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The use of digital project management solutions by project businesses: a case study of a selected platinum mine in the Limpopo province

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ABSTRACT

There have been specific technological shifts globally in the discipline of project management, which include the implementation of Project Management Software (PMS) packages. PMS is a pliant software solution that is used for managing projects: administrating, planning, organising, resources managing, document managing, costs, and time management. The awareness and adoption of PMS is unclear, especially in developing countries. This study has examined the awareness and adoption levels of digital project management solutions by project businesses at a selected opencast platinum mine in the Limpopo Province. The study also investigated project management challenges, and the impediments of adoption and the readiness of project businesses to adopt digital project management solutions. A quantitative research survey was distributed and emailed to project businesses at mine, where 110 project businesspersons participated in this study. SPSS v26.0 software was utilised to process data. The study publicised that the level of awareness of digital project management tools is higher than the level of adoption. Several barriers were identified as the impediments of adopting digital project management tools. It is recommended in the study that PMS developers should consider integrating with other systems that could enhance project management processes. It is also recommended that they should consider creating different packages for all business sizes and project magnitudes.

Keywords: Digital project management tools, project business, Project Management Software (PMS), project management

1. INTRODUCTION

The national economy and employment levels of South Africa has been uplifted by mining businesses from 1900. The mining sector elevated business growth and employment through offering business opportunities to project-based organisations in their neighbouring communities. The organisations are faced with numerous project management challenges despite their different magnitudes. Kuvshinkov et al. (2017:1) highlighted those four out of five projects in the mining sector exceeded their set timeframes and budgets on an average of 43%. This has persuaded software developers to implement digital project management tools that can restrain project management challenges, where the purpose of these tools is to simplify project management activities through automated systems. Advances in project management systems were established in the past 29 years, even though their adoption and acceptance levels are indefinite (Arnold and Javernick-Will, 2013:511). However, it is crucial to understand the substantial awareness, adoption, and practical influence of digital project management tools, particularly in developing countries such as South Africa. Studies by Sajad et al. (2016:39), Puška et al. (2020:90) as well as Hassan and Asghar (2021:26840) have noted that digital project management tools have hardly simplified project activities and

business processes, but instead have been the cause of failure for some projects. This failure is claimed to have been caused by project overruns, over-charges, and customer dissatisfaction arising from the failure to match customer expectations.

There is an exigency for further research in the discipline of project management, therefore, this study focuses on investigating the levels of awareness, adoption, and acceptance of digital project management tools in the South African mining sector. The aim of the study is to investigate the challenges associated with various projects, as well as the awareness and adoption levels of digital project management solutions amongst project businesses at the selected mine in the Limpopo province, to achieve an understanding of how digital project management solutions can contribute to the growth, administration, and management of project businesses.

2. OVERVIEW OF PROJECT MANAGEMENT TECHNOLOGY

Project management technology is a model of technological tools that are used for managing projects (Puška et al., 2020:90). Project management technology involves the deployment of high-tech systems and networks that are utilised for storing and handling project management data (Arnold and Javernick-Will, 2013:510). The use of project management technology has become beneficial in simplifying the planning and communication sections of projects. Gustavsson et al. (2012:527) point out that most project businesses that have invested in technology-tools have barely achieved their anticipated goals and, as such, it is suggested that upon the adoption of technology- tools, business processes should be amended and all project actors should partake in the utilisation of such tools (Gustavsson et al., 2012:522; McGrath and Kostalova, 2020:1).

According to Gustavsson et al. (2012:525) architects are professionals that often utilise technology-tools than any other experts, such as project managers and engineers. The author proceeded to report that the delay in using advanced project digital tools is caused by the lack of mobile devices and the unfamiliarity of digital tools. The reluctance of contractor site managers to adopt digital project management tools is also seen as a barrier as only 40% of contractors in 2012 are reported to be using digital tools in the initiation phase of their projects, only to manage critical factors such as time and resource planning (Gustavsson et al., 2012:525). Nevertheless, this figure is slowly shifting as Klynveld Peat Marwick Goerdeler (KPMG) et al. (2019:8) and Wellingtone (2020:11) have observed differences in the use of technology-tools by contractors. In this regard, McGrath and Kostalova (2020:3) projected that more contractors are likely to introduce Information Technology (IT) tools for their future projects.

Adriaanse et al. (2010:74) declare that the use of technology in organisations could be obligatory or voluntary, depending on the conditions of the industry; some projects have short-term durations that limit the period of initiating and introducing technical tools in their organisations. Son et al. (2012:83) contend that some project site-managers are reluctant to use technology when their commercial contracts contain restrictions regarding the utilisation of technology in managing projects.

2.1 Project management software (PMS)

PMS is the "collection of electronic instruments that enhance the efficiency, planning and tracking of deliverables for a project team" (Bedneko, 2019:1). PMS is a "flexible cloud-based project solutions that ease the project workflow, collaboration and filing" (Kashyap, 2018:1).

The purpose of PMS is to ease business processes in the lifecycle phases of project management (Puška et al., 2020:90).

Project managers in recent times are assisted by many project-management technical apparatuses and practices. The commercial field has noted that stakeholders have become accustomed to requesting quality projects that could be delivered in a short timeframe. Therefore, this has positioned a necessity for further improvements in the field of computer technology (Hajjaji et al., 2010:125). There are some software packages, which are commonly used in project management, such as Microsoft Excel and Microsoft Project, which are applied to analyse risks and construct project management models. Other PMS tools that are commonly used include the Palisade Software and PRISM, which are products of the Palisade Corporation founded in 1984. These tools can be utilised to analyse project risks by generating important statistical techniques such as Monte Carlo simulations, which is a statistical method applied by project managers to gain an in-depth understanding of the effects that risks and improbabilities can have in project management (Al Shaer, 2018:1). The Palisade Corporation is reputable for providing leading project risk analysis software packages. For example, the company established the @Risk package, which has graphical features incorporated with Monte Carlo simulation in MSE (Palisade, 2010:1).

