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Software Cost Estimation Practices Using RASCH Measurement Model: An Indonesian Regional Government Evidence

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Abstract

Software cost estimation (SCE) can be substantial challenges in software development as it could yield inaccurate results. The SCE failure influences project sustainability which might lead to additional costs and times to complete the project. Previous research has provided empirical evidence that the unsuccessfulness of software cost estimation in public sectors is higher than in private sectors. This is due to the actual cost not in line with the estimation cost. The objective of this paper is to determine the SCE practices in the regional government of Indonesia. This research adopts both quantitative and qualitative approaches. The quantitative approach was conducted by distributing questionnaires to government employees who are involved in cost estimation. RASCH model software was used to analyze the data. The qualitative approach involved interviewing personnel in the cost estimation process in regional government. This research involved seven government agencies in West Sumatera Province, Indonesia. The findings of this study show that current practices of SCE in the regional government of Indonesia are not effective although there is a budget ceiling (pagu anggaran) and owner estimate cost (harga perkiraan sendiri). This paper highlights the reasons for inaccurate results of SCE in public sector due to five factors which are: people who have authority to estimate the software cost, time of the estimation, no tool to estimate the software cost, the frequency of changing the scope and requirements of the project, and the number of changes of scope and requirements. However, this research may not include all the factors that influence software cost estimation in government projects yet. There might be other factors that might influence SCE in the public sector. These factors can assist the regional government of Indonesia to effectively and quantitatively analyze the factors that significantly impact software development in Indonesian regional government context. Those factors can be included as parameters in estimating the software cost and also to enhance the software cost estimation process. Thus, it can reduce the risk of the project from overrunning and over budget.

Keywords Software cost estimation practice; public sector; Indonesian regional government

INTRODUCTION

Rosmala & Akbar (2010) defines that the software cost estimation is a process of predicting human resources, time and cost requirements to complete a project. Huang et al. (2007), software cost estimation consists of predicting the cost, quality, risk analysis and other factors that influence software cost estimation. Furthermore, according to Sharma, Bajpai & Litoriya (2012) stated that software cost estimation is a process to estimate the resources, schedule, software size, effort and the whole cost of the project. Hence, many factors influence software cost estimation results. Likewise, cost estimation process is a substantial challenge in software development although there is a great understanding of software

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project performance and software development method selection (Ramasubbu & Balan 2012; Rajkumar & Alagarsamy 2013; Ramesh & Reddy 2016). Besides, the difficulty in estimating the software cost is due to the intangible nature of software, making the cost estimation process even more complex (Kumari & Pushkar 2013).

Software cost estimation process is correlated with the software development process to make an adequate plan so that the project is completed in particular time, budget and resources. In addition, one of the causes of the software development failure is due to inaccurate software cost estimation results Rajkumar & Alargarsamy (2013). Mensah (2003) stated that software development failures could happen in any organization regardless of their organizational size, geographic region, industry, and market group. Thus, it could occur in private sectors, public sectors or any government institutions.

According to Mensah (2003), the public and the private sectors are often forced to cancel software projects because the cost and the dateline far exceeded the initial schedule planning. For instance, one of main issues in software development in Indonesia companies in 2013 due to the actual budget required to complete a project is higher than the estimation cost (Imam & Arry 2015). In addition, due to ineffective cost estimates, the government ICT project failure in the Malaysian context was high. It can be seen that the number of successful projects is less than 31%, while the rest of projects are over budget and canceled (Haslindah, Azizah, Othman 2014). This issue is also faced by companies and the government of USA whereby more than 50% of projects required additional cost for the projects to be completed (Chaos report (2014).

Also, in Finland, the ministry of justice developed a prison information system. The project was a huge overrun in terms of schedule and budget. They have to pay four times more than the "original fix price." The project was unsuccessful due to the users not participating in the development process (ISBG 2004). Based on Standish Group Report on 25,000 software projects data in 2011-2015 reveal that 27-31% of the project is successful (project completed within time and budget estimate), and 17-22% of the project is failed (project canceled or terminated). There is also 49%-56% that falls into a challenging project which means that the project is completed with overrun and over budget. These occurred due to lack of cross-checking of the judgment given by experts in the input and output estimation. Besides that, the organization might not use or misuse the existing models or techniques (Boehm 2017).

