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## RE-EVALUATING USER MOTIVATION IN USING ARCHITECTURAL SOFTWARE IN EACH DESIGN PHASE IN INDONESIA

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**Abstract:** Digitalized era has caused design software to develop so rapidly. As a result, architects and designers are offered various choices of design software to choose from, and sometimes designers use different software on different design phases. However, the motivation of choosing a specific software in specific phases is still unknown. Therefore, this paper aims to investigate the frequencies of certain architectural software usage in different design phases, along with the user's motivation in choosing the software. Qualitative method with grounded theory approach are used in the study. Data is then analysed with directed content analysis extracted from software external and internal quality in ISO/IEC 25010:2011. The result of this study reveals that in earlier (exploratory) design phases, media with high efficiency (such as SketchUp) are preferred, and later phases show a significant increase in the need for precision. Efficiency and output suitability are highly valued in architectural visualisation and presentation needs.

**Keyword:** Architectural Stage, Design Media, User Motivation

**Abstrak:** Era digitalisasi telah menyebabkan software desain berkembang sangat pesat. Akibatnya, arsitek dan desainer disuguhkan dengan berbagai pilihan software desain dan seringkali desainer menggunakan software yang berbeda pada setiap fase desain. Namun, alasan memilih software tertentu dalam fase tertentu masih belum jelas diketahui. Oleh karena itu, makalah ini bertujuan untuk meneliti frekuensi penggunaan software arsitektur dalam fase desain yang berbeda, sekaligus alasan pengguna dalam memilih software tersebut. Penelitian ini menggunakan metode kualitatif dengan pendekatan grounded theory. Data yang didapat dianalisis dengan directed content analysis dari ISO/IEC 25010:2011. Hasil penelitian ini mengungkapkan bahwa pada fase desain awal (eksplorasi), media dengan efisiensi tinggi lebih disukai. Sedangkan fase akhir menunjukkan peningkatan yang signifikan terhadap kebutuhan kepresisian. Efisiensi dan kesesuaian output juga sangat dicari dalam fase visualisasi dan presentasi arsitektur.

**Kata Kunci:** Fase Desain, Motivasi Pengguna, Software Desain

### INTRODUCTION

In this digitalized era, technology, especially design software plays a big part in the architecture field, thus architectural software development and usage is growing very rapidly. This rapid development can be seen from various ranges of design software that architects or designers can choose from. However, the motivation of choosing a specific software to use is still unknown. Indonesian Institute of Architects (IAI) stated that the design process consists of 5 phases; conceptual design phase, schematic design phase, design development phase, working drawing, contractor procurement phase. Other than that, this paper also includes a visualisation and presentation phase as an additional design phase. Due to specific user motivation and characteristics needed in each phase, sometimes designers use different software on different design phases.

Therefore, this paper aims to investigate the usage (frequencies) of certain architectural software in different design phases, along with the user's

motivation in choosing the software. This paper can also help software developers by providing some consideration in developing architectural software, for instance by focusing on certain aspects, according to ISO/IEC 25010:2011. This paper can also help architecture students to prepare themselves, by providing considerations which design software to be mastered.

### RESEARCH METHOD

This study applied a qualitative method with a grounded theory approach (Cresswell, 2009). An online questionnaire is used as an instrument to collect data in a non-random sampling manner. The author does not formulate a hypothesis at the beginning of the study, as it is meant to be descriptive-explorative research. The author attempts to uncover the factors that define the phenomenon through analyzing the collected data from the respondents.

The online questionnaire consists of eight main segments. The first one consisted of respondent's general information/demography (8 questions) and the second segment consisted of respondent's office profile (6 questions). The remaining six segments are divided based on architectural design process as stated by the Indonesian Institute of Architects (Ikatan Arsitek Indonesia/IAI), which are: (1) conceptual design, (2) schematic design, (3) design development, (4) working drawing, (5) construction phase, and one additional phase; visualization and presentation. Each of these segments consists of open-ended questions about used media, the media that plays the most important role and the user's motivation.

The data is analyzed with directed content analysis techniques (Hsieh & Shannon, 2005) through open coding and axial coding (Cresswell, 2009). Open coding analysis is done by extracting a keyword from the open-ended questions, and classifying each in several categories, which are synthesized from the software external and internal quality stated in ISO/IEC 25010:2011. Axial coding is done by analyzing the coincidence between categories using correspondence analysis. Pearson Chi-square test and maximum likelihood ratio Chi-square test are conducted to test the result's feasibility.

**Respondent Demography**

Data were collected within a span of 7 weeks (9th September 2021- 30th October 2021). There are a total of 101 respondents ranging from the age of 15 to 34, with people within the age group of 15-24 as the largest group of respondents (85.1%), followed by the age group of 25-34 (11.9%). Most of the respondents live in DKI Jakarta province (36.6%), West Java (21.8%), and Banten (13.9%). The majority of those who responded are architects (53 people), interns (38 people) in an architectural consultancy company. Most of the respondents work in a company with 6-10 employees (35.6%) and more than 40 employees (19.8%). The companies in which the respondents work are mostly designed buildings with the average area of 100-500 m<sup>2</sup> (32.7%).

