Software Engineering Leadership Competencies in the Information Technology Field

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ABSTRACT

The purpose of this study was to explore how software engineering leaders described leadership competencies in their positions within the information technology field. The research was based on Katz's (1955) three skills model for effective leadership. The overarching research question that guided the study was how software engineering leaders described the utilization of technical, human, and conceptual skills in their leadership positions. Interviews were analyzed using thematic analysis, which generated six themes to address the research questions. New ideas emerged on engineering leadership based on real-world leaders' descriptions of leadership skills with an emphasis on emotional intelligence.

INTRODUCTION

The field of information technology has become an integral part of organizations to support the fast-changing global business world. Within the information technology field, software engineering leaders play a key role in delivering results to customers through new ideas and technological advances (Perri, Farrington, Johnson, & O'Connor, 2019). Information technology is a broad field consisting of professionals who are focused in areas such as software development, systems analysis, network administration, database administration, and numerous other technology-focused disciplines (Beckhusen, 2016). The need for skilled software engineering leaders continues to increase due to the tenfold growth in the information technology workforce since 1970 (Beckhusen, 2016). Within the many disciplines of the information technology field, software engineering managers are one of the largest groups (Beckhusen, 2016). As technology continues to expand, so does the role of software engineering leadership.

Leaders in the technical world of software engineering are challenged with fast-changing technologies, understanding the conceptual aspects of the business, and communicating effectively with others in the organization. The evolving world of technology will continue to put pressure on leaders within the information technology field to modify their role and skillsets (Williams, 2016). Capretz and Ahmed (2018) discovered that people moving into engineering leadership positions struggle with the human aspects of the role. The technical aspects of engineering may be predictable and logical, yet human skills and conceptual skills are less predictable (Capretz & Ahmed, 2018). Kalliamvakou et al. (2017) posited that technical skills were not as important in engineering leadership positions, yet Rottmann, Reeve, Sacks, and Klassen (2016) indicated technical skills were needed in engineering leadership. Thus, there are discrepancies in the literature on the importance of technical, human, and conceptual skills in engineering leadership which needs further investigation.

LITERATURE REVIEW

As the world becomes more reliant on technology advances, the skills of software engineering leaders continue to change. The changes in software engineering leadership skills also impact engineers who are transitioning to leadership roles. Perry, Hunter, Currall, and Frauenheim (2017) noted the need for future engineering leaders to have a variety of skills which may include technical, innovation, and leadership skills. Future engineering leaders may also need to develop social, human, and conceptual skills (Boyatzis, Rochford, & Cavanagh, 2017; Harrison, Burnard, & Paul, 2018; Racine, 2015). The skill set needed for engineering leadership is unique due to global competitiveness, innovation, and advances in technology (Perry et al., 2017), so it is valuable to understand the competencies utilized by current software engineering leaders to help prepare upcoming leaders.

While the existing literature has considered various aspects of leadership skills, there was still a need for additional research. Boyatzis et al. (2017) conducted a quantitative study to investigate the connection between interpersonal skills and effectiveness with engineers from a multi-national manufacturing company. Boyatzis et al. (2017) found a positive connection between interpersonal skills and an engineer's effectiveness but suggested further research was needed to validate the results. Kalliamvakou et al. (2017) utilized a mixed-method study with engineers and engineering managers to understand engineering leadership skills and suggested studying related perceptions within other organizations. Medcof (2017) summarized existing literature in the broad area of technology management to explain the utilization of leadership skills at different management levels and suggested further research due to discrepancies in the literature and the lack of research with technology leaders in organizations. Harrison et al. (2018) studied leadership skills through an entrepreneurial lens and concluded leaders need technical skills, human skills, conceptual skills, and entrepreneurial skills but suggested further work was needed to validate these claims. Rottmann et al. (2015) included entrepreneurial skills as an engineering leader skill and coupled it with the conceptual area of innovation. Based on the need for additional research, the focus of the study was centered on the need to explore how software engineering leaders describe the utilization of skills in their leadership positions.

THEORETICAL FOUNDATION

The theoretical foundation for the study was based on Katz's (1955) three skills model of an effective administrator. Katz (1955) used the concept of administrator and leader interchangeably within his description of a skills approach to leadership. Katz's (1955) three skills model provided the foundation for exploring the utilization of technical skills, human skills, and conceptual skills in leadership positions by software engineering leaders. This researcher utilized Katz's (1955) three skills model to guide the research questions of the study: (R1) How do software engineering leaders utilize technical skills in their leadership positions? (R2) How do software engineering leaders utilize human skills in their leadership positions? (R3) How do software engineering leaders utilize conceptual skills in their leadership positions? A qualitative descriptive methodology and research design were used to address the research questions, with the Northouse Skills Inventory Survey (Northouse, 2018) and in-depth interviews intended to obtain descriptions of the utilization of technical, human, and conceptual skills from a real-world perspective by software engineering leaders.