According to Borštnar and Andreja (2014:19), top managers, project managers and the project team workers at large are backed by technological programs in every project. The authors highlight that IT serves as a communication platform between the organisational structures of project businesses and, as such, every department utilises PMS tools for different functions. Top management uses PMS packages for tracking financial pointers and key performance indicators (KPIs), while project managers use PMS packages for project planning and reporting. The project team members utilise PMS packages for administration and communication purposes. Studies, such as those of Raymond and Bergeron (2007:219) and Pellerin et al. (2013:864), indicate that low-performing projects are those that have low usage of software packages. These studies further state that every project performance is linked to multiple software subsystems. These software subsystems cannot be compromised as they include functions of documentation control, project definition, construction activity administration and cost management.

2.2 Project management technology's influence on growth and success

There is a direct connection between the use of technological tools and the growth of many organisations. Several experienced organisations that are at a high maturity level, are more likely to employ project management technical implements and systems, while 95% of project businesses at the high maturity level utilise project management technical implements and systems, opposed to 55% at a low level of maturity (PWC, 2012:18). According to a survey conducted by Wellingtone (2020:9), many organisations are progressively becoming dissatisfied with their level of project management maturity. This was concluded after 45% of project businesses in 2016 were unhappy about their level of maturity and in 2020 this had increased to 52%. Furthermore, only 35% of project businesses are satisfied with their level of project management maturity. The Wellingtone (2020:9) survey further highlighted project management tools and technology as critical factors in the project management maturity radar. In addition to the above, the KPMG et al. (2019:15) survey reflects that project businesses should invest in new technology for enhanced collaboration implements and artificial intelligence tools to allow quick and effective utilisation of project management

information that will aid decision-making. The adoption of collaborative technological tools (which can be used jointly) is relevant because it was revealed that 51% of project businesses utilise these tools to ensure the delivery of their projects, even although the effectiveness and efficiency of such tools have not been determined (KPMG et al., 2019:11-12). In addition, it was noted that only 8% of project businesses globally have introduced artificial intelligence tools into their organisations to support their projects, but the percentage is expected to increase (KPMG et al., 2019:11-12).

2.3 Recognition and adoption of technical project management solutions

Price Waterhouse Coopers (PWC) (2012:18) point out that the adoption of project management technical tools and techniques has become standardised among project businesses, and record that only 77% of project businesses are mindful of technical project management solutions and use such tools in their projects. The trend is supported by KPMG et al. (2019:8) in their global survey of project management, which found that project management technical tools and procedures were widely used by 71% of project businesses worldwide. However, the Wellingtone (2020:11) survey held a different view, which argues that the employment of project management technical tools and techniques is low, since only 25% of project businesses make use of project management technical tools. According to Wellingtone (2018:12; 2020:11), the adoption of project management technical tools has only changed gradually with an increment of 3% between 2018 and 2020. Considering the above, it is comprehensible that the awareness and adoption of project management technical solutions by project businesses is ambiguous and, as such, more research is needed. Since the utilisation of project management technical tools and practices is associated with an organisation's performance, Figure 1 shows the project performance ranks.

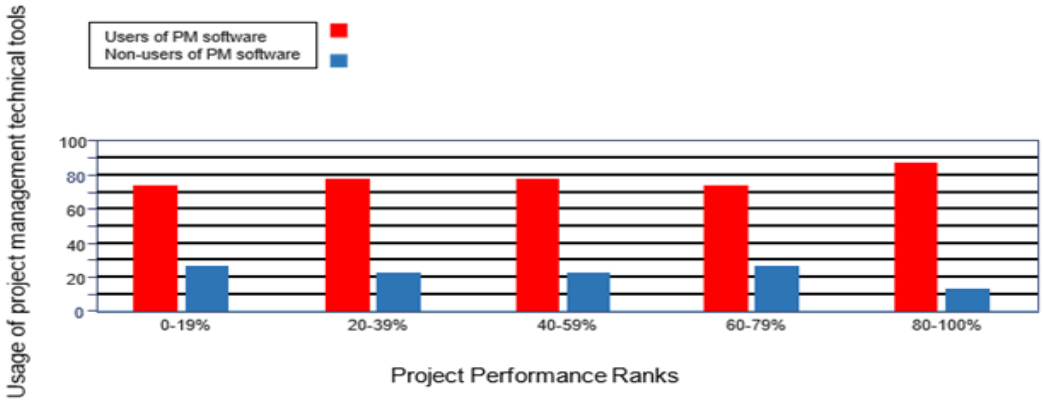

Figure 1: The usage of PMS
Source: Adapted from PWC (2012:19)

Figure 1 portrays a link between the use of project management technical tools and the performance of a project. The Figure reveals that project businesses which use digital project management tools have elevated performance levels compared to those that do not use any tools. PWC (2012:18) dissent that there is a solid connection between the usage of project

management technical tools and project performance. Among well-performing projects, 87% are carried out by project businesses that apply project management technical tools and techniques (PWC, 2012:18).

