Digitalization of Interior Materials as Sustainable Learning Process to Enrich Students' Material Knowledge

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Abstract

Interior design department required experience-based learning through a bank of material samples. The material samples in the physical material library come in various categories and different types. The situation of covid-19 pandemic has enforced rapid growth of transformation on digital technology. Digital material libraries came up as a solution for such a situation. Digital samples of interior materials also can be stored and accessed easily with an internet connection. Otherwise, there are things to be considered due to crucial points in relation to senses experiences such as tactility and smell senses in which students need touch and feel the texture of the materials to explore and understand them better. A qualitative method with a comparative study approach is conducted in this research to investigate which elements of image taking could bring a close impression to the real object. By using this approach an in-depth comparison study will be done in the Interior Design department laboratory of BINUS University to reveal the advantages and disadvantages of images taken by two types of equipment: 2D flat scanner and digital camera. Mosaic Tiles, Carpet Flooring, Upholstery Fabric, Weaving, and Wallcovering. Result of this research will elaborate a glimpse of recommendation of digitization on interior materials to enrich sustainability on distance learning.

Keywords
Digitalization, Technology, Interior Material library, Sustainable Learning, Design.

1. Introduction
In this digital age, information can be disseminated through varieties of media, not only through hardcopy books, journals or in this study, through physical materials. Following the rapid growth of information technology and the impact of the pandemic situation in the past years the technology transformation grows even faster. People were asked to stay home, reduced their mobility, and access to public places, including campuses and other learning facilities such as laboratories, libraries and drawing studios are restricted. Instead of face-to-face learning, virtual class, virtual meetings, digital learnings are conducted. Of course, this situation has influenced and even changed ways of teaching and learning. Like other areas of studies, in the interior design department, there is a lot of experience-based learning, both in the studio and laboratory that cannot be replaced with online activities. One of them is interior material exploration activities. This learning activity is related to students' interior material knowledge and very important in supporting various projects in interior design courses as well as students' final projects, where students must make material concepts related to their interior projects and analyze various types of materials that are suitable for their projects. The situation becomes difficult because during the pandemic they do not have access to visit the material laboratory. One of the solutions to this problem is through a digital material bank or digital material library which can be accessed online by multi-campus students anywhere and anytime. Thus, the learning process and material exploration can continue even though access to the physical material laboratory is limited.

As the object of this study, the Bina Nusantara University, Interior Design Departments' Material Laboratory (or also known as the material library) located in Syahdan Campus occupied a limited space which presently filled with catalogues and material samples for interior finishes such as floor finishes; ceramic, carpet, tiles, wood parquet, vinyl flooring, and so on, wall finishes; wallpaper and wall paints, ceiling, and furniture finishes; high pressure laminate, fabrics and so on (Figure 1). These collection catalogues and material samples are from various brands and were grants from material companies and alumni. Interior materials are products that will always continue to develop and evolve, whether following the latest trend, or latest innovation. Interior materials industry and companies will launch their new line of products at least once every two or three years. Since these samples are for study purposes, when new samples arrive, the old ones will still be kept, which causes accumulation and collection pilling up. With a digital material library, the physical collection can be sorted to the latest and certain important samples only, while the rest of the older collection can be stored digitally.

Figure 1. Material Library, Syahdan Campus
(Source: Wulandari, et.al, 2021)

Witten, et. al (2006) mention three distinct roles of digital libraries in education, first as a learning platform (students experience), second as an authoring space (also in support of student experience) and lastly as a teaching resource (course development) (cited in Owusu-Ansah, et.al., 2019). Not only that, having a digital material library will be very beneficial; it can store enormous amount of digital data and very easily accessed by anyone from anywhere, as long as they are connected to the internet, as Saracevic (2000) points out that digital libraries are related to physical libraries and may perform several similar functions, but digital libraries are also quite different in some functions, as for example in distribution and access, completely different from physical libraries. However beneficial, the digital material library will come with some minus points especially in relation with interior materials and interior samples where tactile experiences, in which students can touch and feel the texture of the materials to explore and understand them better. In some cases, several materials also have a specific smell to be identified as its unique characteristics. These experiences cannot be replaced by viewing a digital image of a material alone. In libraries consisting of books, magazines or other written materials, tactile experiences might not seem that significant. Those written materials can be transformed into digital format and the readers will still acquire the same experiences and content as they were reading a book. While in the interior material library, the physical library offers a better experience for students, since there is a big difference between viewing an image of a carpet online and holding the real samples. Even though both digital and physical material libraries have their own advantages and disadvantages, in this digital era they are both necessary and complemented each other for the purpose of enriching students' interior material experience.