Due to ongoing reports on the inaccuracy of software cost estimation and the important role of software cost estimation in software development, this paper is to determine the software cost estimation practices as well as the factors that influence software cost estimation especially in public sectors.

LITERATURE REVIEW

A. Software Cost Estimation in Public Sector

The common cost estimation technique used by the government is an expert judgment which depends on the experts. The weaknesses of this technique are that the method still cannot be measured because it is hard to document the parameters used by the experts. The experts may be biased, optimistic and pessimistic (Holgeid & Thompson 2013); Rajkumar & Alagarsamy 2013; Whitfiled 20070. When software cost is unquantifiable, it can lead the estimation to be potentially highly biased and unjustified due to it being difficult to verify and validate it (Phongpaibul & Aroonvatanaporn 2014). In addition, GAO (2009) stated that there are many factors influencing the project overrun which are detailed documentation availability, risk analysis conducted, historical data of the previous projects, well trained

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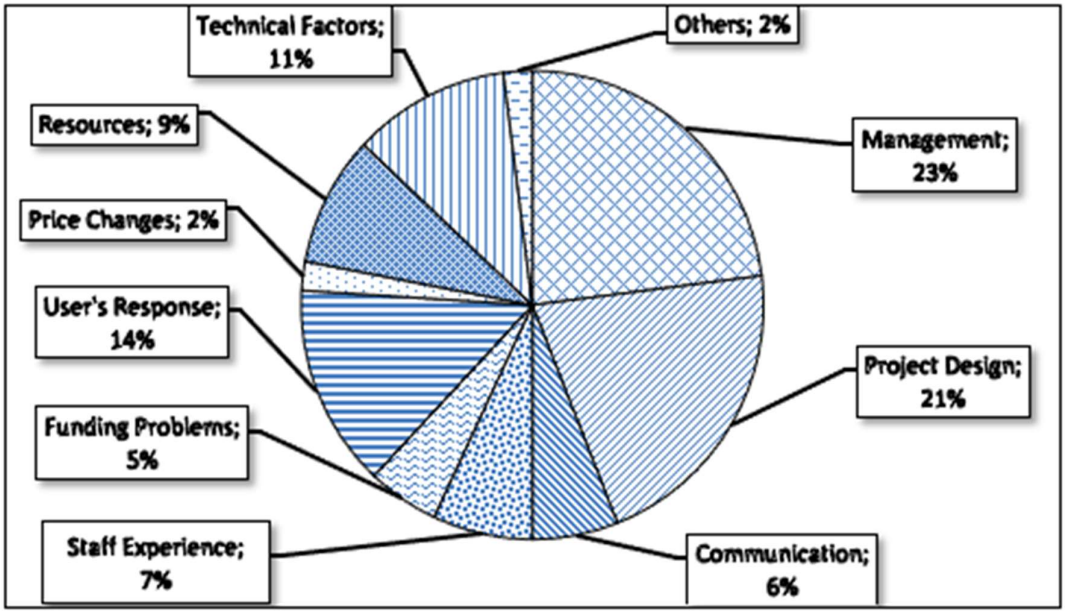
and experienced analyst, adequate budget, adequate cost reserve, unrealistic assumptions and over-optimism.