Brynjolfsson and Yang (1996:39-40) discovered that the implementation of project management technical tools and practices did not often result in anticipated outcomes. McGrath and Kostalova (2020:8) supported these findings by adding that project management technical tools and practices should be backed-up by a high-performance team and a proficient leader as this would help produce the required results. The unanticipated outcomes of project management technical tools are referred to as the paradox of productivity, which includes inaccurate measures of productivity, long observations that are focused on increasing productivity, poor management of PMS tools, and the inability to anticipate a Return on Investment (ROI) of PMS tools (Dewett and Gareth, 2001:337; Bresnahan et al., 2002:28; Bardhan et al., 2007:589; Aubert and Reich, 2009:32). In the past years, many researchers became interested in investigating the impact of project management technical tools and techniques because of the paradox of productivity in organisations. For example, the study of Bryde and Wright (2007:5) exposed the connection between project management technical tool- efficiency and the project team members' expectations, as well as clients' expectations. Ali et al. (2008:5) investigated the effect of PMIS (Project Management Information System) and discovered that PMIS had a positive effect on project performance, while Raymond and Bergeron (2007:217-219) publicised the recurrent usage of PMIS and its positive impact on project performance. The study of Dostie and Jayaraman (2008:1) indicated a high productivity level of employees that used computers against those that did not, while Pellerin et al. (2013:21-22) highlighted the level of PMS usage and its correlation with project performance of engineering projects in Canada. However, these studies were less focused on ascertaining any correlation between the recognition and employment of project management technical solutions and their challenges on the African continent and, as such, the current study focused on South African project businesses.

3. RESEARCH METHODOLOGY

The empirical segment of this study was constructed on a quantitative research design since theories of arguments and models were used to generate data themes and assess philosophies. Data was gathered through surveys and research papers (journals, newspapers, articles, and academic papers). Statistical methods were employed to present the findings of this study, where the focus was to evaluate the statistical levels of adoption, awareness, and challenges of using digital project management solutions and as such, primary data was collected from project businesses.

Wright et al. (2016:97) mentioned that a quantitative study approach starts with an empirical logic that has extensive theories of arguments and models which are used to generate data themes. Quantitative researchers (for example, Elkatawneh, 2016) collect data by utilising various data collection instruments to minimise irrelevant information. This is done to improve the research results and to possess widespread findings regarding the subject of the study. Researchers who employ a quantitative approach collect data through observations and interviews in their field of study, often utilising a survey (Elkatawneh, 2016:2). The dynamics of a quantitative methodology are based on statistical data, which

offers convenience in terms of saving time and resources in a research project. In a quantitative study, generalisation is built based on scientific techniques that are utilised to gather data and researchers can focus on various research groups where participants provide their input based on their experiences (Daniel, 2016:94). The main objective of a quantitative study is to reduce the researcher's direct involvement in the information gathered for the study (Wright et al., 2016:98).

The appropriate paradigm for this study was the interpretive paradigm since the researcher aimed to understand how others comprehend events and theories (Lan, 2018:3), and aimed to comprehend subjective meanings of certain social views and interpret the research findings of several continuums with pragmatism being the focal point (Rahl, 2017:1; Cao Thahn and Le Thahn 2015:24). Interpretation in this study is applied to the adoption levels of project management digital solutions and the challenges encountered by project businesses at the selected opencast platinum mine in the Limpopo Province. The research design of this study was constructed on a cross-sectional descriptive case study to examine the challenges and adoption levels of digital project management solutions.

The target population for this study was a restricted number of selected contracting project businesses at the selected platinum mine, and the population of this study comprised:

- Project managers appointed by the contracting projects businesses in line with the prescripts of the Mine Health and Safety Act, 29 of 1996 in the Republic of South Africa.
- Contracting site managers employed in line with the prescripts of the Mine Health and Safety Act, 29 of 1996 of the Republic of South Africa under regulation 2.6.1 of the Act.
- Contracting supervisors employed in line with the prescripts of the Mine Health and Safety Act, 29 of 1996 in the Republic of South Africa under regulation 2.9.2 of the Act.

The project businesses participants were categorised and selected from 313 contracting organisations at a selected platinum mine and based on the Contractor Management System of the selected mine; 180 contracting organisations were identified as project businesses on system reports (that categorised contracting businesses per their scope of work and nature of business). A total of 110 project businesses participated in the study.

The non-probability sampling technique was suitable for this study since a non-random selection technique was employed to select participants. Purposive/judgemental sampling was applied since not all the contracting businesses that were identified met the criteria of the project businesses that are needed to answer the research questions (Etikan et al., 2016:4; Wright et al., 2016:98). Purposive/judgemental sampling was employed to increase the applicability of the sample so that only businesses that met the criteria of the study sample were included (Trochim, 2020:1).

To improve the response rate, data were collected through structured closed-ended questionnaires, which contained questions that had multiple-choice answers for respondents to choose the appropriate answer (Wilkinson and Birmingham, 2003:11). The researcher reviewed the data collection instruments of other related studies in designing the questionnaire for this study, which was distributed between June 2020 and January 2021.

A single questionnaire was utilised for all participants and selected case analysis was utilised to separate the data. The survey questionnaire consisted of four sections:

Section A of the survey included a demographic and general profile about business details, numbers of employees, number of years in business, nature of projects, and type of project business in the demarcated area. Multiple-choice questions were utilised. SPSS v26.0 was used to analyse data for all sections (A to D) using the selected cases function where data was split between group A (project business that have not adopted digital project management tools) and group B (project business that have adopted digital project management tools).

Section B evaluated the project history and project challenges faced by project businesses within the specified mining area. Multiple-choice questions were utilised. The research objective was to examine project management-related challenges of project businesses in the demarcated area.