Within the seminal article, Katz (1955) acknowledged how the three skills (technical, human, and conceptual) of an effective administrator/leader are interrelated yet also stand on their own merit, so it is valuable to understand the background of each skill individually and holistically. Katz (1955) described technical skills as having proficiency and specialized knowledge within a specific discipline. The development of technical skills has been the focus within organizations throughout the years due to the concrete nature of training individuals and following up with on-the-job experience (Katz, 1955). As part of his analysis, Katz (1955) suggested that technical skills are more prominent in lower-level leadership positions and become less necessary in top management positions.

In 2009, Katz updated his thoughts on technical skills by suggesting leaders in higher-level management positions need to have enough technical knowledge, such as industry background, to make good business decisions. Hence, the first research question, which explores how software engineering leaders describe the utilization of technical skills in their leadership positions, considered the technical skills aspects of Katz's (1955, 2009) skills-based model.

Leaders within organizations may use technical skills to work on processes or physical objects, but also need human skills that focus on working with people (Katz, 1955). According to Katz (1955), leaders demonstrate human skills through self-reflection, such as paying attention to personal reactions

and being aware of people's behavior. Katz (1955) indicated that developing human skills includes improvements in areas such as communication skills, empathy, self-awareness, and awareness of others.

Similar to technical skills, Katz (1955) suggested that leaders in lower levels of management may have higher utilization of human skills due to the number of direct contacts with subordinates, but in contrast to technical skills, human skills continue to be valuable at all levels of management. Katz (2009) further refined his thinking on human skills by clarifying the different levels of human skills, such as intragroup skills at lower levels of management and intergroup skills which may be more important at higher levels of management. The second research question to explore how software engineering leaders describe the utilization of human skills brought new insights into the need to develop human skills within organizations.

In addition to technical and human skills, Katz (1955) specified leaders, especially in higher-level management positions, need conceptual skills. Conceptual skills consist of leaders being able to see the organization as a whole by understanding the interconnectivity within the organization, setting a vision, defining objectives, and making decisions in the best interest of stakeholders (Katz, 1955). Katz (2009) altered his initial thoughts on utilizing conceptual skills and suggested that leaders may need conceptual skills at all levels of leadership within the organization. The third research question added to the ongoing discussion of conceptual skills in leadership positions by exploring how software engineering leaders describe the utilization of conceptual skills in their leadership positions.

RESEARCH METHOD

A qualitative methodology was the best approach for the study due to the inductive nature of the phenomenon to gain insight into the utilization of technical skills, human skills, and conceptual skills in leadership positions by software engineering leaders. Qualitative methodology is used when the researcher is interested in capturing the participant's experiences in a natural setting (Yilmaz, 2013). Obtaining descriptions of the utilization of skills from software engineering leaders in a real-world context may lead to improvements in software engineering leadership. Merriam and Tisdell (2016) claimed the value of using a qualitative methodology is based on the rich information gathered from the participants that can be used to make improvements within organizations. The study used an inductive process with the researcher as the instrument to gather data on how software engineering leaders describe the utilization of technical skills, human skills, and conceptual skills in their leadership positions.

Study Sample

The general population for the study was all software engineering leaders within the information technology field in the United States. The target population was all middle and top-level software engineering leaders within the information technology field in the United States who had more than two years of leadership experience within the software engineering discipline and were connected to the researcher's LinkedIn network. Eighty people in the researcher's LinkedIn network were identified as software engineering leaders within the information technology field, based on their job title, and thus made up the target population for the study. The sample size consisted of 23 software engineering leaders for the Northouse Skills Inventory Survey (Northouse, 2018). Out of the 23 software engineering leaders who participated in the survey, 14 leaders continued to participate in the study by engaging in the interviews. Table 1 details the demographics of the software engineering leaders.

Data Collection

Participants were passively recruited from the researcher's LinkedIn network in the United States based on their work experience in software engineering leadership. The types of leaders who were considered as participants were middle and top engineering leaders who had more than two years of leadership experience within the software engineering discipline in the information technology field. The surveys were completed by 23 of the participants. The Northouse Skills Inventory Survey (Northouse, 2018) consisted of 18 closed-ended statements (Table 2), which the participants rated on a scale of 1 (Not True), 2 (Seldom True), 3 (Occasionally true), 4 (Somewhat true), and 5 (Very true). The participants completed the survey via the SurveyMonkey with no time limit.

