ASSESSMENT OF DIFFERENCES IN WEB-BASED IDEA MANAGEMENT SYSTEMS: INDUSTRY PERSPECTIVE

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Abstract. As a result of increased digitization and increasingly dynamic work environments, web-based idea management system (IMS) research has significantly increased in practical and academic relevance. A Web-based IMS is a manageable, systematic tool to generate and evaluate ideas. The following research gap was identified in IMS literature by the authors - are there industry-specific differences in web-based IMS results based on application type? To fill the gap, this paper aims to investigate how the number of ideas created (quantity), the number of ideas selected (quality), and the number of involved people (involvement) changes depending on the applied IMS type and industry. To achieve the aim of the research, the authors conducted a global survey of 504 organisation representatives from different industries that apply web-based IMS within their organisations. Based on the analysis, Chi-squared test results (p <0.05) allow us to conclude that there is a statistically significant difference at a confidence level of 95% in the number of ideas created and people involved using all five IMS types. Further test results (p < 0.05) allow us to conclude that there is a statistically significant difference at a confidence level of 95% between industry groups in the number of ideas selected when applying external, mixed and active IMS types. All industry groups, except the manufacturing industry, generate more ideas with mixed and active IMS. Agriculture, forestry, fishing, mining, quarrying and activities of households as employers generate the greatest involvement when using mixed, external, and active IMS, while more ideas are selected when using mixed, active and internal IMS. Results show that different types of IMS applications could result in different outcomes in different industries. The main contribution of this research highlights the most likely IMS type industry should use to achieve a desired idea management outcome.

Keywords: idea management systems, industry, Web-based, assessment, performance.

JEL code: M15, O36, O32

Introduction

Web-based idea management systems (IMS) are applied by many well-known organisations such as Panasonic, Fujitsu, Volvo, etc. Many cases show the positive effect that the use of web-based IMS has on organisation performance (Quandt et al., 2019). There is a variety of different tools and methods organisations can use to support their creative idea generation process, (e.g. Bonnardel and Didier, 2020) and web-based IMS is one of such tools that provide a systematic and manageable process for idea management (Mikelsone et al., 2019; Poppe 2020). Web-based IMS provides the users with the first steps to the innovation process (Herrmann et al., 2020), which supports organisations with generating and evaluating ideas. There is a lack of a general model in literature for corporate idea management models (Gerlach and Brem, 2017). This research is based on literature from the system (e.g. Bailey & Horvitz, 2010; Vandenbosch et al., 2006) and structure perspective (e.g. Divakaran, 2016; Narvaez & Gardoni, 2015).

Based on the reviewed literature on IMS and previous works of the authors, it was determined that no research explores how different IMS application types influence IMS results in different industries (Mikelsone et al., 2019). It is very important to fill the gap for the following reason - an exploration of the different IMS type applications and their results in different industries could benefit future research and provide end-users with practical advice. Organisations would be able to make a better-informed decision

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when choosing the type of web-based IMS application that would produce the desired outcome based on their industry group. Although there is a large variety of different web-based IMS and many well-known organisations use these systems, the DeSanctis and Poole (1994) describe in Adaptive Structuration Theory that it is important to understand how different structures (in this paper – web-based IMS) and systems (in this paper – industries) influences each other (in this paper adaptation is highlighted by different IMS types). In practice, both the users and developers see the potential of these systems. The biggest drawback when using web-based IMS is the lack of consistency in positive outcomes, due to which some organisations are hesitant to develop, implement and use these systems. To overcome this stigma, it is important to research web-based IMS type applications in different industries – to spotlight the most promising application types and help organisations make better-informed decisions. To fill the gap, the following hypotheses will be tested: (H1) The number of ideas created using web-based IMS varies across industries; (H2) The number of ideas selected using web-based IMS varies; (H3) The number of people involved in web-based IMS varies from industry to industry.