Digital material libraries or digital material banks in discussion are not something new, although the study is still limited. Some examples of digital material banks that are already available and accessible to the public, which some belongs to academic institution while others belong to industries or material companies, are the Institute of Making, a digital material library belongs to UCL Civil Engineering and Materials Workshop (Figure 2), A Plastic Planet; a digital material library which profiles alternatives materials and Design and Architecture Scotland's A Library of Sustainable Building Materials (Figure 3). The last digital library can be considered as the most complete library with function and features compatible to the needs of those designers and architects. Each of these digital material libraries offers different features. Some of them provide detailed 2D images, while some

others also provide 3D images with 360 degrees rotation videos, thus the viewers can study the materials completely from various sides and angles. These images are also completed with descriptions and specifications of the materials, some even provide a list of suppliers and distributor companies. This is done as an attempt to provide tactile experiences to their online visitors.

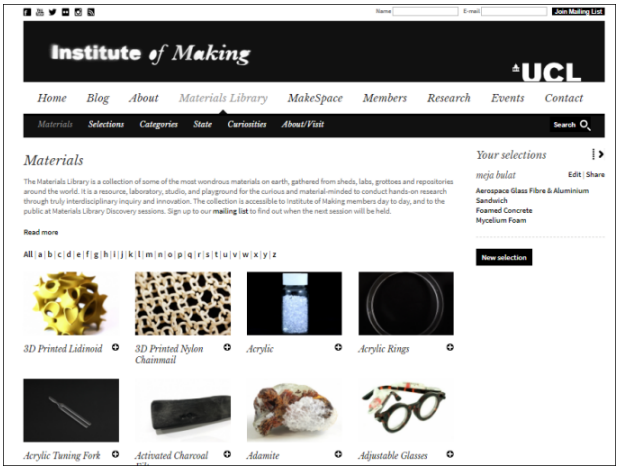

Figure 2. Website page of Institute of Making
(Source: www.instituteofmaking.org.uk)

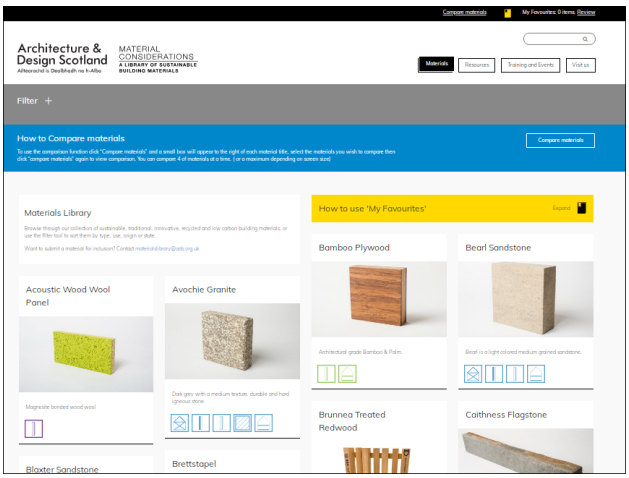

Figure 3. Website page of A Library of Sustainable Building Materials
(Source: www.material.ads.org.uk)

1.1 Objectives

In planning a digital library for interior materials and finishes, one should not overlook the tactile experiences of the users, especially when the users are students. In this material library the purpose of the digital library is not only to show various materials and its description, but also get the experience of texture and detail of the materials. For this purpose, the digitization method or how the physical material is transformed into digital format should be planned carefully. The study aims to compare the digitalization techniques and methods to transform the interior material collection from physical to digital format to enrich students' material experience. The study will also identify the steps in the digitization process and perform digitalization for interior material collection available in interior design material laboratories. The material collection available in the material laboratory will be used as a sample. This study will contribute to the wider study of digitalization within interior design context, especially with the growth of digital program and application used in interior design process.