As stated by Rozalina & Zulkefli (2018), five critical factors affecting SCE in public sectors are under "people factor" which are programmer capability significance towards the successful project, top management support is essential for the project to be successful, top management is understood the objective of the project, the project manager is knowledgeable and competence in ICT and top management is involved and committed to the project. While another factor under "process factor", specifically under risk management which is risks that occur during the software development project manage well. People involved in estimating the software cost are usually a project manager, top management and programmer has an important role in estimating the software cost as well as in software development. First, a project manager is the one who has responsibility managing and controlling the whole project. Hence, the project manager has to control the project and cost so that it is in line with the estimation results. If anything happens in the project which includes the estimation cost, the project manager has to take responsibility to the top management because the project manager reports and explains the progress of project to top management. On the other hand, the decision making for the project relied on top management approval. Therefore, top management requires understanding the objectives of the project. It is significant for the top management to support by giving participation and commitment from the first process of software development till the project is completed. Likewise, risk management is vital for the project due to the many risks that might occur in the project. It can happen anytime during software development. So, if risk can be managed well, the software cost estimation should be in line with the software cost estimation.

On the other hand, as stated by Haslindah, Azizah & Othman (2014); Phongpaibul & Aroonvatanapoorn (2014); Chaos report (2014) that the project manager and top management are lack of knowledge, skill, experience, and familiarity in ICT. Meanwhile, ICT knowledge is significant to define the scope and requirements of the project. Therefore, the scope and requirement are significant in estimating the cost because it encompasses entire activities of software development which is used to estimate the size of the project (Medvedska & Berzisa 2015).

According to Rajkumar & Alagarsamy (2013), many uncertainty factors influence software cost estimation as shown in Figure 1. The most affecting factors are management (23%) and project design (21%). Management commitment is very important for the sustainability of the project because the management is the one who is responsible to manage the whole project. The project design is associated with the project planning and project variables which are significant to identify the requirements and outcome of the project. Renny et al. (2015) & (Zulkefli et al. 2016), number of failures in IT projects is high caused by several factors which include less support by top management, lack of user involvement, the objectives of project unclear and the maturity of organization. Singh and Dwivedi (2014) also stated that the success of a software project depends on various factors that are interrelated to each other. The success of a project is identified by fulfilling all the project requirements within the schedule and cost that has been estimated before. There is no warranty for technology or standard procedure for the development process that would prevent software projects from failures, cost overrun, late delivery, logical errors and incorrect design. The most significant factor that influences the success of a project is management ability and people. It is also important to involve customers in project development so that the requirements will be aligned with the user's needs.

Figure 1. The major uncertainty factors affecting software cost estimation



Source: Rajkumar & Alagarsamy (2013)

Furthermore, software cost estimation in government is complicated as the estimation has to be conducted in the initial stage of the project. Hence, in the first stage of a project, the government is required to prepare detailed scope and requirements of the project; unfortunately, the project team is not equipped in preparing it (Imam & Arry 2015). According to Gumaei, Almaslukh & Tagoug (2015), the organization that estimates the software cost at early phases of a project tends to produce inaccurate results. However, it is necessary to estimate the software cost at early phases due to preparing the project proposal in order to get the budget. The estimation at early phase has high risk due to many uncertainties and risks on the scope and project requirements. As stated by Kumari & Pushkar (2013), there is no detailed information on the scope and requirements during the early phase of the software development. Zulkefli et al. (2011) also explain that the requirements of the project are essential so that the result is accurate. Therefore, it is difficult to estimate the software cost at an early phase of the project because of changes made on requirements. The estimation could be done in a later phase. The later phases refer to the design, implementation and testing stage. Attarzadeh & Hock (2011) stated that the incomplete information on the software causes the difficulties in software cost estimation which led to producing an inaccurate result.

Lack of the historical government project records, as the impact of the data availability is not effective and efficient regarding quantity and quality of data. It is caused by the data not centralized, collected and maintained consistently. As for the impact, the historical data is not effective in estimating the cost (Raffo, Pfahl & Wang 2007). Historical data quality would affect estimation too. Thus, the information determines the success of the project due to incomplete and incorrect information would lead to the estimation failure (Ministry of Transportation and Infrastructure 2013; GAO 2009). So, the better quality the data are, the better-quality estimation would be.

