the above characteristics, analysis of existing documentation is more useful for initiating requirements elicitation. We think that it is difficult to capture the change of requirements from these types of existing documents

provided in literature. Thus, we infer that it is not helpful to mitigate requirements changing. Based on above characteristics we learn that the existing documentation are traceable, it is a good use for reference to developers. This technique is easy to use but it may consume more time and effort since a lot of documents need to be analyzed.

Scenarios: Scenarios analysis need the participation of customer or end users. But it does not rely on customers' perspective to elicit requirements. Thus, we infer that it is useful to elicit requirements without specific customers' participation. And scenarios analysis is used for initiating requirements elicitation and validating the requirements [14, 46]. We think that the using of this technique is mainly to describe requirements and validate requirements. Thus, we consider that it is not helpful to mitigate requirements changing and to identify a target. The scenarios are written in a simple natural language, and it describes a basic understanding of performing the tasks by the system [15]. It is an effective and relatively inexpensive technique [14, 46]. Thus, we consider that it is useful to mitigate the last three challenges.

Focus groups: Focus groups meeting also need the participation of customer or end users. But it does not need to rely on customers' perspective to elicit requirements. And the discussion of the participants is helpful to identify requirements changing and accurate target. Thus, we infer that it can mitigate the first three challenges. For writing understandable requirements, we infer that this technique is not helpful since the literature not mention the formal meeting record and illustrate that it can be referenced. And, focus groups may cause argument and misunderstand among groups [44]. Moreover, focus groups meetings are difficult to meet stakeholders and experts at the same place and the same time due to the busy schedule of them [15]. Thus, we consider that it is not helpful to save time and it is difficult to implement.

Workshops: Participants in workshops are not only customers or users. The discussion of them is also helpful to select an accurate target. However, the collected requirements are usually unchangeable after workshops [15, 56]. Thus, we consider that it is not helpful to mitigate requirements changing. Workshops are structured meetings which require lots of effort to plan well and prepare [15]. And all of these meetings should be recorded [15, 64]. These meeting records are helpful to write understandable requirements. However, workshops require well preparations and it is difficult to meet stakeholders and experts at the same place and the same time due to the busy schedule of them [15]. Thus, we infer that it not helpful to save time and it is difficult to implement.

Market research: Market research is helpful to define clear targets early and provide large amounts of requirements [60]. It can timely capture the market trends and obtain market information. Thus, we consider that this technique can mitigate the first three challenges. And market research is used for gathering market information. The complex information source is also not helpful to write understandable requirements. Moreover,

market research is a complex technique which needs more cost and efforts. Thus, we consider that it not helpful to save time and it is difficult to implement.

5.2 Discussion of differences

Compared with our evaluation results, mainly differences between literature and practice are discussed as follows:

For scenarios, we infer that this technique cannot mitigate the change of requirements and it is not helpful to identify a target. According to the literature, scenarios analysis is mainly used for initiating requirements elicitation and validating the requirements [14, 46]. So our understanding of the scenarios is based on a scenario that has been identified, and the requirements change before the scenarios change. However, in practice, the requirements change after scenarios change. So it can help to predict and capture requirements change. Thus, interviewees thought that scenarios are helpful to mitigate the above-mentioned two challenges

For analysis of existing documentation, we infer that this technique cannot mitigate the requirements change, because we think that this technique is more helpful to obtain requirements, but not for change. According to our results presented in section 5.1, analysis of existing documents is not helpful to capture requirements change. But in practice, user comments and user complaint records also belong to existing documents. And they are very helpful for predict requirements change.

For focus groups, literature about this technique does not mention meeting records, so we infer that it is not helpful to write understandable requirements. But in practice, some companies have detailed and unified forms of meetings records. Thus, in this case, this technique is helpful.

Based on the above analysis, we summarize 4 factors which produce these differences, include:

- Types of companies;
- The level of employee's ability;
- The different usage of elicitation techniques;
- Types of development projects.