2. Literature Review

Unlike the study of digital libraries in general, the study of digital libraries that is specifically applied to interior materials are still limited, therefore as background to the study purposes, the discussion of digital libraries in general will be used. As has been mentioned previously that digital libraries are related to physical libraries and

may perform several similar functions, but digital libraries are also quite different in some functions (Saracevic, 2000), however the definition of digital libraries can still be argued. An early definition of digital library according to Lesk (1997 cited in Saracevic, 2000) digital libraries are organized collections of digital information. They combine the structure and gathering of information, which libraries and archives have always done, with the digital representation that computers have made possible. While what can be considered as digital information are those that can be accessed by computers, which some are "born-digital" or originated in a digital form such as pictures taken with digital camera, web pages, twitter feeds and so on and other physical things that were deliberately converted into digital files or format. Another more complex definition of digital library by Digital Library Federation (DLF) in the United States agreed on definition of digital library: Digital libraries are organizations that provide the resources, including the specialized staff, to select, structure, offer intellectual access to, interpret, distribute, preserve the integrity of, and ensure the persistence over time of collections of digital works so that they are readily and economically available for use by a defined community or set of communities (DLF, April 21. 1999 cited in Saracevic, 2000). However, in this study we are not going to argue further about definition of digital library, as we can conclude that digital library is a collection of digital information that are structured and preserved and according to this definition digital library is no limited to only digital books or other written materials, but can also include digital information from collection of things; from museum, galleries, and in the case of this study is collection of interior materials and finishes.

When the collection of digital material is not "born-digital" then the physical material needs to be transformed into digital form. Digitalization is a terminology that is increasingly used in the past years, it is a term to describe the process of transferring media from printed, audio or even physical form to digital form with the purpose to meet users' needs and to improve performance (Azizah, 2012). The past twenty years has seen academic libraries across the world digitized by their respective organizations with the use of computer technology known as "automation or digitalization or digitization" and digitalization of academic libraries have proven boon for both, the library professionals and research community' across the world (Gupta, 2017). Through digitalization the library collection can be accessed by more people, whether they are students or researchers anytime and anywhere. This situation follows the needs of the digital age where users frequently require information that is always available and can be promptly accessed. Study on digitalization includes digitizing materials and development of databases. The former discusses types as well the process of digitizing materials, while the later examines databases development including title searches, documents, image searches, catalogues, and others (Azizah, 2012).

A careful planning is essential to meet the end users' requirement and quality standard for creating a digital library. Technical feasibility is one of the most important criteria for selecting material for digitalization. The physical characteristics of source material and the project goals for capturing, presenting, and storing the digital surrogates dictate the technical requirements (Zhang & Gourley, 2009). Some of the steps needed to be identified include, the scope, purpose, and the user community, determine the selection and analyses of source material, define the requirements and features of digital library collection, define the resource requirements and lastly the most essential step is the approach to digitization. For digital library, the conversion of material into digital format from physical or hardcopy is a very important task. The formats of the documents, how much time is needed for conversion, who will carry out the digitalization; in-house facility or external contractor and workflow for should be clearly identified (Rathee & Kaushik, 2019). Besides carefully planning the digitization process, other things that need to be carefully selected are the equipment used for digitization. Computer, scanner, and software for editing and saving the digital files are the standard tools, moreover digital camera, 3d scanner and other equipment can also be used. To select the proper equipment, things need to be considered are the format and the size of document or the physical material itself, if they are all written material then standard 2D scanner should be sufficient, however if other physical materials is included, then the use of digital camera with proper lightings or 3D scanner need to be considered.

Some issues and problems that may arise from the digitization process are the digitization system is not fully understood by all parties involved, which will cause errors in the digitization process, and the lack of understanding regarding the legality issue of digital collections. These legality issues should be acknowledged and resolved so that it will not cause any problems in the future. Other problems are technologies, which relate to both hardware and software which are often outdated. Lastly, one should always remember that the main purpose of digitization is not only to preserve the collection but also the issues of access and collection management becomes important (Azizah, 2012).