The interviews included 14 participants who were interviewed via phone/video conference for a minimum of 30 minutes, using a recording device. The researcher utilized an inquiry-based conversation, as suggested by Castillo-Montoya (2016), to obtain details about the participants' experiences by asking

one question at a time, not interrupting, asking clarifying questions, and communicating follow up procedures at the end of the interview.

Data Analysis

The data gathered via the Northouse Skills Inventory Survey (Northouse, 2018) was analyzed by calculating individual participant's scores for each area of the survey (technical, human, and conceptual), as well as mean and standard deviation for each survey statement. The individual participant's scores were calculated based on the three areas of the survey and aligned to the research questions. For example, technical skills (RQ1) was comprised of statements 1, 4, 7, 10, 13, 16, human skills (RQ2) was comprised of statements 2, 5, 8, 11, 14, 17, conceptual skills (RQ3) was comprised of statements 3, 6, 9, 12, 15, 18. In addition to the individual participant's scores, each response was analyzed by calculating basic descriptive statistics such as frequency counts, mean values, and standard deviation.

TABLE 1

DEMOGRAPHICS: NORTHOUSE SKILLS INVENTORY SURVEY (2018) AND INTERVIEWS

Software Engineering Leaders	Title	Length of Time in Leadership Role	Resides in the United States	Has LinkedIn Account
Participant 1	Director	15+ years	Yes	Yes
Participant 2	Manager	6-8 years	Yes	Yes
Participant 3	Senior Director	15+ years	Yes	Yes
Participant 4	Senior Manager	6-8 years	Yes	Yes
Participant 5	Vice President	15+ years	Yes	Yes
Participant 6	Senior Manager	15+ years	Yes	Yes
Participant 7	Director	15+ years	Yes	Yes
Participant 8	Director	12-14 years	Yes	Yes
Participant 9	Director	15+ years	Yes	Yes
Participant 10	Director	9-11 years	Yes	Yes
Participant 11	Director	9-11 years	Yes	Yes
Participant 12	Senior Director	15+ years	Yes	Yes
Participant 13	Senior Director	15+ years	Yes	Yes
Participant 14	Senior Manager	3-5 years	Yes	Yes
Participant 15	Vice President	15+ years	Yes	Yes
Participant 16	CTO	12-14 years	Yes	Yes
Participant 17	Senior Manager	15+ years	Yes	Yes
Participant 18	Senior Manager	15+ years	Yes	Yes
Participant 19	Vice President	9-11 years	Yes	Yes
Participant 20	Vice President	15+ years	Yes	Yes
Participant 21	Senior Director	15+ years	Yes	Yes
Participant 22	Vice President	15+ years	Yes	Yes
Participant 23	Vice President	15+ years	Yes	Yes

A thematic analysis approach was used to find patterns in the interview data. The data was loaded into MAXQDA and initial codes were created based on responses from the participants. After the coding was complete, sub-themes were created before developing the overarching themes. Once the sub-themes were identified, themes were generated that answered each research question. Due to time limitations, the researcher was the only person involved in the creation of themes.

Limitations

In addition to the limitation of theme creation, other limitations existed in the study. Qualitative studies may be subject to bias due to the researcher being part of the instrument and involved in data analysis (Yin, 2016). Some of the limitations that could introduce bias may include interactions with the participants during the interview and interaction with the data during the data analysis, thus the research procedures were described to the participants. During interactions with participants during the interview, it was important to be conscious of potential personal bias throughout the interview and analysis process. Yin (2016) described personal bias as a limitation in qualitative methods due to the risk of viewing the research through a particular research lens. To overcome this limitation, reflexivity was practiced during the interview process by asking open-ended questions and adhering to the interview protocol. To address the limitation of potential bias during data analysis, the researcher removed participants' names from the data. In addition to removing participant information, a thematic analysis process was utilized to analyze the data.

TABLE 2

NORTHOUSE SKILLS INVENTORY SURVEY (2018)

1. I enjoy getting into the details of how things work.
2. As a rule, adapting ideas to people's needs is relatively easy for me.
3. I enjoy working with abstract ideas.
4. Technical things fascinate me.
5. Being able to understand others is the most important part of my work.
6. Seeing the "big picture" comes easy for me.
7. One of my skills is being good at making things work.
8. My main concern is to have a supportive communication climate.
9. I am intrigued by complex organizational problems.
10. Following directions and filling out forms comes easily for me.
11. Understanding the social fabric of the organization is important to me.
12. I would enjoy working out strategies for my organization's growth.
13. I am good at completing the things I've been assigned to do.
14. Getting all parties to work together is a challenge I enjoy.
15. Creating a mission statement is rewarding work.
16. I understand how to do the basic things required of me.
17. I am concerned with how my decisions affect the lives of others.
18. Thinking about organizational values and philosophy appeals to me.