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Likewise, lack of communications also affects the software cost estimation because it causes misunderstanding and conflict in the project. As the impact, the project may delay or fail (Rajkumar & Alagarsamy (2013). Furthermore, the experience, knowledge, skills, and commitment of staff also influence the software cost estimation since they have an important role also in a development process. Other factors are the financial issues and user responses. The financial issues contribute to the project completion because the budget constraints can delay the project. The user responses mean how the users react toward a new system because most of the end users do not have the training to use the new system and it is difficult for them to adapt themselves to using that system (Rajkumar & Alagarsamy (2013).

Cost evaluation is often calculated by people who are inexperienced using the estimating methods and tools. Although they are good in financial and accounting methods, it does not mean they are good in software estimating because it requires specific skills and training (Jensen 2003). According to GAO (2009), the cost estimator has to be multi-talented in analyzing high-quality data. Cost estimation is a difficult task, but yet it is very important. It takes time to develop which cannot be done in a hurry. Hence, the cost analyst needs to be well-trained and have experience because they are not only estimating the cost but also to predict the risk that might occur. As a cost analyst, it requires having knowledge of different disciplines such as accounting, budgeting, computer sciences, economics, engineering, and mathematics as shown in Table 1. However, the individual who does not have skills as a cost analyst are often involved in estimating the cost.

Table 1. Disciplines and concept in Cost Analysis

Cost Analysis	
Disciplines	**Concept**
Economics	Break-even analysis Foreign exchange rates Industrial base analysis Inflation Labor agreements Present value analysis Budgeting
Budgeting	Budget appropriations Internal company (industry) Program specific
Engineering	Design Materials Performance parameters Production engineering Program development test Scheduling System integration
Computer science / Mathematics	Analysis of commercial models Analysis of proposals Development of cost estimating relationship Model development Programming
Statistics	Forecasting Learning curve applications

Cost Analysis	
Disciplines	**Concept**
	Regression analysis Risk/uncertainty analysis Sensitivity analysis
Accounting	Cost data analysis Financial analysis Overhead analysis Proposal analysis
Interpersonal skills	Approach Estimate Knowledge
Public and government affairs	Appropriations process Auditors Legislative issues Outside factors

Source: GAO 2009

Selecting the tool and technique to perform software cost estimation is substantial for cost estimation accuracy. Therefore, it is important to decide the right proper tool that is used for estimating the software cost. However, the common traditional tools used are Microsoft Excel and Microsoft project which have challenges in terms of the accuracy (Rajkumar & Alagarsamy (2013). Zulkefli et al. (2016) stated that most of the project managers used the manual method to perform the calculation due to unavailability of computerized tools. The tools that are usually selected for performing the calculation are EVM, cash flow statement, WBS statement burndown charts, and Gantt charts by using the Microsoft Excel. They also used HP quality center which is an automation method. Unfortunately, it does not have all the functionality that supports cost estimation. The availability of computerized tools is essential for a project which can increase the effectiveness and the efficiency in managing the project cost. However, other difficulties in software cost estimation are novel application software, changing technology and lack of homogeneity of project experience. The novel application of software means each software has its own uniqueness which causes the uncertainty in estimation. The software can be implemented in different environments, but at the same time, it needs to line with technological development. As a result, it will have different project estimates. Lastly, lack of homogeneity of project experience means the software cost estimation should be done based on the previous information of a project. In this case, it requires experience on the similar previous projects (Suharjito & Budi 2013).

Moreover, many software cost estimation models have been established by previous researchers. However, those existing models developed are based on a large number of historical projects from the USA. Hence, it is necessary to adapt those models to the environment in which they are to be used. The software cost estimation model which is developed based on the local project data has higher accuracy compared to the existing model as it reflects on the software development in a particular organization. Not all the parameters of the existing models are applicable with the local software development environment (Javed et. al 2013; Xuang et. al 2007; Suharjito & Budi 2006; Dillibabu & Krisnaiah 2005). Besides that, the existing models commonly use Lines of Code (LOC) and function points for measuring the software size. The primary problem is the lack of a universally accepted definition of LOC. As the impact, many variations of counting the LOC exist. Some models include the comment lines, while other models do not calculate it. LOC is language dependent; the calculations are varied as it depends on the

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programming language used for the software development. While the function point does not consider the tools, methodologies, programming languages, database management systems, processing hardware or any data processing technology in the estimation. It really depends on the functionalities of the system requirement (Matson et. al 1994). It is very difficult to be implemented at the early stages of the project (Patil, Badjate & Joshi 2014). Therefore, it is difficult to implement those existing models in government due to the software cost estimation is performed at an early phase of the project whereby the scope and requirements of the project are not detailed yet.