In relation to digitization of physical interior material into digital format, one of the most significant problems is that the digital format should not overlook 3D shape as well as the detailed texture of the objects for student's tactile experience and material exploration purposes. Tactile experiences are sensations that can be received or

felt by touch. Different interior materials and finishes have different textures, for wood finishes they have matt or glossy textures, for fabrics they have sleek, smooth, and rough and so on. These different materials evoke different tactile experiences, depending on the material itself and how the materials are used in interior, therefore iterative exploration of materials is significant for students' exploration and understanding of materials, as a study shows that a hands-on exploration of material qualities and resulting tactile experiences will be beneficial for students in their design development process (Bakker et al., 2015)

3. Methods

To achieve the aim of the study, which is to compare the digitalization techniques and method to transform the interior material collection from physical to digital format to enrich students' material experience, a qualitative method with a comparative study approach will be used. By using this approach an in-depth comparison study will be done to reveal the advantages and disadvantages of images taken by two types of equipment: 2D flat scanner and digital camera. By using this approach, an in-depth study about a case or phenomena will be done by collecting detailed information through various data collecting methods within a determined time frame (Cresswell, 2009). Bakker and Zubair mention three methods of comparative approach; symmetric comparative, where the comparison processes were done after each subject were discussed thoroughly, asymmetrical comparative, where the first subject was discussed in detail, followed by a discussion of the second subject whilst comparing it with the first subject and last is triangle comparative when there are three subjects to compare (Sumartono, 2017).

Based on the determined approach, data collecting will also be done qualitatively by collecting secondary data or desk research. In this stage, all relevant data from various sources such as books, journal articles, websites, newspapers, reports, and other previous studies that had been done about the subjects will be studied and analyzed. The purpose of this stage includes giving general information about the topic, analyzing previous studies that had been done as well as knowing what other writers think to have basic theory and understanding about this topic. The limitation of this desk research was the lack of articles, reports, and other sources of information published specifically related to interior materials digitization. The next stage is the primary data collection using interior materials available in the physical material library, Syahdan Campus. From all the interior material available, 5 categories of material were selected based on their shape and texture as samples (purposeful sampling). As Jamieson (2007) points out that, within one frame, images may contain a vast amount of information, thus in this digitalization process, interior material samples will be completed with photos as visual aids to support the discussion. Thus, these samples were digitized using two methods, first using a 2D flat scanner and then using a digital camera to find out the advantages and disadvantages of both methods and their results.

The result from both methods will be analyzed using the asymmetric comparative approach, where the categories of samples digitized with scanner will be discussed in detail, followed by a discussion of the samples from the second method of digitization that is with digital camera, whilst comparing them using a descriptive analysis method to gain a conclusion.

4. Data Collection

Interior material samples in the physical material library come in various categories and different shapes, textures, and sizes, depending on the supplier or industries. Some companies already have their own categorization for their products and present the samples in different catalogues or sample books. With this wide range of variation, before starting the digitization process we need to group and categorize these materials and label or code them, not only for the digitalization purposes but also for storage and repository purposes in the future. As many as 34 categories are established in accordance with the availability of the material collection in the library (Table 1). These categories are created based on 3 groups of materials, first, based on the function or application of materials in interior, which includes carpet flooring, curtains, parquet flooring, paint, shutters and coating materials, second, based on type and basic composition of the materials; linoleum, gypsum, glass, leather, metals, ceramic tiles and so on, belongs to this group, lastly based on the production techniques, which include biomaterial, composite, weaving, mosaic, terrazzo and material made by students. This categorization system does not rule out the possibility of adding one or more categories following the development of materials in the future.

