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Asset management in the broadcasting industry at the crossroads of industrial revolution 4.0

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Abstract. *Asset management in the broadcasting industry is at the threshold of innovations coping with disruptions at the crossroads of the Industrial Revolution 4.0. Efficient production workflow and content management are critical in the transition to a digital environment. Small and medium-sized broadcasters and vendors are experiencing the brunt as a consequence of technological disruption. Stringent requirements for digitization of content following new quality control (QC) standards in the transition to digitalisation have become imperative. This study explores a scalable media asset management (MAM) solution especially for small-scale content providers. Seeking answers to questions: (1) How would audio-visual archival processes enable transition to the digital workflow? (2) How do SMEs and vendors encounter non-compliance issues. (3) How metadata features would facilitate MAM processes? The study conducted face-to-face in-depth interviews with broadcasters, content providers and vendors, participant observation and content analysis at production operation centres and production houses to understand their operations and issues. A compatible workflow criteria model to be supported by machine learning is proposed at the end of the study.*

Key words*: MAM, broadcasting industry, Industrial Revolution 4.0*

I. Introduction

The fourth industrial revolution is accelerating the inevitable change. In the broadcast industry, processes would soon become redundant when artificial intelligence is embedded into the broadcast processes. Converging multimedia technologies and high-speed internet is creating models of operations that exacerbated inequality among broadcasters (Schwab, 2017). Such inequalities are compelling broadcasters to embrace global trends in asset management. The main challenge related to the role of audio-visual archives

In the wake of IR 4.0, the need for efficient audio-visual archives situated within the media asset management (MAM) workflow in broadcasting organisations pose numerous challenges when content become digitised and processes become networked (Müller, 2017).

At a time when Malaysia has just introduced the National Fiberisation and Connectivity Plan (NFCP), broadcasters in Malaysia have almost completely migrated to advanced digital broadcasting processes and have already shut-their analogue transmission in October 2019. Likewise, system manufacturers and designers are developing compatible components to fulfil the varying needs of respective broadcasters. Also, broadcast content management or MAM systems are expected to constantly evolve and be upgraded, resulting in significant resources being spent on re-inventing and re-writing media management systems. MAM located under the broad umbrella of digital asset management (DAM) is primed for managing media assets efficiently. Bancroft (2017) and Wager (2005) posited that the content

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processing cycle of content management consists of the following stages: (i) ingest, (ii) create metadata, (iii) set storage/content repository, (iv) access, (v) transform/re-purpose and (vi) distribute. However, the downside of an ineffective archives and MAM system would be a loss of opportunity at the re-purposing and content re-broadcasting stages.

To archiving broadcast content is to endure the test of time. Preserving content of historical importance is imperative as national heritage (Hagedoorn and Ageterberg, 2016). Broadcasters and the society recognise the value of archived content but shy away from systematic preservation. Hence, the proposed model, which enhances the end-to-end MAM workflow from archiving processes, through systematic documentation, up to on-air transmission, would be useful for broadcasters, small and medium sized enterprises (SMEs) and vendors, especially those SME size broadcasters. The availability of such a model would result in zero or minimal rejection at the technical and content quality control (QC) stage before transmission. Users of archived content do not need to re-invent content, but only to re-purpose available content for multimedia broadcasting (Zarwell, 2016-2017).

1.1 Problem Statement

Innovative interventions have undoubtedly caused disrupted operations in the broadcasting industry from time to time. Compliance to evolving standards have affected the systematic executions of workflow, indexing, archiving and retrieval of content for reuse. Established and resourceful broadcasters are gradually coping with such industrial disruptions. However, small and medium-sized (SMEs) content producers and vendors encounter numerous barriers.

The archiving process is inhibited by poor adherence to the metadata indexing requirements. There exists a lack of harmonization in the content search, keywords used in the archives among users. While resourceful broadcasters are coping with this disruption, SME content producers and vendors are struggling to resolve this problem. Non-compliance, ineffective metadata and product rejection cause loss of opportunity for broadcasters. ‘Good to go’ programmes are rejected at the technical quality control stage.

SMEs and vendors are expected to comply before they submit their content for storage and evaluation before broadcast. Standards must match expected quality parameters for a seamless broadcasting experience. This was identified as the major problem even with regular broadcasters, SMEs and vendors who find it difficult to comply with the expected technical standards. A pool of such 1,300 strong-registered vendors support the Malaysian creative industry. Of which about 500 are dormant and only about 800 of them are active. These vendors contribute a vital 40%–60% of airtime to the industry.