Another limitation identified by the researcher was the potential prior connections with some of the participants because the researcher has a LinkedIn account. Since the target population of the study includes middle and top-level engineering leaders within the information technology field and have a connection with the researcher on LinkedIn, there was a chance the researcher may have had past connections with the participants. If a participant had a past relationship with the researcher based on being in the information technology field or having the connection on LinkedIn, the potential relationship may have influenced the responses during the interview, such as not receiving honest answers to questions, and after the interview during data analysis. To help overcome this potential limitation, the anonymity and confidentiality of the data were reiterated before starting the interview and the participants knew they could decline to participate in the interview.

RESULTS

Based on the data analysis, the researcher identified six themes that supported the research questions. The six themes that emerged were:

Theme 1: Technical background can be utilized without involvement in technical details.

Theme 2: Technical background can be utilized to solve problems and provide technical direction.

Theme 3: Emotional intelligence skills are utilized to manage social awareness, self-awareness, and self-management.

Theme 4: Relationship management skills are utilized for effective communication and interaction with others.

Theme 5: Seeing the big picture based on strategic and critical thinking skills can be utilized to solve problems and drive direction.

Theme 6: Innovation can be encouraged through the ability to create fortuitous interactions and understand the business.

While each of the themes lined up with the research questions, there was also some overlap between the themes. For example, the attributes within the theme *relationship management skills are utilized for effective communication and interaction with others* was seen throughout the responses to the interview questions.

DISCUSSION OF FINDINGS

Summary of Findings

The data collected by the researcher in this study answered the three research questions based on the utilization of technical skills, human skills, and conceptual skills in software engineering leadership positions. Analysis of data from the study resulted in six themes described by software engineering leaders who had at least two years of leadership experience in the information technology field and resided in the United States. The summary of the findings presented below is organized by research question and the themes within each research question.

Research Question 1

How do software engineering leaders describe the utilization of technical skills in their leadership positions? The findings from the data revealed two themes:

- Theme 1: Technical background can be utilized without involvement in technical details.
- Theme 2: Technical background can be utilized to solve problems and provide technical direction.

Software engineering leaders described how they utilized their background in technology and software engineering as a basis for leading within their organizations. The software engineering leaders noted the importance of understanding the technical aspects of software engineering but emphasized that they utilized it to manage the organization instead of being directly involved in the details of producing technical outputs. Software engineering leaders discussed how they leveragd their technical base to mentor and coach their teams but did not need to be the technical expert on the team. In addition to using their technical base to guide their teams, software engineering leaders described how their technical base was important for building relationships within the organization. The software engineering leaders felt their technical base gave them credibility with others in the organization, which established trust and respect. For instance, one leader described the ability to translate technical information to wording that non-technical people could understand as a key skill that stemmed from having a strong technical base.

The software engineering leaders discussed how their technical skills changed as they moved from individual contributor roles to leadership roles. The leaders described how they moved away from the technical details as they transitioned into leadership positions. Some leaders noted how their technical expertise got in their way as a leader because they still wanted to be involved in the details and solve the problems for their teams. Thus, instead of having the detailed technical skills to perform software engineering tasks, the leaders indicated it was more important to move away from the technical details and transition to a skill set more involved with enabling and supporting their teams. Software engineering leaders described their reliance on subject matter experts within the team to help understand how things work instead of figuring it out themselves.

Leaders also cautioned about the risks involved in staying in the technical details when moving into leadership roles, such as not focusing on building other leadership skills. One leader suggested delegation as an important skill to help transition out of the technical details and move into a leadership role. In general, while the software engineering leaders enjoyed the technical aspects of software engineering, they realized the importance of getting out of the technical details and focusing on using their technical base to help lead the organization.

The software engineering leaders identified guiding and coordinating as key skills to help drive the technical direction. Facilitation skills were discussed from various angles by the engineering leaders as a way to guide the organization. For example, one leader described the ability to help team members focus on solving the problem to get away from analysis paralysis. By helping the team get beyond identifying the problem, the leader can help team members generate possible solutions.

In addition to guiding and coordinating skills within their teams, leaders discussed using facilitation skills to help drive technical direction across teams and throughout the organization. For instance, taking a more hands-off approach by gathering the people who have the expertise and allowing them to solve problems. The ability to identify the right people to solve the problem was discussed numerous times throughout the in-depth interviews.