Firstly, according to our interview, companies can be divided into 2 types: mature companies and startup companies. For some large and mature companies, resources are often sufficient and the employees usually have high-level abilities. But for startup companies, resources are relatively insufficient, and the employee's capability is not so high. Meanwhile, for mature companies, especially for large companies, focus groups and workshops are difficult to implement and need to consume much time, because it's too hard to organize all stakeholders to join their meetings. On the contrary, for startup companies, focus groups and workshops are simpler to use. They prefer to use these two techniques, because startup companies always don't have too many employees. However, techniques like prototyping

are really complex for startup companies, because they always require specific tools and high-level skills of employees.

Secondly, in different companies, the usage of techniques is different, mainly reflected in the purpose of using techniques and the elicitation phases. For example, different purposes of using prototyping lead to different opinions of interviewees. Moreover, different requirements engineering phases of technique using is also a very important aspect. Some companies use workshops throughout the elicitation process but some only use it in the latter stages. It causes different view on mitigating the challenge 1 to challenge 3.

Finally, the different types of projects are mainly reflected in two aspects, one is the development of brand new projects and the update of existing projects; another is the complexity level of a system. For example, the analysis of existing documents is hardly used for developing brand new projects, but it is very helpful for updating existing projects. Considering the complexity level of the system, it will be different to assess whether these techniques are easy to use and consume less time, such as the prototyping and scenarios.

For above techniques, most of the interviewees considered that scenarios and market research method are better than the other techniques for mitigating the challenge 1 to challenge 3. Prototyping is relatively general. For mitigating the challenge 4, the prototyping and scenarios are relatively good techniques. However, market research method is relatively general. For mitigating the challenge 5 to challenge 6, scenarios analysis is the simplest and time-saving technique. Focus groups and workshops are more complex. From the opinions of these interviewees, we conclude that prototyping, scenarios, workshops, and market research are necessary techniques in practice. Documents analysis is commonly used in product updates. Focus groups are held only when time is abundant. Some interviewees said if time is not enough, this technique can be skipped.

In practice, these techniques are not always used individually. Some interviewees also gave the suggestion about the combination of these techniques. In the initial phase, market research, scenarios or analysis documents (if it's not a brand new product) are necessary. And then, if time is enough, the focus groups meeting can be held. After that, workshops are used for decision making. Scenarios and prototyping also can be used in these two meetings in order to describe requirements and obtain feedback from stakeholders.

6 CONCLUSION AND FUTURE WORK

With the literature review, we find that the research on the elicitation techniques in the market-driven environment is limited. Therefore, we collect these elicitation techniques, and then evaluate and compare them in market-driven context. Based on our aim and objectives, we formulate 4 research questions to perform our study. In our study, we use literature review, snowball sampling and semi-structured interview methods to answer questions. Our findings are illustrated as follows:

For RQ1, it is about techniques collection. We find 22 techniques from 20 articles that are related to market-driven requirements elicitation. 4 techniques of them are models. After a full understanding of these techniques, we find that it is too complicated to compare all of them. Thus, we conduct a pre-interview on these techniques for selection. According to the opinions of interviewees, we finally identify 6 commonly used techniques for comparison, include: Prototyping, Analysis of existing documentation, Scenarios, Focus groups, Workshops, and Market research.

In terms of RQ1.1 and RQ1.2, they are in-depth exploration studies of these techniques. In order to answer RQ1.1, we summarize the characteristics, advantages and limitations of 6 techniques mentioned above. And for answering RQ1.2, we collect 6 challenges about MDRE elicitation in the literature as our criteria, and based on the analysis of these advantages and limitations, we compare and evaluate these techniques with respect to the competence of mitigating challenges.

For RQ2, it is a validation of our comparison result. We interview 8 practitioners. They shared the experience of using these techniques with us, and helped us to compare techniques. The comparison results based on literature are not completely consistent with practice. The differences between literature and practice mostly focus on evaluating scenarios and analysis of existing documentation with respect to mitigate requirements change and evaluating focus groups about writing understandable requirements. And more details are discussed in section 4.4 and section 5.1. After analyzing their different views, we conclude 4 factors which influence techniques evaluation, include types of companies, the level of employee's ability, the different usage of elicitation techniques, and types of development projects. And these factors are rarely considered in the paper.