Section C part 1 evaluated adoption levels of digital project management solutions by project businesses. Multiple choice and dichotomous questions were used. The research objective was to investigate the awareness and adoption levels of technological project management solutions by project businesses in the demarcated area.

Part 2 of Section C accessed the barriers to digital project management solutions by project businesses. A five-point Likert scale was applied. The research objective was to investigate the adoption barriers to digital project management solutions by project businesses in the demarcated area.

Section D evaluated the organisations' readiness and willingness to adopt digital project management solutions in the demarcated area. A five-point Likert scale was applied. The research objective was to determine the level of readiness to explore digital project management technical tools by project businesses in the demarcated area.

The data analysis of Sections A, B and C addressed the last research objective, which was to understand the extent to which project management technology could influence the grow and success of project businesses at the selected mine.

In consideration of the availability and variety of the participants, the researcher either physically distributed or emailed the questionnaire to the project managers, site managers and supervisors of the project businesses at the selected mine.

Table 1: Example of how data was analysed

Variable	**Label on SPSS**	**Label value on SPSS (coding value)**	**Data Analysis**
Profile of the sample			
Gender	Male Female	= 1 = 2	Used SPSS Selected Cases Function (Filtered Group A & B data)
Occupation	Project Manager Contracting Site Manager Contracting Supervisor Other	= 1 = 2 = 3 = 4	Used SPSS Selected Cases Function (Filtered Group A & B data)
Number of employees	1-9 10-20 21-50 51-99 Over 100	= 1 = 2 = 3 = 4 = 5	Used SPSS Selected Cases Function (Filtered Group A & B data)
Number of projects	*#Number*	*#Number*	Used SPSS Selected Cases Function (Filtered Group A & B data)

Number of successful projects	*#Number*		*#Number*	Used SPSS Selected Cases Function (Filtered Group A & B data)
Project related data				
Project management challenges	Selection of options		Not Selected = 0 Selected = 1	Used SPSS Selected Cases Function (Filtered Group A & B data)
Level of awareness and adoption of digital project management tools				
DQ1	Awareness of digital project management tools		Yes = 1 No = 2	Used SPSS Selected Cases Function (Filtered Group A & B data)
DQ2	Use of digital project management tools.		Yes = 1 No = 2	Used SPSS Selected Cases Function (Filtered Group A & B data)
Most used project management software packages				
Project Management Software Packages	Trello		Not Selected = 0 Selected = 1	Analysed data for Group B – using the Selected Cases Function on SPSS
	BaseCamp		Not Selected = 0 Selected = 1	
	Microsoft Project		Not Selected = 0 Selected = 1	
	Smart Sheet		Not Selected = 0 Selected = 1	
	Huddle		Not Selected = 0 Selected = 1	
	Oracle Primavera		Not Selected = 0 Selected = 1	
Analysis of the barriers to adopting digital project management solutions				
SWLS1	Lack of knowledge	Strongly Disagree = SD	= 1	Analysed data for Group A – using the Selected Cases Function on SPSS
		Disagree = D	= 2	
		Neutral = N	= 3	
		Agree = A	= 4	
		Strongly Agree = SA	= 5	
SWLS2	High costs of adoption	Strongly Disagree = SD	= 1	
		Disagree = D	= 2	
		Neutral = N	= 3	
		Agree = A	= 4	
		Strongly Agree = SA	= 5	

Source: Researcher construct

Reliability and validity in this study were achieved by reviewing literature papers, attaining validations from experts, conducting a pilot study, and obtaining approval from the CPUT Research and Ethics Committee of the Faculty of Business and Management Sciences. Internal reliability was measured using the Cronbach's alpha test (α) and the CR test. The researcher was led by the guidelines of the CPUT Research Directorate and Graduate Centre of Postgraduate Management Studies. Coding was applied in the data processing stage. The SPSS v26.0 system was employed to analyse data and a descriptive statistical analysis

approach was employed to process data. Tables and graphs were generated to depict frequencies, as well as the relevant arithmetic means and spread measures.

Ethical approval to conduct this study was sought from the CPUT Research and Ethics Committee of the Faculty of Business and Management Sciences. The researcher was led by the guidelines provided by the CPUT Research Directorate and Graduate Centre of Postgraduate Management Studies. The researcher desisted from the fabrication of authorship, evidence, information, data results or conclusions, plagiarism, revealing information that would harm participants, using vague and inappropriate language, sharing data with others, retain data and other materials longer than necessary and replicating publications.

4. RESEARCH RESULTS

This section presents the statistical findings of this study. Table 2 includes a report of data collected from the sample.

Table 2: Data analysis

Series A	**Series B**	**Group A**		**Group B**	
		Project businesses that have not adopted digital project management tools		**Project businesses that have adopted digital project management tools**	
		Frequency	**Percentage**	**Frequency**	**Percentage**
Profile of the sample					
Gender	Male	55	90.2	43	87.8
	Female	6	9.8	6	12.2
Occupations	Project Manager	5	8.2	5	10.2
	Site Manager	49	80.3	35	71.4
	Supervisor	5	8.2	4	8.2
	Other	2	3.3	5	10.2
Education	Secondary school	9	14.8	6	12.2
	Technical college	49	80.3	16	37.2
	First diploma/degree	3	4.9	25	51
	Master's degree	0	0	2	4.1
Nature of Business	Engineering	63		55	
	Construction	32		37	
	Other	5		8	
Locality	Mokopane local business	57	66.28	29	33.72
	Not Mokopane local business	4	16.66	20	83.33
No. of Employees	1 to 9	40	66	20	41
	10 to 20	15	25	7	14
	21 or more	7	11	22	45
No. of years in business	Less than 1 year	7	11	0	0
	1-5 years	33	54	15	31
	6 year or more	21	34	34	69
No. of years in the mining sector	Less than 1 year	6	10	2	4
	1-5 years	41	67	15	31