To test these hypotheses, the authors performed and analysed results from a global survey consisting of 504 representative responses from different organisations and 20 different industries, that apply webbased IMS. This study's focus is on an organisational level to research web-based IMS application within the Adaptive Structuration Theory framework.

The research presents the following contributions: (1) the results help to understand what outcomes can be expected when applying different web-based IMS application types in different industries; (2) the research results highlight the benefits/implications of adopting different types of IMS for organisations; (3) paper provides managers with the knowledge that lets them make better-informed decisions when choosing a web-based IMS that is the best for the achieving the desired outcome in a given context. Web-based IMS types and their impact on the IMS results provide an insight into the potential application of these systems in different application scenarios.

1. Materials and methods

There was no data on how many organisations globally apply web-based IMS. That was the reason the authors have created separate research to summarise the information about the existing commercially available web-based IMS and have collected information about the approximate number of customers using web-based IMS. According to that research, 107 unique web-based IMS companies have approximately 120000 clients (companies that apply web-based IMS). This research took place in the autumn of 2020. The survey platform "The QuestBack" (https://www.unipark.com/) created by UNIPARK was used to deliver the survey. The main reasons for selecting the above platform were: (1) it focuses on academic surveys; (2) it is widely recommended by leading researchers; (3) the data security required by IMS representatives is ensured by design - BSI-certified data centre per ISO 27001 requirements; (4) it complies with the EU GDPR (General Data Protection Regulations). The survey and analysis were conducted in autumn 2020, resulting in 504 responses from different organisation representatives that apply web-based IMS. The sample of 504 organisations represents 20 different industries. In some industries, the number of responses was small, e.g., Mining and quarrying (5), activities of households as employers (6), Agriculture, forestry, and fishing (10). To ensure a sample size that was large enough for statistical analysis, these industries were grouped around similar economic activities resulting in 7 unique groups (Table 1).

Table 1

Grouped In	dustries and	the Number	of Respondents
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Group	Industries included	Responses
1	Manufacturing	67
2	Construction; Real estate activities; Electricity, gas, steam, and air conditioning supply; Water supply, sewerage, waste management and remediation	90
3	Information and communication; Professional, scientific, and technical activities	75
4	Arts, entertainment, and recreation; accommodation and food service activities	68
5	Financial and insurance activities; Administrative and support service activities; Other service activities	70
6	Wholesale and retail trade; Repair of motor vehicles and motorcycles; Transportation and storage	79
7	Other industries: Agriculture, forestry and fishing, mining, and quarrying, activities of households as employers	55
	Total	504

Source: author's calculations based on survey data

The survey included five different IMS application types based on research by Mikelsone et al. (2019): (1) passive; (2) active; (3) internal; (4) external and (5) mixed. (1) passive IMS application type is without a task focus (participants are welcomed to submit all kinds of ideas without a specific task/goal); (2) in active IMS application type the application process provides the opportunity to create separate/specific tasks (participants generate ideas for the specific task); (3) in internal IMS application type, only people from within the organisation are involved in idea creation (mostly employees, separate departments, etc.); (4) in external IMS application type, the people outside of the organisation are involved in the idea creation process (e.g., crowds, clients, experts, etc.); (5) mixed IMS application type combines internal and external application types, by involving people from within and outside of the organisation.

This paper uses the following IMS results as a measure of outcome of idea management process: idea quality (ideas selected), idea quantity (ideas created) and involvement (people involved). The quality of ideas is the average amount of selected ideas for further development. The quantity of ideas is the number of ideas created, while the involvement measures the number of involved people in the idea creation process (Selart & Johansen, 2011; Giotra et al., 2010; Korde & Paulus, 2016; Deichmann, 2012).