In our study, we find that the opinions in literature are not always consistent in practice. We present analysis of potential reasons for causing these differences. After discussing in section 5.2, we find that these factors play an important role in MDRE elicitation technique studying. And these four factors are firstly considered when developers select techniques. Therefore, we think that these factors should also be taken into account in subsequent studies with regard to elicitation techniques.

Our research is an exploration study of the requirements elicitation techniques in MDRE. The main contributions of our study include: (1) In previous studies, there is a lack of research about the comparison of these techniques in MDRE context, so our study fills this gap. (2) Our study can help developers understand MDRE elicitation techniques better, and choose suitable techniques to support their MDRE work in practice. (3) We find 4 factors which should be studied in-depth in the future MDRE elicitation techniques research.

In the future, we will choose more techniques to compare and select more challenges as criteria through conducting a pre-interview. Moreover, we will interview more practitioners who are not just from China and share their experience with us. And we will find more factors and study them in-depth. It is helpful to better select and apply elicitation techniques.

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APPENDIX I

Overview of selection papers

Database	No.	Source	Title	Author	Year	Research area	Research methods	Summary	Reference
Inspec	1	Journal	Introduction of a process maturity model for market-driven product management and requirements engineering	Tony Gorschek, Andriago Gomes, Andreas Pettersson, Richard Torkar	2011	Market-driven Requirements Engineering	Case study	In this paper, researchers created a model based on the Requirements Engineering Process Maturity (REPM) model for the market-driven environment, named MDREPM. It collected good practices in MDRE and it was also a process assessment framework. It has been validated in the industry.	[4]
	2	Journal	Managing requirements in market-driven software project: Agile methods view	Deepti Mishra, Alok Mishra	2010	Market-driven Requirements Engineering	Case study	In this paper, the authors discussed how to apply agile methods for developing market-driven software product to promote the successful implementation of supply chain management software.	[11]
	3	Conference paper	Improving Market-Driven RE Processes	Pete Sawyer, Ian Sommerville and Gerald Kotonya Lancaster University Lancaster, UK	1999	Market-driven Requirements Engineering	Literature Review	In this paper, the authors proposed good practice guidelines that was helpful for organizations to adapt orthodox requirements engineering to their market-driven businesses. And the authors pointed out that market research can be used for eliciting requirements in market-driven context.	[13]
	4	Conference paper	Market-driven Requirements Elicitation via Critical Success Chains	Tuure Tuunanen, Matti Rossi	2003	Market-driven Requirements Engineering	Case study	In this paper, researchers described the critical success chains (CSC) method, and validated the first version of this method from a large user organization. And in this method, the workshop was used for judging the decision.	[25]
	5	Journal	A Market-Driven Requirements Engineering Process: Results from an Industrial Process Improvement Programme	Björn Regnell, Per Beremark, Ola Eklundh	1998	Market-driven Requirements Engineering	Case study	In this paper, researchers described a specific industrial market-driven requirements engineering process for developing packaged software, called REPEAT (Requirements Engineering ProcEss At Telelogic), The elicitation phase in this process included collection and classification activities. And REPEAT-1 has been evaluated in case studies.	[26]