As stated by Ramesh & Reddy (2016); Shekar & Kumar (2016); Patil, Badjate & Joshi (2014); Rajkumar & Alagarsamy (2013); Khatibi & Jawawi (2012) that the common existing model used is COCOMO models which ignored other important parameters such as customer skills, cooperation, knowledge, hardware issues, personnel turnover levels and all documentation (Ramesh & Reddy 2016; Shekar & Kumar 2016; Patil, Badjate & Joshi (2014); Rajkumar & Alagarsamy (2013); Khatibi & Jawawi (2012). Basically, those factors are significant due to having a big impact on the estimation result. Consequently, there is a need to have a model which describes the software cost estimation complexity from various factors. As mentioned by Kaur & Salaria (2012) that the difficulties in estimating the software cost are influenced by many factors such as lack of historical data, lack of project plan, poor management, project team ability, the pressure to lower estimation and project uncertainty.

B. Software Cost Estimation in Indonesia

Indonesia spending on information technology has increased by 15% in 2015 which is around 176.3 trillion IDR. One of the expenditures is for a software development project (BMI 2015). Before implementing a project, each government institution requires preparing the budget plan (Penyusunan Rencana Anggaran Biaya / RAB). Rencana Anggara Biaya (RAB) is a budget estimate plan on the activities of the institutions in Indonesia Hence, the first stage needs to be done estimating the project cost that requires project development (Adi Nugroho et al. 2009). According to the Presidential Regulation of the Republic Indonesia number 70 of 2012 on procurement goods or services, the government agencies have to make its cost estimation (Harga Perkiraan Sendiri) (Subsection 66 number (5) item a). The purpose of the cost estimation is to ensure the project cost within reasonable cost (Ziyad et al. 2014). However, according to Sosa Star Web (2017), there is no specification technique used to estimate the software cost. They perform the owner's estimated cost based on pagu anggaran. Besides that, the government often changes the scope and requirements of a project which causes project delay

Based on the Presidential Regulation No. 4 of 2015, every procurement process of goods and services that are conducted by public sectors and private sectors of Indonesia must make the owner estimate cost (OEC) or Harga Perkiraan Sendiri (HPS) (INKINDO 2017). Harga Perkiraan Sendiri (HPS) is the estimation of price goods and services of a project which use as the highest bidding limit offered by consultants or software providers. According to the Presidential Regulation no. 70 of 2012, the software is considered as a good which requires the owner to estimate the cost in the planning stage. Before estimating the owner's estimated cost, the Committing Officer (CO) requires identifying the requirements and specification. Unfortunately, the OEC is very difficult for the software cost estimation due to there are no standard techniques for reference and guidance (Sholiq et al. 2016). The OEC is used to estimate the cost and state the technical specification of the project. However, most of the private sectors and the public sectors are finding it difficult to make a request or to offer the software development project due to facing difficulties in performing their own price estimate (OEC). If the estimation is too high for the fair price, the companies or the government will be potential losses. If the

estimation is lower than the fair price, then it will have the potential for the software procurement failures due to the software providers not being interested in doing the project (Imam & Arry 2015).