For each of the industry groups and IMS application type used, the mean values of ideas created, selected, as well as the number of people involved were calculated. To test the hypothesis, the Chi-squared and t-test were used to measure whether there are statistically significant variations between IMS types, industries, and their idea management outcomes. For each test statistic, the p-values and degrees of freedom were calculated. The p-value is the probability of obtaining a value of the test statistic that is as extreme as, or more extreme than, the actual value obtained when the null hypothesis is true. Thus, the p-value is the smallest significance level at which a null hypothesis can be rejected, given the observed sample statistic. Hypothesis for testing: (H1) The number of ideas created using web-based IMS varies across industries; (H2) The number of ideas selected using web-based IMS varies across industries; (H3) The number of people involved in web-based IMS varies from industry to industry.

2. Results and discussion

Analysis of ideas created when applying different IMS types in different industry groups

As shown in Table 2, the mean values of ideas created vary between industry groups. Are these differences statistically significant? Analysis of variances was used to assess the significance of the difference between the number of ideas created in different industry groups - the chi-squared test results are summarised in the following table. (Fox & Weisberg, 2019). Calculations were done using the ANOVA function of R version 4.1.2 (R Core Team, 2021).

Table 2

Industry group	Internal IMS	External IMS	Mixed IMS	Active IMS	Passive IMS
1	1 332.9	5 721.8	5 532.8	3 693.1	748.3
2	1 248.3	4 876.8	4 900.8	3 245.5	464.7
3	1 387.7	4 946.4	5 507.3	4 176.6	1 269.9
4	995.8	5 402.5	5 916.4	4 618.2	1 280.6
5	1 058.4	6 011.1	5 447.5	4 458.9	695.4
6	1 924.4	5 726.5	5 976.2	5 198.2	1 269.6
7	526.7	4 227.2	4 994.2	4 276.4	1 104.2
Total	1 229.7	5 268.7	5 439.8	4 193.7	975.7

Mean Values of Ideas Created by Industries and Applied IMS Types

Source: author's calculations based on survey data

Chi-squared test results (p < 0.05) allow us to conclude that the differences in the number of ideas created are statistically significant using all five IMS types at a confidence level of 95% (Table 3.)

Table 3

Chi-squared Test Results on Differences Between Mean Values of Ideas Created by Industries and Applied IMS Types

IMS Type	Internal IMS	External IMS	Mixed IMS	Active IMS	Passive IMS
<i>p</i> -value	0.0361	0.0003	0.0008	0.0174	0.0213

Source: author's calculations based on survey data

Additional questions were raised during the study - is there a statistically significant difference in the number of ideas created between competing IMS types: external vs internal, active vs passive, mixed vs active? Table 4 summarizes the test's results using R function *t.test* from package '*Stats*'.

Table 4

Industry	EIMS vs IIMS		AIMS v	s PIMS	MIMS vs AIMS		
group	<i>t</i> -statistic	t-critical	<i>t</i> -statistic	t-critical	<i>t</i> -statistic	<i>t</i> -critical	
1	4.0899	2.0595	6.0004	1.9908	2.5036	1.9901	
2	4.8837	2.0211	6.7012	1.9855	2.3738	1.9901	
3	5.3449	1.9983	5.0112	1.9935	1.9900	1.9925	
4	5.9585	2.0395	5.2315	1.9949	1.8370	1.9949	
5	7.0337	2.0049	6.6535	1.9897	1.2940	1.9930	
6	4.7332	2.0167	7.4270	1.9867	1.0869	1.9917	
7	6.7680	2.0369	5.4495	1.9996	0.9586	1.9901	
Total	14.0055	1.9672	14.8636	1.9639	4.5022	1.9643	

Test on Differences Between Mean Values of Ideas Created by Industries and Comparable IMS Types Results

Source: author's calculations based on survey data

There is statistical significance in all industry groups when looking at the first two pairs of comparable IMS types. From this, it can be concluded that the external IMS type leads to a higher quantity of ideas created than the internal IMS type in all industry groups. For the third pair of IMS types, the first and second industry group is statistically significant. From this, it can be concluded that the third pair, active IMS type, leads to a higher quantity of ideas created than the passive IMS type in all industry groups. The mixed IMS type leads to a higher quantity of ideas created than the active IMS type in the first and second industry groups. These statistical inferences are all accurate at a 95% confidence level. Lastly, for the third to the seventh industry group, the survey did not provide sufficient evidence that mixed IMS leads to a higher quantity of ideas created than the set evidence level.