Analog processes have outlived existing MAM systems considering changes to the digital environment. Besides, the deluge of content pouring in from the programming side (85%) and content from the news division constitutes about 15% of the total airtime (RTM). These sources for airtime content are found in four categories: (1) in-house production from regular broadcasters, (2) private local productions from vendors, (3) syndicated overseas programmes from vendors, looping productions or repeat programmes and (4) news and current affairs partly contributed by stringers. These sources have adhered to their respective standards.

1.2 Research Question

i. How would audio-visual archival processes enable transition to the digital workflow?
ii. How do SMEs and vendors cope with non-compliance issues?
iii. How metadata features would facilitate MAM processes?

II. Literature Review

Primary data search was conducted with subject matter experts in a broadcasting station, business owners and vendors to establish and crystalized the nature of the problem. This was followed by secondary data search that confirmed the research questions and provided leads on the important questions to be asked during in-depth interviews.

2.1 Formats of Indexing

Archives using metadata standards resort to the index-editor or the PBCore metadata standard, for example: eFilm_ReSources_L1 contains the L1annotation names. L1 and L2 relate to the Level 1 and Level 2 descriptive categories in the PBCore metadata structure [6]

In addition, the Oral History Metadata - that creates metadata is a back-end system, where the archivist processes content for the front-end user linked to a W3C's eXtensible Metadata Language (XML) file displaying the required metadata used for retrieval from the archive (Breaden, Holmes, and Kroh, 2016-2017).

Besides multiple formats of archive storages, the search for required titles and clips of historical content is problematized by the use of unrelated and too many keywords. At the same time, similar content is also available in multiple languages (Phang and Soh, 2016-2017).

Instead, automatic image cataloguing for DAM is also suggested (DigitalAssetManagement.com, Metadata Quick Start, 2018). This method allows uploading and retrieval processes seamlessly that enables ease of location and tracking at will by clients. Unfortunately, some would try to claim otherwise. IBM's Visual Recognition, Adobe's Smart Tag and Extensis are some of such examples. Such cataloguing technology can be tailor made for machine learning of content archival purposes and quality control before the end of the workflow. Broadcasters have the option of repurposing archived content for alternative programming or future distribution.

Archiving existing and new content begins at the ingest stage, followed by embedding metadata and file format (e.g. B/W 65GB assets, M4V digital video for streaming from an open source). A reader or a photo-editing application to extract embedded data is required for editing and repurposing for further use (Curtis and Draper, 1999).

2.2 Content Management

In order to achieve seamless content management, there must be an agreed structural format for metadata presentation to be accessed and decoded. Next, various attribute terms (vocabulary) used must be standardised so that content could be processed intelligently (Curtis and Draper, 1999). For example, the vendor attributes or the date attribute can mean the creation date, the expiry date, the date of birth. The processing component must be able to interpret the metadata vocabulary correctly given its current context. There has been significant work done by various industrial bodies to propose domain specific metadata vocabularies (IEEE Learning Objects Metadata, 2018)

Numerous media intelligent applications are available for MAM (Rowe and Churchville, 2016). Yet, such applications do not mesh with the needs of the small producers and vendors (Bancroft, 2017). According to Lederman (2014), there is yet to emerge a unified system for the organisation of content and retrieval, much less a lasting system for digital content storage and retrieval.

2.3 Theoretical Framework

Industry Industry experts recommend The Content Management System (CMS) as the Standard model for media assets management workflow (Müller, 2017), which offers adaptations as a theoretical framework for the study.

The workflow includes an indexing system that reduces manual management of incoming content for storage. The workflow provides for efficient documentation for monetization of archived material. The CMS model is often adapted to real-time situations by production companies. Technical and production QC features are articulated for producers before putting content through the workflow. The model outlines the main features of a practical MAM system.

Table 1. Adaptation from CMS for a scaled framework of the MAM workflow (Muller, 2017).

Ingest	Manage	Distribute
Indexing and Creation of Metadata	Master control Room	Technical Gate-keeping
Embedded Applications	Production Operations Centre (POC)	Content Delivery and Syndication to clients.
Incoming Content Acquisition	Short-term archive and storage for broadcasting call	On-wards processing for on-air broadcast

Source: (Muller, 2017)

Table 1 illustrates a generic MAM or CMS model articulating possible functions to be included into the three main processes: (1) ingest, (2) manage and (3) distribute.