**RESULT AND DISCUSSION**

Respondent's user motivation are analysed through a directed content analysis (Hsieh & Shannon, 2005) from ISO/IEC 25010:2011, and adapted according to the study's results. Each category and their respective subcategories of user motivation are listed in table 1. 'Functional suitability' refers to the degree of performance of the media against its intended purpose, while 'external suitability' is the degree of the media's suitability towards the user's external conditions (as per client's needs, already learnt at school, and habit). 'Output suitability' defines the degree to which the output of the media is suitable to the user's desire, and 'efficiency' refers to the ability of the media to work effectively and efficiently as per desired timing requirements. The category 'compatibility' indicates the media's capacity to adapt and work together with other systems/media, and the degree to which it allows

suitable collaboration with other users. The term 'usability' relates to the ease in which a media may be used, as well as the amount of work or time required to learn how to use it. 'Universal' refers to the degree to which the media is used everywhere by acquaintances/surroundings, and 'affordability' indicates the media's inexpensiveness to be acquired. The last category 'no other choice' refers to when the user is required to use the media or if it's the only media they mastered.

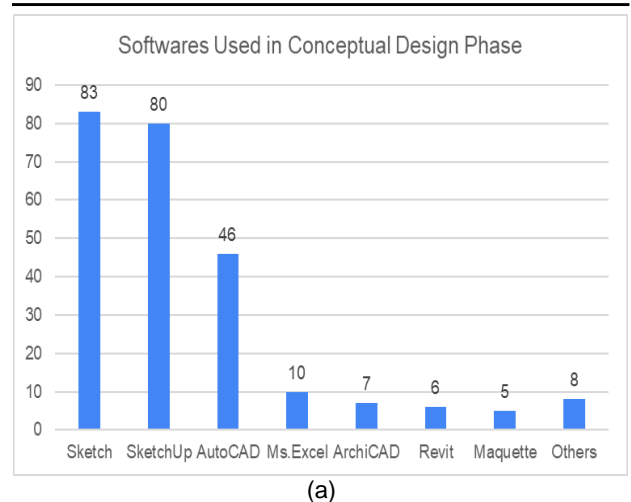
**1. Conceptual Design Phase**

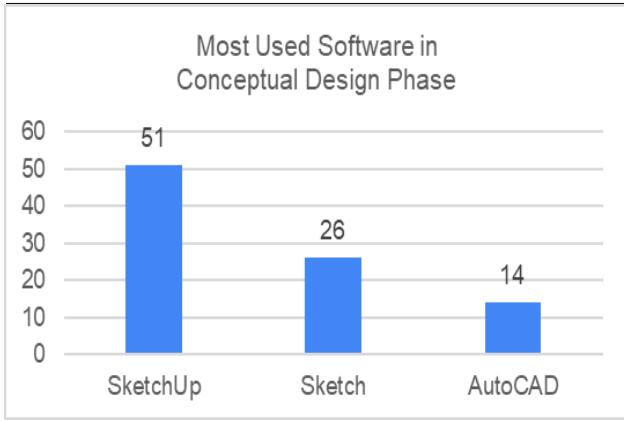
**Frequency of Preferred Media in Conceptual Design Phase**

The conceptual design phase in the architectural process includes: (1) design program (2) processing data related to the site (3) achieving the design objectives (4) identifying constraints and requirements that will produce design concepts based on the analysis (IAI). The research findings pointed out that Sketch and SketchUp are the two most prominently used media in the conceptual design phase (shown in figure 1a). SketchUp is the most frequently used software by architects in this stage (51 respondents), followed by manual sketching (26), and AutoCAD (14) (figure 1b).

**Table 1.** Categories and Subcategories of user motivation

Categories	Subcategories	Definition
Functional suitability	Functional completeness	degree to which the functions in media covers all the specified tasks and user objectives
	Functional correctness	degree to which the functions in media provides the correct results with the needed degree of precision
	Functional appropriateness	degree to which the functions in media facilitates the accomplishment of specified tasks and objectives
External suitability	-	-
Output suitability	Output quality	degree to which the media produces wanted output quality for the respective stage
	Output type	degree to which the media produces desired output format for the respective stage
Efficiency	Performance efficiency	degree to which the response and processing times of a media when performing its function meet requirements
	Efficiency of use	degree to which the media is perceived as practical, efficient, flexible and fast by the user during use
Compatibility	Interoperability	degree to which two or more systems or components can exchange information and use the information that has been exchanged
	Collaboration	degree to which the media allows collaboration between multiple users
	Adaptability	degree to which a product or system can effectively and efficiently be adapted for different or evolving hardware, software, or other environments
Usability	Learnability	degree to which a media enables the user to learn how to use it with effectiveness, efficiency in emergency situations
	Operability	degree to which a product or system is easy to operate, control and appropriate to use
	Simple user interface	degree to which a user interface enables pleasing and satisfying interaction for the user
	Accessibility	degree to which a product or system can be used by people with the widest range of characteristics and capabilities to achieve a specified goal in a specified context of use
Universal	-	-
Affordability	-	-
No other choice	-	-

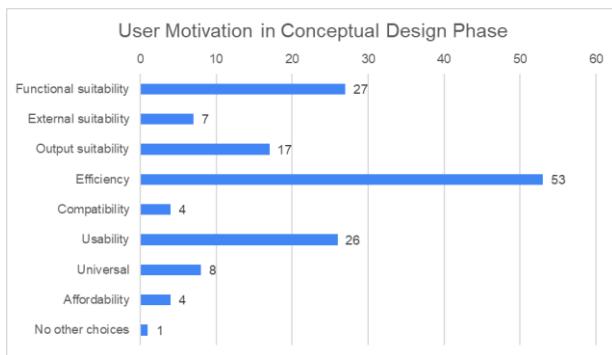




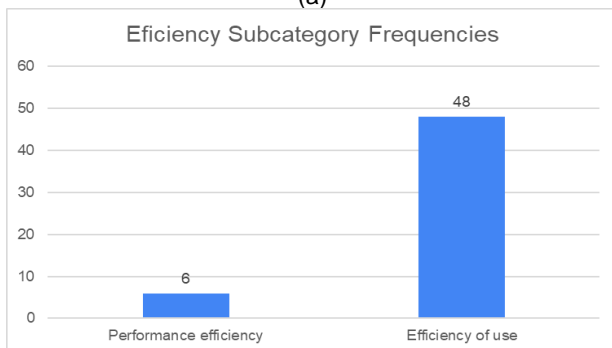
(b)  
**Figure 1.** Media used by architects (a), and most frequently used media (b) in the conceptual phase