	6 year or more	14	23	32	65
Project related data					
Projects	Number of Projects initiated	1084		1782	
	Successful Projects	1068	98.5	1755	98.5
	Unsuccessful Projects	16	1.5	27	1.50
Project Management challenges	Identified	- Lack of resources - Limited budget - Changes in project requirements - Economic changes - Supplier-related issues		- Poor communication - Economic changes - Supplier-related issues - Unanticipated weather conditions	

Source: Researcher construct

Gender - Most of the participants employed by the project businesses are male for both groups of businesses. The results include n=55, representing 90% for Group A and n=43; representing 87.8% for Group B. Very few participants were female (n=6; representing 9.8% for Group A and n=6; representing 12.2% for Group B). The data suggest that most project businesses within the mining industry employ predominantly male candidates for their senior positions.

Occupations - The leading occupations for both groups are contractor site managers (n=49; representing 80.3% and n=35; representing 71.4%). In Group A, the second most dominant occupation is contracting site supervisor (n=5; representing 8.2%) and the project manager (n=5; representing 8.2%). For Group B, the second highest occupation is project manager (n=5; representing 10.2%) and the 'other' occupations (n=5; representing 10.2%). The 'other' occupations for Group B included two safety officers, one construction manager and two Quality Assurance, Environmental, Health and Safety managers. The least dominant occupation for Group A is the 'other' occupations (n=2; representing 3.3%) which consists of one managing director and one safety officer. For Group B, the least dominant occupation is contracting supervisor (n=4, representing 8.2%). From this data, it can be concluded that the key occupation of project manager is not as dominant as anticipated for project businesses that operate in the mining sector.

Education - Most respondents in Group A have technical college qualifications (n=49; representing 80.3%), while the highest educational level for Group B is a first degree and/or diploma qualification (n=25; representing 51%). The second highest educational level for Group A is secondary school (n=9; representing 14.8%) and technical college education for Group B (n=16; representing 32.7%). Master's degrees were lacking among participants, with Group A returning 0 and Group B (n=2, representing 4.1%).

Nature of Business - Most of the project businesses that participated in this study selected engineering as their nature of business (Group A is represented by 63% and Group B is represented by 55%), followed by construction (Group A at 32% and Group B 37%). The 'other' category represents the lowest values for both groups (Group A at 5% and Group B at 8% selection rate). The 5% for Group A represents mining (1%), pest control (1%) and

waste management (2%), while the 8% for Group B represents mining (2%) and information technology (6%).

Locality – There are 66.28% (n=57) of Mokopane district project businesses that have not adopted digital project management tools; and 33.72% (n=29) that have adopted digital project management solutions. There is also 83.33% (n=20) of project businesses that are not from the Mokopane district that have adopted digital project solutions; and 16.66% (n=4) that have not adopted digital project management solutions. The results show that the cluster of non-local Mokopane (Waterberg) district project businesses have a high proportion of participants that have adopted digital project management tools. However, there is a high number of Mokopane district project businesses that have not adopted digital project management tools, which suggests that locality does play a role in influencing the adoption of digital project management tools.

Number of employees - Most of the project businesses that have not adopted digital project management tools (Group A) have between 1 to 9 employees, representing 66% (n=40), while most of those that have adopted digital project management tools (Group B) have 21 or more employees, representing 45% (n=22). The second highest ranking for Group A is project businesses that have between 10 and 20 employees (representing 25%; n=15), and 1 to 9 employees for Group B (representing 41%; n=7). The lowest ranking for Group A consists of businesses that have 21 or more employees (representing 11%; n=7), and 10 to 20 employees for Group B (representing 14%; n=7). These results were important in indicating the influence of workforce size in adopting digital project management solutions. The results suggest that project businesses with a higher number of employees are more likely to adopt digital project management solutions than those with fewer employees.

Number years in business - Most of the project businesses that have not adopted digital project management solutions (Group A) are those that have been in operation for between 1 and 5 years (representing 54%; n=54), while most of the project businesses that have adopted digital project management tools (Group B) are those that have been in operation for 6 or more years (representing 69%, n=34). The second cluster of project businesses that have not adopted digital project management tools (Group A) are those with 6 or more years of business operation (representing 34%; n=21). The second group of project businesses that have adopted digital project management tools (Group B) contains businesses that have been operating for 1 to 5 years (representing 31%; n=15). There are also seven project businesses in Group A with less than one year of business operation, which have not adopted digital project management tools, representing 11%. Group B does not have businesses that have been operating for less than one year.

Number of years in the mining sector - Most of the project businesses that have not adopted digital project management solutions (Group A) are those with between 1 and 5 years of business operation in the mining sector (n=41; representing 67%), while most of the project businesses that have adopted digital project management tools (Group B) are those with six or more years of business operation in the mining sector (n=32; representing 65%). The second grouping of project businesses that have not adopted digital project management tools (Group A) are those with six or more years of business operation in the mining sector (n=14; representing 23%). Group B, that have adopted digital project management tools, includes businesses that have been operating in the mining sector for 1 to 5 years (n=15; representing 31%). There are also six project businesses in Group A with less than one year in business operation in the mining sector (representing 10%) and two project businesses for

Group B that have adopted digital project management tools (representing 4%). Group B does not have businesses that have been operating for less than one year. These results suggest that industry experience has an influence on the adoption of digital project management tools in the same way as experience in the mining industry.\

Projects - The data shows that Group B project businesses have embarked on far more projects than Group A project businesses. This indicates that project businesses that have more experience and exposure tend to adopt digital project management tools.