While the software engineering leaders agreed that helping drive technical direction was an important skill, this skill was used differently at different levels within the organization. For example, middle-level engineering leaders were more focused on driving technical direction within their teams or with another team, compared to senior-level engineering leaders who drove technical direction across the whole organization. While software engineering leaders drove the technical direction from different perspectives, based on their roles within the organization, these skills were always an important part of their jobs as leaders.

Software engineering leaders used a variety of problem-solving skills based on their level of leadership. Senior-level software engineering leaders' problem-solving skills were based on seeing patterns across the organization, whereas middle-level software engineering leaders worked directly with their teams to help resolve problems. The software engineering leaders described how problem-solving skills consist of the ability to ask the right questions based on their technical background. Software engineering leaders described how they asked open-ended questions to help their teams think through all the implications of a potential technical solution.

Being able to understand the problem from a business perspective and solve it from a software engineering perspective was a key skill identified by the software engineering leaders. This skill connects technical and conceptual skills and corresponds to Katz's (1955) theory that technical and conceptual skills can stand alone but are also interrelated. The software engineering leaders agreed that the ability for a leader to have enough technical background to help drive problem resolution and communicate the problem was a critical skill.

To summarize the answer to research question one regarding software engineering leaders' utilization of technical skills, leaders felt that having a technical background was important to help drive technical direction and problem-solving. It is also valuable to note that while technical background was important, staying out of the day-to-day application of technical details was also important. The software engineering leaders noted how a technical background gave them credibility and can be used with skills such as guiding, coordinating, problem-solving, and communication to help connect business problems to technical solutions. Thus, it is important for upcoming software engineering leaders to utilize their technical background, but understand they no longer need to be the technical expert. Upcoming software engineering leaders need to maintain their technical skills and also consider honing their human and conceptual skills to be capable of driving a business in the right technical direction.

Research Question 2

How do software engineering leaders describe the utilization of human skills in their leadership positions? The findings revealed two themes:

- Theme 3: Emotional intelligence skills are utilized to manage social awareness, self-awareness, and self-management.
- Theme 4: Relationship management skills are utilized for effective communication and interaction with others.

The first theme is focused on the concept of emotional intelligence. Although none of the participants in the research study explicitly used the words emotional intelligence, the explanations and examples they used to describe their utilization of human skills fit into the concepts of emotional intelligence as described by Goleman (2000). The second theme, which focused on relationship management, was seen across the responses in all three areas of skills, technical, human, and conceptual.

When discussing human skills with the participants, numerous skills surfaced that related to self-awareness. Goleman (2000) described self-awareness as the ability to understand your own emotions and how they impact others. The software engineering leaders highlighted skills such as knowing yourself, being aware when you are wrong, and being true to yourself. Participants pointed out how challenging it was to reflect on your own words and actions, but indicated it was important because no one wants to work with a "brilliant jerk." Having the ability to be self-aware when you are in the wrong and be true to yourself ties closely with the concept of human skills. Katz (1955) touched on the skill as self-

awareness when describing how leaders need to be sensitive to the emotions of others within the organization and be your true self on a daily basis.

In addition to the skill of self-awareness, the skill of self-management, the ability to control emotions, emerged from the data in this study when discussing the utilization of human skills. The ability to listen, stay in the moment, control frustrations, and maintaining self-control to be calm, cool, and collected during stressful situations, were key findings when discussing human skills. All the software engineering leaders who participated in the study said that self-control was important, but many indicated it was a hard skill to master. The software engineering leaders described situations where they needed to stay calm, cool, and collected when dealing with stressful situations. Participants noted how the lack of self-control can lead to losing relationships within the organization and can create a perception of poor leadership ability, but the overuse of self-control can be detrimental to leadership. For example, if software engineering leaders hold back emotions, they may not have an impact on the team. Participants described this as being monochromatic, which can be seen as not being engaged, not caring, or not being passionate about the work to be accomplished. Goleman (2000) discussed the value of self-control to manage disruptive emotions but noted that overuse of this skill can show lack of passion. The software engineering leaders in this study agreed with this concept and were quick to note that there is a fine line between using self-control and appearing to be disengaged or disinterested. The engineering leaders described maintaining the subtle balance of self-control as a key skill.

The software engineering leaders discussed social awareness as an important human skill. Goleman (2000) noted that social awareness was not about just being friendly; it was about using a friendly demeanor to get work completed to meet the goals of the organization. The skills that emerged from the data included the ability to be persuasive, have empathy, have influence, understand how to navigate politics, understand people by reading the room, and interpreting personalities.