Another step before the digitalization process is labeling and coding the material samples. There is not yet any standardized labeling or coding system for interior materials, unlike the universal coding for books in library, every material companies have their own labeling and coding system, thus we established certain coding system for the material samples available using the formula: [Material Code – Material Brand (shortened to 3-4 letters) – Series Code – Book No – Sample No], for example VF-TACO-B-001-01 will be read that the material is from vinyl flooring category produced by TACO, series B, catalogue book no. 1 and sample material no. 1. In certain cases, if there are 2 or 3 pieces of the same catalogue book available in the library, then the code will be VF-

TACO-B-001 for the first catalogue book, VF-TACO-B-002 for the second one and so on. There are 34 material categories with 34 different codes listed in the Table 1 below.

Table 1. Material Category

No	Material Name/Category	Material Code
1	Metal	M
2	Carpet Flooring	CF
3	Linoleum	LINO
4	Parquet & Panel Flooring	PQF
5	Vinyl Flooring	VF
6	Homogenus Tile	HT
7	Rubber Floor	RF
8	Curtain Fabric	CUR
9	Leather	LEA
10	Upholstery Fabric	UPHO
11	High Pressure Laminate	HPL
12	Plastic Laminate Sheet	PLS
13	Paint	Paint
14	Coating and Finishing	CST
15	Non-Timber Forrest Product	NTFP
16	New Biomaterial	BIO
17	Natural Fiber	NFIB
18	Ceramic/Porcelain/Potter	CT
19	Composite/Carbon Fiber/Other	COM
20	Plastic Based	PLAS
21	Glass	GL
22	Gypsum	GYP
23	Natural Stone	NS
24	Paper	P
25	Solid Surface	SS
26	Wallcovering	WLC
27	Wicker/Weaving	W
28	Students Work	STU
29	Terrazo	TER
30	Concrete	CONC
31	Shutters, Slide, Doors	SHUTD
32	Mosaic	MSC
33	Solild Wood	SW
34	Processed Wood	PW

As samples for this study not all material from each category will be used, only certain materials from 5 material categories with distinctive textures and shapes will be used as samples and they are, Mosaic Tiles (MSC), Carpet Flooring (CF), Upholstery Fabric (UPHO), Weaving (W) and Wallcovering (WLC).

5. Results and Discussion

In the discussion, images of the samples taken by scanner will be labeled as sample A and samples taken by digital camera will be referred as sample B. Both sample A and B from the same objects will be lined up and compared based on their material category. First category is Mosaic Tiles (MSC) with porcelain, ceramic, stained glass, and glass as their material basis. They are produced in a variety of colors, shapes, and modules, in interior applications usually used as kitchen backsplash and wall treatments in restrooms or bathroom as well as for other decorative uses. As samples in this study, 4 types of mosaic tiles are selected, flat shell motif (Figure 4), checker motif (Figure 5), 3D shell motif (Figure 6) and bubble motif (Figure 7).

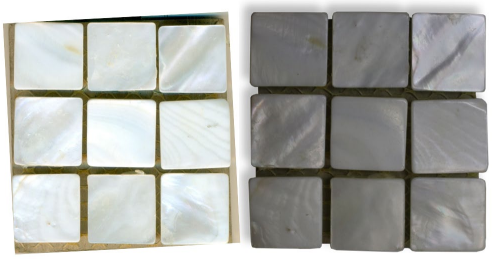

Figure 4. Flat Shell motif sample A (left), Flat shell motif sample B (right)
(Source: Chadijah, et.al, 2022)

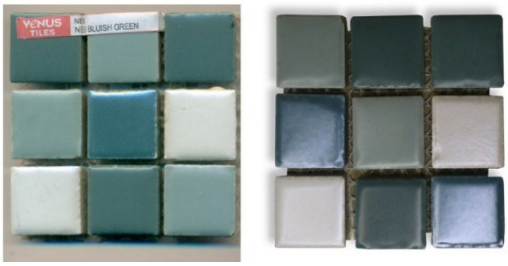

Figure 5. Checker motif sample A (left), Checker shell motif sample B (right)
(Source: Chadijah, et.al, 2022)

For the flat shell and checker motifs mosaic tiles digitization results can be seen that sample A taken by scanner are brighter and have better lighting. The lights are equally distributed among the surface of the materials, especially for the shell motif sample (Figure 4), the shell or pearl like pattern can still be clearly seen. This is as a result that during the scanning process the light in the scanner moves evenly over the samples distributed the same amount of lighting. While sample B digitized using a digital camera seems darker and does not resemble the actual material. There is a reduced glossiness with the digital camera-capturing technique compared to the scanner technique. When digitization is done using a digital camera, one needs to know the appropriate intensity of lighting and camera angle, thus the light will distribute evenly among the surface of the material especially if the effect of the material such as the glare, glossiness of the surface wanted to be clearly seen by the user.