**User Motivation in Conceptual Design Phase**

In the conceptual design phase, respondents mostly seek for efficiency (53), the functional suitability (27), and usability (26) of the media, as shown in figure 2a. Conceptual design is the phase where speed, convenience and practicality are prioritized because the design is focused on exploration, and seeks to provide information to clients as effectively as possible. Therefore, efficiency in the architectural media is an important aspect for architectural software development, especially in conceptual design. Efficiency of use (48) and performance efficiency (6) is the two most prominent reasons in defining the media's efficiency (figure 2b).



(a)

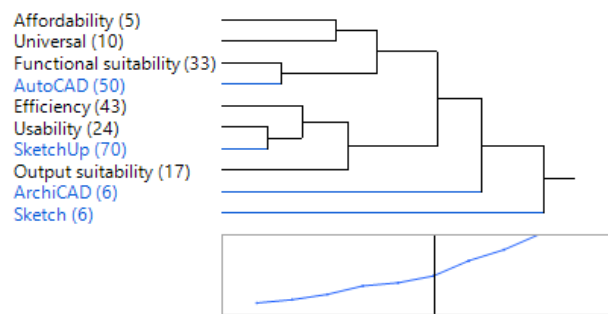


(b)

**Figure 2.** Distribution of user motivation categories (a) and its subcategories (b) in choosing media for conceptual design phase.

**1.c. Correspondence between Preferred Media and User Motivation in Conceptual Design Phase**  
 Pearson Chi-square test based on the

correspondence analysis between user motivation and preferred media in this phase (figure 3) shows a value of 0.1540, and the maximum likelihood ratio Chi-square test has a value of 0.1284. AutoCAD is chosen for its affordability (5), universality (10), and functional suitability (33), while SketchUp is used mainly for its efficiency (43), usability (24), and output suitability (17). SketchUp is considered to be fast and flexible to operate, hence the high efficiency. It is also considered easy to operate because of its intuitive controls (high usability). Following SketchUp, AutoCAD is mostly perceived as functionally suitable by respondents since it is considered to be able to finish the tasks in this stage well: from exploring various forms and design alternatives, is accurate, measurable, but not too detailed and complicated, meanwhile ensuring architects can still have a grasp about the general spatial scale of the conceptual design.

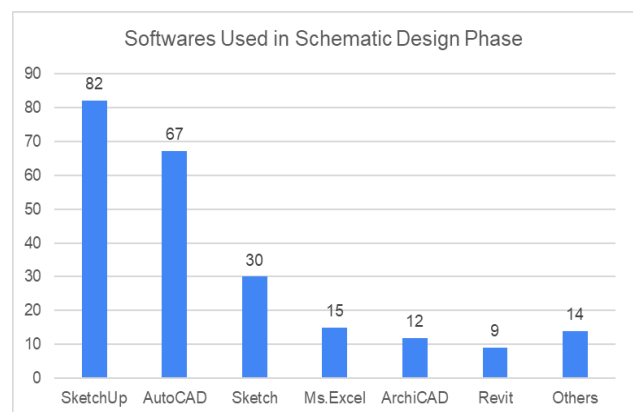


**Figure 3.** Correspondence between chosen media and user motivation in conceptual design phase shown in cluster diagram.

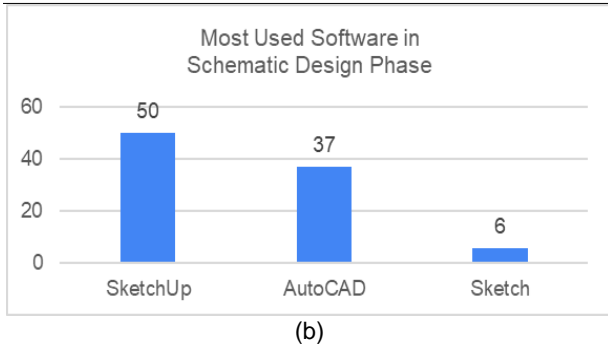
**2. Schematic Design Phase**

**Frequency of Preferred Media in Schematic Design Phase**

The schematic design phase includes the activities of creating the most suitable architectural form that can meet the design program requirements. This stage also includes determining the estimated floor area, information on material use, sustainability analysis, construction systems, costs, and construction time. The research findings pointed out that SketchUp and AutoCAD are the two most prominently used media in the schematic design phase (shown in figure 4a). SketchUp is the most frequently used software by architects in this stage (50 respondents), followed by AutoCAD (37) (shown in figure 4b).