	6	Conference paper	Requirements Engineering Process Improvement: An Industrial Case Study	Georgi A. Markov, Anne Hoffmann, Oliver Creighton	2011	Requirements Engineering	Literature Review Case study	In this paper, researchers presented an approach and summarize the lessons learned from an industrial requirement engineering improvement project. In the results part, researchers presented an issue, it was about misbalance between technology-driven and market-driven requirements. And in the future work part, researchers presented that storytelling can be used as a potential elicitation technique to solve these problems. But it has not been validated.	[31]
	7	Journal	Uni-REPM: validated and improved	Mikael Svahnberg, Tony Gorschek, Thi Than Loan Nguyen, Mai Nguyen	2013	Market-driven Requirements Engineering	Case study	In this paper, Uni-REPM was validated in practice, and it was verified that it was a quick, easy, and cheap assessment method. And the Uni-REPM model was also helpful for elicitation process.	[39]
	8	Conference paper	Requirements Lifecycle Management and Release Planning in Market-Driven Requirements Engineering Processes	Björn Regnell, Par Carlshamre	2000	Market-driven Requirements Engineering	Case study	In This paper, two developed industrial market-driven requirements engineering processes at different companies were compared and based on the comparison results, researchers identify similarities and differences between the RDEM and REPEAT models.	[40]
Scopus	9	Journal	Understanding big consumer opinion data for market-driven product design	Jian Jin, Ying Liu, Ping Ji, Hongguang Liu	2016	Market-driven Requirements Engineering	Case study	This paper emphasized big consumer data as requirements elicitation resources, such as twitters, blogs, and product reviews. They conducted a cased study by using Amazon.com and showed the possibility of using big consumer data to analyze requirements in market-driven context.	[27]
	10	Conference paper	A prototype tool for QUPER to support release planning of quality requirements	Richard Berntsson Svensson, Pontus Lindberg Parker, Björn Regnell,	2011	Market-driven Requirements Engineering	Case study	In this paper, the author mentioned a challenge for software organizations was to set right quality requirements in the release plan. They developed a tool called QUPER, and evaluated it in a small case company, and found that the QUPER prototype can obtain a clear overview of product and quality requirements level.	[28]
	11	Journal	Uni-REPM: a framework for requirements engineering process assessment	Mikael Svahnberg, Tony Gorschek, Thi Than Loan Nguyen, Mai Nguyen	2015	Market-driven Requirements Engineering	Interview and Case study	In this paper, the author mentioned a framework called Uni-REPM, which was designed for assessing requirements engineering process to mitigate challenges. In this paper, the author mentioned some challenges not only in bespoke RE but also in MDRE.	[29]
	12	Conference paper	A case study evaluation of the guideline-supported QUPER model for elicitation of quality requirements	Richard Berntsson Svensson, Björn Regnell	2015	Market-driven Requirements Engineering	Case study	This paper presented a model, QUPER, which was used for supporting quality requirements decision-making in the release plan. The author evaluated complete version of QUPER guidelines in a mobile company with 24 professionals.	[30]

	13	Conference paper	Managing Software Quality Requirements	Laura B.Phillips, Aybüke Aarum, Richard Berntsson Svensson	2012	Requirements Engineering	Case study	This paper aims to explore quality requirements management practices at present in Australian organizations. The practices focused on the elicitation, handling processes and interdependency management aspect etc. Researchers conducted 6 mini case studies. In these companies, one of them was entirely market-driven software development company. And the results showed that this company elicits requirements through analyzing the existing documentation. And the results also showed that this technique can be used in market-driven context.	[32]
	14	Conference paper	Managing constant flow of requirements: screening challenges in very large-scale requirements engineering	Sanja Aaramaa, Tuomo Kinnunen, Jari Lehto, Nebojša Taušan	2013	Market-driven Requirements Engineering	Case study	This exploratory conducted an industrial case study to clarify a practice about managing the constant flow of requirements. This case study was conducted in market-driven context. In this study, company's internal documents include process descriptions, example requirements, and workshop notes can be used as data sources.	[33]
	15	Journal	Requirements engineering challenges in market-driven software development An interview study with practitioners	Lena Karlsson, Asa G.Dahlstedt, Björn Regnell, Johan Natt och Dag, Anne Persson	2007	Market-driven Requirements Engineering	Case study	This paper presented results from an industrial qualitative survey. This paper researched on practice and challenges of market-driven requirements engineering in Swedish organizations. And researchers summarized some emerged challenges in market-driven context.	[34]
	16	Conference paper	How cloud providers elicit consumer requirements: An exploratory study of nineteen companies	Irina Todoran, Norbert Seyff, Martin Glinz	2013	Market-driven Requirements Engineering	Interview	The authors of this paper interviewed 19 cloud service providers. They found some traditional elicitation techniques in these providers, and some ad-hoc techniques. Cloud service is similar to market-driven product, it usually cannot reach consumers, and because it's a new concept, no competitors can be studied. Finally, the authors thought some specific elicitation techniques should be invented for cloud service providers.	[35]
	17	Conference paper	Videos vs. Use Cases: Can Videos Capture More Requirements under Time Pressure?	Olesia Brill, Kurt Schneider, Eric Knauss	2010	Requirements Engineering	Experiment	The author in this paper illustrated that traditional elicitation techniques are difficult to use for embedded systems. They compared scenario, video, and visualization in the market-driven context in this paper. They also compared video method with use case method and found it was more useful than use case in the experiment.	[36]
	18	Journal	An Industrial Case Study on Distributed Prioritisation in Market-Driven Requirements Engineering for Packaged Software	Björn Regnell, Martin Höst, Johan Natt och Dag, Per Beremark, Thomas Hjelm	2001	Market-driven Requirements Engineering	Case study	In this paper, the author focused on packaged software development, they conducted a case study to observe and evaluated distributed prioritization process. They also mentioned some MDRE challenges in this paper.	[37]