The CMS model above addresses content management that follows a two-tier model. The top tier is a generic three-step flow of ingest, manage and deliver or distribute, generally found at most broadcast workflow. Below these steps, a detailed set of functions provide an interface to enable the integration of incoming content, construction of metadata, technology for various applications and the final programs for transmission. This process is scalable, mixed, and matched for vendors and 'small-time' producers.

III. Method

To establish the existence of valid problem, first, primary data was searched from among subject matter experts. Next, secondary data confirmed the research questions and provided leads into important questions to be asked.

The exploratory, qualitative research methods (Denzin & Lincoln, 2000) led to films content analysis, face-to-face in-depth interviews through specific recommendations from the LPF and snowballing. Secondary data was also collected at various premises of informants in the Klang Valley, Kelantan and Kuching.

Content analysis in the media context is defined as "a research technique that is based on measuring the amount of something (violence, negative portrayals of women, or whatever) in a representative sampling of some mass-mediated popular form of art" (Berger, 1991). In this study, the researcher obtained data from newspapers, bloggers' responses and

films content. Twelve (12) interviews were conducted with experts in film industry, concerned publics and officials from the LPF.

Participant observation (DeWalt & DeWalt, 2002) and content analysis opportunities were made possible at the LPF projection room, archives and LPF-producers/distributors workflow charts provided close insights.

Textual analysis and reporting that emerged from primary and secondary data open coding, include labelling concepts and developing categories are reported in the findings.

IV. Results and Discussion

Results from the data and content analysis provided varying outcome that differed from some of the traditional practices in the Broadcasting Industry. One general fact established though is the technological disruption experienced by broadcasters is demanding urgent and systematic intervention, while SMEs and vendors are compelled innovate.

Table 2. Main Categories and Themes that emerged from data

Categories	Themes
Workflow	Ingest Manage Distribute
Metadata tracking	Metadata field Formatting and indexing
Machine learning	Archives Content and QC Technical QC

4.1 Interventions at the workflow

Interventions are essentially installed in stages where they are urgently needed. The MAM archiving processes are expected to be fully digital first for them to be compatible for automation to read and recognise content efficiently in the workflow. This would be refined as artificial intelligent components are installed. The MAM process recognises two kinds of digitised content in storage: deep archive and online storage. The deep archive is a storage for next transmission (within six months), whereas the online storage is meant for the current transmission (within a week). The system is able to search any indexed material in the deep archive and restore it to the online storage after use. The workflow cascades as Ingest, Manage and Distribute.

4.1.1 Ingest

At this stage, incorrect indexing of incoming content by vendors and archivists who use a standard field for machine recognition. Archivist inputting variously would be ‘speaking in different languages’ that becomes

incomprehensible to the machine. Secondly, the playback machines used at the archive are outdated and cannot be restored to work efficiently, and the content itself is available in multiple formats. These issues must be resolved first.

Personal interview with the engineer in charge at the Production Operation Centre (POC) insist that, 'Production materials, raw footages and edited footages meant for post-production are purposefully catalogued using simple metadata for ingestion'. He also said, 'Technicians are well-trained specialists to work at their specialised area. Technicians performing ingestion will only focus on ingestion and those in charge of storing will know all about the storage process'.

He continued, *'Some material in the archive is of poor quality, for example, Opah (1983), the drama shot in a 16 mm film. We have digitised the footages but we still need to mend it from black and white films with scratches. For some of P. Ramlee's films, the reels are torn. These are some of the challenges in restoring the quality of the archived material before ingestion'.*

4.1.2 Manage

Deep archive online storage strategies for broadcasting have to be managed as ingestion of content starts four days to a week before transmission. MAM operates under the broader umbrella of Digital Asset Management (DAM Foundation Consultancy, 2017). For example, MAM is responsible for transmission, where files are stored in formats called 'OP1' and 'OPATEM', which are different. In MAM, content appended audio and video, one file comes with audio, video and the header. In DAM, it comes with video and four audios or eight audios separately. When content specific title is required for transmission, it is compressed and retrieved from the archive.

4.1.3 Distribute

Personal interview with the engineer in charge at the Production Operation Centre (POC), once again said, 'In the MAM process, segmentation within a programme occurs a few times. For example, a one-hour programme will be chopped into four blocks for the insertion of commercials, promos and PSAs. Once on air, the system will be programmed to insert them. This is what the MAM system or machine understands, 'what to do and what should be done' before program distribution.