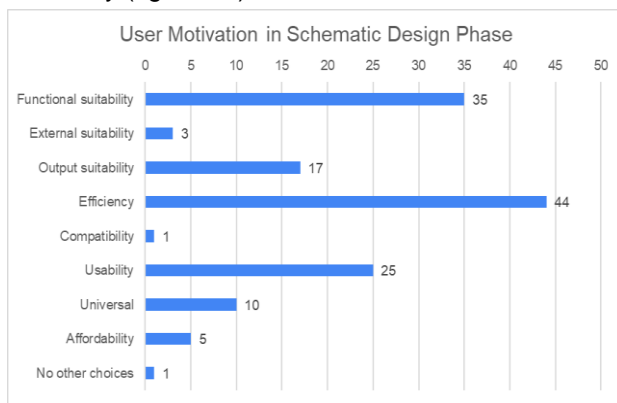


(a)

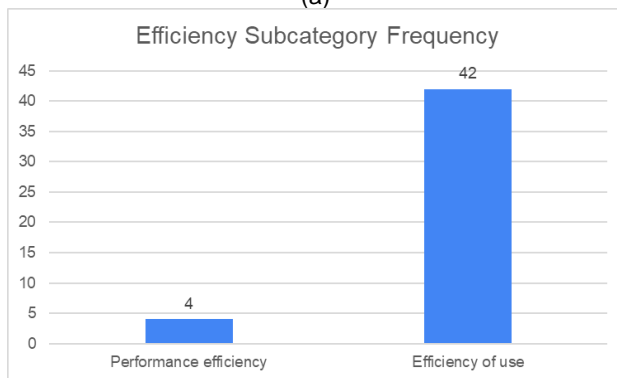


**Figure 4.** Media used by architects (a), and most frequently used media (b) in schematic design phase.

**User Motivation in Schematic Design Phase**  
 Similar to the previous phase, design exploration still played a big part in the schematic design phase. Therefore, the main concern is to use the media as fast and easy as possible to provide the design ideas to clients, hence efficiency is also the main motivation of using the media for the schematic design phase. In the schematic design phase, respondents mostly seek for efficiency (44), followed closely by functional suitability (35), and usability (25) of the media, as shown in figure 5a. Functional suitability significantly increased because in this phase, the design needs to be more neat, precise and detailed than in the conceptual phase. Efficiency of use (42) and performance efficiency (4) is the two most prominent reasons in defining the media's efficiency (figure 2b).



(a)

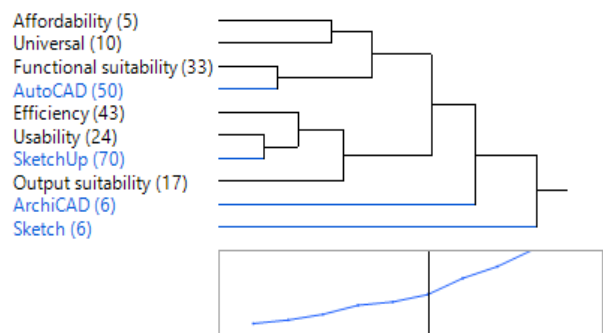


(b)

**Figure 5.** Distribution of user motivation categories (a) and its subcategories (b) in choosing media for schematic design phase.

**Correspondence between Preferred Media and User Motivation in Schematic Design Phase**

The maximum likelihood ratio Chi-square test based on the correspondence analysis between user motivation and preferred media (figure 6) in this phase has a value of 0.0166, and Pearson Chi-square test shows a value of 0.0304. SketchUp is chosen for its efficiency (43), usability (24), and output suitability (17), while AutoCAD is used mainly for its functional suitability (43), universal (10) and affordability (5). Similar to the previous phase, SketchUp is considered to be fast to operate, hence the high efficiency. The efficiency mostly comes from the efficiency of use (42) sub-category. It is also considered easy to operate because of its simple and intuitive controls (high usability). Following SketchUp, AutoCAD is perceived as functionally suitable by respondents since it is able to finish the tasks needed in this stage well, from enabling easy design exploration, while still providing a neat, measurable and more detailed output.

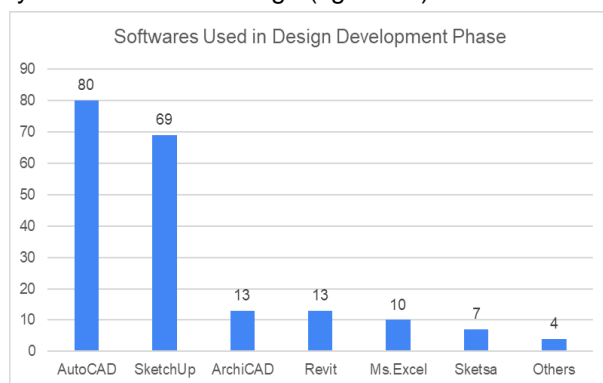


**Figure 6.** Correspondence between chosen media and user motivation in schematic design phase shown in the cluster diagram.

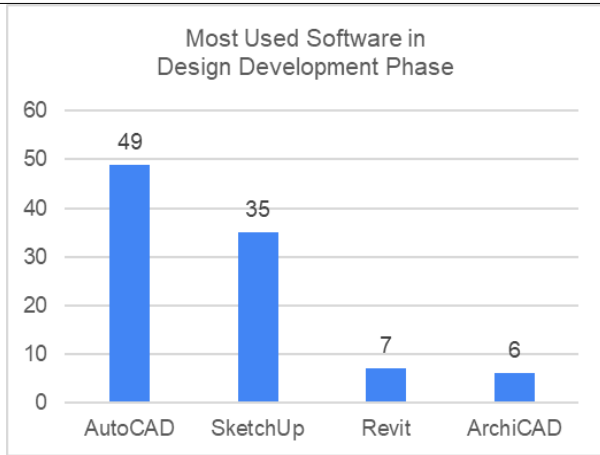
**3. Design Development Phase**

**Frequency of Preferred Media in Design Development Phase**

The design development phase includes providing drawing documents that contain more detailed information, such as construction systems and structures, mechanical and electrical in buildings, building materials, detailed energy analysis, as well as more detailed construction cost estimation. The research findings pointed out that AutoCAD and SketchUp are the two most prominently used media in the design development phase (shown in figure 7a). In this stage, AutoCAD (49) has taken over SketchUp (35) for the most frequently used software by architects in this stage (figure 7b).