Figure 6. 3D Shells motif sample A (left), 3D shells motif sample B (right)
(Source: Chadijah, et.al, 2022)

Figure 7. Bubble motif sample A (left), bubble shell motif sample B (right)
(Source: Chadijah, et.al, 2022)

The next set of samples are still from the Mosaic Tiles (MSC) category but instead of tiles with flat surfaces, this time with mosaic tiles with 3D surfaces (Figure 6 and 7). The results from these samples are more less similar with the previous sample. The glossiness level is more responsive with sample A, rather than sample B, the glare and shell-like material becomes more visible with scanning techniques. However, since this material is 3D, the depth and shape of the material can be clearly seen and even feel through sample B. Especially if we look closely at the bubble motif sample B (Figure 7), the glare is following the shape of the material, instead just a flat glare in sample A. Thus, the user can still sense the depth and shape of the material.

Following samples are from the Carpet Flooring (CF) category. Carpet is a textile floor covering usually consisting of an upper layer of pile attached to backing. Originally made from wool, but today, various types of carpet can be made from synthetic fibers such as polypropylene, nylon or polyester. While the specific type of carpet used as a sample in this study used a 100% solution dyed method with nylon fiber material and cut/loop construction (Figure 8). Carpet has a distinct texture and feel that is challenging to digitize. Like the previous results with 3D mosaic tiles, the texture is of an irregular repeat makes the object feel like it has a surface quality, the texture is shown by areas of light and dark shadow can evoke memory of touch. Sample A digitizes with scanner resulting in a color that is a bit bluish but more like the actual material, while sample B becomes more yellowish from the lighting setting. However, the feel of texture, depth and softness of a carpet can be sensed better from sample B, while sample A seems rather flat.

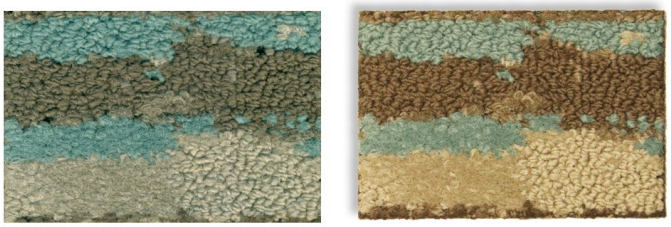

Figure 8. Carpet flooring sample A (left), Carpet flooring motif sample B (right)
(Source: Chadijah, et.al, 2022)

Next set of samples are from the Upholstery Fabric (UPHO) category. The upholstery fabric consists of various materials, from silk, polyester, cotton, with a variety of motifs, texture, and color. The variety is endless. As samples for this study, a light and dark color velvet fabric is selected (Figure 9) to see the differences between the scanner and camera capturing technique. From these samples can be seen the colors captured by both equipment show similarities, unlike the previous samples with significant color differences. However, the texture in the dark color fabric sample A is not as clear as sample B. Sample B shows more depth and velvety texture that can be sensed by the user. The size of the texture also appears clearer in sample B. Furthermore, the bumps and glossiness in sample B can be seen more significantly as well in sample B, especially for the dark color fabric.

Figure 9. Velvet fabric sample A (left), velvet fabric sample B (right)
(Source: Chadijah, et.al, 2022)

Synthetic rattan from the Weaving (W) material group is the next set of samples to compare (Figure 10). This material is using High-Density Polyethylene as the primary material and source the raw material from a new 5050 joint venture between resin and compounding technologies, while the output of materials produced through weaving technique is like the traditional rattan weaving technique. However, through synthetic material, more variety of colors can be produced unlike the traditional rattan with only natural light brown colors. This material can be applied to various interior elements, such as furniture finishing, wall treatment and façades. If we compare from the digitization technique, sample A looks flat. The 3-dimensional shapes and texture cannot be seen and sensed, unlike sample B. The color in sample A also seems yellowish, as an effect from the scanner lighting, while in sample B the color is more like the actual sample.