At the pre-transmission stage a digitally interactive section will enforce compulsory QC at the end of the MAM process. When QC is completed, the content is sent back to the beginning of the process to be ingested into the MAM system. Every item is indexed to the MAM specification. Two copies are created: one copy of the content is ingested into the MAM process and the other master copy is printed into the XDCAM format without re rendering and sent to the deep archive.

4.2 File base format for metadata tracking

A file-based format is recommended for multimedia content providers to comply. They need to learn basic metadata field requirements for their content to be compatible to the house MAM workflow equations.

4.2.1 House Format

Broadcasters have their respective house formats for the entire DAM/MAM processes, which is made known through producer/vendor supply policy document. Hence, the DAM and MAM systems convert all archive materials batch by batch into house formats that are recognised. Content in media formats that are obsolete, such as films and '2-inch' and beta tapes, is converted first. The machines that can play back these materials are obsolete now.

Therefore, vendors should send their content in recommended file-based formats. Vendors are given two formats (codec options): XDCAM 422 and Apple Processor 422.

4.2.2 Metadata Field

Broadcasters General MAM metadata fields required are not limited to, media format, media ID, title, episode, duration, segments of content (Table 3).

Table 3. Metadata recognised by DAM and MAM systems.

Standard field data entry at Ingest Station
• Media ID • Media format • Title of content • Producer • Date of production • Location • Episode(s) • Segmentations • Duration • Video Standard • Audio Standard

4.3 Decision Making

How machine learning can facilitate accurate decision making in the MAM processes in the context of multimedia content providers would be the concern of decision makers.

4.3.1 Archives

Applied MAM system must first be 'taught' to automatically recognise what is fed to it [4]. While MAM is conducive to machine learning [6], archivist have manually coded large volumes of data for transactions at the front end of the MAM process when content arrive from various sources.

The system in use at the archives must be capacitated to recognise the metadata field of the house format. Here files are stored in "OP1" and "OPATEM" formats. News content is stored separately in DALET and OCTOPUS formats. The system will automatically track and upload the required content and classify, store, tag and provide essential data for users. For example, if you do not tag the photo of "Tunku Abdul Rahman, the 1st Prime Minister", the system will just tag the closest generic name such as *"a Malay Man*". When fields are empty, the metadata entry now has to be researched and entered manually'.

4.3.2 Quality Control

The main QC feature before ingestion include content QC and technical QC. Producers at the source manage self-censorship of content but censorable content can always slip by. This censorship is guided by (1) the guidelines found in the Film Censorship Act 2002 (LPF 2002. The National Film Censorship Board of Malaysia) and (2) the Broadcasters' Content Code 2004 (The Malaysian Communication and Multimedia Content Code, 2014).

Table 4. Brand Quality Control Criteria

Criteria for Quality Control
• MCMC (1998) sections 211, 212, 232, 233
• Content Code 2004 criteria
• Race, religion, racism sensitivities
• Political alignment
• Program, products congruent to station branding

Broadcast stations will remind producers of their QC obligations at the stage of pitching. Next, the same content will undergo a second review after the final edit to address sensitivities such as racism, incongruent politics not appropriate for airing and branding QC. The content QC also comments on audio-visual quality. Subjective evaluation has to rely on experienced producers. The MAM system cannot perform this task.

4.3.3 Technical QC

At the technical QC, the machine takes over the evaluation of content. The machine is calibrated with the expected range of technical compliance parameters that the content should match.

The volume of content coming in for 24/7 broadcasts. The old system of deck-to-deck QC is not humanly possible. Machines have now taken over this portion of the workflow. After the QC evaluation, producers are updated about the corrective action to be taken. Producers and vendors sometimes make corrections up to four times. This is an outcome of using non-compliant equipment at the shooting and editing stages. They need to convert production chain to the same Apple, Adobe Premier or AVID formats used by the station.

Three basic checks are carried out at the technical QC. The first check is for white luminance that must come from the colour bar only. The camera in use must generate the colour bar, and the programme continues on the same luminance. If the measurement of white luminance of the colour bar is higher than 700 mV, there will be a whitewash or 'clipping' in the content. Such picture quality is unacceptable.