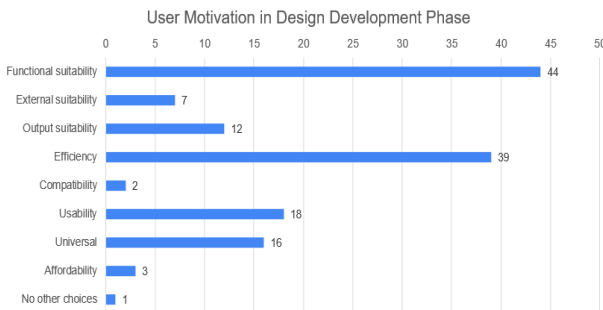
(a)



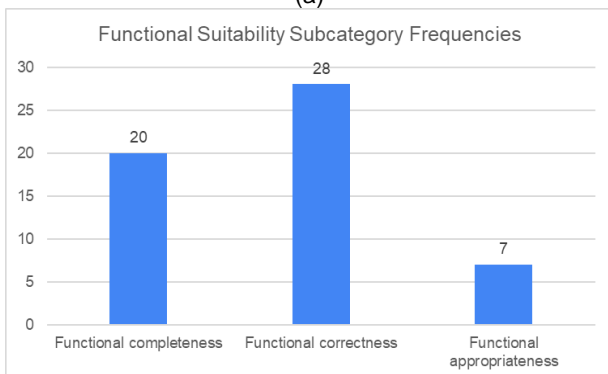
(b)  
**Figure 7.** Media used by architects (a), and most frequently used media (b) in the design development phase.

**User Motivation in Design Development Phase**

In this phase, design needs to be as neat, detailed and precise as possible, not only for the conceptual and spatial scale purposes. For that reason, respondents mostly seek for functional suitability (44) in using a design media, as shown in figure 8a. In this functional suitability, the most prominent sub-category is functional correctness (28) which means precisions, and functional completeness (20) which includes full and easy features (shown in figure 8b). Efficiency (35), being the second motivation, means that users still seek for efficient capacity, along with easy and fast to use media, in order to fulfill the precision needed in this phase.



(a)

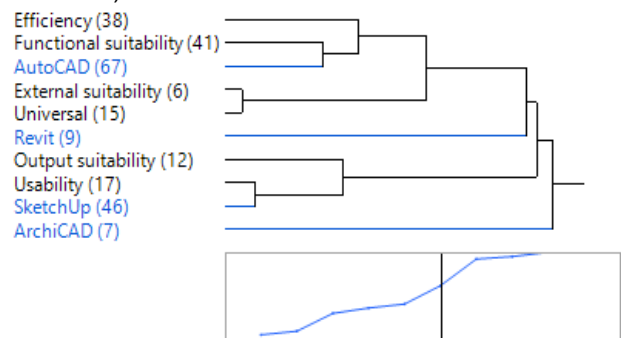


(b)

**Figure 8.** Distribution of user motivation categories (a) and its subcategories (b) in choosing media for design development phase.

**Correspondence between Preferred Media and User Motivation in Design Development Phase**

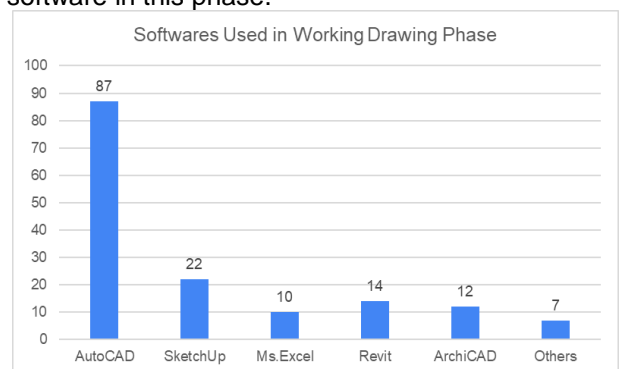
The maximum likelihood ratio Chi-square test based on the correspondence analysis between user motivation and preferred media (figure 9) in this phase has a value of <0.001, and Pearson Chi-square test shows a value of 0.0002. AutoCAD is mostly chosen for its functional suitability (41) and efficiency (38), followed by universal (15) and external suitability (6). As explained before, AutoCAD enables precision and neat output needed in this phase because of its features that makes design development easier, hence the high functional suitability. Moreover, in achieving that precision, AutoCAD is considered to have high efficiency due to its efficient capacity and easy and fast to use. In this phase, SketchUp is mostly chosen because of its usability (17) and output suitability (12). It means that it has an intuitive and simple interface that makes it easy to use and comprehend, while creating a sufficient output quality for the design development phase (simple, informative, aesthetic).



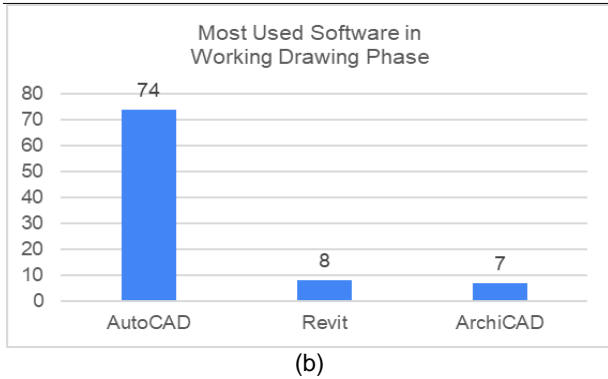
**Figure 9.** Correspondence between chosen media and motivation in design development phase shown in cluster diagram.