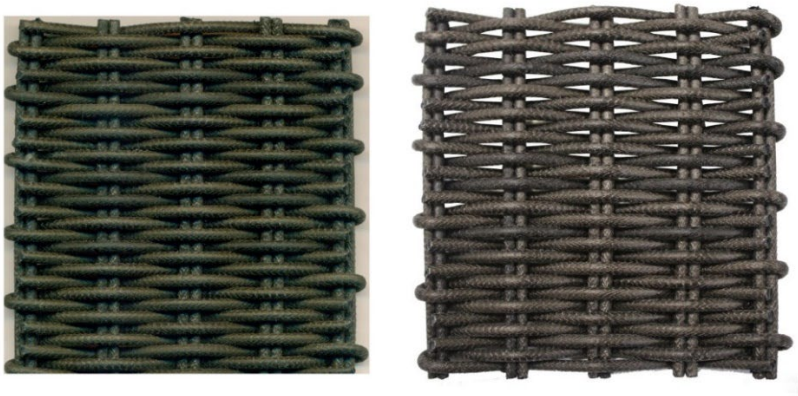

Figure 10. Synthetic rattan sample A (left), synthetic rattan sample B (right)
(Source: Chadijah, et.al, 2022)

The last set of material wallcovering material (WLC). Wallcovering or usually known as wallpaper is a standard material used in interiors as wall treatments. This material has been around since 105 AD and until today still considered as one of popular wall treatment materials, beside paints. However, the selected sample for this study is not an ordinary wallcovering. It is a handwoven and handmade product crafted by diligent and careful hands of woven communities in Indonesia by using unconventional materials such as raw natural fiber (Figure 11). Thus make this wallcovering sample have a different and distinct texture unlike the standard wallpaper. For this sample, the result between scanning and camera-capturing techniques shows significant differences in colors. Sample A shows a more yellowish color, following the light from the scanner, while sample B shows color more like the actual sample. However, texture and depth are less visible in sample B, this may be caused by the lighting setting of the digital camera.

Figure 11. Wallcovering sample A (left), wallcovering sample B (right)
(Source: Chadijah, et.al, 2022)

The study above has shown us a comparison between two different techniques of material documentation. The 2D scanner provides an undetailed result due to image noise and resolution. This technique is limited to flat images with no lighting control available, producing a limited angle to take a picture and yellow-ish color tone. With limited angle there will be no distortion, which may appear when flat objects are documented with a camera. Meanwhile, the 2D scanner offers an even lighting for flat type material samples, such as stone and laminates. This technique is also best for the shining shell-like surface with appropriate glare-effect as shown on figure 6. With a scanner, image editing will also be more efficient. It offers practical, and timesaving uses during the documentation (digitalization) activity.

In comparison, pictures taken by digital cameras have become a solution for the lighting control issue. It can provide a variety of photo angles to enrich image data about the materials with the proper lighting intensity. These advantages are bringing noise-free images and provide the deepened view of bumpy materials such as bubble mosaic, carpet, weaving rattan, and images that shows flexibility (eg. fabric and leather). This result has the potential to deliver appropriate information to the students, where they can easily recognize visual appearance of material. However, issues related to lighting control, camera placing and unstable photo taking should be carefully identified. Due to the variety of texture, while documenting with camera, the lighting settings, especially the white balance need to be adjusted with the lighting in location thus the color of the material will not be contaminated with light that has color tone (such as tungsten light with yellow effect or neon light with green effect). When the same object photographed with different light sources can determine the differences in the highlight, that is obvious, the highlight is the area with illuminated effect at the object (Hunter, et.al, 2007), as well as the effect on the material to be digitized. To maximize the appearance of different shapes and texture, the use of cameras needs to be supported with a variety of lighting settings in accordance with the material surface characteristics (Figure 12). With the appropriate lighting settings, the character of 3 dimensional objects can be emphasized to bring out the feel of the actual material. If one failed to identify these issues, the result of this technique could also become low due to incompetency of camera operations. Besides considering the lighting effects on the objects/material surface, in digital photography, the post-production process becomes a necessity and reasonable step (Freeman, 2007), depending on the goals to be achieved in a photo. In this case of interior material digitalization, certain materials may require a longer post-production or editing process for the color quality to match as closely as possible to the original materials. However, this post-production or editing process sometimes also needed to maximize the digitalization results from a scanner, which still more practical than digital photography.