	19	Journal	Preliminary Results from an Empirical Study in Market-Driven Software Companies	Carina Alves, Silvia Pereira, George Valença, João Pimentel, Rodolfo V. C. L. de Andrade	2007	Market-driven Requirements Engineering	Questionnaire and interview	In this paper, the authors first identified some challenges in market-driven requirements engineering in the literature and then studied with 13 market-driven companies to evaluate and validate these challenges in real-world MDRE context.	[38]
	20	Journal	Exploring bottlenecks in market-driven requirements management processes with discrete event simulation	Martin Höst, Björn Regnell, Johan Natt och Dag, Josef Nedstam, Christian Nyberg	2001	Market-driven Requirements Engineering	Case study	This paper presented a simulation study of a market-driven requirements management process. It showed how REPEAT models can be used to explore overload conditions of an industrial market-driven requirements management process for developing packaged software.	[41]

APPENDIX II

Snowball sampling result of elicitation techniques

No.	Title	Reference
1	Mitigation strategies to major challenges faced in market driven development scenario	[2]
2	Introduction of a process maturity model for market-driven product management and requirements engineering	[4]
3	Revisiting Requirements Elicitation Techniques	[6]
4	Managing requirements in market-driven software project: Agile methods view	[11]
5	Improving Market-Driven RE Processes	[13]
6	Requirements Elicitation: A Survey of Techniques, Approaches, and Tools	[14]
7	Comparison of Various Requirements Elicitation Techniques	[15]
8	Market Driven Requirements Elicitation via Critical Success Chains	[25]
9	A Market-Driven Requirements Engineering Process: Results from an Industrial Process Improvement Programme	[26]
10	Understanding big consumer opinion data for market-driven product design	[27]
11	A prototype tool for QUPER to support release planning of quality requirements	[28]
12	Uni-REPM: a framework for requirements engineering process assessment	[29]
13	A case study evaluation of the guideline-supported QUPER model for elicitation of quality requirements	[30]
14	Requirements Engineering Process Improvement: An Industrial Case Study	[31]
15	Managing Software Quality Requirements	[32]
16	Managing constant flow of requirements: screening challenges in very large-scale requirements engineering	[33]
17	Requirements engineering challenges in market-driven software development An interview study with practitioners	[34]
18	How cloud providers elicit consumer requirements: An exploratory study of nineteen companies	[35]
19	Videos vs. Use Cases: Can Videos Capture More Requirements under Time Pressure?	[36]
20	An Industrial Case Study on Distributed Prioritisation in Market-Driven Requirements Engineering for Packaged Software	[37]
21	Preliminary Results from an Empirical Study in Market-Driven Software Companies	[38]
22	Uni-REPM: validated and improved	[39]
23	Requirements Lifecycle Management and Release Planning in Market-Driven Requirements Engineering Processes	[40]
24	Exploring bottlenecks in market-driven requirements management processes with discrete event simulation	[41]
25	Introducing Support for Release Planning of Quality Requirements-An Industrial Evaluation of the QUPER Model	[42]
26	Market-Driven Requirements Engineering Process Model – MDREPM	[43]
27	Procedural Model of Requirements Elicitation Techniques	[44]
28	Requirements Elicitation Techniques: Comparative Study	[45]
29	Effective Requirements Development-A Comparison of Requirements Elicitation techniques	[46]
30	Software Requirements-Styles and Techniques	[47]
31	Requirements Elicitation Using a Combination of Prototypes and Scenarios	[48]