The participant project businesses yielded similar results of project success. Project businesses that have adopted digital project management solutions were successful in 98% of their projects, which is like project businesses that have not adopted digital project management tools.

Project management challenges - Internal challenges affected project businesses that do not use digital project management tools more than those that do. For example, the 'lack of resources', 'limited budget' and 'changes in project requirements' were internal challenges that affected project businesses that do not use digital project management tools, whereas project businesses that use such tools are only affected by 'poor communication' in their projects. Regarding external challenges, they similarly affected both groups of project businesses. For example, 'economic changes' and 'supplier-related issues' affected both groups of project businesses. The only external challenge that individually affected project businesses that use digital project management tools was 'unanticipated weather patterns', which was prompted by the higher number of outdoor construction projects.

Table 3 shows dichotomous scaling values regarding the awareness and usage of digital project management tools based on project businesses that participated and suggests that 59.1% (n=65) of project businesses were aware of digital project management solutions, whereas 40.9% (n=45) were not aware. Table 3 also shows that 44.5% (n=49) of project businesses use digital project management solutions and 55.5 (n=61) do not use digital project management solutions.

Table 3: Level of awareness and adoption of digital project management tools

Coding	Variables	PM PHASE	Dichotomous scaling			
			YES		NO	
			Percentage	Frequency	Percentage	Frequency
DQ1	Level of digital PM tools Awareness	Project Initiation	59.1	65	40.9	45
DQ2	Level of digital PM tools usage in Projects	Project Initiation	44.5	49	55.5	61

Source: Research construct

Figure 2 illustrates the awareness levels of digital project management systems. The chart is classified as per the number of business operating years of the project businesses in the mining sector. Figure 2 shows that project businesses that have been operating in the South African mining sector for 16 to 20 years and more have the highest rate of digital project management tools awareness, followed by those with between 6 and 10 years (representing 76.9%), then by those with between 11 and 15 years (representing 66.7%). The project businesses with less than one year and those with 1 and 5 years in operation represent the lowest rates of awareness. The results above suggest that experienced project businesses

in the South African mining sector are more aware of digital project management tools than those that are less experienced.

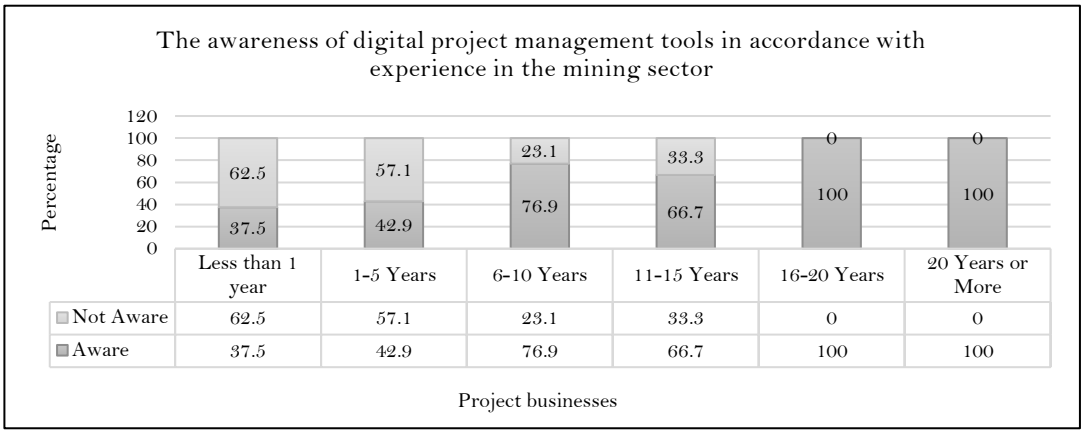

Figure 2: Awareness levels of digital project management systems

The information in Table 4 shows the extent of utilisation of digital project management tools, which addresses one of the research aims of this study. It can also be seen that digital project management solutions are utilised for numerous purposes. Considering this data, it can be confirmed that most project businesses use digital project management frequently for planning projects and managing safety and risk (categorised as the 1st class of usage). Digital project management solutions are also used for scheduling, time-tracking, and managing workflows in projects (categorised as the 2nd class of usage). However, digital project management solutions are less utilised for managing the budget, human resources, and procurement (categorised class 3 usage).

From Table 4 it is clear that project businesses in the South African mining sector mostly focus on the 1st class and 2nd class functionalities when having to adopt digital project management solutions. Some project businesses, however, are not making full use of digital project management tools.