**4. Working Drawing Phase**  
**Frequency of Preferred Media in Working Drawing Phase**

Working drawing phase includes converting the design concept into drawings and detailed technical descriptions, with technical specifications and requirements for construction, calculating the quantity of work, and a clear, precise, and detailed estimate of implementation costs (in the form of a Detailed Engineered Drawing / DED document). The research findings pointed out that AutoCAD alone is the most prominently used media in the conceptual design phase (shown in figure 10a and 10b). Revit (8) and ArchiCAD (7) are the other two mostly used software in this phase.



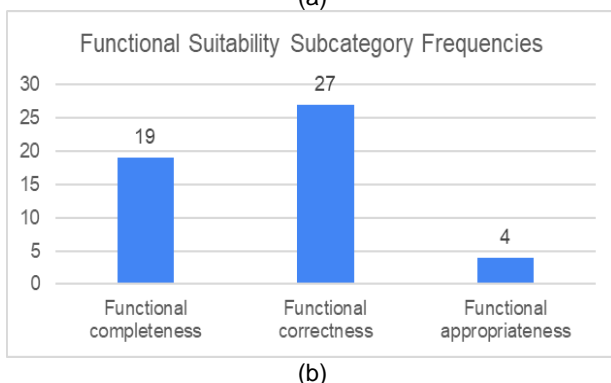
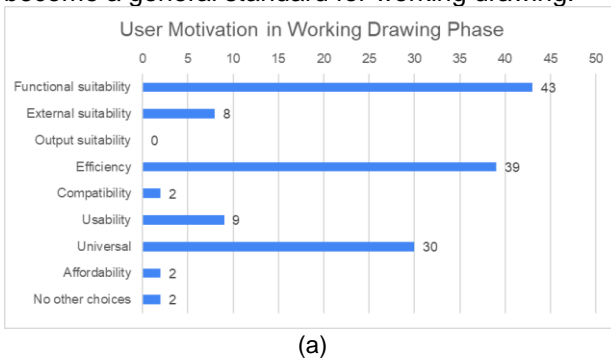
(a)



**Figure 10.** Correlation between chosen media and motivation in design development phase shown in cluster diagram.

**User Motivation in Working Drawing Phase**

Similar to the design development phase, working drawing needs to be neat, detailed and precise. Consequently, respondents mostly seek for functional suitability (43) and efficiency (39) from a design media (figure 8a). In this functional suitability, the most prominent sub-category is functional correctness (28) and functional completeness (20), as shown in figure 8b. In this phase, motivation regarding the media’s universality increased significantly due to colleagues and partnership with other fields of study (such as electrical, mechanical, contractor). That means in this phase, the media needs to be understood and used by others, not only the architects. It is also said that AutoCAD has become a general standard for working drawing.

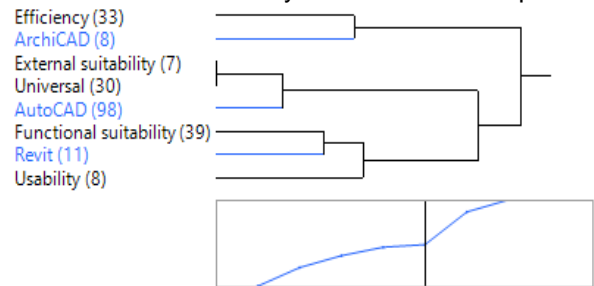


**Figure 11.** Distribution of user motivation categories (a) and its subcategories (b) in choosing media for working drawing phase.

**Correspondence between Preferred Media and User Motivation in Working Drawing Phase**

The maximum likelihood ratio Chi-square test based on the correspondence analysis between user

motivation and preferred media (figure 12) in this phase has a value of 0.0141, and Pearson Chi-square test shows a value of 0.0920. AutoCAD is mostly chosen because it is considered universal (30), since it is commonly used by fellow colleagues and other fields of study and considered to be a standard for working drawing. Meanwhile, Revit is mostly chosen because it is functionally suitable (39) and usable (8). The output (2D and 3D) integration and automation are the main reasons for the high number of functional suitability. ArchiCAD is mostly chosen because of its efficiency (33), because the features are faster and easier for this phase. It should be noted that the usage of Revit and ArchiCAD tends to be constant from the initial phase, which means both media are constantly suitable in various phases.