32	Requirements engineering: elicitation technique	[49]
33	Selecting Requirement Elicitation Techniques for Software Projects	[50]
34	Guidelines for the Selection of Elicitation Techniques	[51]
35	A walkthrough of Requirement Elicitation Techniques	[52]
36	Comparing knowledge elicitation techniques: a case study	[53]
37	Focus Groups For Eliciting Requirements In Information Systems Development	[54]
38	Successful Requirement Elicitation by Combining Requirement Engineering Techniques	[55]
39	Requirements Elicitation and Elicitation Technique Selection: A Model for Two Knowledge-Intensive Software Development Processes	[56]
40	Software Engineering Research Revisited	[57]
41	Market-Driven Requirements Engineering Processes for Software products a Report on Current Practices	[58]
42	User Studies: A Practical Approach to User Involvement for Gathering User Needs and Requirements	[59]
43	Issues in Requirements Elicitation	[60]
44	Using Storytelling to record requirements: Elements for an effective requirements elicitation approach	[61]
45	Laddering theory, method, analysis, and interpretation	[62]
46	Using Card Sorting Technique to Classify Requirements Change	[63]
47	Effective Communication in Requirements Elicitation: A Comparison of Methodologies	[64]

APPENDIX III

Snowball sampling result of challenges

No.	Title	Reference
1	Market-Driven Requirements Engineering for Software Products	[1]
2	Mitigation strategies to major challenges faced in market driven development scenario	[2]
3	Challenges in Market Driven Requirements Engineering	[3]
4	Introduction of a process maturity model for market-driven product management and requirements engineering	[4]
5	Managing Constant Flow of Requirements: Screening Challenges in Very Large-Scale Requirements Engineering	[33]
6	Requirements engineering challenges in market-driven software development – An interview study with practitioners	[34]
7	How cloud providers elicit consumer requirements: An exploratory study of nineteen companies	[35]
8	An Industrial Case Study on Distributed Prioritisation in Market-Driven Requirements Engineering for Packaged Software	[37]
9	Preliminary Results from an Empirical Study in Market-Driven Software Companies	[38]
10	Uni-REPM: validated and improved	[39]
11	Requirements lifecycle management and release planning in market-driven requirements engineering processes	[40]
12	Market-Driven Requirements Engineering Process Model – MDREPM	[43]
13	Market-driven requirements engineering processes for software products - a report on current practices	[58]
14	Challenges in Market-Driven Requirements Engineering - an Industrial Interview Study	[65]
15	Elicitation and management of user requirements in market-driven software development	[66]
16	Requirements Triage-Challenges and Solutions	[67]
17	The Evolution of Emerging Technologies in Market-driven Software Product Development	[68]
18	Bespoke, Mdre And Challenges In Mdre In Comparison With Bespoke	[69]
19	BESMART - a framework for shifting from BESpoke to Market driven requirements engineering	[70]
20	A Study in Market-Driven Requirements Engineering	[71]
21	On Overcoming Market-Driven Software Development Challenges: requirements refactoring	[72]
22	A Unified RE Approach for Software Product Evolution: Challenges and research agenda	[73]
23	Simulation of Market-Driven Requirements Engineering Processes	[74]