RESEARCH METHOD

The research methodology used a combination of quantitative and qualitative approaches. The quantitative is conducted by distributing the questionnaires to the respondents. The purpose is to gather the information related to the current practice of software cost estimation in a regional government agency from 96 sample respondents that were calculated by using Lemeshow approach due the exact know of population unknown. Likewise, a qualitative approach was done through interviews of respondents from the different agents in West Sumatera Province. The respondents are government employees who are involved in software cost estimation in West Sumatera Province. The government employees chosen are from three agencies which are DISKOMINFO, BAPPEDA, and LPSE. DISKOMINFO (Dinas Komunikasi dan Informatika) is a communications and informatics agency. BAPPEDA (Badan Perencanaan Pembangunan Daerah) is a regional agency for planning and development. LPSE (Lembaga Pengadaan Secara Elektronik) is a provider of electronic procurement systems for government goods or services which operates by using electronic procurement systems. The respondents are from four cities and three agencies in West Sumatera Province. The cities are Padang, Pakumbuh, Solok and Bukittinggi, while the regencies are Sinjunjung, Tanah Datar, and Lima Puluh Kota.

The Rasch model is used to analyze the data. The Rasch model allows researchers to determine the participant, item and correlation between participant and item (Engelhard & Stefanie 2013). Hence, Rasch analysis is an instrument measurement to measure for what is supposed to measure which include to identify the competence respondents. This will determine the capability of respondents towards software cost estimation results. This can be seen through the person map in Figure 2. It revealed that 40.62% of the most competent respondents, 45.83% of the moderate competence and 13.54% of the less competent respondent. As a conclusion, based on the instrument validity analysis, it is proved that the participants involved were capable of being a respondent to answers related to software cost estimation issues.

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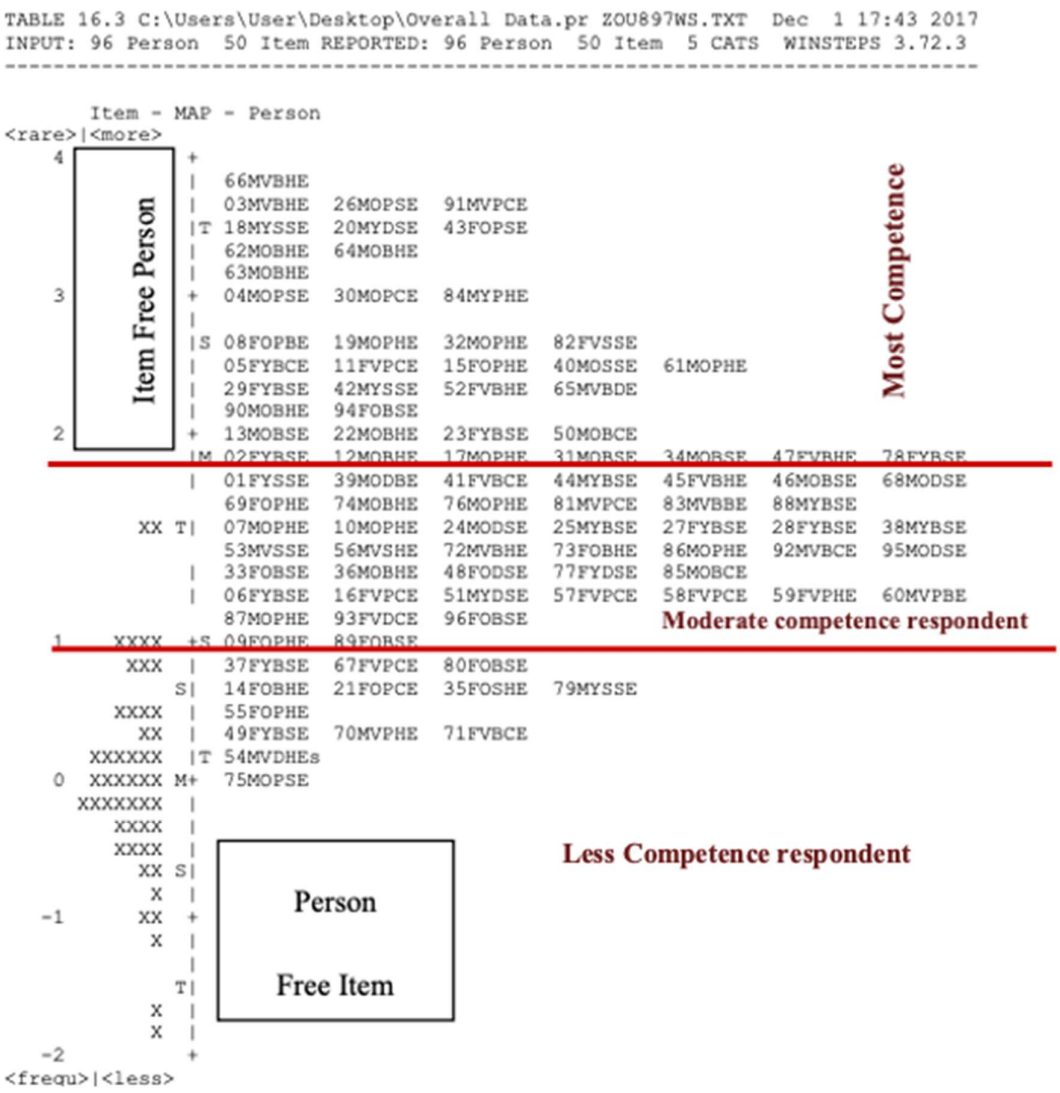