Participants described the importance of having empathy for others in relation to social awareness because it is hard to understand the reactions of others unless you can put yourself in their shoes. The software engineering leaders discussed how empathy with customers, employees, and peers was an important skill to master to understand how to work with people. During the interviews, discussions about having empathy led to discussions about the ability to understand people. The software engineering leaders described how they gained empathy by reading people's body language, listening, and reading reactions. Some software engineers commented that they did not put much effort into understanding people until they moved into leadership positions. The software engineering leaders discussed how most of their focus was on the technical aspects of the job when they were individual contributors and wished they had been given more training on social aspects before being moved into leadership positions.

The last skill in the context of social awareness was the ability to navigate politics within the organization. Many of the software engineering leaders described the challenge of learning to navigate politics and indicated they spend a lot of time improving this skill. Thus, an important outcome of the research was the need to train upcoming software engineering leaders in social skills before moving into leadership roles and then provide on-going training to continue improving these skills.

Participants discussed the importance of interaction, communication, and relationship building in a software engineering leadership role. Goleman et al. (2013) noted the importance of the ability to manage relationships yet indicated that many leaders do not have this skill. Relationship management consists of the ability to interact with others and build personal bonds (Goleman et al., 2013).

The concept of relationship management surfaced in every aspect of the research in this study. For example, when discussing technical skills, software engineering leaders described using their technical base to build relationships within their teams. Relationship management was also prevalent in the discussion of conceptual skills when describing critical thinking skills and working with people across the organization. During the human skills portion of the interviews, relationship management was a culmination of the ability to interact with others, implement strong communication skills, and build relationships.

The software engineering leaders within this study discussed the value of relationship building, not only within their teams but across the organization. Having the ability to build relationships was a key component when describing how work gets done. The software engineering leaders stressed the importance of building relationships within the team to understand what motivates employees, build relationships with peers to gain buy-in and exchange work efforts, and build relationships with stakeholders to manage priorities and deliver results.

In addition to building relationships, having strong communication skills was identified as an important skill utilized by the software engineering leaders in this study. Similar to the ability to build relationships, software engineering leaders need to communicate with others who are within their teams, their peers, their stakeholders, and their managers. The need for software engineering leaders to have strong communication skills is not a new discovery. No matter which area of skills was being discussed (technical, human, or conceptual) the ability to communicate continued to surface within the interview responses as critical to achieving success as a software engineering leader.

The last area of focus regarding relationship management that surfaced in the study was the ability to interact with others. There was some overlap with communication skills here, but some additional skills emerged from the data. Software engineering leaders discussed the utilization of conflict resolution skills, not only within their teams but with other teams within the organization. The software engineering leaders noted how conflict resolution skills were paired with other skills such as empathy, understanding personalities, and listening skills.

One additional key concept was collaboration skills. Numerous software engineering leaders identified collaboration as one of the most important skills utilized by software engineering leaders. Participants explained that collaboration helped when setting expectations and staying on the same page with everyone in the organization. Software engineering leaders at every career level (managers to vice presidents) described the importance of partnering with others, especially when there are numerous teams working with different software applications.

Collaboration has also become an important skill in software engineering leadership due to the global economy. Cetindamar et al. (2016) touched on the importance of collaboration, especially in the global business world, where teams must learn to coordinate work across cultures. The findings in this study built on that idea as software engineering leaders described the importance of gaining knowledge from people with a variety of backgrounds and people of different genders, races, and ages.

Overall, the utilization of human skills became a very in-depth and significant focal point in the findings within this study. While Katz (1955) indicated that human skills were valuable for all levels of management, this study took it one step further by making the connection with Goleman's (2000) concepts of emotional intelligence and relationship management (Goleman et al., 2013). Human skills were discussed at length during the specific questions related to human skills, but the mention of human skills also permeated the responses in technical and conceptual skills. Thus, human skills emerged as the most important skills utilized by engineering leaders.

Research Question 3

How do software engineering leaders describe the utilization of conceptual skills in their leadership positions? The findings revealed two themes:

- Theme 5: Seeing the big picture based on strategic and critical thinking skills can be utilized to solve problems and drive direction.
- Theme 6: Innovation can be encouraged through the ability to create fortuitous interactions and understand the business.

Software engineering leaders recognized the importance of driving the direction of the organization. Katz (1955) described the importance of leaders having conceptual skills, such as the ability to understand where the organization needs to go and then guiding the team to get there. This concept could be seen in the responses from interview participants such as continuously looking across the organization to improve efficiencies and having the ability to anticipate where the organization needs to go to continue to be successful.

A key finding from the interviews was the perception by many of the software engineering leaders that strategic thinking skills are challenging for people who transition into software engineering leadership positions. An example of this would be getting too involved in the day-to-day tasks for deliverables instead of looking forward to what needs to be done in the future. The software engineering leaders in top management roles, such as Vice Presidents, were much more aware of the value of this skill, which aligns with Katz's (1955) claim that conceptual skills were more prevalent in high-level managerial roles.