APPENDIX IV

Excluded challenges

No.	Challenges	Description	Exclusion Reason	Reference
1	Requirements duplication and overload	A high number of requirements are elicited due to multiple sources	It is related to repository management	[1] [4] [39] [43] [69] [70] [72] [73]
2	Technology Push Vs Market pull.	It is necessary to have a good balance between technology push and market pull.	It is related to prioritization and release plan process.	[1] [4] [38] [39] [43] [65] [67] [69] [71]
3	Requirements validation	Requirements are usually validated after the product is released into market.	It is related to requirements validation and release plan process.	[3] [38] [71]
4	Requirements selection	It is difficult to select what requirements should be satisfied in which release.	It is related to requirements selection and release planning process.	[1] [4] [34] [38] [40] [43] [65] [66]
5	Prioritization	Prioritization is very difficult process in MDRE context due to the continuous flow of requirements and improper knowledge of employees.	It is related to prioritization process.	[3] [37] [67] [69] [70]
6	Requirements dependencies	It is necessary to consider requirements dependencies when release planning.	It is related to release plan process.	[1] [4] [34] [70]
7	Manage Continuous flow of customer requirements	It is difficult to manage continuous flow of customer requirements due to the requirements change continuously.	It is related to requirements management process.	[2] [33] [34] [66]
8	Organization stability	Staff's knowledge about the product can impact product development.	It cannot be mitigated by selected elicitation techniques	[1] [4] [34] [65]

APPENDIX V

Evaluation results of interviewee A

	C1	C2	C3	C4	C5	C6
Prototyping	L	L	L	H	L	L
Analysis of existing documentation	H	H	H	H	L	H
Scenarios	H	H	H	H	L	H
Focus groups	H	H	H	H	L	L
Workshops	L	L	L	H	L	L
Market research	H	H	H	L	L	L

Evaluation results of interviewee B

	C1	C2	C3	C4	C5	C6
Prototyping	L	L	L	H	L	L
Analysis of existing documentation	L	L	L	H	L	H
Scenarios	H	H	H	H	H	H
Focus groups	H	H	H	H	H	H
Workshops	H	H	H	H	H	L
Market research	H	H	H	L	L	H

Evaluation results of interviewee C

	C1	C2	C3	C4	C5	C6
Prototyping	L	H	L	H	L	L
Analysis of existing documentation	H	H	H	H	H	H
Scenarios	H	H	H	H	H	H
Focus groups	H	H	H	H	H	H
Workshops	H	H	H	H	H	H
Market research	H	H	H	L	L	L

Evaluation results of interviewee D

	C1	C2	C3	C4	C5	C6
Prototyping	L	H	L	H	H	H
Analysis of existing documentation	H	H	H	H	H	H
Scenarios	H	H	H	H	H	H
Focus groups	H	H	H	L	H	H
Workshops	L	L	L	H	L	L
Market research	H	H	H	H	L	L

Evaluation results of interviewee E

	C1	C2	C3	C4	C5	C6
Prototyping	L	L	L	H	L	H
Analysis of existing documentation	H	H	H	H	L	H
Scenarios	H	H	H	H	H	H
Focus groups	H	H	H	L	L	L
Workshops	L	L	L	H	L	L
Market research	H	H	H	L	H	H

Evaluation results of interviewee F

	C1	C2	C3	C4	C5	C6
Prototyping	L	H	L	H	L	H
Analysis of existing documentation	H	H	L	H	L	H
Scenarios	H	H	H	H	H	H
Focus groups	H	H	H	H	L	L
Workshops	L	L	L	H	H	H
Market research	H	H	H	L	L	L

Evaluation results of interviewee G

	C1	C2	C3	C4	C5	C6
Prototyping	L	H	L	H	L	H
Analysis of existing documentation	H	H	H	H	H	H
Scenarios	H	H	H	H	H	H
Focus groups	H	H	H	H	L	L
Workshops	H	H	H	H	L	L
Market research	H	H	H	L	H	H

Evaluation results of interviewee H

	C1	C2	C3	C4	C5	C6
Prototyping	L	H	L	H	L	H
Analysis of existing documentation	H	H	H	H	H	H
Scenarios	H	H	H	H	H	H
Focus groups	H	H	H	H	L	L
Workshops	H	H	H	H	L	L
Market research	H	H	H	H	H	H