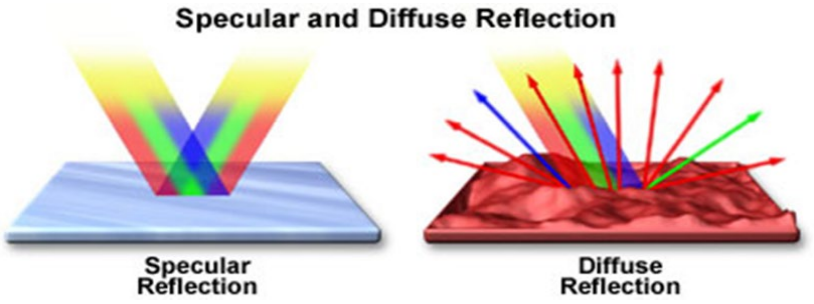

Figure 12. Reflection on different surfaces
(Source: https://u42.co/Tech-Blog/Light-and-Photography/Light-and-Photography.html)

6. Conclusion

Amid the unprecedented time of covid-19 pandemic, long-distance learning has become an answer to ensure continuity of teaching- learning process. Digitalization of the material library in the Interior Design Department of BINUS University supports the needs of material access while physical attendance in the laboratory is not allowed. In realization, digital transformation from physical objects to digital images requires a consideration in material experiences (due to lack of tactility and aromatic sensing in digital form).

From this study, can be point out that image capture becomes a factor in the digitalization process, especially its requirement whether using a scanner of digital camera. It is agreeable that different types of material require different equipment and when selecting materials for digitizing, technical questions should be addressed include type of materials, surface of material, its color and other critical features that want to be shown digitally. Thus, suitable equipment can be selected and used. From the comparative study of material documentation, we can conclude that both equipment, the scanner and digital camera has their own strengths and weaknesses. However, when using digital camera, there are important factors to be considered:

1. Provide proper lighting to reduce noise and illustrate a real material surface (especially glossy materials). The images shown in the digital library are required to be seen clearly along with the real color tone (neutral lighting is recommended). Lighting also can build a bumpy effect that shows texture and surface depth.
2. Variety of camera angles are helpful for making the real image perception, as it builds the material dimension by showing the thickness, width, and length/ diameter of the materials. Also, images show material along with the vernier callipers can add more information needed.

Through this study, hopefully, the students can use the digital collection to understand the material, gain appropriate perception of materials characteristics, ready-to-use material collection to support design presentation, and have an experience to interact with the materials close to as it is in the real life. Lack of references related to digital photography techniques is one of the limitations of this study, besides lack of equipment for digitalization.

Further studies on providing user experiences are highly required in the future to support distance teaching-learning activities and interactions withing digital material libraries. Not only how the material samples are digitized, the establishment of data repository is also crucial. Moreover, the data formats must be defined in a standardized manner to be easily accessible to its users (Kimmig et al., 2021). With the growth of digital technology in every aspect including interior design, currently some of the common digital technology uses in interior design process are 2 and 3-dimensional drawing and modelling programs on a computer, artificial intelligence products, virtual reality (VR) and so on. Within the interior architecture itself, there are numerous design products generated via digital technology and there is a gradually increasing demand for such applications (Demirarslan & Demirarslan, 2020), this has opened an opportunity for further research. Not only to digitalize the material samples and establish a digital material repository, but also to study on how these digital material sample can be applied directly in 2 or 3-dimensional drawing and modelling.

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