Analysis of Ideas Selected Applying Different IMS Types in Different Industry Groups

As shown in Table 5, the mean values of ideas selected vary between industry groups.

Table 5

Industry group	Internal IMS	External IMS	Mixed IMS	Active IMS	Passive IMS
1	13.7	17.2	26.5	19.3	7.1
2	10.3	11.2	27.3	19.4	2.6
3	14.2	8.5	26.6	18.0	8.9
4	15.2	8.4	15.7	20.9	3.8
5	15.0	17.1	26.7	22.1	3.0
6	13.5	13.5	28.1	24.7	6.4
7	11.3	7.3	17.4	15.8	2.6
Total	13.2	11.8	24.4	20.2	5.6

Mean Values of Ideas Selected by Industries and Applied IMS Types

Source: author's calculations based on survey data

Analysis of variances was used to assess the statistical significance of the differences between the number of ideas selected in different industry groups - the chi-squared test results are summarised in the following Table 6.

Table 6

Chi-squared Test Results on Differences Between Mean Values of Ideas Selected by Industries and Applied IMS Types

IMS Type	Internal IMS	External IMS	Mixed IMS	Active IMS	Passive IMS
<i>p</i> -value	0.1329	0.0192	0.0147	0.0058	0.0776

Source: author's calculations based on survey data

Chi-squared test results (p < 0.05) allow us to conclude that the differences between industry groups in the number of ideas selected are statistically significant using external, mixed, and active IMS types at a confidence level of 95%. In the case of internal and passive IMS type, the survey did not provide sufficient evidence that the differences between industries in the number of ideas selected are statistically significant at a confidence level of 95%.

Additional questions were raised during the study - is there a statistically significant difference in the number of ideas selected between competing IMS types: external vs internal, active vs passive, mixed vs active? Table 7 summarises the test results using R function *t.test* from package '*Stats*'.

Table 7

Industry group	EIMS vs IIMS		AIMS v	s PIMS	MIMS vs AIMS		
	<i>t</i> -statistic	t-critical	<i>t</i> -statistic	<i>t</i> -critical	<i>t</i> -statistic	t-critical	
1	0.5485	2.0639	4.0110	1.9879	1.3189	2.0181	
2	0.2475	2.0244	7.3141	1.9879	1.5723	1.9939	
3	1.6272	2.0049	2.4638	2.0057	1.6792	2.0181	
4	1.5938	2.0066	5.5633	2.0040	1.4742	1.9913	
5	0.4191	1.9925	8.3273	1.9983	0.9951	1.9996	
6	0.0094	2.0154	4.5102	1.9913	0.7146	2.0003	
7	1.8957	2.0086	5.8524	2.0129	0.3972	2.0141	
Total	0.8334	1.9659	11.6034	1.9636	2.2356	1.9658	

Test on Differences Between Mean Values of Ideas selected by Industries and Comparable IMS Types

Source: author's calculations based on survey data

Since *t*-statistic > *t*-critical in all industry groups for the second pair of comparable IMS types, we can conclude that active IMS type allows a higher number of ideas selected than passive IMS type in all industry groups. This statistical inference is correct at a 95% confidence level. For the first and third pairs of comparable IMS types, the survey did not provide sufficient evidence that the differences of ideas selected in all industry groups are statistically significant at a confidence level of 95%.

Analysis of Involvement Applying Different IMS Types in Different Industry Groups

As shown in Table 8, the mean values of involvement vary between industry groups.