Two key findings surfaced from the discussions about encouraging innovation. The first finding was related to the importance of balancing innovation with the needs of the business. In other words, not innovating only for innovation's sake. Instead, engineering leaders discussed the importance of guiding teams to innovate but ground innovations in reality, to improve the organization. Katz (1955) did not discuss innovation in his initial research on conceptual skills. More recently, innovation has been a

consideration because the concept of innovation has gained momentum with the rise of information technology (Silva & Di Serio, 2016).

The second key finding was the idea of creating fortuitous interactions. The idea behind this skill set is to think about how to get people in the organization to interact with each other on a regular basis. Participants described the value of creating fortuitous interactions (providing opportunities for interactions to occur by chance rather than being planned), because it creates an environment where people can freely share ideas and are more aware of projects that are being worked on within the organization. In addition to creating fortuitous interactions, participants indicated the importance of understanding how the business works, such as the way a company makes money and spends money, as key to having influence as a software engineering leader.

When looking holistically across the whole study, the participants indicated that human skills were the most important skills needed in software engineering leadership. While technical skills were considered important, they were seen as more of a foundation for software engineering leadership. Similarly, conceptual skills were seen as valuable, but not used as much as human skills. Human skills, including emotional intelligence and relationship management, emerged as the key skills needed in software engineering leadership. Many of the participants indicated the technical skills came easy to them, yet the human skills were harder to grasp and implement when moving into software engineering leadership positions.

While some of the skills identified in this study reiterated the results found in other studies (Kalliamvakou et al., 2017; Rottmann et al., 2015, 2016), new ideas emerged on the skills needed for software engineering leadership. For example, the aspects of emotional intelligence (social awareness, self-awareness, self-management, and relationship management) were a key finding in this study that added to the body of knowledge in engineering leadership. In addition, the study supported the updated ideas from Katz (2009) that leaders need to have some aspect of technical, human, and conceptual skills at all levels of leadership. The findings of this study showed that engineering leaders felt all three skills (technical, human, and conceptual) contributed to their success as software engineering leaders. The key takeaway was understanding how to utilize these skills when transitioning from an individual contributor role to a software engineering leader position.

CONCLUSIONS AND RECOMMENDATIONS

The researcher conducted the Northouse Skills Inventory Survey (Northouse, 2018) and interviews with software engineering leaders who had numerous responsibilities in their daily jobs. Boyatzis et al. (2017) noted a limitation in the study of engineers due to time-sensitive demands within organizations. To address this potential limitation, the researcher proactively set time expectations for participants in both the survey and interviews.

The researcher had prior connections with some of the study participants based on the fact that the researcher was in the information technology field. Due to the connection with some of the participants, the researcher refrained from potential bias and maintained objectivity when analyzing the results of the study. To reduce bias, the researcher removed demographic information and participant names prior to starting the coding process. Thus, the coding was done without any knowledge of who provided the data. To reassure participants, the researcher reiterated the autonomy and confidentiality of the study.

Future Research

Based on the outcome of this study, future research could include conducting a qualitative research study with engineering leaders that is only focused on emotional intelligence and relationship management based on theories from Goleman (2000) and Goleman et al. (2013). Researchers could consider a quantitative research study with either upcoming or existing engineering leaders to determine their level of emotional intelligence before and after training on human skills. Other areas of research could include further investigation of communication skills, differences in skills utilized by lower-level managers (such as supervisors with less than two years of experience), and the perceptions of software engineering leaders who did not rise through the technical ranks within software engineering. A future study to investigate the skills utilized by leaders from other disciplines within information technology such as Operations, Program Management, Project Management, Quality Assurance, and Technical Support may also prove valuable to continue the conversation on software engineering leadership.

Implications

The theoretical implications based on the findings of this study were more in alignment with Katz's (2009) updates to his three-skills leadership theory than his original work (Katz, 1955). In addition to supporting Katz (2009), this study added to the concept of the three skills for effective leadership by specifying the optimal level of technical skills to be utilized by software engineering leaders, making a connection to emotional intelligence (Goleman, 2000), making a connection to relationship management (Goleman et al., 2013), and indicating how conceptual skills were the least utilized skills by software engineering leaders. The findings within this study added to the body of knowledge on engineering leadership through the lens of Katz's (1955, 2009) three skills models by uncovering additional findings that can be applied to the ongoing discussion about engineering leadership.