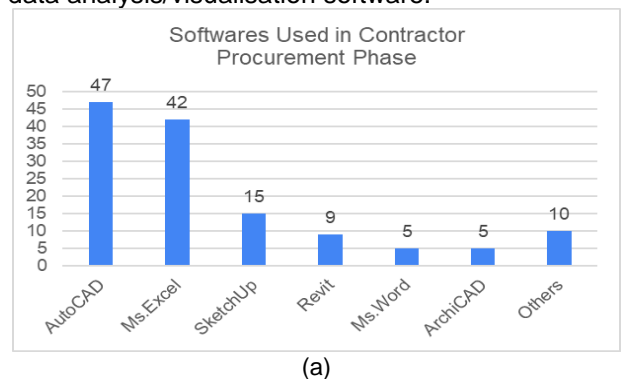


**Figure 12.** Correspondence between chosen media and motivation in the working drawing phase shown in cluster diagram.

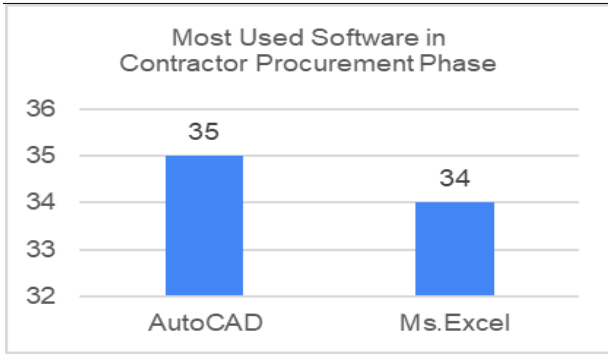
**5. Contractor Procurement Phase**

**Frequency of Preferred Media in Contractor Procurement Phase**

In this phase, architects are prompted to prepare tender documents (job plan description, technical specifications, cost plan/pre-tender estimate, and bill of quantities) based on the construction drawing, providing technical explanation, pre-qualifying contractors, and offering recommendations to the client. AutoCAD is the most significantly used media in this phase (47), followed by Microsoft Excel (42) (shown in figure 13a). Most respondents still choose AutoCAD (35) as the most frequently used software in this phase, followed shortly by Microsoft Excel (34). Architect’s work in this phase requires rigorous checking from the previous phase, specifically on basic design data (building area, green ratio, etc.). Hence, AutoCAD became the most used software in this phase. Meanwhile, calculations of design data required for contractor procurement are stored in Microsoft Excel, which is the most commonly used data analysis/visualisation software.



(a)

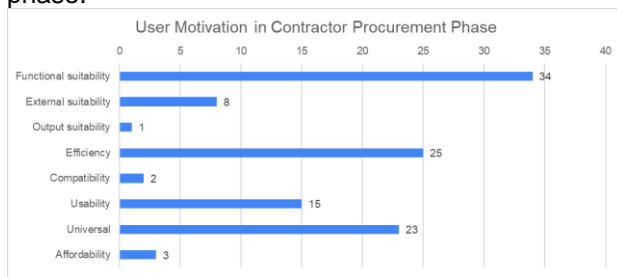


(b)

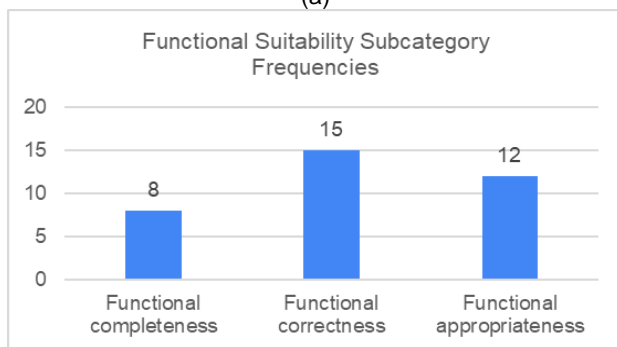
**Figure 13.** Medias used by architects (a), and most frequently used media (b) in contractor procurement phase.

**User Motivation in Contractor Procurement Phase**

The study shows that most respondents seek for the media’s functional suitability (34) for this phase, followed by efficiency (25), and its universality (23). The most prominent subcategory under ‘functional suitability’ in this stage is functional correctness (15), followed by functional appropriateness (12), and functional completeness (8). The output of this phase requires precision (area, volume of materials, etc.), therefore functional correctness, which includes the media’s precision and clarity, became an important motivation. It has to be noted that several respondents stated they didn’t participate in this phase.



(a)



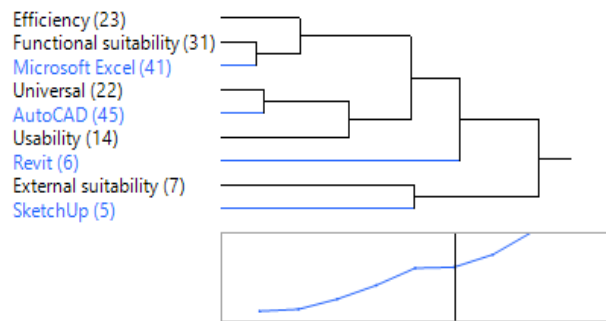
(b)

**Figure 14.** Distribution of user motivation categories (a) and its subcategories (b) in choosing medias for contractor procurement phase.

**Correspondence between Preferred Media and User Motivation in Contractor Procurement Phase**

Pearson Chi-square test based on the correspondence analysis between user motivation and preferred media in this phase (figure 15) shows

a value of 0.5977, and the maximum likelihood ratio Chi-square test has a value of 0.4320. AutoCAD (45), being the most-used media in this phase, is chosen for its universality (21). The designs that made it into this phase have been ‘curated’ by various experts (structural, mechanical, electrical, etc.), which mostly also employ AutoCAD as their basic drafting tool. On the other hand, Microsoft Excel is sought for its functional suitability (31), and efficiency (23) since it is known as a basic software for processing data. SketchUp (5) is mainly selected for its external suitability.



**Figure 15.** Correspondence between chosen media and user motivation in contractor procurement phase shown in cluster diagram.

**6. Visualisation & Presentation Phase**  
**Frequency of Preferred Media in Visualisation & Presentation Phase**

While it is not stated explicitly in the IAI’s version of architect’s scope and work, visualisation and presentation phase holds an integral role in most of the previously stated phases. The term ‘architectural visualisation’ is commonly referred in the industry as the process of generating a nicely rendered visual material that shows the designed architecture before it is built. The term ‘architectural presentation’ however, comprises other actions, such as verbal and written delivery of design concepts, where architects aim to ‘visualise’ their ‘justifications’ during negotiating agreements between stakeholders (El-gammal, 2008). All architects’ area of work requires visualisation and presentation, which involves the use of specialised media such as 3D renderers, photo editing software, or even conventional media, which is worth investigating. The study indicates that Lumion (65) is the most used media in the visualisation & presentation phase, followed by SketchUp (59) and Enscape (46). Lumion (35) is the most frequently used media by respondents, followed by Enscape (23), and SketchUp (19).