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Table 8

Industry group	Internal IMS	External IMS	Mixed IMS	Active IMS	Passive IMS
1	1 278.1	8 750.3	11 732.1	8 757.3	720.0
2	686.4	8 831.8	9 294.9	5 988.5	1 867.3
3	2 150.3	15 203.1	21 715.9	12 847.1	4 322.6
4	2 829.5	15 551.9	14 427.8	9 863.8	4 075.4
5	2 684.5	12 201.3	18 073.5	12 517.9	2 594.5
6	2 144.7	19 470.0	15 641.9	12 500.8	7 984.5
7	363.4	9 491.7	10 866.4	11 454.8	2 901.0
Total	1 751.0	12 910.0	14 368.3	10 381.5	3 573.5

Mean Values of Involved by Industries and Applied IMS Types

Source: author's calculations based on survey data

Analysis of variances was used to assess the significance of the difference between the involvement in different industry groups - the chi-squared test results are summarised in Table 9.

Table 9

Chi-squared Test on Differences Between Mean Values of Involved by Industries and Applied IMS Types *p*-values

IMS Type	Internal IMS	External IMS	Mixed IMS	Active IMS	Passive IMS
p-value	0.0093	<0.0001	0.0097	0.0339	0.0023

Source: author's calculations based on survey data

Chi-squared test results (p < 0.05) allow us to conclude that the differences between industry groups in the involvement are statistically significantly using all IMS types at a confidence level of 95%.

Additional questions were raised during the study - is there a statistically significant difference in the involvement between competing IMS types: external vs internal, active vs passive, mixed vs active? Table 10 summarises the test's results using R function *t.test* from package '*Stats*'.

Table 10

Test on Differences Between Mean Values of Involved by Industries and Comparable IMS Types

Industry	EIMS vs IIMS		AIMS v	s PIMS	MIMS vs AIMS		
group	<i>t</i> -statistic	<i>t</i> -critical	<i>t</i> -statistic	<i>t</i> -critical	<i>t</i> -statistic	<i>t</i> -critical	
1	2.2897	2.1009	3.4685	1.9908	0.9624	1.9901	
2	3.9923	2.0423	2.1275	1.9925	1.4639	1.9917	
3	4.8404	2.0129	2.9750	1.9876	1.7401	1.9996	
4	3.7175	2.0117	2.5057	1.9930	1.2789	2.0076	
5	3.7169	1.9971	2.7274	1.9983	1.2793	1.9955	
6	3.3830	2.0484	1.7276	1.9876	0.8271	1.9917	
7	6.3638	2.0452	2.7950	2.0049	0.1488	1.9901	
Total	8.6904	1.9689	6.3755	1.9640	2.7254	1.9647	

Source: author's calculations based on survey data

Since t-statistic > t-critical in all industry groups for the first two pairs of comparable IMS types, except industry group sex when active and passive IMS is compared, we can conclude that external IMS involves

more than internal IMS in all industry groups, as well as active IMS, involves more than passive IMS in all industry groups, except industry group sex. These statistical inferences are correct at a 95% confidence level. The survey did not provide sufficient evidence at a confidence level of 95% that mixed IMS involves more than active IMS.

Conclusions

Different types of IMS applications across different industries could lead to different idea management outcomes in terms of quantity of ideas, quality of ideas and people involved in the idea management process. In this paper, the authors highlight the different outcomes organisations in different industries can expect based on the different IMS type applications. Through researching potential web-based IMS applications, it is concluded that these systems can be universally applied to different specific uses and by different organisations and industries. The inferences within this research are made as follows:

Differences in the number of ideas created are statistically significantly using all five IMS types at a confidence level of 95%. Authors conclude that external IMS type allows to create more ideas than internal IMS type in all industry groups, as well as active IMS type allows a higher number of ideas created than passive IMS type in all industry groups, and mixed IMS type allows to create more ideas than active IMS type in the first and second industry group. These results correspond to the existing literature which highlights that the connections between potential adopters and other actors of innovation are most important in ensuring the diffusion of innovation (e.g. Boukamel et al. 2019; Skinner et al., 2018). The active IMS type is more attractive when the desired result is to generate more ideas than the passive type if the people involved is not known in advance. To create more ideas in all industries, except the manufacturing industry, mixed and active IMS types should be applied. The manufacturing industry generates more ideas with external and active IMS types.