The practical implications based on the findings of this study can help organizations develop upcoming software engineering leaders by using the information to improve leadership training for upcoming and existing software engineering leaders. The following is a list of skills to consider when developing leadership programs for software engineering leaders based on the findings from this study:

1. Technical skills. As people move from individual contributor roles to leadership roles, it is important to understand how to move away from personally handling all the technical details by teaching facilitation and delegation skills.
2. Human skills. Conducting courses on emotional intelligence may assist existing and upcoming software engineering leaders in learning to work on self-awareness, self-management, social awareness, and relationship management skills.
3. Conceptual skills. Increase awareness of the value of seeing the big picture and asking the right questions when solving problems. More specifically, this could be done by increasing connectivity to the rest of the organization by improving software engineering leaders' understanding of business functions within organizations.

Recommendations

As software engineers transition from individual contributor roles to leadership roles, they have a technical base in software engineering, but may struggle to transition away from the technical details and move into a broader leadership position. It is important for software engineering leaders to find the balance between keeping up with technology trends and moving away from technical details. Training on skills such as facilitation and delegation may help upcoming engineering leaders understand their new role and gain a perspective on the level of technical detail needed in a software engineering leadership position.

Software engineering leaders noted how it was important to help the team solve problems and to provide technical direction in a software engineering leadership position. This involved the ability to ask the right questions, getting the right people in the room, and being able to understand the business impact of technical decisions. While some of these skills may be learned on the job, they could be enhanced or accelerated by providing specific training classes focused on business acumen. In other words, learning how the business functions, understanding business terminology and understanding how all the systems relate within the organization may help software engineering leaders with problem-solving and driving technical direction.

In addition to teaching software engineering leaders about the right level of technical skills, there needs to be a focus on teaching human skills, such as emotional intelligence. Based on the in-depth responses in the interviews in this study, skills such as self-awareness, self-management, and social awareness, surfaced as key skills needed in software engineering leadership. Training on emotional intelligence skills and subsequent application of these skills can be valuable in improving the overall skills of software engineering leaders.

Relationship management skills also surfaced as a key skill that software engineering leaders used in conjunction with everything they did on a daily basis. For example, relationship management was used with the software engineering leader's technical base to build relationships within their teams. Software engineering leaders also mentioned relationship management as important to build relationships across the organization with peers and stakeholders using communication and collaboration skills. Training on how to improve these skills would be valuable for upcoming and existing software engineering

leaders. Based on the results of the study, establishing coaches or mentors may be beneficial for application of relationship management skills on a daily basis.

Similar to utilizing a technical base to help drive the team in problem-solving, the results of this study indicated the use of critical skills and strategic thinking were a key part of software engineering leadership. The software engineering leaders in high-level leadership positions were more in-tuned to the value of this skill. They specified the value of looking forward instead of being in the day-to-day details. The software engineering leaders also indicated the importance of seeing across the whole organization to better understand the ripple effect of changes made within one area. Similar to the skills identified above, this skill could be learned from time spent on the job but could also be accelerated by providing software engineering leaders an overview of the organization and the connection between systems.

The final area of focus within this study was looking at how innovation can be encouraged within the organization by engineering leaders. Silva and Di Serio (2016) indicated the importance of innovation to improve competitive advantage within an organization. Thus, it is important to consider how innovation can be successfully factored into the demands within software engineering. Software engineering leaders described how they balance the needs of the business with the ability to be innovative. Software engineering leaders indicated they encourage innovation, but within the context of solving business problems. The other key finding that surfaced in regard to innovation was the ability to create fortuitous interactions. In other words, creating situations where people come together by chance instead of planned or formal meetings. Training software engineering leaders on ways they can encourage innovation while still balancing the needs of the business could go a long way in creating a competitive advantage in an organization. In addition, helping software engineering leaders understand how to create fortuitous interactions may lead to improved communication and collaboration across the organization.

Conclusions

There are many aspects to the skills needed in software engineering leadership. While software engineering leaders may have a strong technical background based on formal training or hands on application, they do not always get the same level of skills training in human and conceptual skills. Improving human skills such as emotional intelligence and relationship management were identified by the software engineering leaders in this study as key skills for software engineering leadership within the information technology field. This ties back to the theoretical foundation from the Katz's (1955, 2009) three skills model for leadership, and expands upon engineering leadership based on real-world perceptions from software engineering leaders.

In addition to improving human skills, this study uncovered that conceptual skills were not utilized as much by software engineering leaders, but still deemed important, especially when moving into higher-level software engineering leadership positions. Thus, additional focus on developing critical thinking, strategic thinking, encouraging innovation, and understanding business acumen could be valuable skills for software engineering leaders. Software engineering leaders play a key role in organizations, as seen in the results of this study, be being in a central position within the organization to drive technical results and achieve organizational objectives. Therefore, it is valuable to continuously improve software engineering leadership skills within organizations.

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