Figure 2. Person map

FINDINGS AND DISCUSSION

Based on findings, the regional government of Indonesia requires an owner estimate cost which refers to *pagu angaran.* The problem is there is no standard to calculate owner estimate cost, for instance the elements that should be included in owner estimate cost and there is no method for calculating it. Although the estimator can refer to *pagu anggaran,* it does not solve the difficulties in estimating the software cost due to *pagu anggaran* use as reference for the limited amount (the highest and the lowest amount) allowed for the project. In this case, the parameters used to estimate the software cost is not clear. Thus, it causes underestimation or overestimation which affect the project. Moreover, the software cost estimation is conducted one year before the project starts whereby the scope and requirements are not defined clearly. This is connected with previous research which says that overestimation occurs due

to the software cost estimation performed during the early phase of the project which lacks detailed scope and requirements during that phase. As the impact, based on the empirical study results, scope and requirements sometimes change. However, even though the change made is not much, it still gives impact on the software development process. Thus, the critical factor of the software cost estimation is influenced by "people factor" and "process factor".

Moreover, the results of a survey on software cost estimation practices are described in Table 2. It revealed that the person who has authority to estimate the software cost is information and technology (IT) staff with a ratio 38.54%. Hence, most of the estimation is done by IT officers. Then, followed by a cost analyst, project manager, others and accountant. Thus, it might cause the issue in software cost estimation results, especially the SCE looks from many aspects which requires experience and knowledge from multi-disciplines of the estimator. In terms of the software cost estimation time, it is indicated that the software cost estimation in the public sector conducted during the project proposal phase with a ratio 86.45%. Only a few projects estimated during the feasibility study, scope and requirement analysis as well as the later phases. Hence, based on the result above most of the public sectors conducted the estimation at the early phase of the project which is during the project proposal phase whereby the scope and requirements are not complete. In this case, the software requirement will still develop in general. So, in order to produce an accurate result, the estimation should be done when the project scope and requirements are completed which has its detailed information. This also can be seen based on the frequency of changing the scope and requirements of a project which is more than 50% of a project that often changes the scope and requirements. In addition, the number of changes made in scope and requirements are a little with ratio 68.75%. Then, 8.33% of the project has substantially changed the scope and requirements and 19.80% of the project is moderately changing the project scope and requirements. Meanwhile, the number of projects that never change the scope and requirements are only 3.12%. Although the number of changed scope and requirements of a software project is a little, yet it also influences the software development process.

The most influential factors of the inaccuracy of software cost are no proper tool to estimate the software cost (37.5%) and lack of experiences in previous related projects (29.16%). The public sector should have a computerized tool that supports the software cost estimation process. Besides having a proper tool, it requires the experience and information of the previous projects.