Results show that the differences between industry groups in the number of ideas selected are statistically significant using external, mixed, and active IMS types at a confidence level of 95%. In the case of internal and passive IMS, the survey did not provide sufficient evidence that the differences between industries in the number of ideas selected are statistically significant at a confidence level of 95%. Based on research, it can be concluded that active IMS allows a higher number of ideas selected than passive IMS in all industry groups. This statistical inference is correct at a 95% confidence level. For the first and third pairs of comparable IMS types, the survey did not provide sufficient evidence that the differences of ideas selected in all industry groups are statistically significant at a confidence level of 95%.

The following IMS types should be applied in different industries to create more ideas that will be selected for development.

- The manufacturing industry generates more ideas for selection with mixed, active and external IMS types.
- Construction; Real estate activities; Electricity, gas, steam and air conditioning supply Water supply, sewage, waste management and remediation – generates more ideas for selection with mixed, active and external IMS types.
- Information and communication, professional, scientific, and technical activities generate more ideas for selection with mixed, active, and internal IMS types.
- Arts, entertainment, and recreation; accommodation and food service activities generate more ideas for selection with mixed, active, and internal IMS types.

- Financial and insurance activities; Administrative and support service activities; Other service activities - generates more ideas for selection with mixed and active IMS types.
- Wholesale and retail trade; Repair of motor vehicles and motorcycles; Transportation and storage generate more ideas for selection with mixed, active, and internal IMS types.
- Agriculture, forestry and fishing, mining, and quarrying, activities of households as employers generate more ideas for selection with mixed, active and internal IMS types.

From the research, it can be concluded that the differences between industry groups in the involvement are statistically significant using all IMS types at a confidence level of 95%. In all industry groups, for the first two pairs of comparable IMS types, when active and passive IMS types are compared, we can conclude that the external IMS type involves more than the internal IMS type in all industry groups, as well as active IMS type, involves more than passive IMS type in all industry groups, except in wholesale and retail trade, repair of motor vehicles and motorcycles, transportation and storage industries. These statistical inferences are correct at a 95% confidence level. The survey did not provide sufficient evidence at a confidence level of 95% that mixed IMS type involves more than active IMS type.

The following IMS types can be applied in different industries to boost involvement.

- Manufacturing industry creates the greatest involvement with mixed, active and external IMS types.
- Construction, real estate activities, electricity, gas, steam and air conditioning supply Water supply, sewerage, waste management and remediation – create the greatest involvement with mixed, active, and external IMS types.
- Information and communication, professional, scientific, and technical activities create the greatest involvement with mixed, active, and external IMS types.
- Arts, entertainment, recreation, accommodation, and food service activities create the greatest involvement with internal, active, and mixed IMS types.
- Financial and insurance activities; Administrative and support service activities; Other service activities - create the greatest involvement with mixed, active, and external IMS types.
- Wholesale and retail trade; Repair of motor vehicles and motorcycles; Transportation and storage create the greatest involvement with external, active, and mixed IMS types.
- Agriculture, forestry and fishing, mining, and quarrying, activities of households as employers create the greatest involvement with mixed, active and external IMS types.

The research has the following limitations: the study only deals with available commercial web-based IMS, not with privately designed or non-commercial web-based IMS. In further research, the privately designed or non-commercial web-based IMS could be researched. The study was limited to 7 industry sets grouped based on similar economic activity due to the limited sample size for some of the 20 industries from which responses were received.

The research presents the following contributions: (1) the results help to understand what outcomes can be expected when applying different web-based IMS application types in different industries; (2) the research results highlight the benefits/implications of adopting different types of IMS for organisations; (3) paper provides managers with the knowledge that lets them make better-informed decisions when choosing a web-based IMS that is the best for the achieving the desired outcome in a given context. Web-based IMS types and their impact on the IMS results provide an insight into the potential application of these systems in different application scenarios.

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