The second check is for chrominance on colour. The camera must reproduce true colour. For example, when a yellow shirt during recording is seen as yellow-green during transmission, it is caused by a poor calibration of

chrominance at the source. When this issue was raised with the technician responsible, there was no clear response and the question went unanswered. The TV station in question can be sued. There are two standards of chrominance: 75% and 100%. Most Asian countries use the Asia-Pacific Broadcasting Union (ABU) standard of 75% (Table 4).

Table 5. Criteria for technical QC recognised by MAM

Criteria for Technical QC and Evaluation
• Luminance @ 700 mV or0.7 V on the white area, to check white colour from the colour bay only. • *Chrominance on Colour*. Two standards of chrominance: 75% and 100%. The ABU standard Malaysia uses is 75%. Only USA and Japan use 100% chrominance level. • Audio level generated from colour bar @ tone by dB Full-scale – 18dB

The third check is on the sound level. When recording sound, there is an audio tone and a colour bar. The tone must be generated at the source using dB full-scale −18 dB if this is not calibrated and monitored correctly at the recording, then audio level at transmission will be poor.

Vendors have to correct, re-edit and reproduce their content to its recommended quality when their materials are rejected. This is a very expensive and tedious process. Some vendors are happy to comply after they have migrated to the file-based format, which does simplify matters. The issue is different broadcasters demand differing submission formats that are only compliant to their specific systems and workflow. Small company producers and vendors, "…encounter the prospect of reinvesting large amounts of resources to comply" as they put it. "At times, upon checking, our recordings are in compliance, but station machines are not calibrated accordingly", producers lament.

V. Conclusion

It has become imperative for SMEs and vendors to fall in compliance to the conceptual Content Management System (CMS) standards set by main stream broadcasters. This adoption is necessary as mainstream broadcasters would soon be opting for machine learning features that recognise and facilitate efficient workflow. The study has arrived at four conclusions:

i. Machine learning has apparently become the imperative enabler to automated metadata-driven content programming playout at the end of a broadcasting production workflow.

ii. Established broadcasters are well endowed with resources to manage technological disruptions to their broadcast processes.

iii. Vendors are cautious in taking up the challenge with limited resources to make the required interventions to sustain in the industry.

iv. Broadcasters, small company producers and vendors to align their content submission and metadata indexing for archiving standards compliance.

v. Broadcasters, small company producers and vendors to harmonise their program and technical quality control parameters for a seamless workflow compatible to all main stream broadcasters.

vi. Finally, mainstream broadcasters have demonstrated their capacity to cope with the challenges of IR4.0. However, SMEs and vendors rely much on financial resources and fresh talents to manage their disruptions.

Proposal as solutions

The study proposes that small and medium sized broadcasters (SMEs) and vendors endeavour to adhere to metadata recognized systems such as illustrated in Table 3: Metadata recognised by DAM and MAM systems; Table 4: Brand Quality Control Criteria; Table 5: Criteria for technical QC recognised by MAM. This complex recognition system should be facilitated by artificial intelligence features. With the volume of programmes going on air through multiple channels machines should be taught to recognize gatekeeping functions to ease the burden and relief human overload. It is apparent that Machine learning has become the imperative enabler to automated metadata-driven content programming playout at the end of the production workflow.

There have been grievances raised among the technical community about machines taking over their job functions, but the volume of content turnover is unmanageable, and thus it is inevitable for machines to take over eventually. The introduction of artificial intelligence will ease the burden of human dependence. However, the accuracy of some sections of metadata entries and the programme content QC still depend on human intervention.

It is still left to producers and vendors to comply with such to manage the MAM system efficiently. Automatic recognition of content as per the indexed information works at will. What is not currently possible by the machine is only caused by the human incapacity. Technical QC only enhances the quality of station broadcasting and audience experience.

Compliance to set standards would drive achievement of zero or minimal rejection at the technical and content QC stages before transmission. This would largely improve assets management processes and their workflow. The availability of a scaled down MAM compliant model would ensure seamless production processes for the less endowed broadcasters and vendors.

Innovations emerging from the broadcasting industry in the IR 4.0 era should be published through The Malaysian Press Institute (MPI) and media organization such as the Asia-Pacific Institute for Broadcasting Development (AIBD) in collaboration with funders like Petronas.

Finally, mainstream broadcasters have demonstrated their capacity to cope with the challenges of IR4.0. However, SMEs and vendors rely much on financial resources and fresh talents to manage their disruptions.

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