Table 4: Levels of digital project management tools awareness and adoption

	Project businesses that use digital project management tools			**Dichotomous scaling**			
Class	SPSS Coding	Variables	PM PHASE	N=49			
				YES		NO	
				%	Frequency	%	Frequency
1st Class	DQ3	Use digital PM tools for planning in projects	Project planning	95.90	47	4.10	2
	DQ11	Use digital PM tools for managing risks in projects	Project execution	87.80	43	12.20	6
	DQ12	Use digital PM tools for managing safety in projects	Project execution	91.80	45	8.20	4

2nd Class	DQ4	Use digital PM tools for scheduling in projects	Project planning	85.71	42	14.29	7
	DQ7	Use digital PM tools for time-tracking in projects	Project control & performance	75.50	37	24.50	12
	DQ8	Use digital PM tools for Workflow Management in projects	Project execution	75.50	37	24.50	12
	DQ9	Use digital PM tools for collaboration in projects	Project execution	75.50	37	24.50	12
3rd Class	DQ5	Use digital PM tools for budgeting projects	Project control & performance	67.30	33	32.70	16
	DQ6	Use digital PM tools for human resource management in projects	Project control & performance	69.40	34	30.60	15
	DQ10	Use digital PM tools for procurement purposes in projects	Project initiation	59.20	29	40.80	20
	Number of all respondents		49				

Source: Researcher construct

Table 5 shows that the most used PMS package is Microsoft Project (representing 59.2%). The study by Magwali (2018:60) also revealed that Microsoft Project is the most well-known and commonly used system. Oracle Primavera (representing 8.5%), GanttPro (representing 8.5%) and Smart-sheet (representing 4.2%) PMS packages were also used. The 'Other' group of various software packages represents 16.9%. This group included Beltanalyst, Dynamicanalyst and Conveyer Design software; Business Intelligence (BI) Project and Asset Maintenance (AMT) Software; Drillsoft HDX; Focal Point and ERS Bio; 'GPM2 and SKF Project Tools; 'Liebherr Crane Planner 2.0; Monday.com; Microsoft Teams and TORAS-Techincal Operational Risk Assessment System. Huddle, Zoho Projects, BaseCamp and Trello software packages were the least-used packages in this study. The variety of choices is due to the preferences and knowledge of the digital project management tools, as well as the diversified scope of work of each project business.

Although there is not much information on the general use of various PMS packages, this study has shown that most project businesses prefer using independent and industry-specific systems.

Table 5: Most used project management software packages

Project Management Software (PMS) Packages	**Usage**	
	Selection Frequency	**Percentage**
Trello package	1	1.4%
BaseCamp package	-	-
Microsoft Project	42	59.2%
Smart-sheet	3	4.2%
Huddle	1	1.4%
Oracle Primavera	6	8.5%
Proofhub	-	-
Zoho Projects	-	-
GanttPro	6	8.5%
Other	12	16.9%

Source: Researcher construct

Table 6 present data about the barriers to adopting digital project management tools. The table lists that most of the participants in this study supported the items that were used to determine the existence of the barriers to adopting digital project management solutions. Items that have higher values of 'strongly disagree' and 'disagree' include 'lack resources to use digital project management solutions', 'lack of knowledge about digital project management solutions', 'lack of technological experts to handle digital project management solutions' and 'complexity of processes in the mining sector' that represent a slight shift of unsupportiveness. However, from the data in Table 6, the most recognised barriers to adopting digital project management tools in the South African mining sector are the 'high costs associated with digital project management solutions' and 'uncertainty about the ROI of digital project management solutions.

Table 6: Analysis of the barriers to adopting digital project management solutions

Code	Cronbach's test α:	CR:	AVE:	Scale			Results
	0.800	0.979	0.403				
	Items measured:			SD + D	N	SA + A	Supported/ unsupported
SDNAS1	Lack of knowledge about digital project management solutions			5	3	53	Supported
SDNAS2	High costs associated with digital project management solutions			3	2	56	Supported
SDNAS3	Lack of resources to use digital project management solutions			7	2	52	Supported
SDNAS4	Lack technological experts to handle digital project management solutions			5	2	54	Supported
SDNAS5	Lack of information and popularity about digital project management solutions			4	3	54	Supported
SDNAS6	Lack of competition driven by the adoption of digital project management solutions			2	5	54	Supported
SDNAS7	Uncertainty about return on investment (ROI) of digital project management solutions			2	3	56	Supported
SDNAS8	Complexity of processes in the mining sector			5	9	47	Supported

Source: Researcher construct

Table 7 reveals that most of the items herein were not supported by the participants of this study. The results show that most project businesses that participated are not fully ready to adopt digital project management tools.

From Tables 6 and 7 Cronbach's alpha coefficient values range from 0.800–0.932, implying that the items included in the tables have a high internal consistency. According to Tavakol and Dennick (2011:52), Almomani et al. (2018:5) and Taber (2018:1296), a Cronbach coefficient value >0.50 is acceptable and a value >0.91 is strong and reliable. The CR of the items in Table 6 of this study is 0.979 and in Table 7 it is 0.996, which indicates good CR values, as recommended by various researchers (Fornell and Larcker, 1981:46; Lam, 2012:1332; Huang et al. 2013:219; Yong and Pearce, 2013:80; Wipulanusat et al. 2017:64). The AVE value of 0.4 in Table 1.5 of this study is acceptable as it carries a CR value of 0.979, which Fornell and Larcker (1981:46), Lam (2012:1332) and Huang et al. (2013:219) confirm

that it is ample to verify the existence of a valid connection among the items tested in this study. Table 1.6 displays an AVE value of 0.5 (with a CR value of 0.996).