Table 2. Result on the practice of software cost estimation survey

No	Questions	Frequency	Percentage (%)
1	**People who have authority to estimate the software cost:**		
	IT officer	37	38.54%
	Accountant	3	3.12%
	Project Manager	17	17.70%
	Cost Analyst	26	27.08%
	Others	13	13.54%
2	**The software cost estimation is conducted during:**		
	Project proposal phase	83	86.45%
	Feasibility study	5	5.20%
	Scope and Requirement Analysis	5	5.20%
	Later Phases	3	3.12%
3	**The most influential factor of the inaccuracy of software cost estimation.**		
	Scope and requirements are not clear	15	15.62%

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No	Questions	Frequency	Percentage (%)
	There is no tool to estimate the software cost	36	37.5%
	Not using an available software cost estimation	12	12.5%
	Lack of experiences in previous related projects	28	29.16%
	Lack of top management support	5	5.20%
4	**The frequency of changing the scope and requirements of the project.**		
	Never	3	3.12%
	Seldom	23	23.95%
	Sometimes	52	54.16%
	Often	18	18.75%
5	**The number of changed scope and requirements of a software project.**		
	No	3	3.12%
	A little	66	68.75%
	Moderately	19	19.80%
	Substantially	8	8.33%

Moreover, according to qualitative result, people who involve in estimating the software cost is lack of understanding on the software cost estimation concept because based on their understanding, software cost estimation is about predicting the cost require for software project development. Despite predicting the cost, the most important thing is to understand the related elements that should include in software cost estimation. Furthermore, the current technique apply in public sector of Indonesia is expert judgment and estimation by analogy. The weaknesses of the expert judgment technique are difficult to identify the parameters use by the experts due to it relies on the expert knowledge and experience. While estimation by analogy technique is related with historical data in order to make the assumptions. The difficulties of the technique are lack of historical data of related projects. Therefore, in estimation often involve IT consultant and IT staff. However, another challenge is people who involve in estimating the software cost do not have IT background. In addition, the cost estimators in regional government of Indonesia are not familiar with any model since the estimation is done by using owner estimate cost which refers to *pagu anggaran.* However, there are some parameters of software cost estimation included in estimating the software cost such as: project complexity, the number of users, the level of difficulties the programming language, hardware, man-months, transportation, tax and the project requirements. Hence, the main factors of the software cost estimation are technology, people, process dan organizational factors.

CONCLUSION

Software cost estimation is a substantial challenge in software development even though there are techniques or models of software cost estimation have been proposed for the last thirty years. The result of this study shows that the current technique of the software cost estimation in regional government of Indonesia is not effective because the result of software cost estimation is inaccurate. As the impact, the software development required additional cost in order to complete the project. The problem is no clear measurement in preparing the estimation. The public sectors have to perform owner estimate cost, however there is no criteria or standard measurement to estimate the software cost. Therefore, it is becoming more complicated. It still has many uncertainties that give an inaccurate result. In fact, Indonesia has a standard in goods and services procurement which refers to pagu anggaran, but it is still not efficient. The reason is due to pagu anggaran that is just a reference for the maximum amount of

budget allocated for each program that was produced by the Ministry of planning and the Ministry of Finance of Indonesia. Components required to estimate the software cost is not available. Therefore, there is a need to have a criterion that can be used to prepare to estimate the software cost so that the software cost estimation process is more effective and efficient as well as to get a better estimation result.

LIMITATION & FURTHER RESEARCH

Thus, future research should focus on developing a proper tool of the software cost estimation in the regional government of Indonesia. Besides, the value components in the proposed model are not measured yet; hence it considers defining the value based on the historical data in the government. Like, COCOMO models the value of multipliers are defined based on the historical data of the software cost estimation in the USA. Therefore, the model should be calibrated before using it in a particular place. Moreover, the current reference to measure the salary of a person month is based on the national association of Indonesian consultants. The future research should try to identify whether the salary is compatible with the regional government condition. Besides that, the future research should also identify other factors that might have a significant impact on the software cost estimation in public sectors.

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