**User Motivation in Visualisation & Presentation Phase**

Architects regularly visualise and present their ideas to fellow architects or clients. This is why efficiency (58) becomes the most prominent user motivation in choosing media, since design changes often occur within the design process (figure 17a). The ‘efficiency of use’ (48) of the media is the dominant subcategory within the motivation ‘efficiency’, followed by the software’s performance efficiency (14) (figure 17b). The media’s output suitability (48) also holds an important factor in this phase as the output needs to

be suitable to their respective companies' aesthetical quality standards. Functional suitability (20) and usability (18) also determines the user's choice to use certain media in this phase.

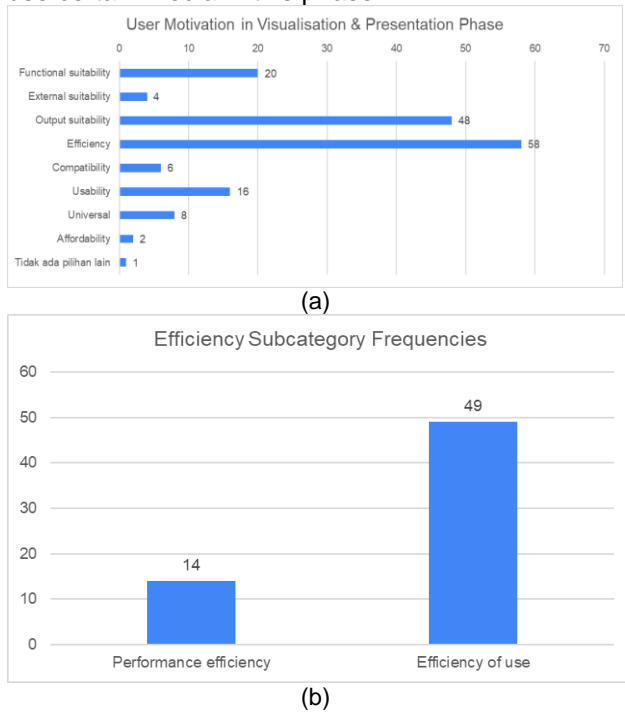


Figure 17. Distribution of user motivation categories (a) and its subcategories (b) in choosing medias for visualisation & presentation phase.

**Correspondence between Preferred Media and user Motivation in Visualisation & Presentation Phase**

Pearson Chi-square test based on the correspondence analysis between user motivation and preferred media in this phase (figure 18) shows a value of 0.0612, and the maximum likelihood ratio Chi-square test has a value of 0.0453\*. Lumion (62) is reputable for having a relatively realistic render result with minimum settings, thus why it is mainly chosen for its output suitability (46) and usability (15). Respondents chose Enscape (36) for its efficiency (55), and compatibility (6), while SketchUp (27) is commonly chosen for its universality (8).

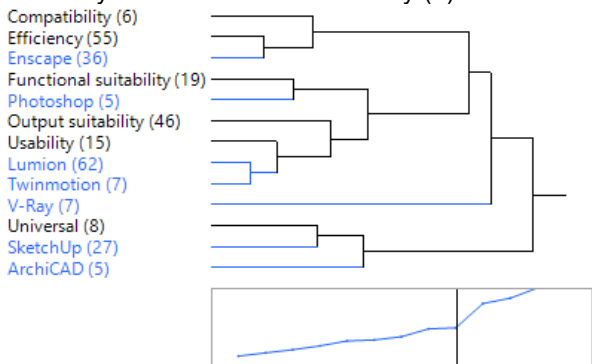


Figure 18 Correspondence between chosen media and user motivation in visualisation & presentation phase shown in cluster diagram.

There are three prominent motivations in choosing media in overall design stages: efficiency (n=258), functional suitability (n=203), and usability (n=109).

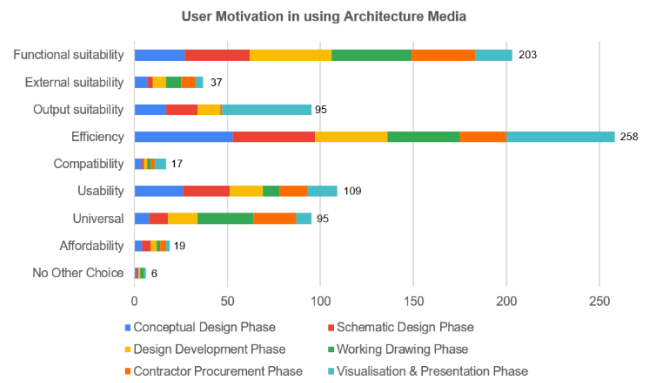


Figure 19 User motivation in using architecture media for all design phases.

**CONCLUSION**

In the early design phase (conceptual and schematic), the most sought motivation in a media is efficiency. SketchUp is considered to have a high correspondence to efficiency, thus becoming the most used software in the early design phase. As it gets into the later stages, media that enables completeness, correctness, and is appropriate is preferred (functionally suitable). In this phase, AutoCAD is mostly used for its high functional suitability. Meanwhile in the construction procurement phase, the basic data processing software Microsoft Excel rose up as the most used software for its efficiency and functional suitability. Earlier design phases value efficiency for exploratory ways – to generate a large number of alternatives in a short period of time. Precision is less important in the early stages of the design process, but it becomes more important as the project progresses, thus the motivation for functional suitability increases. Visualisation and presentation phase highly values efficiency and output suitability from the media. Lumion is mostly considered to have good and 'suitable' results, while Enscape is perceived as an efficient media for this phase since it is fast, practical, and has auto-update features. Some of the limitations of our research is the limited number of respondents & its diversity, because this research results mainly come from respondent's answers, and the result may vary according to (respondents).

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