Table 7: Analysis of the readiness to adopt digital project management solutions

CODE:	**α:**	CR:	**AVE:**	SCALE			Sample size	RESULTS:
	0.932	**0.996**	0.5	**SD + D**	**N**	**SA + A**		**Supported/ Unsupported**
	Items measured:							
SDNAS 9	Recognise various digital project management solutions			43	6	12	61	Unsupported
SDNAS 10	Recognise opportunities and challenges of digital project management solutions			44	4	13	61	Unsupported
SDNAS 11	Recognise digital project management solutions that are applicable to the organisation			44	3	14	61	Unsupported
SDNAS 12	Recognise the benefits of digital project management solutions			46	3	12	61	Unsupported
SDNAS 13	Have a clear vision about implementing digital project management solutions			50	4	7	61	Unsupported
SDNAS 14	Have communicated the vision of implementing digital project management solutions throughout the organisation			51	3	7	61	Unsupported
SDNAS 15	Have defined roles, responsibilities and accountabilities regarding the adoption of digital project management solutions			51	3	7	61	Unsupported
SDNAS 16	Have enough technical skills (human capacity) to deploy and adopt digital project management solutions			49	4	8	61	Unsupported
SDNAS 17	Have evaluated the impact of digital project management solutions in the sector			50	2	9	61	Unsupported
SDNAS 18	Have sufficient resources to initiate the utilisation of digital project management solutions			44	1	16	61	Unsupported
SDNAS 19	Have the affordability to use digital project management solutions			33	6	22	61	Unsupported
SDNAS 20	Have analysed the organisational changes associated with the adoption of digital project management solutions			49	5	7	61	Unsupported
SDNAS 21	Staff members are ready for the changes associated with the adoption of digital project management solutions			21	4	36	61	Supported
SDNAS 22	Business data and transactions with employees online can be executed safely when using digital project management solutions			30	7	24	61	Unsupported

Source: Researcher construct

5. DISCUSSION

The study aimed to investigate the awareness and adoption levels of digital project management tools and techniques among project businesses at the selected mine in the Limpopo Province. It has been revealed in this study that the level of awareness for digital project management tools is higher than the level of adoption. The data of this study suggested that experienced project businesses in the South African mining sector are more

aware of digital project management tools than those that are less experienced. The results concur with Mazzarol et al. (2010:111) who discovered that businesses with high experience tend to adopt new technical systems as they have sufficient financial resources. The study also revealed that projects businesses which have not adopted digital project management tools experience internal challenges, such as lack of resources supported by Bhika and Pretorius (2019:488), limited budget supported by Murwira and Bekker (2017:141), and changes in project requirements (Kagogo and Steyn, 2019:266; Komal et al., 2020:17). Project businesses that have adopted digital project management tools face communication challenges in their project phases. External challenges such as economic changes and supplier-related issues were recognised as challenges that affected all project businesses, whereas unanticipated weather patterns only affected project businesses that have adopted digital project management tools. In relation to the above, McQuerrey (2019:1) stated that economic changes in South Africa affect project businesses on the four dimensions of high interest rates, high tax rates, low employment levels and low consumer expenditure. The research of Kafile and Fore (2018:185), Shehu et al. (2019:3) and Fourie and Malan (2020:13-14), added that the issue of suppliers is a constant challenge for South African project businesses. El-Sawalhi and Mahdi (2015:9) affirmed that severe weather patterns affect the project execution phase, as Ballesteros-Pérez et al. (2018:680) believes that construction project activities are more probable to be affected by weather conditions.

This study further discovered several barriers that affected project businesses which have not adopted digital project management tools which included: the lack of knowledge about digital project management solutions, the high costs associated with digital solutions, the lack of resources for using digital solutions, and the lack of technological expertise to handle digital project management tools. These barriers were also identified as factors that affected the readiness of project businesses to adopt digital project management tools.

6. CONCLUSION

Overall, this study revealed that the level of awareness of digital project management tools is higher than the level of adoption. Projects businesses that have not employed digital project management tools experience internal challenges, such as lack of resources, limited budget and changes in project requirements. The study contributed to extending the body of knowledge by clarifying that project businesses which have not employed digital project management tools noted poor communication as the greatest internal challenge that negatively affects their projects. The study further clarified that external challenges such as economic changes and supplier-related issues affected all project businesses. Unanticipated weather patterns affected only project businesses that employed digital project management tools. Discoveries in this study revealed that several barriers' tools such as: the lack of knowledge about digital project management solutions, the high costs associated with these solutions, a lack of resources for using these solutions and the lack of technological expertise to handle digital project management tools affected project businesses that did not employ digital project management. These barriers were also identified as factors that affected the readiness of project businesses to adopt digital project management tools. Several recommendations were listed in this study to help tackle the issues discovered in this study.

Recommendations - There are several recommendations derived from this study which are listed below:

- It is recommended that the South African business development agencies should consider offering ongoing training programmes that are focused on digitalisation and knowledge building in the discipline of project management.
- The South African mining sector should set a minimum standard requirement for project management training.
- Project businesses should invest in innovation and technology.
- Software developers should consider integrating with external systems that can enhance project management processes.

Below are recommendations that are listed in alignment with the limitations of this study. These recommendations are to be considered in future studies:

- A qualitative or longitudinal method of collecting data could be used in future research and investigations to collect further information regarding the use of digital project management tools.
- Future research and investigations could be based on experimental research design to investigate the implications of future developments of digital project management tools. A correlational research design could also be considered in future research when investigating the connection of numerous experiences among project businesses in different business sectors.
- Future studies could focus on different mining industries, business sectors and other developing countries.

Limitations and future research - Several limitations were identified that have implications for future investigations and research projects:

- The research instrument of this study was closed-ended, thereby rendering the research methodology of this research to be quantitative, which restricted the opinions of the respondents.
- This study was based on a case study method, which focused on a limited group of project businesses in a restricted location of the Limpopo Province of South Africa.
- The study was also conducted in an opencast platinum mine region and cannot be generalised, as such empirical findings in different mining industries and other business sectors are needed.

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